33d CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. No. 91.

U.S.

# REPORTS

OF

# EXPLORATIONS AND SURVEYS,

TO

## ASCERTAIN THE MOST PRACTICABLE AND ECONOMICAL ROUTE FOR A RAILROAD

FROM THE

# MISSISSIPPI RIVER TO THE PACIFIC OCEAN.

MADE UNDER THE DIRECTION OF THE SECRETARY OF WAR, IN

# 1853-4,

ACCORDING TO ACTS OF CONGRESS OF MARCH 3, 1853, MAY 31, 1854, AND AUGUST 5, 1854.

## VOLUME III.

Mo. Bot. Garden
1909

WASHINGTON:
A. O. P. NICHOLSON, PRINTER.
1856.

IN THE HOUSE OF REPRESENTATIVES—FEBRUARY 14, 1855.

*Resolved*, That there be printed, for the use of the House, ten thousand copies of the reports of surveys for a railroad to the Pacific, made under the direction of the Secretary of War, embracing the report of F. W. Lander, civil engineer, of a survey of a railroad route from Puget's Sound, by Fort Hall and the Great Salt lake, to the Mississippi river; and the report of J. C. Frémont, of a route for a railroad from the head-waters of the Arkansas river into the State of California; together with the maps and plates accompanying each of said reports necessary to illustrate them.

Attest:

J. W. FORNEY,

*Clerk of the House of Representatives of the United States.*

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THIRTY-SECOND CONGRESS, SECOND SESSION—CHAPTER 98.

SECT. 10. *And be it further enacted*, That the Secretary of War be, and he is hereby authorized, under the direction of the President of the United States, to employ such portion of the Corps of Topographical Engineers, and such other persons as he may deem necessary, to make such explorations and surveys as he may deem advisable, to ascertain the most practicable and economical route for a railroad from the Mississippi river to the Pacific ocean, and that the sum of one hundred and fifty thousand dollars, or so much thereof as may be necessary, be, and the same is hereby, appropriated out of any money in the treasury not otherwise appropriated, to defray the expense of such explorations and surveys.

Approved March 3, 1853.

THIRTY-THIRD CONGRESS, FIRST SESSION—CHAPTER 60.

Appropriation: For deficiencies for the railroad surveys between the Mississippi river and the Pacific ocean, forty thousand dollars.

Approved May 31, 1854.

THIRTY-THIRD CONGRESS, FIRST SESSION—CHAPTER 267.

Appropriation: For continuing the explorations and surveys to ascertain the best route for a railway to the Pacific, and for completing the reports of surveys already made, the sum of one hundred and fifty thousand dollars.

Approved August 5, 1854.

# CONTENTS OF VOLUME III.

EXTRACTS FROM THE [PRELIMINARY] REPORT OF LIEUTENANT A. W. WHIPPLE, CORPS OF TOPOGRAPHICAL ENGINEERS, UPON THE ROUTE NEAR THE THIRTY-FIFTH PARALLEL, WITH AN EXPLANATORY NOTE BY CAPTAIN A. A. HUMPHREYS, CORPS OF TOPOGRAPHICAL ENGINEERS.

PARTS **I--IV** OF THE REPORT OF LIEUTENANT A. W. WHIPPLE, CORPS OF TOPOGRAPHICAL ENGINEERS, UPON THE ROUTE NEAR THE THIRTY-FIFTH PARALLEL.

# EXPLANATORY NOTE.

The reports of the Secretary of War and the revising officer, which appear in volume one, were founded, so far as they relate to the route near the 35th parallel, upon the preliminary report of Lieutenant Whipple. The following chapters, being those which are principally referred to in those revisory reports, are, therefore, republished. They are chapters two, three, four, five, and eleven, with a portion of appendix B. The preliminary profiles are also reprinted.

A. A. HUMPHREYS,
*Captain Topographical Engineers.*
*In charge of office of Pacific R. R. Explorations and Surveys.*

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*Extracts from the [preliminary] report of Explorations for a Railway route, near the thirty-fifth parallel of north latitude, from the Mississippi river to the Pacific ocean, by Lieutenant A. W. Whipple, Corps of Topographical Engineers.*

## CHAPTER II.

CONSIDERATIONS REGARDING THE TERMINI OF THE RAILROAD.—EXPLANATION OF THE MAPS.

Three of the principal centres of trade upon the Mississippi river are St. Louis, Memphis, and Vicksburg. To these cities converge railroads, constructed or proposed, from harbors upon the northern lakes, from the principal ports upon the Atlantic shore, and from those upon the Gulf of Mexico, uniting the interests of the northern, middle, and southern States. From the above mentioned places railroads have been projected, and several are in process of construction, westward to the extreme limits of the States of Louisiana, Arkansas, and Missouri, each with a purpose of forming a link in the great chain of communication which must ultimately lead to the Pacific ocean.

The question immediately arises, which of the various routes shall be at first prolonged; or, can there be found a location for a main trunk that may be advantageously united with several of these branches, affording nearly equal facilities to interests so widely diffused? Nature seems to point out such an intermediate location near the parallel of thirty-five degrees north latitude, referred to in the preceeding instructions.

Following the south bank of the Canadian river for nearly one-third of the whole distance to the Pacific, we pass into the valley of Rio Grande del Norte, near the centre of New Mexico, where the soil is the most fertile, the population is the most numerous, and the mines are the most productive of any part of this interior portion of our possessions.

From Vicksburg to Shreveport the course of the railroad—already under construction—is nearly west. Should it be continued, as has been contemplated, to Preston, on Red river, the tendency will be considerably north of west. If prolonged, it would naturally ascend the fertile valley of the False Washita to a junction with the main branch from Fort Smith, which, in

accordance with our survey, may follow that stream for many miles, to its source near the south bank of the Canadian. A reference to Captain Marcy's map of the survey of Red river and its branches, seems satisfactory evidence of the feasibility of such a connexion. Not only is the deviation from a direct line quite inconsiderable, but as neither hills nor cañons intervene, gradients will be favorable without expensive excavations or embankments.

In the report of the same officer we find additional advantages in favor of the route, with regard to the excellence of the soil upon and near the region to be traversed. He states that "the lands included within the Choctaw reservation which are not occupied or made use of by them are embraced between the 97th and 100th degree of west longitude, and are bounded on the north and south by the Canadian and Red rivers, being about one hundred and eighty miles in length by fifty miles in width; and constituting an aggregate of about nine thousand square miles of valuable and productive lands, or one thousand square miles more than the State of Massachusetts." This section includes the whole valley of the False Washita, which we propose the railway from Preston should traverse.

Various portions of this country are more specifically described. Captain Marcy speaks of "charming landscapes; of soil remarkable for fertility; vegetation in old Indian corn-fields twelve feet high; of beautiful springs and streams; of natural meadows clothed with luxuriant grasses; broad and level bottom-lands covered with dense crops of wild rice, and of excellent timber, large and abundant." He adds: "Indeed, I have never visited any country that, in my opinion, possessed greater natural local advantages for agriculture than this." The kinds of timber he mentions are "gigantic pecan, overcup, white-ash, river elm, hackberry, and post-oak."

A more favorable location for a railway than that described could scarcely be desired. The distance by this line to Albuquerque, as measured upon Captain Marcy's map, is from twelve to fifteen miles less than from the same point to Doña Ana by the southern trail.

Two routes leave the Mississippi river at St. Louis: one, recently opened, proceeds nearly west to Independence; the other, now in process of construction, leads southwest, through Springfield, to the Neosho, and, if prolonged, would intersect the Memphis middle branch upon the Canadian, not far from the headwaters of the False Washita. Every indication presented upon our route, and the well-known geological character of the intervening country, led to the belief of the practicability of such a line. Bridging the Arkansas and Canadian rivers might be difficult, although, doubtless, points can be found where bluffs converging to the river would greatly facilitate such an operation.

The branch from St Louis to Independence would join the main trunk upon Rio Galisteo. Upon this line we have abundant information—the reconnaissance of Major Emory, with a profile through the Raton mountains, and the survey of Lieutenants Abert and Peck, with a profile by Dr. Wislizenus, of the Cimarron route to Santa Fé. A copy of this latter profile will accompany the map, and show the availability of that route to unite with our own upon a branch of the Galisteo river. With reference to this route, Lieutenant Abert, who traversed it in 1845, says: "I find the maximum grade to be eighty-five and six-tenths feet per mile. It occurs between Cold Spring and Cedar Creek. * * * There are no difficult places to bridge, but water and wood are extremely scarce." * * * Lieutenant Peck, who accompanied Lieutenant Abert, refers to this route as follows: "With reference to the railroad, I am inclined to think that a route to Galisteo can be found in the general direction of the Santa Fé trail, which will be more favorable than that by the Canadian. By keeping to the north, so as to cross the Cimarron plains and come upon the head of the Canadian at the north end of the Great Cañon, the ground will be more favorable, as it is less cut up by cañons than it is where the Canadian escapes from the high table further south. Building material—that is, in the way of timber—would be scarce on the northern route from about Cotton Wood Fork to the very entrance into New Mexico. The rapid falling off of the country from Santa Fé to San Felipe must have struck you; and it has undoubtedly been suggested to you, that a road once brought as far as Galisteo ought to keep as far to the north as possible, crossing the Rio Grande near San Domingo.

From this place it might rise gradually along the face of the bluff behind San Felipe, and so around the point of bluff to the village of Santa Anna; from which place a good route exists, entering the valley of Cibolleta from the northeast, and then emerging from the Cibolleta valley about five miles below Laguna. This route would save descending and again ascending several hundred feet, that would be necesssary were the road to pass though Albuquerque."

The various explorations above referred to, in connexion with our own, show a generally uniform slope, embracing the area in question, from the eastern base of the Rocky Mountains to the river Mississippi. Over such a country several different routes for a railway, doubtless, with greater or less facility, might be selected. It would have been interesting to have prolonged these various routes to a common intersection; but to attempt it would be to hazard the completion of the main duties with which we were charged. Contenting ourselves, therefore, with such information as might be gained from extraneous sources, we hastened to Fort Smith, the most western point, near the parallel of 35° north latitude, then accessible by steam navigation.

Upon the Pacific coast San Francisco possesses all those advantages upon which a great commercial emporium depends. Its position is central with respect to our possessions there, and it possesses a harbor of unrivalled magnificence, lying at the confluence of the Sacramento and San Joaquin rivers, which drain great valleys of unsurpassed fertility. These streams are navigable, and the banks are lined with excellent timber. Dense forests cover hills and mountains; mines of gold and quicksilver yield unprecedent returns; and, to crown all, the climate is mild and salubrious during every season of the year. Such are some of the superior advantages which seem to render imperative the termination of the great Pacific railway at the port of San Francisco.

Should local interests secure the construction of the main road direct to a frontier harbor—San Diego or Puget's Sound—or to other smaller ports, trade could scarcely be forced from its natural channel. By a branch through the Sacramento valley, northeast, or by the San Joaquin river and Tulare lake, southwest, a junction would probably be formed with the main railway, in order to obtain the great desideratum of an uninterrupted communication throughout. Commerce demands that this communication should be obtained by the shortest available route. Northeast and east from San Francisco, the Sierra Nevada forms an impassable barrier. Nearly all the known passes are concentrated near the latitude of 35°, where the interference of the coast range with Sierra Nevada has produced a succession of low broken ridges, with valleys between. Here was to be sought the gate to San Francisco, and an opening for the trade of the Pacific waters. Upon the same parallel west of the Mississippi, is a union of interests from eastern States. It was our duty to unite these points, and ascertain whether a route known to possess so many substantial advantages might not prove favorable throughout.

The accompanying maps, profiles, and tables, are designed to condense, as well as possible, all the facts developed by the exploration; or at least those having a intimate connexion with the question of a railway. The full red line marks the trace of our wagons, to one of which a viameter was attached for measuring the distances traversed, accompanied by the surveying party observing courses and altitudes. The profile No. 1 gives a section upon this line. In such hasty operations it was not expected that such a profile would, in all cases, be shown favorable for a railway. To have attempted to wind around the hill-slopes, where a track should be laid, would have occupied much more time than we had at our disposal. But in order to correct the actual profile to that which the contour of the ground showed to be practicable, topographical notes and sketches were carefully made, and the concluding results are shown in profile No. 2. The dotted red lines indicate trails of reconnoitering parties. Blue lines coincide nearly with section No. 2. Dotted blue lines represent the general direction of routes which, from indications, are supposed to be more favorable than those traversed. It would be desirable to examine them more closely.

As detailed information is given upon the profiles regarding the gradients required, I pro-

pose, in this hasty portion of my report, to give merely a brief sketch of our explorations, confining myself quite strictly to matter relating to the project for a railway.

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# CHAPTER III.

GENERAL DESCR PTION OF THE ROUTE TRAVERSED FROM THE MISSISSIPPI RIVER TO THE RIO DEL NORTE.—ADVANTAGES AFFORDED BY NEW MEXICO

Our barometric observations were commenced at Napoleon, which, situated at the junction of the Arkansas river with the Mississippi, is but slightly elevated above high-water mark. The observations, properly reduced, give for the height of this place eighty-two feet above mean tide of the Gulf of Mexico. The river Arkansas presents low banks and forests of timber, densely matted with vines. An unvarying evenness of surface extends ninety-eight miles to Pine Bluff. This is a town of some importance, pleasantly situated upon a plateau, about ten feet above the previous level of the river's bank. This plateau extends several miles, and, bearing pines, exhibits a soil more porous and less luxuriant in vegetation than the lower bottoms; hence, doubtless, a more healthy location. Twenty miles beyond appeared another ridge, somewhat higher than the last, covered with plantations. Passing this, we returned to low banks, with moss-covered trees and tangled vines, with here and there a venturesome plantation creating a pleasant break in the monotonous wilderness.

The beauty of Little Rock, one hundred and forty-eight miles by land from Napoleon, created an agreeable surprise. Situated fifty feet above the river, upon the first swell of a metamorphic ridge that extends southwest beyond the limits of the State, its location is at once picturesque, and free from the pestilential vapors that infest the low lands. The town itself is laid out with charming taste, nearly every house occupying a square, ornamented with shade trees, shrubbery, and flowers. By observation the height of Little Rock was found to be three hundred and ten feet above the sea. Supposing Memphis ninety-six feet above tide-water, the difference of level between it and Little Rock is two hundred and fourteen feet, and the distance one hundred and fifty-five miles, giving an average grade of 1.4 foot per mile. From information that seems reliable, it appears that from the point opposite Memphis to the river St. Francis, thirty-nine miles, is an extensive marsh, subject to annual overflow. The present travelled road is said to be raised from ten to fifteen feet above the general level of the country. For a railway, therefore, this portion of the route would require an expensive embankment. Thence to Little Rock, one hundred and sixteen miles, a slightly undulating prairie presents a favorable location for a railway.

Above Little Rock we find the banks still luxuriant in vegetation, and finely timbered. Leaving the granite ridge, we enter the lower carboniferous formation, soon passing into coal measures, where at numerous places veins of coal of excellent quality crop out. Few villages or plantations occupy the immediate banks of the river. Healthier locations are found upon high lands a few miles inland.

The "La Fourche" and "Petit Jean" are the first mountain ranges that impinge upon the river. These are said to extend southwest twenty or thirty miles, where they slope into a plain. There, it is supposed, the railroad from Little Rock to Fort Smith will pass without obstruction, and nearly in a straight line. The "Petit Jean" is said to be nine hundred and fifty feet high.

Passing the Dardanelle Rock, a precipice apparently one hundred and fifty feet high, we proceed along banks still covered with forests of cotton wood, with pines upon the hill-tops. The Magazin, a finely timbered mountain, eleven hundred feet in height, approaches within three or four miles of the river.

In the vicinity of Piney river—so called from its abundant supply of pine timber—coal is

said to be very abundant. It is bituminous, but less soft than that furnished by the eastern markets. It burns with a clear flame, without smoke, and with little residuum. Cropping out in veins, it is easily obtained, and is generally used in blacksmiths' shops, in grates, and in steamboats of this region. Van Buren we found a flourishing village, with evidences of wealth, enterprise, and prosperity. It is the centre of trade for an extensive agricultural district. Being situated at the foot of a hill on the river's left bank, it has once or twice been flooded by extraordinary freshets of the river. These freshets have previously occurred once in about ten years. The worst was in 1833, when nearly all the bottom-lands of the river were submerged. The last, in 1844, was less extensive. It is to be hoped that floods will not again occur, as fear of the devastation they produce is doubtless one cause of the scarcity of plantations upon the soil of this fertile valley.

The site for Fort Smith, five miles above, was selected in 1817 by Colonel Long, and called Belle Point. It occupies an elevated point of land immediately below the junction of the Poteau, a small tributary from the southwest, with the Arkansas. The hill which forms the basis of the fort, is of a dark gray micaceous sandstone, in horizontal laminae, and rises about thirty feet above the water. The country back of the fort has an undulating surface, gradually ascending as it recedes, and is covered with heavy forests of oak, tulip tree, sassafras, &c. Towards the south, from thirty to forty miles distant, rise to the height of two thousand feet, summits of the Point Sucré and Cavaniol mountains, which stand on opposite sides of a branch of Poteau river. The spot proving in every respect a favorable one, under protection of the military, there sprang into existence a town, now grown to a flourishing city. Observations place it four hundred and sixty feet above the level of the sea. Supposing the distance from Little Rock to be one hundred and sixty miles by land, the elevation one hundred and fifty feet, will give a grade less than one foot to the mile. Should the high lands intervening offer as few obstacles as supposed, the railway to this point may be constructed at moderate expense. Such a road, even should it proceed no further, would be of incalculable advantage to the State.

The mineral resources of Arkansas are worthy of consideration. Lead, copper, silver, and iron ore, are said to be abundant. The iron mountains near the Missouri line are alone worthy a railroad. Beds of coal are of great extent, cropping out in various places near the river Arkansas. The veins are thick, and easily worked; the quality is excellent, and the mines apparently inexhaustible. Extensive quarries of roofing slate found here, are now supplying the markets of Cincinnati and St. Louis.

Timber, of the best quality for the purposes of a railway, this country furnishes in abundance. Wheat, cotton, and maize, are staple productions of the State. With an outlet for these products, such as a railroad would afford, population would increase, and the virgin soil of Arkansas no longer lie dormant.

Dr. Shumard, geologist and naturalist upon the exploring expedition of Captain Marcy, kindly presented to me his thermometrical observations at Fort Smith, extending for a period of more than a year. These show a climate most favorable to agricultural purposes. For the year ending June 1, 1852, the mean temperature is 65°.47. The mean for August, the warmest month, was 89°.4. The least, 34°.84, is the mean for January. But one storm of snow is recorded during the year; that was two inches, in January. Rain occurred every month; the least in September, October, and January, averaging one and one-third inch each. May appears the rainy season; twelve and one-sixteenth inches having been measured during the month. For the year, the fall recorded is fifty-one and one-fourth inches. There were two hundred and nineteen moist days, eighty-two rainy, and one hundred and twenty-six dry days; twenty not having been noted. The mean temperature of summer is 86°.98; of autumn, 69°.11; of winter, 42°.23; of spring 63°.57. The highest temperature recorded is 104°, in August; the least, 4°, occurred in January. The summer referred to is that on which this place was visited by the scourge of cholera.

Astronomical observations place Fort Smith in 35° 22′ 55″ north latitude; longitude, 94° 21′ west of Greenwich.

Passing the river Poteau with a southwest course, we crossed the low bottom-lands, and proceeded ten miles, to Ring's plantation, our first encampment.

The Poteau flows from the southwest, with a gentle current, averaging probably seventy-five feet in width for several miles, but increasing to four hundred feet near the mouth. Its banks are of a dark shale, indicating the presence of coal. By spirit level the surface of the stream, which may also represent the Arkansas, is found to be * * * feet below camp Wilson, near the fort. Timber and stone are upon the spot, and a single arch of about one hundred feet would span the stream. The country is flat nearly to Ring's house, situated upon the brow of a ridge of gentle hills, which, stretching across from Fort Coffee to the Poteau, bounds the delta included between the rivers near their junction. Upon this plantation wells forty to fifty feet deep furnish excellent water, resting upon a bed of coal.

From Ring's plantation to Choctaw agency—five miles—the road led us over hilly ground, which could have been avoided by inclining towards the banks of either the Arkansas or Poteau. The latter communicates with a narrow prairie extending almost uninterruptedly west to Sans Bois creek, affording, for thirty miles, an excellent trace for a railroad.

Within this distance were several small streams—Camp creek, Coon creek, and Long Pond creek—averaging ten to fifteen feet in width, with water a few inches deep. The Sans Bois, densely wooded, like other streams, may be spanned by a bridge from eighty to one hundred feet in length. Timber and stone are abundant, and a rocky bottom forms a good foundation for the construction of a viaduct.

We ascended the left bank of the Sans Bois, crossing Cooper's creek, fifty feet wide, and several small ravines.

To the south fork of the Canadian we passed a hilly country, where ravines and heights were finely timbered, forming charming groves.

To our left the guide pointed out a prairie, which we should have followed to Gaines' creek, had not the approach to it been too densely wooded; thereby we should have saved some distance, and avoided several bad hills.

The east branch of the south fork of the Canadian, with hard, gravelly bottom, and a good foundation for piers, will require a bridge from seventy-five to one hundred feet span. The banks are high and considerably broken.

Passing onward to Coal creek, which we crossed, forty feet in width, we found the country so rough as to compel us to deviate several miles from the road in search of a more level route for the survey. The creek heads in the range of Shawnee hills, five hundred feet in height, extending from the immediate bank of the Canadian several miles south. By the much-travelled road, the ascent and passage caused nearly the destruction of our wagons. After laborious explorations to the right and left, and by the assistance of a Shawnee guide, we found that by following a more southern branch of Coal creek to its headwaters below the range of hills, we could, by a direct and shorter route, pass the gently swelling divide to the waters of Boggy river. Had we known the route in season, we could have cut out a road to unite with the main trail, where it crosses the first affluent of Red river, in less time than it took us to perform our disastrous march and weary our mules upon the beaten track.

We are now near the termination of the coal measures, and passing to the lower carboniferous formation. Bituminous coal is found cropping out, and in many places are mines of it between Fort Smith and the Shawnee villages; especially on the Sans Bois and Coal creeks. It was used in our blacksmith forges, and found to be of superior quality. There are evidence of an inexhaustible supply for railroad and other purposes.

Besides coal in this formation, we have limestone and sandstone, excellent for the construction of bridges and viaducts. Quicklime is also easily obtained. The whole country traversed from Fort Smith contains a soil exceedingly fertile, and by creeks and rivulets is supplied with

pure and unfailing water. Its fertile prairies are frequently cut into gentle ridges and valleys, like the most favored portion of New England. Timber of superior quality abounds upon the whole of the route. The highlands are chequered with groves of various oaks, while dense forests in the wide bottoms of the streams afford a great variety of excellent timber—ash, oak, white elm, black walnut, and pecan. To a considerable extent, this country is already cultivated by the Choctaws, Chickasaws, Creeks, and Shawnees, that possess it. Their fields of wheat and maize are luxuriant. Potatoes, tobacco, and rice are produced. Cattle, horses, and sheep thrive upon the wild grass prairies that nature has so strangely alternated with forests, adding to the beauty of the landscape and the wants of the Indian farmer.

Fruits, especially peaches, melons, and grapes, grow in profusion. Many fine settlements already exist in this region; that called Little River, on the opposite bank of the Canadian, is particularly flourishing. Having passed the large and beautiful basin fertilized by the branching waters of the river Boggy, which flows through a pleasant valley towards the southwest to unite with Red river, we ascended the ridge which terminates in Delaware mount, and forms the eastern boundary of the great prairies.

The ascent is about sixty feet within the distance of a mile.

Beyond, the face of nature was changed, and the undulating grassy plains appeared as if reposing upon the waves of ocean.

The carboniferous group has now given place to the extensive red sandstone formation, affording continually building material and quicklime. White amorphous gypsum also begins to appear. The soil, however, formed of red clay and argillaceous sandstone, continues fertile and well watered.

Crossing Topofki creek, a small stream with gravel bed, thirty feet wide, and numerous smaller branches flowing towards the Canadian, we arrived at old camp Arbuckle, where now exists a flourishing settlement of Delaware Indians. Here we had hoped to obtain a guide; but the river Canadian being remarkably low, and the season unusually dry, the Indians feared lest we might suffer for want of water, and declined the service.

Leaving the last vestige of semi-civilization, we crossed rolling prairies, which divide the waters of the Canadian from the affluents of Red river, and encamped on a tributary to Walnut creek. Various springs were passed during the day, affording plenty of water, while grass was everywhere abundant.

A few miles northeast from our camp, near the confluence of Walnut creek with the Canadian, is Chouteau's old Indian trading post, where, since the tragic death of the proprietor, Kichai Indians have sought a resting place, to form the connecting link between the quiet Delawares and the murderous wild bands of Kioways and Comanches.

From this point the famous forest of Cross Timbers commences. Captain Marcy remarks that "this extensive belt of woodland, which forms one of the most prominent and anomalous features upon the face of the country, is from five to thirty miles wide, and extends from the Arkansas river in a southwesterly direction to the Brazos, some four hundred miles."

Our route for about sixty miles, following the delightful valleys of Walnut and Deer creeks, skirted the edge of this forest. The timber which it furnishes—post oak and black jack—though small, is exhaustless, and would serve for railroad ties. The wide and fertile bottom lands that line the creeks, however, furnish timber of larger size—oak, elm, black walnut, and hackberry abounding throughout the region.

Bountiful nature has here supplied all the advantages that the agriculturist would require—abundant crystal steams of purest water, luxuriant valleys for cultivation, extensive prairies of nutritious grama for pasturage, and unfailing forests of oak for fuel.

Passing the headwaters of Deer creek, in longitude 98½°, we leave the big north bend of the Canadian to our right, and pursue a course nearly west. Soon, rising upon the swelling

prairies which support the celebrated natural mounds, the scene was changed, and, for the first time, appears, for a day's march, a nearly treeless, barren waste.

Gypsum, which has been occasionally seen since leaving camp No. 29, in the valley of Deer creek, has now become exceedingly abundant. Extensive veins of it, beautifully crystallized, frequently occur, sometimes containing caves ten to twelve feet in diameter.

Among the uncouth ravines, red clay predominates, and gathers the waters into numerous small springs and streams, slightly impregnated with salts of magnesia in solution. These communicate at times a disagreeable taste to the waters.

Beyond the natural mounds, a mile west from camp No. 30, we approached a beautiful stream, flowing towards the Washita. It is finely timbered with post oak, alamo, and elm. It contains fish; and we call it Gypsum creek, because its waters are tinctured with salts derived from the decomposition of that mineral. This was our entrance into the fertile basin, where numerous, unfailing rivulets, with luxuriantly wooded valleys, form the headwaters of the False Washita of Red river. We cross the pretty rivulets Bear creek and Elm creek, and make our encampment (No. 31) on Comet creek. All of these streams have timbered banks and fertile valleys.

Continuing to traverse the rolling prairies which divide the streams, fine views of beautiful valleys, fringed with red foliage of trees, constantly delight us.

Near camp No. 31 we found oolitic sandstone, limestone, and shells, indicating the lower bed of the cretaceous formation which overlies the gypsum. This proves that the sandstone we have been passing is the new red, like that of Lake Superior. The nutritious buffalo grass first appeared in this region, and here we had the first chase for the noble game from which it was named.

From camp No. 30 to camp No. 33, a distance of about forty miles, our route lay wholly in the basin, watered by numerous affluents of the False Washita. To our surprise, beauty and fertility were among its chief characteristics.

Red marl and gypsum characterized the soil. Grass was everywhere abundant. Red oak, post oak, black jack, cotton wood, and elm fringed the streams with dense, dark green, foliage.

To have followed the fine valley of the False Washita to its junction with Red river would doubtless have developed the same general features throughout, with a route for a railway to Preston direct, and of the most favorable character.

A few hours' march took us across the low dividing ridge which separates the waters of Red river from the Canadian. As we ascended the hills, the country became more arid and sandy. From the crest, toward the north, at a distance of a mile, appeared the wide valley of the Canadian, with here and there patches of forest or a fringe of alamos. Abrupt ravines showed pools of water and foliage of refreshing green.

Elsewhere, the parched hills wore the sombre aspect of a dreary waste, with which the deep carmine hue of the Canadian seemed in unison.

The bed of the river we found about six hundred yards wide, with streams a foot deep coursing through it in a network of channels. Though saturated with red marl, the water was pleasant to taste, and, when clarified by pieces of mucilaginous cactus, afforded a more grateful beverage than the slightly saline waters we had left behind.

The valley of the Canadian possesses alluvial bottoms, covered with loamy soil and occasional patches of grass.

To cut off a bend of the river, we passed through the Antelope hills, and struck the dry bed of a stream, which we followed to the Canadian to find water for camp.

These hills consist of coarse friable sandstone, cemented by lime. They are the last mesa remnants of an elevated plain now worn away, by diluvial and atmospheric causes, to gentle hills and abrupt ravines. Occasional fields of sand, the absence of water, the scarcity of the verdure of grass and trees, rendered this march of eighteen miles the most dreary of our route.

On reaching the Canadian the country improves; the valley grows wide and more fertile;

herds of buffalo are occasionally seen grazing upon the hill-sides. Turkeys congregate under the dark green foliage of scattered copses, that form an agreeable contrast to the pale red tint that is spread over the landscape of river and plain. As we proceed, the Canadian becomes deeper and less muddy. Numerous streams bring down their tribute from the hills, but disappear beneath the surface where they unite with the valley of the Canadian.

Many of these rivulets are well wooded, and will furnish a small supply of timber.

The alluvial bottom lands of the Canadian, as well as the narrow belts of its tributaries, which increase in length and importance as we recede from the vicinity of the headwaters of the False Washita, produce natural vineyards and orchards of plum trees. The grapes, unlike wild varieties in the eastern States, possessed a thin skin and a soft pulp deliciously sweet.

Colonel Long, in 1817, and Lieutenant Abert, in 1845, noticed upon this part of the river the same general characteristics: "The valley of the Canadian, twenty miles from its issue out of the mountains, appeared twenty-five miles in width; and, though not so fertile as some lands in the Mississippi valley, might, by proper cultivation, support a numerous population. At the junction of Tucumcari creek the river bed was found to be sixty yards wide, forty yards being covered with water ten inches deep. On the 8th were found grape vines loaded with fruit. Descending the Canadian, the country became more plain and fertile. The river valley opened wide, and was bounded on both sides by low and rounded hills, instead of abrupt and perpendicular precipices. The general surface was but little elevated above the river, and nearly unbroken." * * * "The immediate valley of the river had now become little less than ten miles in width, and had in some places a fertile soil." * * * "The next camp was on the southwest side of the river, under a low bluff which separates the half-wooded valley from the open and elevated plains. The small elms along this valley were bending under the weight of innumerable grape vines now loaded with ripe fruit; the purple clusters crowded in such profusion as almost to give a coloring to the landscape."

To such testimony of the adaptation of this country to the culture of fruit and the manufacture of wine, it is scarcely necessary to add the coincidence of our own observations.

This portion of our route being so well known to be favorable to the location of a railway, we left the Canadian valley, and, passing several pleasant brooks and springs, gradually ascended to the Llano Estacado. That apparently boundless plain, without a shrub or tree as far as sight could penetrate, is covered with a thick carpet of buffalo grass, cropped by numerous herds of antelope and deer. The formation of the Llano is of the cretaceous period, overlying trias. The upper stratification is chalky limestone, upon marl and red sandstone. Numerous clear rivulets of pure water issue from the base of the cliffs, and fertilize narrow belts of the valleys leading to the Canadian. Upon these little streams grow a border of trees, and a profusion of vines loaded with purple fruit.

The northern slopes of the Llano, under the bluff edge, one or two hundred feet above the base, are covered with a dense forest of cedars. Protection from the prevailing southwest winds has enabled these trees to obtain a moderate size. It is possible that some may be found suitable for railroad ties. The supply of fuel from this source would be abundant. The wood is exceedingly hard and durable—inferior only to mezquite, with which our route abounds. Among the ancient ruins of fortifications, upon Pueblo creek and elsewhere, erected previous to the conquest of Mexico by Cortez, were found cedar beams or ties which remain nearly perfect. A specimen, now deposited in the Smithsonian Institute, was procured at the ruins of "El Moro," where are Spanish incriptions, dated 1606, testifying to the existence of these ruins at that early period.

The remarkable durability of the prairie and mountain firs of this region give them a value for timber above what has usually been awarded them. For fuel, the traveller of the prairies has long held them in high estimation.

Leaving the Llano Estacado, we pass a belt of forty miles in extent, with numerous woodless

chocolate-colored streams, and reach the well known Rio Tucumcari, called by Mexicans, on account of its wide and fertile valley, "Plaza Larga."

Although it is nearly two hundred miles distant from Rio del Norte, flocks of sheep are frequently driven to graze for a season at this favored spot. The creek is a permanently flowing stream, fringed with trees, and fertilizing a wide belt of country which extends to the Canadian river.

The Tucumcari hills, near by, are remnants of the great Llano Estacado, and their slopes likewise contain many large cedars. Throughout this region, artesian wells could be resorted to with advantage, to increase the supply of water.

From this point to Anton Chico our route was constantly upon the upper part of the trias red clay and sandstone. The summits of the bluffs are of white sandstone, forming a good material for constructions.

Passing over a gently rolling country, with here and there a stream gliding through woodless valleys of red marl, we cross Laguna Colorado, Pajarito, and other creeks flowing into the great valley of the Canadian below the cañon.

Then, ascending a low range of hills, we pass the divide, and encamp on Hurrah creek near where it pays tribute to the Gallinas, a branch of Rio Pecos. Water and grass were plenty, but wood was scarce.

The next day, having passed several shepherds' huts, many herds of cattle and flocks of sheep feeding in green pastures, we went down into the valley of the Pecos. A border of cultivated fields, with wheat, oats, and maize, extends along the valley.

Anton Chico rests near inviting orchards upon the brink of the stream, enclosed between two steep banks four hundred feet in height. A gentle slope along a smooth hill-side renders the descent to the river comparatively easy. To ascend its western bank was the first great obstacle encountered upon the route.

Mr. Campbell, the principal railroad engineer, was sent to explore, and found two routes by which the object could be accomplished. The first descended to the valley, and followed the course of the river to a ravine, through which, winding with curvatures of half a mile radius, the bank could be ascended with a grade of eighty feet per mile. The other proposed to keep the top of the eastern bank to a point above the town, where the cañon is narrow enough to allow a viaduct to be constructed reaching the crest of the opposite bank. The saving of several miles in distance and ten feet per mile in grade would probably compensate for the great expense of such a structure. Stone of the best quality for such purpose exists upon the spot. Magnificent pines are found fifteen or twenty miles distant in the mountains, such as are considered in this country to afford the best and most durable timber for "vigas" (beams or rafters) of houses.

The excavation that will be required is in coarse gravel, easily removed.

Once upon the western bank of the Pecos, the railway may follow the route surveyed through Cañon Blanco to La Laguna, or, I believe, ascend along the crest of the Cañon, Pass la Cuesta, to Pecos springs, and thence by the summit, marked on the accompanying profile, proceed to the headwaters of Rio Galisteo. No mountains, but a high table-land merely, appearing to intervene, and the distance from stream to stream being but a few miles, it seems quite probable that this course might prove available.

By Cañon Blanco there is no difficulty, except at the point of leaving it. There, to diminish the grade, it will be necessary, at considerable expense for cutting and filling, to ascend by the side of the cañon. Beyond this point the route is plain, with light grades and gentle curvatures, to a branch of Rio Galisteo east of the Gold mountains. Following its gentle stream through a wide puerto of the Rocky mountains, we pass within twenty miles of Santa Fé, and strike Rio del Norte at Pueblo de San Felipe, where formerly a bridge spanned the river. This route leads directly by the rich placers of gold and other precious metals, which are said to abound at the junction of the eruptive and metamorphic rocks.

The more direct route, *via* Carnuel Pass, would require labor of excavation and steeper grades. It passes, however, through an out-crop of coal, and leads to Albuquerque, or to the remaining narrow gorge of the Del Norte at Isleta, where the river cuts through banks of diluvial drift, which, rising perpendicularly twenty feet above the water, form natural abutments for a bridge.

The valley of Rio Grande del Norte is well known. The bottom land that can be irrigated is very extensive. One-fifth of it is probably under cultivation, producing wheat, maize, fruits and vegetables. The soil and climate seem particularly adapted to the culture of grapes, which grow luxuriantly and to perfection. The wine produced is finely flavored, and, with an easy communication with a market, may become an article of commerce and a source of wealth to New Mexico. But the resources of this Territory are not confined to the belt which may be flooded by the waters of the Rio del Norte. Numerous springs and streams chequer this region, with fertile spots among the mountains.

Colonel McCall, inspector general of the army, in his report dated July 15, 1850, estimates "the land now cultivated" in New Mexico at about two hundred square miles. "Land cultivable now vacant," exclusive of the vast regions occupied by the Navajoes, Moquis, Zuñians, and wilder tribes of Indians, is estimated at about four hundred and ninety square miles. He asserts "with confidence" that "the figures are not too high." Judging from those portions I have myself visited, I am inclined to the opinion that the estimate falls below the actual amount. Seven hundred square miles, however, watered by acequias and cultivated as usual like one vast garden, will produce supplies sufficient to support a numerous population.

The high mesas, which extend in various directions from the foot of the Rocky Mountains and Sierra Madre, although from the want of sufficient rains unfit for cultivation, are by no means valueless. They are covered with a thick carpet of curled grama—the most nutritious grass that grows—affording abundant and unfailing pasturage, during every season of the year, to unlimited herds of cattle and flocks of sheep. The expense of raising them is but a trifle. Within the past few years merchants have transported wool to St. Louis, and made handsome profits. Heretofore it was esteemed nearly valueless. With an improved breed of sheep and railway transportation, wool-growers of New Mexico might control the eastern markets.

Colonel McCall, in relation to Indian depredations, states that, "as far as" he "could ascertain positively, by summing up individual cases, forty-seven thousand and three hundred sheep were driven off by these Indians" (from New Mexico) within eighteen months prior to the 1st of September, 1850. Doubtless, the Indians took many flocks from shepherds in the mountains that were not officially reported.

"Some twenty or twenty-five years ago, before the hand of the red man had fallen so heavily upon them, the people of this State, as well as of Chihuahua, sent annually to the city of Mexico vast numbers of sheep, as well as cattle and mules. At this day, not one thousand are sent from districts that formerly furnished their hundreds of thousands, such has been the rapacity and the relentless spirit of the Navajoes and Apaches."

Notwithstanding the extent of these depredations, and the drain since 1846, for the support of the army and of emigrants, vast numbers of sheep have been annually driven to California markets.

I believe we are beginning better to understand our "red brethren," and soon will accord to them some of the rights due to true "native Americans." Based upon such principles, it would not be difficult to civilize all the wild tribes I have ever met with in my wanderings. They would then, like the Pueblo Indians of New Mexico, have a community of interests with the whites—tilling patches of fertile soil among the mountains, and grazing flocks and herds upon the illimitable plains over which they roam; thus acquiring a surplus with which to trade for such clothing and other necessaries as they may need. Savage warfare will then cease, and the resources of New Mexico—agricultural, pastural, and mineral—will be developed, and, if they choose, the people may build cities and aqueducts in the deserts, as did the Spaniards two centuries since at Gran Quevira.

Notwithstanding the richness of her mines of gold, of silver, of copper, and of iron, the deposits of coal that have been discovered in New Mexico have probably a more direct and practical bearing upon the project of a railway. The mountains east and west from Rio Grande—the Sandia and Manzana ranges, as well as the Sierra Madre—furnish a large supply of superb firs for timber. Near the base of the mountains, on gravel ridges and in dry ravines, are found cedar and mezquite, furnishing for the people sufficient fuel.

But the excellent coal, which is said to crop out in the Carnuel Pass and in the famous basin of Cibolleta, would, with railroad transportation, afford a large supply of this necessary commodity.

Hence, with the increase of population, the development of the precious metals, the manufacture of wine, and the produce of wool and other articles, will afford rich freights, east and west, in exchange for fabrics of every kind, and luxuries required from the older States.

Such seem a few of the considerations that will have an influence upon the prosperity of the Pacific railway.

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# CHAPTER IV.

GENERAL DESCRIPTION OF ROUTE TRAVERSED FROM RIO DEL NORTE TO PORT OF SAN PEDRO.—REMARKS UPON THE VALLEY OF RIO COLORADO.

West of Rio del Norte, a ridge easily crossed brings us to Rio Puerco. A branch called Rio de San Jose, passing beds of coal, leads, by a gradual ascent, near to the summit of Sierra Madre. Two passes here were examined—both practicable; one leading by the Camino del Obispo, the other by Ojo del Oso. The latter, by report of my principal assistant surveyor, A. H. Campbell, esq., who examined it, scarcely needs excavation to prepare the way for iron tracks. The Obispo Pass would probably require a maximum grade from eighty to ninety feet per mile, and a tunnel of perhaps three-quarters of a mile, through soft limestone rock, at the summit. But nature has modelled the slope upon each side of the pass; and beyond, the route glides quietly into the extensive, well watered, and beautiful valley leading to Zuñi. The route across the Sierra Madre passes extensive forests of excellent pine timber.

It is a singular fact that, throughout New Mexico, Pueblo Indians are universally conceded to be the most sober, honest, and industrious portion of the inhabitants of this Territory. My own observations would tend to confirm the fact. The Indians of Zuñi cultivate a portion of an extensive valley, in the midst of which their pueblo is built. Without irrigation, depending only upon occasional rains, they produce abundant crops of grain and vegetables. Even though they had furnished forage for Fort Defiance, their supply of maize seemed inexhaustible. These Indians are more shrewd and more enterprising than the lower class of Mexican population. They comprehend the advantage of trade which the opening of a railway through their country would afford, and are eager for its accomplishment. The Caciques met in council and delegated three of their best men to show us the excellent route due west to Rio Colorado Chiquito, below the junction of Rio Puerco of the West. The service was accomplished to our complete satisfaction. The route was excellent, nearly devoid of hills, with frequent springs and streams of water, and grama grass abundant.

Here is where the route through Campbell's Pass, at Ojo del Oso, unites with the main line. It possesses the advantage of a low summit and easy grades along the channels of the two streams it follows. But the waters of Rio Puerco of the West, being generally lost below the surface, fail to produce the fertility that distinguishes the Zuñi route.

The Colorado Chiquito is a stream smaller than the Gila, but similar in many respects. The banks are fringed with cotton wood; the valley is wide, the soil rich, and the gravelly ridges are covered with fragments of pottery, among ruins of ancient Indian pueblos. Drift wood here is very abundant, indicating occasional freshets, and plenty of timber near the sources of

the river. This stream we followed nearly west about sixty miles. Here the river turned northwest. Desiring to continue as we were, upon the parallel of 35°, a small reconnoitring party advanced to explore the low pass, where a spur of the Mogoyon mountains is broken by the volcanic peaks of San Francisco.

We had sent to Moqui, hoping to obtain Indian guides through this country also, but the messengers returned unsuccessful. They brought tidings that, by hundreds, the Moquis were dying by small-pox. Only three men could be found in health, and they were insufficient to throw the dead over the walls.

Without a guide, therefore, we moved onward about eighteen miles to a cañoned stream, with sides so precipitous and deep as to obstruct our march. Following north for a passage, fifteen miles brought us to its junction with the Colorado Chiquito. Again we explored westward, and with complete success. By an almost uniform grade, we ascended the wave-like swell of the Mogoyon spur, and, at the southern base of the San Francisco mountains, reached the head-waters of the San Francisco river. Here were vast forests of excellent timber, cedar, oak, and pine, covering the plains, and stretching southerly, over a region watered by San Francisco streams, to the furthest limits of vision. North of us rose the volcanic mountains, white with snow, and covered with new varieties of magnificent firs.

It was now between Christmas and New Year, and we were upon one of the most elevated parts of our whole route, seven thousand and two hundred feet above the level of the sea. The winter we knew to be unusually severe, as Mr. Leroux, for three previous winters, had seen these mountain peaks devoid of snow. Now, even at the base where we encamped, snow eight enches deep was lyng upon the surface. But we were in a region where curled grama was everywhere abundant, and our mules fared well upon what they could glean from the rocky hill-sides. A thermometer immersed in Leroux's spring read 48°.4 Fahrenheit. This is undoubtedly the mean temperature of the place.

Continuing our explorations west-southwest without difficulty, we found a route leading to a stream marked by Captain Sitgreaves, upon his manuscript map, "Bill Williams' fork," and represented as flowing into Rio Colorado forty-five miles below the Mojave villages. Following its course, we soon overlooked a vast region of charming country, which we called the "Black Forest." Notwithstanding the depth of winter, and the snowy mountains not far behind us, here nature had put forth spring flowers and green herbage.

To our regret, the drainage of this region was to the southeast, and Bill Williams' fork took the direction towards Rio San Francisco and the Gila. Disappointed, but not discouraged, we turned west, crossed streams, and, having made a circuit of one hundred miles, sent back messengers to bring up the train by a favorable route we had discovered. Our reconnaissance still continued in advance of the main body of the surveying party, communicating by signal smokes or messengers the proper course for it to pursue.

Partridge creek we now followed until it entered an extensive basin, so abundant in curled grama that we called it "Chino valley." This appeared like a branch of that to which we had previously traced Bill Williams' fork, and our hopes were again chilled by finding Partridge creek also turning east of south.

Thus far we had found no want of water, grass, and wood; no difficulty in the progress of our train of wagons, and scarcely an obstacle to the construction of a railway. But a continuous range of mountains seemed to deny our westward progress.

We ascended Chino valley northwest two days' march, finding no puerto for a passage through the mountain range, and no water among the ravines for our animals. The whole country to the northwest and north looked extremely unpromising; plains, barren and waterless, flanked upon the west by the still unbroken chain of mountains. In fact, it was the region over which Captain Sitgreaves passed two years before, finding no water for eighty miles, and

crossing, beyond, two ranges of mountains whose steep declivities were practicable only for pack mules.

We were now nearly five thousand feet above the level of the Rio Colorado, distant, in direct line, about one hundred and twenty-five miles. That would give a uniforn grade, the whole distance, forty feet to the mile. It was, therefore, necessary to avoid ascents, and seek a route where a declivity might commence at the earliest moment.

Retracing our steps, we explored the same range south. Fifteen miles from Partridge creek we found flowing, through a dark grove of overhanging ash and hickory, a limpid stream, where ducks, turkeys, and deer were abundant. Five miles beyond Turkey creek we came upon Pueblo creek, so called on account of extensive ruins of houses and fortifications that lined its banks.

Thinking that this stream might change its southeast course and flow westward, we proceeded near to the base of Mount Hope. There ascending an elevated peak, the drainage of the country still appeared east of south, over the same great tract of fertile country we had previously seen from Bill Williams' fork.

Thirty miles south, at the base of Black mountain, seemed a low summit. But there were surer indications of a break in the mountain chain where cut by a branch of Pueblo creek. So, returning thither, we ascended its finely-timbered banks nearly due west. In six miles we gained the summit of a pass where two streams found their sources within five hundred feet of each other; one flowing eastwardly into Pueblo creek, the other westwardly along the course we sought. This cut through the sierra seemed formed by nature for a passage. Wide Indian trails and ruins of extensive fortifications, constructed centuries since upon the heights to defend it, showed that not only present tribes, but ancient races had deemed this "Aztec Pass" of great importance. Upon the northern side the mountain slope was regular, and followed in a spur parallel to Pueblo creek, enabling the engineer to commence his ascent so as to pass the summit with a favorable grade. A deep cut, or perhaps a tunnel of two or three hundred yards, might be required through the narrow hill which forms the divide. Leaving "Aztec Pass" behind us, we gently descended fifteen or twenty miles along the rivulet, which flowed sometimes above and sometimes below the surface. Our stream now turning northwest towards Yampai creek, in that direction appeared a valley uninterrupted even to the horizon. The reconnoitring party again turned westward over a rolling prairie, and, somewhat to our surprise, in ten or twelve miles we found our course cut by the creek we had left. It now flowed west of south, with cañoned banks fifty feet high. The general surface of the country was gently rolling. Following our stream—which now we call Cañon creek—we found that the country became more rough, the cañon deeper cutting through, and a few miles below emerging from the eruptive barrier that once opposed the flow of its waters. Although no extraordinary difficulty may be apprehended in constructing a railway through the channel formed by the stream, it was no natural road for our wagons. Turning westward, we crossed the Aquarius range of mountains, and found a favorable passage, which our train followed through "Cactus Pass" to "White Cliff" creek. This was a fine mountain stream that fretted upon its rocky shores, shaded by cotton wood and willows. It emptied into Big Sandy, the latter flowing south, and seldom showing water above the surface. Twelve miles below we again joined Cañon creek. The stream of transparent water, probably fifty feet wide and two feet deep, glides upon a pebbly bed, and nourishes upon its borders reeds and rushes of vivid green. Budding alamos line its banks, and mezquites cover the fertile valley. It is early in February, but the thermometer at midday stands 80° Fahrenheit, giving the climate of advanced spring. Following the creek for about thirty miles, to our regret it flowed nearly south, crossing three successive ranges of eruptive mountains, whose barriers were occasionally broken into cañons. There, having received an affluent from the east, it turned westward to the junction with the Rio Colorado.

This stream, indicated upon old Spanish and English charts, is designated Rio Santa Maria. Captain Sitgreaves, supposing when he saw its mouth that it was the same he had already named at its source in the mountains, calls it "Bill Williams' fork." It is an important stream, draining an extensive tract of country heretofore unknown. Alternate sections of its valley furnished scenery of strange contrasts. For five or six miles we follow marl bottoms, luxuriant with vegetation, with a stream rapid, clear, and two feet deep, shaded by dense groves of alamo, mezquite, and willow; then, gradually yielding to a sandy soil, the water passes beneath the surface, and for an equal distance we traverse a blank and dreary desert. There the quaint cereus giganteus and humbler cactaceæ, with occasional yuccas and curious shrubs, form a landscape extremely singular, but of which one soon wearies. Fortunately, these barren wastes seldom extend uninterruptedly above a few hours' march with the train.

Although our route equalled all we had reason to anticipate, it yet seems probable that the main eastern branch would lead through a more favorable country, by the Black Mountain to "Val de Chino." Thence a reconnaissance eastwardly might discover a passage through the Black Forest across the headwaters of Rio San Francisco, and unite with our trail upon Cañon Diablo, near the Colorado Chiquito.

What we saw of this country was full of interest to each department of science. There were extensive forests, abounding with game; wide grass valleys, affording pasturage to innumerable herds of deer; crystal brooks alive with trout, their fertile banks once cultivated and now lined with ash and walnut timber. From the heights were frequently seen, looking down upon us, the fleet cimaron, or mountain goat. That this solitude had not always been unbroken by man, was shown by the numerous ruins of stone houses that lined the borders of the streams, and the still high walls of extensive fortifications that covered the heights surrounding.

We traversed this region in winter, but the climate was that of spring, and vegetation was already rapidly advancing. Unpropitious as was the season, the botanist found much to delight him. New species of trees and tropical shrubs were collected; rare and beautiful plants were obtained; strange forms and unknown species of cactaceæ were gathered.

It was a beautiful view that burst upon us, as we ascended a hill and first beheld the Colorado sweeping from the northwest to unite with Bill Williams' fork, almost beneath our feet. One long and loud huzza burst spontaneously from the men, sending a thrill through every nerve. Their dreamy forebodings were cast upon its waters, and all felt relieved from a burden of anxieties.

The river appeared three or four hundred yards wide, with a dark and reddish hue, flowing with a swift current between bluff banks worn through the midst of wide alluvial bottoms. The valley was sprinkled with large alamos, and bounded by hills leading back to sharp ridges of mountains, by which below the junction it was contracted to a cañon. Upon the opposite side seemed a succession of mountains, which, receding from the river towards the northwest, terminated about ten miles above. There a wide plane seemed to extend indefinitely westward, and possibly might lead in about one hundred miles to San Gorgonio Pass, the fine puerto discovered by Lieutenant Williamson, to the valley of Los Angeles.

Ascending the left bank of the river about twenty miles over soil evidently rich, and in some places showing evidence of having been cultivated, we reached a point where spurs from the mountain impinged upon the river, forming an unexpected obstacle to the progress of our wagons. Labor for a few days, perhaps for a few hours, might probably have cut around their points a practicable way. But our time was precious; it was doubtful whether, with the utmost diligence, we could reach the settlements before our supply of subsistence should be exhausted. Therefore, abandoning our wagons, except a light vehicle to which was attached the viameter, and in which the lighter instruments were carried, we packed upon mules our collections, provisions, and necessaries, and cached such things as we could spare. Then crossing the spurs, we entered the fine valley of the Chemehuevis Indians. They are a band of the great Pai-ute

("Pah-Utah") nation, but live separate and distinct from the mountain robbers, whom we shall have occasion again to mention. This band contains probably two hundred warriors—short, but robust and well formed, with regular features, and a pleasing air of activity and intelligence. They received us kindly, and flooded our camp with a portion of the surplus produce of their fields for trade. The principal articles of traffic were beans, squashes, maize, and wheat—the latter usually ground to flour. Although the season was the latter part of February, when their winter's store had been consumed and the quantity for seed reserved, still the supply seemed limited only by the demand. Their villages were mostly upon the west bank of the river, and covered considerable space; yet of the fertile soil thus occupied not one acre in a hundred seemed cultivated.

We were now met by Mojaves, who, acting as guides around the next spur that formed a cañon, conducted the surveying party through a pass, invisible from the river, where not a hill intervened.

We now entered that great basin of the Colorado, several miles in width, and probably forty miles in length, which for ages—since the first visit of the Spaniards—has been the home of the Mojave tribe.

Successively, as we approached their several villages, five principal chiefs, each with his own particular band of warriors, met us in state, with all the forms and ceremonies with which they are wont to dignify great events. When informed of the object of our visit they were greatly pleased. They met in council, and determined to do all in their power to advance the interests of the Pacific railway survey.

They loaded us with provisions of flour and beans in return for cast-off clothing, and sent two guides, Ir-i-te-ba and Cai-rook, to conduct us to the intersection of the Salt Lake road with Mojave river.

The valley of the Rio Colorado forms a distinguishing feature in the topography of the western portion of the continent. It is the recipient of all the waters that drain the basin between the Sierra Madre and Sierra Nevada, or coast range, and extends, from its sources in the Rocky Mountains, to the Gulf of California. This region abounds in barren hills, naked plains, and wild cañons; yet it has frequent fertile spots, where water and timber are plenty, and where valleys of considerable extent have narrow belts of fertile soil. As instances, we may mention Rio Gila, Colorado Chiquito, Bill Williams' fork, and Rio Mojave. All contain, to a greater or less extent, soil favorable to agriculture. The southern bank of the Rio Gila, lately acquired by treaty from Mexico, contains large tracts of land capable of being irrigated and of producing excellent crops. Pimo Indians from time immemorial—certainly since they were first visited by Coronado, in 1540—have cultivated cotton of excellent quality. Specimens, which I showed to gentlemen in Texas, were pronounced nearly equal to the best Sea Island cotton of South Carolina. Tobacco, maize, wheat, beans, and melons, are also cultivated by Pimos and Maricopas upon the Gila. The soil upon all the rivers above mentioned would, doubtless, produce similar crops.

But the valley of Rio Colorado itself affords a large extent of fertile bottom-land, which may be perfectly irrigated and easily cultivated. The soil is pronounced to be far superior to that of the Del Norte, and being elevated at the Mojave only three hundred and fifty feet above the sea, the climate is milder and more tropical. As the Mojaves, Chemehuevis, Cuchans, and Cocopas, all cultivate without irrigation, it is probable that more rain falls here than in New Mexico. Judging from our own experience, and the robust health and fine personal appearance of all the Colorado Indians, no climate could be more salubrious. There are probably from one hundred and fifty to two hundred square miles of arable land in one tract occupied by Mojaves. The Chemehuevis, a band of Pai-utes, possess a tract of about thirty square miles. Below, near the junction of Bill Williams' fork, is a basin containing about thirty square miles. Thence, to within a short distance of the mouth of Rio Gila, I have no personal knowledge. The map of Captain Sitgreaves indicates an extensive valley there, not less

than eighty miles long, and averaging, at least, five miles in width, making four hundred square miles. It is occupied by three bands of Indians—"Yampais," "Cu-chans," and "Mojaves." From ten to fifteen miles above the junction of Rio Gila to the mouth of Rio Colorado is a wide strip of bottom-land, averaging, for ninety or a hundred miles, from ten to fifteen miles in width, giving at least one thousand square miles. Looking from the desert south, an extensive tract of country, from fifty to sixty miles in width, appears the bed of an ancient lake, now possessing a fertile soil, and capable of irrigation from the Colorado. Without this last, we have already estimated sixteen hundred and sixty square miles of arable land upon the Colorado. Beside maize, wheat, beans and melons, which, without irrigation, Indians now cultivate so abundantly, the soil and climate are remarkably adapted to the cultivation of cotton, sugar-cane, and rice. There can be no doubt that the valley of the Colorado is destined, at some future day, to be divided into plantations, supporting a numerous population.

The river itself is worthy of some consideration. From the Mojave villages to near its confluence with the gulf, the average width of the stream is from three hundred to five hundred yards. When at the junction of the Gila with the Colorado, in October and November, 1849, no change was apparent in the height of the stream; this is the dryest season of the year, and no ford was known upon the river. From the mouth of Bill Williams' fork to Mojave villages, no place occurred where the depth of the channel was less than five or six feet. The current is rapid, but apparently not more so than that of the Ohio. The height, at the confluence of Bill Williams' fork, is two hundred and seventy feet above the level of the sea; distant, by course of the river, three hundred miles. This estimate would give an average inclination to the stream of nine-tenths of a foot per mile, slightly exceeding that of the navigable waters of the Arkansas. Steamboats navigate already as high as the mouth of Rio Gila, eighty miles from the Gulf, furnishing supplies to Fort Yuma. Captain Sitgreaves states that, at his camp No. 51, a large rock occupies the middle of the channel. This is supposed to be the principal bar to the navigation of this river to the Mojave villages. The rock could be removed by blasting; and then, should the railroad follow the route that has been indicated, this navigable river would bear to and from the Mojave depot commerce of no inconsiderable value.

About forty miles above the junction of Bill Williams' fork we left the Colorado at the mouth of a dry arroyo, heretofore supposed to be the bed of Rio Mojave. Gradually ascending the barren slope of the hill-side ten miles from the Colorado, we found several small springs of good water. Twenty miles beyond, we encamped upon a pretty rivulet, which watered a small valley that had been converted by the mountain Pai-utes into a luxuriant garden. Passing the crest of a hill, and leaving to our right the wide valley supposed to belong to Mojave river, by a gradual ascent over wide prairies of rich grama grass, we reached a rocky glen, where were springs abounding in excellent water. No timber was here, although low cedars afforded plenty of fuel.

From Rock spring, five miles led us to the summit, fifty miles beyond and 5,292 feet above Rio Colorado; the grades, however, by detours upon the ascending slopes, need not exceed seventy feet per mile.

We then passed into a dry ravine leading to Soda lake, which seems to absorb the waters of Rio Mojave. Turning from the valley of the ravine referred to, we ascended the hill-side, where, nineteen miles from Rock spring, were oozing, from an outcrop of marl, small rills of water. Should deep holes be dug, or tanks be constructed at this place, an abundant supply of water might doubtless be obtained.

The vegetation of this region consists of beautiful palm-like yuccas, cactaceæ, larrea, and patches of grass. From "Marl Springs" we ascended the mountain, to cut off a detour made by the surveying party, through a fine looking valley to our left. Crossing granitic hills, we soon saw upon our right a row of volcanic buttes and metamorphic mountains, beyond which appeared a deep and wide valley, probably that of the veritable Mojave.

In the far horizon north is seen a snow-white peak, said to be on Rio Virgin, or Santa Clara. Northwest, stands in high relief the lofty range of the Sierra Nevada, between which and Rio Colorado have been counted nine distinct ranges of mountains.

Passing on, we soon came to a ridge and commenced our descent; at first steep, then more gentle, along an arroyo, to a puerto at the foot of a large metamorphic mountain, where we had a view westward to the great valley before seen. In the midst seemed a lake, supposed to be mirage; to the left, however, curled a tall column of smoke, where, undoubtedly, were the camp-fires of the advance party, and water.

Having travelled about fourteen miles, we made a noon halt. The country traversed looked dreary—a mass of rock and gravel without useful vegetation.

At 5 p. m. we proceeded two miles down the arroyo and entered a field of drifted sand. By moonlight the effect was beautiful; it seemed a fairy scene, with the bright and placid firmament above, and the earth beneath covered with snow-white sand. The air was fresh, not cold, and all seemed to enjoy the march. Mexicans and Americans were singing, each his favorite song, as easily we trod the hard surface of drift. Even mules and the carretela had made but light impressions upon the compact surface. Two or three miles of this interesting but dreary prospect, which, sweeping from the southwest, seemed to extend indefinitely towards the north, brought us to a puerto in a low rocky ridge of hills, upon the northwest side of which, sand, piled nearly to the top, left bare the summits only.

Soon we struck the smooth bottom of a lake of efflorescent salts, probably sulphate of soda. Traversing this with a good road for about six miles, at 10 o'clock in the night we reached the camp of Lieutenant Ives, where water and grass were abundant; the latter was salt and the former brackish. Mules drank freely, but the water was unpalatable to men. By viameter, our distance from Marl springs is thirty-one miles, the greatest jornada upon our route. For nearly half the distance the soil is hard gravel; ten miles are sandy, the remainder being upon the hard clay forming the bed of the lake.

By results of the survey, Soda lake is found to be seven hundred and sixty-six feet above our crossing of the Colorado, the distance by trail being ninety-seven miles, and the average descent eight feet per mile.

Whether a channel exists by which the Mojave river finds its way to the Colorado is a problem not yet solved. We regretted exceedingly that time for a closer examination was not at our disposal. Our trusty Indian guide, however, assured us that the dry channel of that stream passed uninterruptedly north of our route to the Colorado, and that wagons could pass through it without encountering a hill

Such a route as he describes, with water found by digging, is undoubtedly the most favorable for a railway that exists across the desert west from the Colorado river.

The true channel of the Mojave river, where it enters Soda lake, is but a bed of sand, which we ascend thirteen miles before finding running water. There it is a rapid rivulet, its clear waters making melody with the pebbly shore. A few miles higher up on the stream barrenness gave place to fertility; tulares, grass, alamos, and willows, covered rich meadows.

The river here is fifty yards in width and knee-deep. Mezquite trees, tornillas loaded with fruit, form occasional thickets.

For seventy-five or eighty miles above our course followed the gentle meanderings of Rio Mojave. The soil of the valley is rich, and there is plenty of water for irrigation, although occasionally it disappears for a short distance beneath the surface. There are cotton wood and mezquite for fuel. Timber is scarce and small, except near the sources of the stream in the San Bernardino mountains, where magnificent oaks, pines and spruce occur.

At the point of leaving the river we found it one hundred and fifty yards wide, and two and a half feet deep; its alluvial bottoms still fertile and densely covered with alamos and willows. Mounting the left bank, we found large springs gushing from the verdant slope. The air thermometer reading 15°.9 Cent., the temperature of the spring water was 19°. 1 Cent. = 66°.4 Fahrenheit; which, probably, is the mean temperature of the climate in this region.

Ascending the wide-swelling prairie which leads to all the passes near the junction of the

Sierra Nevada with the coast range, our course was directed south 38° west towards an apparent gap in the mountains east of the snow-capped peaks of Sierra San Bernardino. Grass is thinly scattered over the plain, and beautiful yucca trees abound thirty feet in height. Sweet-berried cedars began to appear, affording excellent fuel. The Mojave river, not far upon our left, divides into three branches, heading in the mountains; the most eastern said to take its rise near Cajon Pass.

Proceeding through groves of yuccas beautiful as cocoanut and palms of southern climates, and dense thickets of cedars, by a gradual ascent, averaging probably sixty feet to the mile, we reached the summit of Cajon Pass, where the mercury measured 25.4 inches. Standing upon the crest, one could look far towards the north and northeast over immense prairies of gentle inclination. This pass appears the most truly difficult part of our route. It seemed, however, possible, by winding from the Pacific side around the slope of the mountain, thus increasing the distance, to locate the route upon a spur bounding the valley of Cajon creek, to the foot of the crest of drift over which passes the road. Here may commence a tunnel of about four or five miles in length, and eight hundred feet below the surface at the summit; thence becoming gradually less, until it issues upon the prairie slope near the Mojave river. The material is easily excavated, and would be useful in forming embankments required to cross a ravine leading to the spur referred to above. The termini, at least, will require arching; within, the rock may be firm enough to support the superincumbent weight.

In Cajon creek are boulders of marble, crystalline, white and pure as possible. This would form building material of incomparable beauty; there are also, probably, in the mountains, veins of it affording good quarries. Auriferous quartz has also been found in this vicinity. The botanist was delighted with the western slope of the Sierra Nevada, affording a class of vegetation new to our route. Four different species of cactaceæ were found upon the first mile of our descent—a new piñon, a new and magnificent oak, two new species of firs or pines, a currant, sycamore, and cowania. The hills are covered with a verdant red-barked shrub; the mountains with oaks and pines of many varieties. Here we find abundant material for the construction of a railway. With a few exceptions, this range of mountains must be our main dependence for supplies of pine timber until we may meet the forests of San Francisco mountains.

We descended about twelve hundred and fifty feet in eleven miles from the first point of striking the arroyo at the foot of the ridge. As we proceeded, the valley opened finely; mountain torrents swelled the creek, that boiled and fretted with granitic rocks. The descent became less steep, and the sides of the valley were regular slopes, where a railway might ascend so as to rise far above the bed of the creek, and diminish the grade to one hundred feet per mile in the cañon above.

This development diminishes the obstacles of Cajon Pass. The work will not be so extremely difficult nor expensive as at first seemed probable. Our greatest regret is, that it leads not directly to a port as safe and commodious as that of San Francisco.

Having descended the Cajon creek about five miles, we left the way to San Bernardino, and keeping the road west, under the base of the mountain, entered a region of great beauty. We travelled twenty miles along a descent inappreciable to the eye, and arrived at Cocomongo rancho, where we encamped upon the beautiful stream that waters it.

We continued our course west-southwest, by a road nearly as level and smooth as if graded for a railway, twenty-four miles to "El Monte." The valley traversed is continuous from the Cajon, fifteen to twenty-five miles in width, with soil abundantly rich, fertile, and at present well watered. Some of the streams crossed—Cocomongo, San José, and Rancho de Chino—are fed by permanent springs. Many others owe their origin to melting snows of the mountains. All were charmed by the beautiful scenery and heavenly climate. Fine spreading oaks and sycamores were sprinkled in pleasing variety with flowering shrubs through the valley.

From El Monte, passing a few hills, we enter the valley of Los Angeles. The stream upon which it is situated is about fifty yards wide and two feet deep. There were numerous acequias irrigating vineyards, orange and olive groves, peach orchards, gardens, and corn fields. Even as early as March 21st, full-grown oranges were seen ripening in the open air.

The town had the sombre cast of a Spanish pueblo, relieved, as it were, by innovations of American comforts. There was the bustle and activity of a business place. Many new houses were in process of construction. Everywhere was indicated a thriving population and a land of intrinsic wealth. Los Angeles is said to number five thousand inhabitants.

Our course from Los Angeles was twenty-four miles nearly south, over the low plains and a slight ridge, to the port of San Pedro. The town is situated on a bluff thirty feet above the ocean. Spring tides here rise nine or ten feet—neap tides from four to five. Small vessels, by crossing the bar with ten or twelve feet at high water, enter a basin at the mouth of San Gabriel river, where they are perfectly secure. A city has there been laid out, but its success is problematical.

At the playa (port,) shipping is said to be completely sheltered, except from southeast winds, which seldom occur, and only in winter. During the last season but one such storm occurred, and a ship in port rode it out at anchor. A breakwater, it is said, of about a mile in length, would afford complete protection even to a fleet; and wharves could be extended to deep water, so as to afford every advantage of a first rate harbor.

For a great portion of the route from the Mississippi we followed natural channels, where streams flow nearly east and west. The river Arkansas and the Canadian lead us to the base of the Rocky Mountains. Thence crossing table-lands to Rio Pecos, we ascend to the head of the Galisteo, which is followed to Rio del Norte. Descending Rio del Norte to Albuquerque, we cross to the Puerco and join Rio San José, which leads to Ojo del Oso, near Campbell's Pass, the summit of Sierra Madre. We now reach Rio Puerco of the west, which furnishes a valley to Rio Colorado Chiquito. The latter carries us to Chevelon's fork, where we turn westward, crossing the final spur of Mogoyon mountain and the headwaters of Rio San Francisco, to a branch of Bill Williams' fork, which leads to the Colorado. Thence we would propose to ascend to the mouth of Mojave river and follow the bed of that stream to the base of Sierra Nevada. The route should traverse, thence, the northern slope of the San Bernardino spur, which is said to furnish numerous rivulets, bearing clear waters into the sandy plains below. Approaches from the east to the various passes in this range—"Walker's," "Cañada de las Uvas," and "Tejon"—are known to be favorable. To examine these passes minutely, in order to determine that which shall be available for a railway to San Francisco, was a duty intrusted to another, whose labors, it is hoped, will be crowned with success.

As the shortest line to the Pacific ocean, we proceeded to San Pedro through the Cajon Pass, which is, indeed, difficult; but, should no better be found, ought not to be esteemed a barrier to the construction of a Pacific railway.

More specific information regarding the feasibility of this route for a railway, I beg leave to present in the form of reports from my principal assistants upon the survey.

That of the railroad surveyor is designed to speak more definitely upon the most favorable curves and grades available upon this line, and the labor required to construct the railway.

The geologist and mining engineer notices the rocks, and their adaptation to the purposes of construction; also the positions of beds of coal and mines of precious metals.

The botanist describes the forest trees, the quality and amount of timber, the produce of the soil, and its adaptation to agricultural purposes.

The zoologist refers to the game noticed upon the route; their habits and means of subsistence.

The details of our operations, with the results of the scientific investigations to be deduced from them, are necessarily deferred to the subsequent part of this report.

# CHAPTER V.

REMARKS OF A. H. CAMPBELL, PRINCIPAL ASSISTANT RAILROAD ENGINEER, UPON THE GRADES AND CURVES REQUIRED.

*General Description.*—From Fort Smith to the Pecos there is very little to impede the construction of a railway. But I think the opinion that has been pretty generally expressed throughout the country that a railway may be located anywhere, in whatever direction, across the prairies, between the western frontiers of our States and the Rocky Mountains, other things being equal, as cheap or cheaper than in the United States generally, is erroneous—particularly so with reference to that portion of the plains passed over by our exploration. These extended prairies being devoid of trees, affording an almost unlimited range of vision, became softened by the effect of distance, and present the appearance of one uninterrupted surface as wild, and as wide, and as smooth as the ocean; but in detail they are exceedingly uneven, being cut up by deep ravines, with elevated spurs and ridges between them, some of them impracticable except by heavy summit cuttings and enormous embankments across the valleys. There are, however, many favorable streams which take their rise under the Rocky Mountains, and flow eastward to the Mississippi and its tributaries, and it is in the valleys of these streams that the cheapest and best railway routes are found; the passage from one valley to another requiring the same system of ascents and descents as most of the locations in the States.

Among the most remarkable and most favorable of these streams, in point of length and directness and easiness of occupation, is the Canadian. The valley of this stream is practicable from its mouth to one of its sources near the Pecos, being, with but few exceptions, broad and free from obstacle. A shorter and perhaps cheaper line may be had south of this river, from Forth Smith to the Antelope Hills, near the 100th meridian of west longitude, thereby cutting off the great bends and avoiding the earthy bluffs which are worn away by the action of the waters. These bluffs occur at intervals as far west as the Shawnee settlements.

*From Fort Smith to Antelope Hills.*—The principal cut-off would be from Fort Smith to Chouteau's old trading post, and from this point to the Antelope Hills. From Fort Smith a good route extends up the Poteau river some ten or twelve miles, where it can be crossed more favorably on account of its high banks; thence up the valley of a small creek, one of its tributaries, called Basil creek. This valley heads in a small range of mountains, or hills rather, which extend nearly parallel with Sans Bois creek. Passing this summit with a grade of about fifty feet per mile as a maximum, we get upon the waters of the Sans Bois creek, down which we descend to its great bend near Cooper's creek, thence up the main branch to the divide between it and Gaines' creek. This summit is an inconsiderable one, requiring about forty-five feet per mile as a maximum grade. Following down Gaines' creek to its junction with Coal creek, the main branch of the south fork of Canadian; thence up the valley of Coal creek to its head, crossing the divide between the Boggy, a tributary of Red river, and the Canadian, about nine miles south of Shawnee village; continuing along the slopes of this ridge, across the gently rolling prairies, with occasional strips of woodland heading one of the leading streams of the Boggy, crossing Marcy's wagon trail about ten miles west of Shawnee Town to a low place in the Canadian "divide;" thence down the slopes to that river, near the mouth of Topofki creek. From the head of Coal creek to this point it is believed there will be required no grade exceeding fifty-two feet per mile.

From Topofki creek to the mouth of Walnut (Simpson) or Chouteau's (Marcy) creek the route lies up the Canadian; keeping up Walnut creek to its source in the "divide," along the "divide" for several miles, descending by a gradual slope to Deer creek; thence up this creek to its source; thence for several miles along the divide; thence down to one of the valleys of the Washita; up this inviting stream to its source in the sharp "divide" about twelve miles east of the Antelope Hills; thence by a gentle descent to the Canadian. The advantages of this over the river

route is, that it will save about thirty-five miles of distance; and, besides, it passes a well watered and timbered region as far as the Cross Timbers. The valleys of the Walnut and Deer creeks and the Washita are well timbered, and afford an abundance of good land, and a constant supply of water.

From near the Antelope or Boundary Hills the valley of the Canadian is the proper route, from its directness, gentle ascent, and ready supply of water. Its general course is nearly due west to the mouth of Tecumcari creek, and the ascent of these (the one I believe the tributary of the other) very gradual to the summit between them and the Pecos.

From Fort Smith to the Antelope Hills the cost of the graduation, bridging, and masonry, other things being equal, would not, I am of opinion, come up to the average cost of the railways of New England. The soil is loose and gravelly, and the rocks of coarse sandstone, but very little rock-cutting necessary, and fine timber of oak, maple, hickory, walnut, pecan, and pine, is abundant as far as Deer creek; and there is some timber, principally cotton wood, upon the Washita. It may be said of the whole route from Arkansas to the Pecos, that it will compare most favorably with any similar extent of railway east of the Mississippi in point of grade, curvature, and ease of construction.

Passing the divide between the waters of the Canadian and the Pecos about one and a half mile north of our encampment on "Hoorah" creek, with light excavation and easy grades, the most favorably route extends over a nearly level prairie to the Gallinas valley. The valley of this stream is easy of access and egress, there being suitable valleys for occupation; and, indeed, from this point to the Pecos, about four or five miles above Anton Chico, the ground is exceedingly favorable. The maximum grade from the Canadian divide to this point, it is believed, will not exceed forty-five feet per mile—the graduation light, the soil being loose and gravelly.

*From the Pecos to Albuquerque, via Rio San Antonio, or Cañon Carnuel.*—The problem of leaving the Pecos is a more difficult one than we have yet had to solve. There are, however, two methods which are practicable in the vicinity of our exploration, and I doubt not that, by following the river to one of its valleys heading with the Galisteo, a very easy mode of crossing the Rocky Mountain range can be accomplished. To determine a suitable point for crossing near Anton Chico, and to even approximate to its cost, would require very careful surveys with the level and the compass. The approach from the east is not so difficult. The river can be crossed with a single span of 150 feet at Anton Chico, or about half a mile below with a less span.

Proceeding, then, from either of those points, one route would lead up a small valley south of the town, which heads in the elevated plateaux through which the Pecos cañons, as at Cuesta; pursuing a westerly course thence, over a rolling region, to Cañon Blanco. The average ascent per mile to this point is but forty-three feet, but the maximum grade for the first ten miles will be at least eighty feet per mile. The other route from the Pecos would cross the river some four or five miles above the town by a viaduct, at an elevation of from one hundred and fifty to two hundred feet; thence to a point some ten or twelve miles from Anton Chico, connecting with the other route to the summit between Cañon Blanco and the Pecos. This route would be several miles the shorter, and the maximum grade probably not exceed seventy feet per mile. The great cost of a viaduct on this route, however, would render it a question as to which of these routes would be preferable. From the entrance to Cañon Blanco, the line explored pursues that cañon to near its western limit; thence over the divide, into the basin between the Rocky Mountains and the Pecos. For several miles the ground descends in the cañon to about halfway through; thence ascends to the divide above mentioned. The drainage of this cañon is southeasterly, probably to the Pecos, the main cleft opening and descending in that direction. The grades through Cañon Blanco will be light, not exceeding twenty feet per mile, except at the western limits, where it will require at least sixty feet grade, and from thirty-five to forty feet cutting, to attain the summit. From this summit, a little south of Las Lagunas, to the main ummit of the Rocky Mountains, at the San Pedro mountain, the line traverses a rolling country,

descending at an average rate per mile of about thirty-three feet to the lowest point of this basin, which drains, it is supposed, into or towards Las Salinas. From this point the San Pedro Pass can be approached with a grade of about thirty-five feet per mile. This pass divides the waters which flow into the Rio Tuerto from those that flow into, or towards, Las Salinas. About nine miles further is another pass or summit, which divides the waters of the Tuerto from those of the Rio San Antonio, in the Cañon de Carnuel, with a forty feet cut at the San Pedro summit, and a descending grade of about eight feet per mile for seven miles. We pass the second summit with only about forty-feet cutting, and thence descend at the rate of about eighty-two feet per mile for thirteen miles; thence down the sloping mesa to the Rio Grande, opposite Isleta, at a rate of about from twelve to fifteen feet per mile. At Isleta the Rio Grande contracts through a comparatively narrow gorge, presenting a most favorable point for crossing. Three spans of from one hundred and fifty to two hundred feet will effect this object, there being a bluff on both sides favorable for landing, without embankments.

From Isleta the line continues across the elevated spur which lies between the Rio Grande and the Puerco. To attain this summit without excavation, the rock being basalt and lava, a grade of fifty-three feet per mile ascending, and of forty feet per mile descending, will be required.

We are now, as it were, at the base of the Sierra Madre, at the mouth of the San José, which heads on its summit, affording three points for crossing, viz: one point near the Zuñi road, or Camino del Obispo; the other by the Cañon del Gallo and Zuñi Pass; and the third by Campbell's Pass, on the Fort Defiance road. The valley of the San José extends uninterruptedly to the summit of the mountains, heading in the last named pass with the Rio Puerco of the West. This pass lies about due west from Sierra de San Mateo, or Mount Taylor, and is entered by a wide and beautiful and apparently level valley, the narrowest point at the summit being about three miles. Its northern side is composed of high, red sandstone bluffs, surmounted by escarpments of yellow sandstone; the former appears to have assumed every fantastic form in Gothic architecture. The south side of the pass is formed by the great spurs of the Zuñi mountains. The Zuñi group of the Sierra Madre trends northwesterly from the Camino del Obispo, and terminates in this pass. The Rio Puerco of the West heads east of, and turns the point of these mountains, and extends southwesterly, with a uniform descent, to its junction with the Colorado Chiquito. The average ascent of this valley of the San José from its mouth is about twenty-three feet per mile, but the maximum grade, it is believed, will be only about thirty-five feet per mile to pass the mountains. A light cut through the loose and gravelly soil at the culminating point, and we descend to the Colorado Chiquito, by the Puerco of the West, uninterruptedly, at an average descent of thirty feet per mile.

At a point called the "Hay Camp," on the San José, this valley divides, one branch heading near the Camino del Obispo; and several miles above, another valley, the Cañon del Gallo, occurs, which begins in the Zuñi Pass. This latter valley was not explored, but it is much lower than the Camino del Obispo, and is represented by intelligent Mexicans and others who have passed it as being very favorable for a railroad, presenting no very great obstacle to its construction. A trail for pack-mules from Zuñi to the Ojo del Gallo, at the mouth of Cañon del Gallo, threads through this gorge. From all I learned and all I saw when in the vicinity of this pass, I am of opinion that a grade of between sixty and seventy feet per mile will suffice to cross the mountain at this point; the descent thence to the Pueblo de Zuñi is very gradual.

The route by the Camino del Obispo is more difficult and will require an ascending grade of eighty feet per mile, and a tunnel at the summit of about three-quarters of a mile in length. Descending to Zuñi, this route traverses a gently sloping and well-watered valley, with a grade not exceeding sixty feet per mile. From Zuñi to the Rio Puerco, at camp No. 74, (Navajoe spring,) the line passes over the rolling country between Zuñi creek and the Puerco, with undulating grades, the maximum not exceeding twenty-five feet per mile. From the mouth of

the Puerco of the West the route continues down the Colorado Chiquito for seventy-five miles, with an average descent of only six feet per mile, thence striking west to the pass south of the San Francisco mountain. By the route surveyed the distance from the river to this pass is forty-two miles, with grades of forty, forty-six, and forty-five feet per mile. By leaving the Colorado Chiquito further east than the point of survey, this grade may be materially modified. Passing this summit, the route continues west for thirty miles over an undulating region north of Bill Williams' mountain, through thick pine forests, with undulating but descending grades, the maximum being about thirty feet per mile. Here a small summit is passed which divides the waters of the San Francisco from those flowing northwesterly towards the Little and Great Colorado. With light work here the proper route turns southwesterly towards the Val de Chino, a tributary of the San Francisco river, a distance of forty-five miles, with a maximum grade of forty feet per mile. Crossing this valley to reach Pueblo creek, an ascending grade of fifty feet per mile for fourteen miles, thence an ascending grade of forty-five feet per mile for fifteen miles, enables us to make the Aztec Pass with forty feet cutting.

The Aztec Pass divides the waters that flow into the San Francisco and Bill Williams' fork, the former flowing to the Gila, and the latter to the Great Colorado. From this pass the best route would continue down this stream to near camp No. 108; thence over a small divide between Cañon creek and White Cliff creek; thence down the latter to its junction with Big Sandy, the main branch of Bill Williams' fork. From Aztec Pass, for fifteen miles, the descending grade will be sixty-five feet per mile; thence across the Cañon and White Cliff creeks summit, with light work, and down White Cliff creek thirty miles to the mouth of Cañon creek, with a descending grade of fifty-one feet per mile, the descent, via Cañon creek, from camp No. 108 would be about seventy-five feet per mile, through a deep cañon of basaltic rock. From the mouth of Cañon creek the valley of Big Sandy and Bill Williams' fork presents no obstacle that cannot easily be overcome, either in grade or curvature, to the Great Colorado. In the Striped cañon there are several salient points which it will be necessary to tunnel to the extent of from one hundred and fifty to two hundred feet, in order to maintain a workable curve.

Between camps Nos. 120 and 121 Big Sandy unites with Bill Williams' fork, which comes from the northeast. From a careful examination of my topographical notes, triangulations, deductions, &c., I feel confident in stating my opinion as to the source of this fork—that it is in a pass which we saw some few miles to the south of us, between the Black mountain and Mount Hope. By a slight detour in the Val de Chino, this pass can be attained, and the valley of Bill Williams occupied for the route there, by saving about fifty miles of distance and the probability of an uninterrupted descent of about twenty-eight feet per mile.

Following up the left bank of the Great Colorado, whose ascent for thirty-four miles is about one and a half foot per mile, a suitable point for crossing was found among the "Needles," a series of porphyritic and trap dikes, through which the stream forces a passage. Notwithstanding the formidable appearance of the rocks at a casual glance, there are but three points where they infringe directly upon the river, and these points are quite narrow and easily perforated or blasted off entirely. To cut off a large bend of the river in the Pah-Utah valley, grades of about sixteen feet per mile will be necessary to pass the gravelly spurs of the plain. At the crossing, the rocks afford enduring abutments, and the river, being one hundred and fifty yards wide, easily spanned. From this point a proper location will be found, by leaving the river and commencing the ascent of the high table lands that lie between the Great Colorado and the Mohave rivers, through the pass hitherto supposed to be the *embourchement* of the latter, but which was found to be but a dry bed of a stream heading in the elevated rim of the Great Basin, which undoubtedly extends thus far south. Thence turning southeasterly to a junction with the Sierra Nevada, at the San Bernardino mountain, the exploration continued west and through a pass in the highest point of this river, there being much lower ground both to the north and south of this point, as shown by the map. This pass is attainable, however, by practicable grades, the maximum being about sixty-four feet per mile.

The distance from the "Needles" to the pass is about ninety miles. Cutting thirty feet at this summit, we have an uninterrupted descent for fifty-six miles (following the *detours* of a great valley) to Soda lake, an immense dry and sandy basin, in which the Mohave loses its waters, at a maximum rate of only seventy-five feet per mile.

From Soda lake to the point on the Mohave at which the Spanish trail leaves that river, a distance of ninety miles, the average ascent of the stream is but eighteen feet per mile. Leaving the river near this point, a route is practicable up the dry gullies which lead to the summit of the Cajon Pass, at the wagon road, the narrowest point of the divide: the distance to the pass is twenty-four miles. For nearly twenty miles the maximum grade will be about sixty feet per mile; thence through the divide by a tunnel of two and a half miles, (rock, white conglomerated sandstone,) and grade of ninety feet per mile. A more favorable approach to this pass is believed to exist at the head of the Mohave, close under the San Bernardino mountain.

The stream which heads in the Cajon Pass, and flows to the Pacific, is very rapid in its descent; but the slopes on the right bank are regular, and are broken but in few places by narrow gorges of tributary streams. This being the case, by descending with a grade of one hundred feet per mile for about twenty miles—keeping up on the slopes of the mountain, passing, by means of a short tunnel or heavy cutting, the salient spur which forms the right bank of the stream below—the valley of Los Angeles is reached. From the foot of this grade, keeping upon the slopes, for twelve miles the grade is lessened to sixty-three feet per mile. This point is about half a mile east of Cocomongo rancho; thence to the crossing of the Rio San Gabriel, near the village of Monte, thirty miles, with a maximum of thirty-eight feet per mile; thence to the city of Los Angeles, with about the same light grade, or from the Monte to the port of San Pedro, thirty miles, with a descent of about twelve feet per mile.

To make a minute estimate of the probable cost of a railway from the Mississippi to the Pacific cannot come within the province of this exploration; it being well known that, for such a purpose, the most accurate and detailed measurements are required. The barometric observations, however, have developed a most interesting profile, and are sufficiently reliable to determine the great question of *practicability* beyond a doubt. There are but three points on the entire route explored at which the work may be said to be difficult; these are the Pecos, the Cañon de Carnuel, (at Albuquerque,) and the Cajon Pass in the Sierra Nevada.

And these sections will not differ by a comparison with the Baltimore and Ohio railroad from Cumberland to Wheeling, or any of the railroads which cross the Alleghany mountains, in point of grade, curvature, and boldness of graduation. There is but one point on the route where it will be necessary to employ less than a 1000 feet radius; this point is in Striped Cañon, on Bill Williams' fork.

In conclusion of this hasty statement, I desire to state that the few hours taken at intervals from the calculations and arrangements for the barometric profile, and the superintendence of and plotting of the topography on the general maps, have not been sufficient for a full consideration of this important matter; it is due, therefore, that proper allowance be made for its hastiness.

Respectfully submitted:

ALBERT H. CAMPBELL,
*Engineer and Surveyor.*

Lieutenant A. W. WHIPPLE,
*United States Topographical Engineers,*
*In charge of exploration for a railroad route near 35th parallel.*

* * * * * * * *

# CHAPTER XI.

### CONCLUDING REMARKS.

The concluding report will describe many new species both of plants and animals. We will also be enabled to present to the department a complete geological and mineralogical section from the Mississippi river through the Rocky Mountains, the Sierra Madre, the chains east of Rio Colorado and the Sierra Nevada, to the Pacific ocean. This was a field new to science, and our geologist, with abundant experience both in Europe and America, was well fitted for this exploration. The various formations have been developed, the ages of mountain chains established, and the position of mineral regions determined.

Specimens of rock for building material have been procured in order to test the qualities of hardness, durability, and general adaption to the purposes of construction.

Sketches have been obtained of landscapes, as well as of animals, plants, Indian portraits, scenes, ancient paintings, hieroglyphics, and curiosities.

An extensive series of meteorological and magnetic observations have been obtained for climatological investigations, and for the determination of the elements of inclination, declination, and intensity, over the region traversed. They are necessarily deferred to the conclusion of our operations.

In relation to this subject I would, however, refer to the accompanying climatological map, with remarks prepared by L. Blodget, esq., from observations collected by the Smithsonian Institution in connexion with those made during the survey. It will be perceived that the parallel of 35° is particularly favored by rain. The valley of the Canadian, the Zuñi region, the vicinity of the San Francisco mountains, and the Aquarius range, have evidently a large supply of precipitated moisture. The arid deserts between the Mississippi and the Pacific coast are here contracted to their narrowest limits; consequently, upon this route there are more springs, more streams, and more woodland, than can be found upon lines I have traversed further south.

The gradients found to be practicable are marked upon the profile.

Curves of less radius than half a mile occur only in the Cajon Pass, and on Cañon and Big Sandy creeks, where they break through low mountain chains of metamorphic rock. There are there a few sharp turns, and it would be necessary in one place to tunnel through a point perhaps four or five hundred feet in thickness to attain a radius of one thousand feet. The few other bad places would require cutting, as upon the Hudson River railroad, at the edge of the bluffs. But already it has been mentioned that the Cajon Pass is considered only as the last resort for an entrance to the Pacific coast; and the firm belief that, by ascending the main eastern branch of Bill Williams' fork, both Cañon Creek and Big Sandy may be avoided.

The principal bridges would be required at Rio Pecos, Rio Del Norte, Cañon Creek, and Rio Colorado; all others are of minor importance. The first and second have already been mentioned. Cañon Creek, I doubt not, may be avoided by following the main eastern branch of Bill Williams' fork. Should it prove otherwise, it would be necessary to throw arches across the stream at three several points where cañons occur. The best of stone for this purpose is abundant in the vicinity. Two excellent points for crossing the Colorado occur—one at the cañon immediately below the junction of Bill Williams' fork, the other where rocky spurs impinge upon the river below the Mojave villages. The width of the stream between natural abutments, at these points, does not exceed two hundred and fifty yards.

Our line could in many places be made straighter and shorter, should wells be dug at proper points; either common or artesian wells would undoubtedly be successful throughout the whole distance from Fort Smith to Rio Pecos. Between that stream and the del Norte the strata are too much broken to be depended upon. Westward there are points where they could probably be made available. Rio Puerco, which at some seasons, in places, sinks, could doubtless be

reached by this means. If so, a very rich soil, now unoccupied, would become available to agriculture. The whole region from the Sierra Madre to the Colorado Chiquito could probably be fertilized by the same agency. With the desire to test this question, we carried a small boring apparatus; but not having time to devote to the undertaking, the instrument was sold to certain citizens of New Mexico, who proposed to make a trial of its virtues. Between the Colorado Chiquito and Rio Colorado, volcanic forces have too much tilted and broken the regular strata to allow any dependence to be placed on this means of increasing the supply of water. Fortunately, however, the southern slopes of the mountains abound in permanent springs and streams, which renders the resort to wells unnecessary. From Rio Colorado to the Mojave river, to avoid ascent to mountain springs, we must have recourse to artificial means of procuring water. Should the Mojave have a channel to the Colorado, the water cannot pass below the level of the latter stream, and by perforations to the proper depth, must be obtained. In Soda lake, by turning the sod, we found an abundance of brackish water. Pure water would probably be found twenty or thirty feet below the surface. Rio Mojave now furnishes an abundant supply until we reach the eastern base of the Sierra Nevada, from which numerous rivulets are said to flow. After passing the Sierra Nevada, neither in the valley leading to San Pedro nor in those we would follow to San Francisco, is want of water apprehended. Wherever permanent streams do not occur, common wells or artesian borings would prove available.

Snows upon this route can never prove the slightest obstruction to a railway. From Memphis, on the Mississippi river, to Rio Pecos, snow storms rarely occur in winter. At Fort Smith, as has been shown, only one such storm was noted in the winter of 1852; that covered the ground to the depth of two inches. From thence to the Pecos, snow may occasionally fall to the depth of three or four inches, but must rapidly be absorbed by the warm, porous soil. I doubt whether the surface would remain whitened for ten days during the year.

Passing the ranges of the Rocky Mountains east and the Sierra Madre west of the Rio Grande, storms are said to be more frequent, covering the surface with snow sometimes to the depth of a foot. But here, too, the snow quickly melts, and forms no obstruction to travellers. We passed the latter range late in November, and not the slightest trace of snow was visible among the loftiest peaks. The first seen was in December, glistening upon the distant peaks of Sierra Mogoyon. During the latter part of December and the first of January we were at the base of the San Francisco mountains, the only place where much snow was found upon our route. It never exceeded eight inches in depth upon the surface, was nowhere drifted into banks, and formed no obstruction to our march. We believed, nevertheless, that the season was unusually severe, and the amount of snow fallen was almost unprecedented. Soon after leaving these mountains, snow disappeared. But on the 18th of January, when on a reconnaissance in the Aztec mountains, another storm occurred; snow falling to the depth of four inches. Four days afterwards we were again at the same spot, and the snow had nearly disappeared; the southern slopes were entirely bare. Leaving this range, we saw no more indications of snow except upon a few distant mountain summits. Without doubt, between the Aztec Pass and California a few storms may occur in winter, covering the surface with snow to the depth of three or four inches; but so mild a climate soon melts it away.

Fuel is believed to be more abundant upon this route than upon any other known from the Mississippi to the Pacific. The State of Arkansas and the Choctaw territory, as far as Shawneetown, are covered with wood, excellent for fuel, and also furnish an abundance of coal. Westward of Shawneetown we have wood upon the streams, and live oak and black jack in the Cross Timbers to the head of the Washita; thence to the Pecos are occasional forests of cedars, which afford excellent fuel. From the Pecos to Albuquerque, and thence to Zuñi, is a constant succession of pines, firs, and cedars. Coal, also, is found in this region. Beyond Zuñi, cedar wood covers a wide extent of country for about forty miles. Beyond, plenty of fuel could be floated down the Colorado Chiquito from the well wooded region of the Mogoyon, from whence it issues. Near the headwaters of Rio San Francisco there are forests of pine, interspersed with cedar thickets. These extend to the head of Bill Williams' fork. Thence to the Colorado, and

even to the base of Sierra Nevada, although there are many mezquites and alamos in the valleys of the streams, and some cedars upon the hills, a general scarcity of fuel prevails. Upon the mountain slopes of California, the supply both of timber and fuel is supposed to be exhaustless.

## COST OF CONSTRUCTION.

From so hasty a survey, little more could be expected than to furnish approximate materials for a rough estimate. The time allotted to the preparation of this part of the work scarcely admits a reference to that data. It will be furnished to the department for future examination.

A few remarks, however, expressing merely in general terms the ideas impressed by the field observations, may not be inapplicable to the conclusion of this subject. For this purpose I propose to divide the line into sections, and, by a comparison with roads already constructed, draw an inference of the probable expense of completing the Pacific railway.

SECTION I. *From Fort Smith to camp* 33, *near the head of Washita river, three hundred and sixty-five miles.*—The general surface is an inclination nearly uniform of four feet to the mile. Following the line of profile 1, there are hills and undulating prairies, intersected by frequent rivulets. The soil is fertile; timber and stone for construction abundant. The labor required for masonry and graduation will compare favorably with the average upon the railroads of the State of New York. The average total cost for construction and equipment of New York railroads, as reported by the State engineer, is $45091.84 per mile. As steamboat navigation exists to the mouth of the Canadian, ten per cent. added ought certainly to cover all the extraordinary expenses due to the locality described; making $49,600 per mile, or $18,104,000 for the total cost of construction and equipment of this section.

SECTION II. *From camp* 33, *head of Washita river, to Tucumcari creek, two hundred and eighty-one miles.*—Following the valley of the Canadian, the average grade is eight feet per mile. Although there is some good soil upon the streams, many sandy spots occur, and the general aspect of this section is that of sterility. Water can easily be obtained; but timber of good quality for railroad ties is scarce. Cedars are abundant, it is true; but it is doubtful whether they would be available except for fuel. The main supply would, therefore, be of oak, obtained from the Cross Timbers at the eastern end of the section. For graduation and masonry, our standard of comparison may be the same as before. But increased expenses for transportation will make it proper to add twenty per cent. to the original, making the estimate about $54,100 per mile, or for the section $15,202,000.

SECTION III. *From Tucumcari creek to Albuquerque, two hundred and one miles.*—Leaving the Canadian river, the surface is undulating to Rio Pecos. Thence to Albuquerque much labor will be required—equal, probably, to that employed upon the Hudson River road. The total cost of construction and equipment of the latter is stated to be $81812.16 per mile. As good timber is abundant upon the latter part of the line, and we are among a civilized people of agricultural and pastoral pursuits, where wages of native labor are low, it is believed that thirty per cent. added to our standard may, with proper economy, accomplish the work. This estimate amounts to $106,355 per mile, and for the section $21,377,355.

SECTION IV. *From Albuquerque to Zuñi, one hundred and fifty-one miles.*—The labor required for graduation and masonry upon this section will be less than upon the last, and an abundance of good timber and stone is easy of access. The cost of construction and equipment on this portion of the route may be compared with the western railroad from Worcester to Albany, which is $64,218 per mile. Adding forty per cent. for increased expenses of transportation, &c., and our estimate amounts to about $90,000 per mile, equal to $13,590,000 for the section.

SECTION V. *From Zuñi to San Francisco Springs, one hundred and ninety-eight miles.*—Throughout this portion of the route excellent timber may easily be obtained from the Zuñi mountain of Sierra Madre, from Sierra Mogoyon by rafts down the Colorado Chiquito, and,

finally, in the vast forests in the midst of which this section terminates. Much of the distance along the Colorado Chiquito, and elsewhere, being nearly level, the labor required for graduation and masonry will be quite light—probably less than that expended upon the Providence and Worcester railroad, which cost, per mile, $44,774. Fifty per cent. added for extraordinary expenses, gives about $67,161 per mile, and for the section $13,320,265.

SECTION VI. *From the San Francisco Springs to the Rio Colorado, two hundred and seventy-nine miles.*—It has been already stated that over this section more favorable ground is believed to exist south of the main portion of our route. If not, the labor of graduation and masonry through the cañoned creeks will far exceed that upon any previous portion of the road. It would be similar to what was required along the cliffs of the highlands on the Hudson River road. But in estimating the cost, sixty per cent. increase will probably cover the extraordinary expenses due to locality, provided the road be built continuously from the coast, so as to furnish railway transportation for supplies. Total cost of construction and equipment of Hudson River road, $81812.16 per mile. Add sixty per cent., and we have about $131,000 per mile, and for the section $36,549,000.

SECTION VII. *From Rio Colorado to the Pacific, three hundred and seventy-four miles.*—The line traversed is recommended only in case subsequent explorations should prove that the more direct routes suggested are less favorable than appearances would indicate. The expense, however, is estimated with due regard to the magnitude of the work. It is believed, however, that upon no portion of this route, except the tunnel through Cajon Pass, can the difficulties exceed what was encountered upon the Baltimore and Ohio railroad; and for the greater part of the distance, where wide valleys are followed, labor of graduation and masonry will be very small. In making the comparison referred to above, we find reported the sum of $58,410 as the total cost per mile. To this we would add cent. per cent., giving about $117,000 per mile, or for the section $43,758,000. This is supposed to include about $5,000,000 for the tunnel of the pass.

RECAPITULATION OF ESTIMATE.

| Section. | Length in miles. | Average cost per mile. | Total amount for graduation and equipment complete. |
|---|---|---|---|
| I | 365 | $49,600 | $18,104,000 |
| II | 281 | 54,100 | 15,202,000 |
| III | 201 | 106,000 | 21,306,000 |
| IV | 151 | 90,000 | 13,590,000 |
| V | 198 | 67,161 | 13,320,265 |
| VI | 279 | 131,000 | 36,549,000 |
| VII | 374 | 117,000 | 43,758,000 |
| Total | 1,849 | 89,903 | 161,829,265 |

I am aware that the above estimate far exceeds those made by eminent engineers, such as E. F. Johnson and Septimus Norris. But it is believed, that, without having been eye-witnesses of the uninhabited regions through which it is proposed to execute a work of such magnitude, they have failed to appreciate the extent of the difficulties which such an unprecedented condition of things would produce.

It is true that, should a general route be agreed upon, and a portion of the cultivable valleys it would traverse thrown open to actual settlers, two years would produce an astonishing change in this region. Fields of grain and vegetables would spring up, as if by magic, from one end

of the line to the other; and, upon each section, an adequate supply of subsistence would doubtless be afforded from local productions. But there are other difficulties attending the absence of facilities for transportation, and of the innumerable conveniences of a numerous population, which can be remedied only by the completion of the railway. The expense of the operation would also be modified to conform to the method of its commencement and the manner in which it may be conducted.

To begin simultaneously from the eastern and western limits, and proceed to a mutual junction, would enable the road itself, in a great measure, to bear the burden of its own supplies. The grading, however, in order to hasten the completion of the work, would doubtless be carried on from New Mexico, and probably at the same time from various other points.

Its successful and speedy completion, however, can be effected whenever the people of this country feel its importance to the union, dignity and prosperity of the United States, and are willing—in consideration of the national advantages to be derived—to give efficient national aid.

I have the honor to be, sir, very respectfully, your obedient servant,

A. W. WHIPPLE,

*Lieut. Top. Engineers, in charge of Exploration.*

Hon. JEFFERSON DAVIS,

*Secretary of War.*

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## [PORTION OF] APPENDIX B.

*Table containing the distances, altitudes, * * * * of each camp from Fort Smith to the Pacific ocean.*

| Camp. | | Name of station. | Viameter distance from— | | Altitude above the sea. |
|---|---|---|---|---|---|
| | | | Preceding station. | Fort Smith. | |
| | | | *Miles.* | *Miles.* | *Feet.* |
| No. | 0 | Fort Smith, (Camp Wilson) | | | 460. 3 |
| | 1 | Ring's Prairie | 10. 00 | 10. 00 | 564 7 |
| | 2 | Choctaw Agency | 5. 00 | 15. 00 | 558. 5 |
| | 3 | | 8. 82 | 23. 82 | 336. 3 |
| | 4 | | 4. 94 | 28. 76 | 432. 4 |
| | 5 | | 8. 60 | 37. 36 | 677. 9 |
| | 6 | | 2. 74 | 40. 14 | 595. 9 |
| | 7 | San Bois Creek | 9. 83 | 49. 97 | 595. 9 |
| | 8 | ------do | 7. 50 | 57 47 | 643. 8 |
| | 9 | ------do | 8. 75 | 66. 22 | 698. 2 |
| | 10 | | 17. 50 | 83. 72 | 650. 4 |
| | 11 | Near Gaines' Creek | 2. 75 | 86. 47 | 688. 9 |
| | 12 | Near mouth of Coal Creek | 13. 50 | 99. 97 | 625. 8 |
| | 13 | ------do | 5. 25 | 105. 25 | 614. 3 |
| | 14 | Head of Coal Creek | 10. 25 | 115. 50 | 720. 1 |
| | 15 | Near Shawnee villages | 10. 00 | 125. 50 | 752. 5 |
| | 16 | Near Shawnee Town | 8. 50 | 134 00 | 771. 3 |
| | 17 | Branch of Boggy Creek | 11. 60 | 144. 60 | 765. 5 |
| | 18 | Boggy Creek | 13. 00 | 157. 60 | 889. 9 |
| | 19 | Branch of Topofki Creek | 14. 50 | 172. 10 | 1072. 2 |
| | 20 | Topofki Creek | 12. 25 | 184. 35 | 1172. 4 |
| | 21 | Beaver's Town | 14. 00 | 198. 35 | 1211. 2 |
| | 22 | Branch of Canadian river | 18. 00 | 216. 35 | 1338. 2 |
| | 23 | Road from Chouteau's | 10. 50 | 226. 85 | 1294. 7 |
| | 24 | Walnut Creek | 6. 00 | 232. 85 | 1130. 6 |
| | 25 | Branch of Walnut Creek | 11. 95 | 244. 80 | 1431. 5 |
| | 26 | Branch Creek | 16. 00 | 266. 80 | 1436. 5 |
| | 27 | Near Deer Creek | 15. 00 | 275. 80 | 1331. 3 |
| | 28 | ------do | 13. 00 | 288. 80 | 1668. 0 |
| | 29 | | 19. 50 | 308. 30 | 1728. 5 |
| | 30 | Gypsum Creek | 15. 50 | 323. 80 | 1832. 8 |
| | 31 | Washita river | 11. 50 | 335 30 | 1750. 7 |
| | 32 | Comet Creek | 15. 25 | 350. 55 | 1950. 6 |
| | 33 | Washita river | 14. 50 | 365. 05 | 1893. 0 |
| | 34 | Near Canadian river | 20. 00 | 385. 05 | 2343. 2 |
| | 35 | First camp on Canadian river | 12. 25 | 397. 30 | 2392. 5 |
| | 36 | On Canadian river | 19. 00 | 416. 30 | 2302. 7 |

## [PORTION OF] APPENDIX B—Continued.

| Camp. | Name of station. | Viameter distance from— | | Altitude above the sea. |
|---|---|---|---|---|
| | | Preceding station. | Fort Smith. | |
| | | *Miles.* | *Miles.* | *Feet.* |
| No. 37 | On Canadian river | 15.50 | 431.80 | 2391.1 |
| 38 | ....do.... | 17.50 | 449.30 | 2500.6 |
| 39 | ....do.... | 11.75 | 461.05 | 2524.2 |
| 40 | ....do.... | 14.50 | 475.55 | 2676.6 |
| 41 | Last camp on Canadian river | 19.25 | 494.80 | 2865.3 |
| 42 | Antelope Creek | 18.37 | 513.17 | 3396.5 |
| 43 | Arroyo Bonito | 19.88 | 533.05 | 3528.8 |
| 44 | Beautiful View Creek | 20.75 | 553.80 | 3718.6 |
| 45 | Arroyo Amarillo | 19.75 | 573.55 | 4128.0 |
| | Llano Estacado | ---- | ---- | ---- |
| 46 | Rocky Dell Creek | 27.50 | 606.05 | 4207.0 |
| 47 | Near Halt Creek | 23.50 | 624.55 | 3980.5 |
| 48 | Branch of Fossil Creek | 22.25 | 646.80 | 4093.3 |
| 49 | Tucumcari Creek | 20.00 | 666.80 | 4191.8 |
| 50 | Laguna Colorado | 19.00 | 685.80 | 4541.6 |
| 51 | Pajarito Creek | 16.00 | 701.80 | 4701.8 |
| 52 | Hurrah Creek | 13.75 | 715.55 | 5034.3 |
| 53 | Sheep Springs | 23.00 | 738.55 | 5425.7 |
| 54 | Anton Chico | 6.25 | 744.80 | 5414.3 |
| 55 | Cañon Blanco | 22.75 | 767.55 | 6503.3 |
| 56 | Lagunas | 16.75 | 784.30 | 6995.5 |
| 57 | ---- | 17.25 | 801.55 | 6471.9 |
| 58 | San Antonio | 22.50 | 824.05 | 6624.1 |
| 59 | Albuquerque | 18.75 | 842.80 | 5032.8 |
| 60 | Atrisco | 0.88 | 843.68 | ---- |
| 61 | Isleta | 12.16 | 855.84 | 4945.1 |
| 62 | Rio Puerco | 22.78 | 878.62 | 5372.0 |
| 63 | Rio Rita | 18.30 | 896.92 | 5675.7 |
| 64 | Covera | 13.77 | 910.69 | 6280.4 |
| 65 | Hay Camp | 14.66 | 925.34 | 6440.4 |
| 66 | Sierra Madre | 17.71 | 943.05 | 7330.9 |
| 67 | Agua Frio | 8.06 | 951.11 | 7946.6 |
| 68 | Inscription Rock (El Moro) | 17.49 | 968.60 | 7413.9 |
| 69 | Ojo del Pescado | 14.23 | 982.83 | 6774.5 |
| 70 | Zuñi | 11.74 | 994.57 | 6354.9 |
| 71 | Arch Spring | 8.83 | 1003.40 | 6485.4 |
| 72 | ---- | 10.77 | 1014.17 | 6329.7 |
| 73 | Jacob's Well | 19.69 | 1033.86 | 6064.7 |
| 74 | Navajo Spring | 7.04 | 1040.89 | 5665.7 |
| 75 | Rio de la Xara | 12.13 | 1053.02 | 5557.6 |
| 76 | Rio Puerco of the West | 10.87 | 1063.89 | 5537.6 |
| 77 | Lithodendron Creek | 11.59 | 1075.48 | 5212.5 |
| 78 | First camp on Colorado Chiquito | 11.99 | 1087.47 | 5014.1 |
| 79 | On Colorado Chiquito | 14.42 | 1101.89 | 4775.5 |
| 80 | ....do.... | 8.63 | 1110.52 | 4747.5 |

## [PORTION OF] APPENDIX B—Continued.

| Camp. | Name of station. | Viameter distance from— | | Altitude above the sea. |
|---|---|---|---|---|
| | | Preceding station. | Fort Smith. | |
| | | *Miles.* | *Miles.* | *Feet.* |
| No. 81 | On Colorado Chiquito | 4.94 | 1115.46 | 4934.6 |
| 82 | ——do—— | 1.35 | 1116.81 | 5225.3 |
| 83 | ——do—— | 4.90 | 1121.71 | 4981.9 |
| 84 | ——do—— | 10.99 | 1132.70 | 4836.2 |
| 85 | ——do—— | 15.88 | 1148.58 | 4775.3 |
| 86 | ——do—— | 4.44 | 1153.02 | 4875.3 |
| 87 | Last camp on Colorado Chiquito | 1.51 | 1154.53 | 4928.6 |
| 88 | —— | 11.11 | 1165.64 | 5518.1 |
| 89 | Cohnino Caves | 14.61 | 1180.25 | 6298.2 |
| 90 | Near San Francisco Spring | 11.81 | 1192.06 | 6859.5 |
| 91 | Leroux's Spring | 10.46 | 1202.52 | 7450.6 |
| 92 | —— | 8.23 | 1210.75 | 7336.7 |
| 93 | —— | 6.17 | 1216.92 | 7216.9 |
| 94 | New Year's Spring | 8.54 | 1225.47 | 6767.7 |
| 95 | Lava Creek | 9.77 | 1235.23 | 6246.0 |
| 96 | Cedar Creek | 9.89 | 1245.12 | 5753.6 |
| 97 | Partridge Creek | 13.26 | 1258.38 | 5189.2 |
| 98 | ——do—— | 3.89 | 1262.27 | 5182.5 |
| 99 | ——do—— | 13.52 | 1275.79 | 5056.6 |
| 100 | Picacho Springs | 0.87 | 1276.66 | 4867.8 |
| 101 | —— | 7.45 | 1284.11 | 5241.3 |
| 102 | Turkey Creek | 8.69 | 1292.79 | 5548.6 |
| 103 | Pueblo Creek | 5.71 | 1298.50 | 5107.7 |
| 104 | ——do—— | 6.67 | 1305.17 | 5661.2 |
| 105 | Cañon Creek | 5.98 | 1311.15 | 5750.1 |
| 106 | ——do—— | 5.80 | 1316.94 | 5293.4 |
| 107 | ——do—— | 12.16 | 1329.10 | 4640.9 |
| 108 | ——do—— | 0.30 | 1329.40 | 4680.1 |
| 109 | White Cliff Creek | 11.29 | 1340.69 | 4711.0 |
| 110 | Cactus Pass | 9.64 | 1350.33 | 5182.0 |
| 111 | White Cliff Creek | 7.97 | 1358.30 | 3511.6 |
| 112 | Big Horn Springs | 11.60 | 1369.90 | 2760.9 |
| 113 | Mouth of Cañon Creek | 12.83 | 1382.73 | 2116.3 |
| 114 | Bill Williams' Fork | 9.21 | 1391.94 | 1845.4 |
| 115 | ——do—— | 4.35 | 1396.29 | 1722.6 |
| 116 | ——do—— | 6.21 | 1402.49 | 1563.3 |
| 117 | ——do—— | 4.08 | 1406.56 | 1501.6 |
| 118 | ——do—— | 6.10 | 1412.66 | 1433.1 |
| 119 | ——do—— | 5.56 | 1418.22 | 1343.4 |
| 120 | Mouth of Big Sandy Creek | 6.44 | 1424.66 | 1218.2 |
| 121 | First camp on Bill Williams' Fork | 6.52 | 1431.18 | 948.0 |
| 122 | On Bill Williams' Fork | 8.97 | 1440.15 | 851.0 |
| 123 | ——do—— | 6.83 | 1446.98 | 881.0 |
| 124 | ——do—— | 7.22 | 1454.20 | 674.2 |
| 125 | ——do—— | 3.90 | 1458.10 | 414.1 |

## [PORTION OF] APPENDIX B—Continued.

| Camp. | Name of station. | Viameter distance from— | | Altitude above the sea. |
|---|---|---|---|---|
| | | Preceding station. | Fort Smith. | |
| | | *Miles.* | *Miles.* | *Feet.* |
| No. 126 | Last camp on Bill Williams' Fork | 8.69 | 1466.79 | 325.2 |
| | Mouth of Bill Williams' Fork | 4.33 | 1471.12 | ---------- |
| 127 | First camp on Colorado river | 4.74 | 1475.86 | 272.0 |
| 128 | On Colorado river | 5.02 | 1480.88 | 224.7 |
| 129 | ------do | 9 06 | 1484.94 | 270.0 |
| 130 | ------do | 11.39 | 1501.32 | 370.0 |
| 131 | ------do | 29.87 | 1531.19 | 250.2 |
| 132 | Mojave villages | 1.02 | 1532.21 | 326.1 |
| 133 | Crossing of Colorado river | 9.46 | 1541.66 | 368.5 |
| 134 | On Colorado river | 0.33 | 1541.99 | 415.7 |
| 135 | Last camp on Colorado river | 2.78 | 1544.77 | 350.4 |
| 136 | ---------- | 20.71 | 1565.48 | 2109.3 |
| 137 | Pai-ute Creek | 9.06 | 1574.55 | 2745.8 |
| 138 | ---------- | 13.38 | 1587.93 | 4377.4 |
| 139 | Rock Spring | 6.66 | 1594.59 | 4938.8 |
| 140 | Near Marl Spring | 17.65 | 1613.23 | 3959.9 |
| 141 | ---------- | 16.41 | 1628.64 | 2220.1 |
| 142 | Soda Lake | 13.34 | 1641.98 | 1116.8 |
| 143 | On Mojave river | 12.31 | 1654.29 | 1239.3 |
| 144 | ------do | 12.94 | 1667.22 | 1700.9 |
| 145 | ------do | 11.18 | 1678.40 | 1980.6 |
| 146 | ------do | 19.48 | 1797.38 | 2225 7 |
| 147 | ------do | 22.37 | 1720.25 | 2555.4 |
| 148 | North of Cajon Pass | 24.47 | 1744.72 | 3539.7 |
| 149 | South of Cajon Pass | 19.43 | 1764.15 | 2623.4 |
| 150 | Coco Mongo Creek | 19.72 | 1783.87 | 1307.9 |
| 151 | San Gabriel Creek | 24.16 | 1808.03 | 354.5 |
| 152 | Los Angeles | 14.26 | 1822.27 | 457.1 |
| 153 | San Pedro | 23.00 | 1845.27 | ---------- |

EXPLORATIONS AND SURVEYS FOR A RAILROAD ROUTE FROM THE MISSISSIPPI RIVER TO THE PACIFIC OCEAN.

WAR DEPARTMENT.

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# REPORT

OF

# EXPLORATIONS FOR A RAILWAY ROUTE,

NEAR THE THIRTY-FIFTH PARALLEL OF NORTH LATITUDE,

FROM

# THE MISSISSIPPI RIVER TO THE PACIFIC OCEAN:

BY


## LIEUTENANT A. W. WHIPPLE,

CORPS OF TOPOGRAPHICAL ENGINEERS

ASSISTED BY

## LIEUTENANT J. C. IVES,

CORPS OF TOPOGRAPHICAL ENGINEERS.


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1853–4.

# LETTER TO THE SECRETARY OF WAR.

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WASHINGTON, D. C., *June* 30, 1855.

SIR: In conformity with your instructions, the accompanying report of explorations for "a railway route from the Mississippi river to the Pacific ocean" is hereby submitted to the department. As in many respects it differs from my previous communication upon this subject, I beg leave to make the following brief explanation. Upon my return from field duty, at the end of May, 1854, Congress, then in session, desired to obtain the principal results of the survey; and I was directed to furnish them before its adjournment. The mass of material collected was too great to be carefully looked over within the time specified, and it became necessary to make up a trace of the route by a superficial inspection of the notes and field computations. The remarks accompanying it were sketched in the same hasty manner. As for some months afterward no further information was called for, the assistants were discharged, and the work partially suspended. At the succeeding session of Congress, the Pacific railroad reports were ordered to be reprinted; and it was then suggested as proper to make a revision of the material, provided it might be done without delaying its publication. The astronomical positions, therefore, were revised, and the general maps reconstructed. Accurate profiles being of primary importance, the barometric observations, upon which they depend, were re-examined, and the altitudes of numerous additional points determined. These have been united with the field topography, making, for a portion of the route, a series of sketches, upon a scale of $\frac{1}{60000}$; thus delineating the proposed location for a railway, and giving approximately the natural inclination of the surface upon that line. Profiles have been constructed upon the same horizontal scale, showing the grades, and, roughly, the cutting and filling required to obtain them. These exhibit, upon certain sections, fewer difficulties than superficial examinations had led me to expect. The length of the line, determined by this trace, is less than that measured by the odometer, which followed many sinuosities and large deflections that, for a railroad, would be unnecessary. A barometric profile has been constructed through Campbell's Pass of the Sierra Madre, by which that mountain range may be crossed without a tunnel or deep excavation, with a maximum grade of fifty feet per mile, the summit level being 6,952 feet above the sea. This avoids the sharp crest where a tunnel was proposed, upon the direct route to Zuñi by the way of the Camino del Obispo.

The summit of Aztec Pass is found to be only 6,058 feet above the sea. With moderate excavation and embankment it can easily be surmounted.

The connexion with Lieutenant Williamson's survey, from Tah-ee-chay-pah Pass to Rio Mojave, shortens the length of the route to San Francisco, and avoids the Cajon Pass, with the expensive tunnel which it would require.

The above are some of the considerations which have led to a modification of nearly all of the approximate results previously submitted.

The material gathered upon the survey has required a diffusive report. It has, therefore, been divided into distinct parts, in order that the various subjects it embraces—each having its obvious and appropriate bearing upon the main purpose of the expedition—may be directly referred to.

In conclusion, permit me briefly to refer to the officers and assistants, to whose energy and scientific ability the government is mainly indebted for whatever there is of value in the information afforded by the exploration.

Lieutenant J. C. Ives, of the corps of topographical engineers, who was placed in charge of a separate party, devoted himself with great assiduity to the duties with which he was intrusted. His field labors in the magnetic and astronomical departments were unusually arduous, frequently, after a fatiguing march, occupying the greater portion of the night. Upon our return to Washington, with zeal and ability he aided in various branches of the scientific operations until selected to assist Captain Humphreys in the supervision of the work in the office of Pacific railroad explorations and surveys.

The scientific collectors, the civil engineer, and assistants, whose names are mentioned in the Itinerary, deserve great praise for the faithful and able manner in which their duties were performed.

The officers of the escort to the expedition were 1st Lieutenant John M. Jones, 7th infantry; Lieutenant J. C. Tidball, 1st artillery; and Lieutenant D. S. Stanley, 2d dragoons. Each, in his appropriate sphere, contributed greatly toward the success of our operations. The quiet and peaceful manner in which we passed through the various tribes of Indians, usually hostile toward Americans, is a proof of the sound discretion of those officers, and the good discipline of the men composing their command.

I have the honor to be, very respectfully, your obedient servant,

A. W. WHIPPLE,
*1st Lieutenant Corps of Topographical Engineers.*

Hon. JEFFERSON DAVIS,
*Secretary of War.*

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Lith. of SARONY, MAJOR & KNAPP, New York.

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from the left bank looking W. N. W.

EXPLORATIONS AND SURVEYS FOR A RAILROAD ROUTE FROM THE MISSISSIPPI RIVER TO THE PACIFIC OCEAN.

WAR DEPARTMENT.

ROUTE NEAR THE THIRTY-FIFTH PARALLEL, UNDER THE COMMAND OF LIEUT. A. W. WHIPPLE, TOPOGRAPHICAL ENGINEERS, IN 1853 AND 1854.

# ITINERARY.

WASHINGTON, D. C.

1854.

# ERRATA.

Page 31, line 39, for "captains" read *captives.*
Page 76, line 19, for "vocabularly" read *vocabulary.*
Page 82, line 16, for "improvisatore" read *improvisated.*
Page 99, line 51, insert a comma after "miles," and erase the comma after "stream."
Page 106, line 19, for "to Zuñi, to the Gila," read *from Zuñi to the Gila.*
Page 112, line 7, for "encampe" read *encamped.*
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Page 133, bottom line, for "D. J. Miles" read *D. S. Miles.*

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# INTRODUCTION.

## INSTRUCTIONS FROM THE WAR DEPARTMENT.

"WAR DEPARTMENT, *Washington*, *May* 14, 1853.

"Under the 10th and 11th sections of the Military Appropriation act, approved March 3, 1853, directing 'such explorations and surveys' to be made as might be deemed necessary to 'ascertain the most practicable and economical route for a railroad from the Mississippi river to the Pacific ocean,' the War Department directs such explorations and surveys to be made as will develop the availability for this purpose of that portion of our territory which lies near the parallel of 35° north latitude. The following instructions with reference thereto are issued for the government of the different branches of the public service:

"1. The party for this exploration and survey will be commanded by First Lieutenant A. W. Whipple, of the topographical engineers, who will be assisted by brevet Second Lieutenant J. C. Ives, topographical engineers, and such civil assistants as may be required and the Secretary of War approve.

"2. The Adjutant General will detail the necessary escort, transportation for the provisions and equipage of which shall be furnished by the Quartermaster General. Second Lieutenant D. S. Stanley, second dragoons, will act as quartermaster and commissary to this expedition.

"3. Upon the proper requisitions, officers on duty in the quartermaster and commissary departments at the various military posts upon the route will furnish, as far as possible, all necessary supplies, which will be paid for at cost prices from the appropriation for the survey.

"4. Medical stores will be furnished by requisitions upon the Surgeon General.

"5. Ammunition and arms may be obtained from the Ordnance department.

"This party being organized, will collect the necessary instruments and equipments. It will then repair to the field with the utmost despatch, and proceed with the survey and reconnaissance in question. The main party will rendezvous at some convenient point on the Mississippi river, and thence proceed by the most favorable route westward towards Rio del Norte. From hasty reconnaissances, and from such information as can be obtained from other sources, it may be determined from what point upon the river Mississippi the proposed railway should commence, and whether it may be advantageously connected with any railway already projected by States or companies westward from that river.

"The reconnaissance will continue along the headwaters of the Canadian, cross the Rio Pecos, turn the mountains east of the Rio del Norte, and enter the valley of that river at some available point near Albuquerque. From thence westward, extensive explorations must determine the most practicable pass for a railway through the Sierra Madre, and the mountains west of the Zuñi and Moquis countries, to the Colorado. In these explorations Fort Defiance can be made a depot for supplies, and may furnish subsistence and transportation thence for the remainder of the route. From Walker's Pass it would be advisable to pursue the most direct and practicable line to the Pacific ocean, which will probably lead to San Pedro, the port of Los Angelos, or San Diego.

"Lieutenant Whipple will immediately detail an officer, with a small party, to proceed

directly to Albuquerque, in New Mexico, in order to make that place a cardinal astronomical point in the survey, and to hasten preparations for the necessary explorations in the mountainous regions of New Mexico before the approach of winter.

"Over such portions of the route as evidently afford no material obstacle to the construction of a railway, a rapid reconnaissance will suffice. This work, however, must be checked by numerous geographical points determined by astronomical observations.

"Through mountain passes greater accuracy will be necessary, in order to determine (roughly) the grades and curves to be adopted, and the probable expense of their construction. Great attention will be given to those collateral branches of science which more or less directly affect the solution of the question of location for the proposed railway: the nature of the rocks and soils; the means of obtaining water upon arid plains—whether by tanks or artesian wells; the products of the country, animal, mineral and vegetable; its population and resources; its supply of timber and other materials for the construction of a railway; the location, character, habits, tradition, and language of the Indian tribes.

"Meteorological and magnetic observations will be attended to; the hygrometrical and electrical states of the atmosphere will be noticed; and all practicable measures will be adopted in order to develop the character of the country through which the party is to pass.

"On or before the first Monday of February next Lieutenant Whipple will report the result of his investigations.

"After the completion of the field-work, the party will be disbanded in California; the soldiers no longer required will be placed at the disposal of the commanding officer of that department; and Lieutenant Whipple, with such officers and assistants as he may deem necessary, will proceed to prepare for Congress a detailed report of the operations of the survey.

"The sum of forty thousand dollars will be set apart to defray the expenses of the survey intrusted to Lieutenant Whipple.

"JEFFERSON DAVIS,
"*Secretary of War.*"

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"WAR DEPARTMENT, *Washington, July* 25, 1854.

"SIR: You will, with as little delay as possible, furnish this department with a report of your operations, embracing—

"1st. A map exhibiting the actual line or lines surveyed by yourself and your assistants, on your late explorations to ascertain the most practicable route for a railway to the Pacific; and also a table showing the astronomical points determined for checking the lineal surveys, and the data upon which these determinations are founded.

"2d. A profile of the route traversed, marking each station where a height was ascertained, and a table of the results of the observations made with the barometer or other instruments, by which the relative heights of different points were determined.

"3d. A condensed statement of the character of the soil, the timber, the supply of water, and, as far as ascertained, the depth of snow in winter, for every section of the line traversed.

"For the immediate use of the government, the relative longitude and the relative heights of points along any given line are required. A discussion of the absolute longitude and heights, also the preparation of the natural history, geology, &c., may be deferred, without injury to the object now in view.

"The map and profile should indicate new routes or lines to be surveyed, and those heretofore surveyed, by which obstacles on the line followed may be avoided.

"Very respectfully, your obedient servant,

"JEFFERSON DAVIS,
"*Secretary of War.*

"Lieut. A. W. WHIPPLE,
"*Topographical Corps, Washington.*"

## PREPARATIONS FOR THE SURVEY.

Among the first of the preliminary duties required by the preceding instructions, were the organization of a party, and the collection of the necessary surveying instruments. The former was soon effected. So great was the number of applicants to the War Department for this work, that the services of many who had been most highly recommended were necessarily declined.

The following is a list of those employed:

| Name. | Residence. | Duties. |
|---|---|---|
| 1. J. M. Bigelow, M. D. | Ohio | Surgeon and botanist. |
| 2. Jules Marcou | Massachusetts | Geologist and mining engineer. |
| 3. C. B. R. Kennerly, M. D. | Virginia | Physician and naturalist. |
| 4. A. H. Campbell | Virginia | Principal assistant railroad engineer. |
| 5. H. B. Möllhausen | District of Columbia | Topographer and artist. |
| 6. Hugh Campbell | Texas | Assistant astronomer. |
| 7. William White, jr | Pennsylvania | Assistant meteorological observer and surveyor. |
| 8. George Gibson Garner | Maryland | Assistant astronomer and secretary. |
| 9. N. H. Hutton | District of Columbia | Assistant engineer. |
| 10. John P. Sherburne | New Hampshire | Assistant meteorological observer and surveyor. |
| 11. Thomas H. Parke | Pennsylvania | Assistant astronomer and computer. |
| *12. Walter Jones, jr. | District of Columbia | Assistant surveyor. |

A portion of the instruments required for our operations it was found a matter of great difficulty to obtain, in consequence of the recent outfit of parties for scientific explorations. Commodore Perry had just gone upon his mission to Japan; Captain Ringgold was completing his preparations to explore in the North Pacific ocean; Dr. Kane was in readiness to recommence his search for the lost ship of Sir John Franklin; and Governor Stevens, in charge of a party to examine the northern route for a Pacific railroad, had secured the few instruments of the kind referred to which the others had left. Every portable transit, magnetometer, and barometer, that could have been purchased in the shops, or borrowed from scientific societies and observatories, had been already appropriated for one or the other of these expeditions. The ordinary surveying and astronomical instruments were, as usual, furnished by the Topographical Bureau; but barometers we were obliged to have made for the occasion, and it was necessary to wait until they could be completed.

The needful preparations for transportation and subsistence were meanwhile progressing. In these operations we were greatly indebted to the Quartermaster General's department, for the aid and facilities it afforded. Major Crossman, at Philadelphia, gave the matter his personal attention, and in less than two weeks our wagons, tents, &c., were constructed and delivered to the railroad company for transportation to Cincinnati. In order that no time should be lost, Lieut. Ives immediately set out for New Mexico, by the way of San Antonio, Texas, and El Paso. At the latter place were a few astronomical, magnetic, and meteorological instruments, which having been deposited there by the Mexican Boundary Commission, were placed at our disposal by the honorable Secretary of the Interior. Having obtained these, Lieut. Ives was instructed to repair to Albuquerque, and there await the arrival of the main party; making, meanwhile, astronomical, magnetic, and meteorological observations, obtaining information of the country beyond, and completing such preparations as should facilitate our progress westward from that place.

On the 29th of May, the last division of the party left Washington for the Mississippi river and the frontier; a portion going by the way of New York city, in order to obtain the instruments that were there being completed. We then hastily proceeded to Cincinnati, where Lieu-

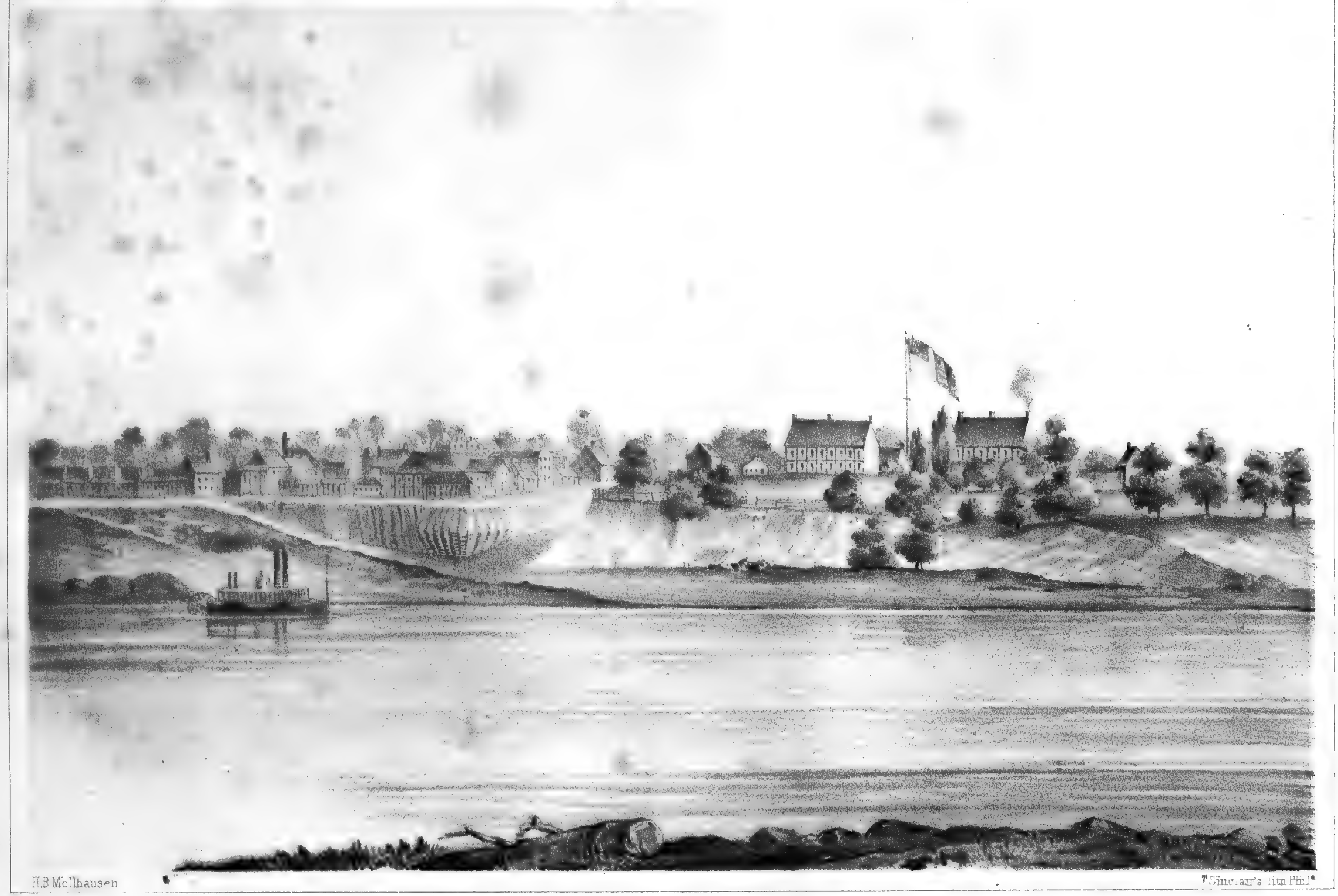
* Mr. Jones was taken ill soon after leaving Fort Smith, and was obliged to leave the party to return home. Mr. Abner C. Gaines, of Oregon, was then appointed to the vacancy, but served only a short time, when, for the same cause, he was compelled to resign.

tenant Stanley, the acting commissary, was purchasing stores for the subsistence of the party. To these were added a few presents for the Indians, from a small fund granted by the Indian bureau for this purpose.

Unfortunately the Quartermaster's supplies, sent by railroad from Philadelphia, had not yet arrived; but as an agent had accompanied the train to attend to them, and as the rapid falling of the river created fears lest navigation might be suspended, it was not deemed prudent to delay our own departure on that account. We therefore immediately took passage for Memphis. There we learned that the State of Arkansas had already given a charter for branch railroads from Little Rock, which would connect Memphis with Fort Smith, and that no doubt was entertained of the feasibility of constructing them. Special examinations within the State seemed unnecessary, and we therefore hastened by the way of Napoleon, Little Rock, and Van Buren, to Fort Smith; acquiring such information, and taking such notes, by the way, as circumstances would admit.

We arrived at Fort Smith on the 2d of July. Capt. Montgomery, the army quartermaster at that place, had, with great promptness and energy, made the desired preparations for our departure. The escort ordered from Fort Gibson had also arrived, under the command of First Lieut. Jno. M. Jones, 7th infantry. Nothing but the Quartermaster's stores from Philadelphia were wanting to enable us to proceed with the reconnaissance. While awaiting these, astronomical and meteorological observations were made, as a basis for future operations; and the geologist, the botanist, and the zoologist employed themselves in examining the surrounding country to obtain collections in their various departments. A special expedition was made to the summit of Sugar-loaf mountain, where meteorological observations were taken, and many interesting additions made to the scientific collections.

On the 11th of July, I learned by letter from Mr. White, who was in charge of the camp equipage from Philadelphia, that the boat on which the property was being transported from Cincinnati had run aground upon a sand-bar in the Ohio river. To remedy, as far as possible, the misfortune of this delay, we borrowed tents and wagons from Capt. Montgomery, proposing to proceed with the survey so slowly as to afford the party an opportunity to become acquainted with the duties which would be required of them, and enable our own train to overtake us when it should arrive.



H.B. Mollhausen

T. Sinclair's Lith. Phila.

FORT SMITH, ARKANSAS.

# PART I.

# ITINERARY.

## CHAPTER I.

### *From Fort Smith to Scullyville.*

**Commencement of the survey.—Thunder-storm.—Ring's plantation.—Scullyville.—Arrival of stores at Fort Smith.—Explorations in vicinity of the Poteau.—Visit to Fort Coffee.—Choctaw Academy.—Account of the Choctaws and their government.**

*July* 14, 1853.—From Camp Wilson, a few hundred yards south of the fort, the survey was commenced, with chain, compass, and level. The astronomical and barometric stations were connected with the town and with the flag-staff at the barracks. The chainmen and rodmen being ignorant of their duties, little more than teaching them could this day be accomplished. The parties at present are divided as follows: Mr. Albert Campbell, surveyor; Mr. Hutton, leveller; Mr. Sherburne, barometric observer; Messrs. Jones and Gaines, signal bearers; Messrs. Garner and Parke, astronomical assistants. Our astronomical instruments consist of two sextants of 8-inch radius, divided to 10″, by Gambey, of Paris; artificial horizons of Mercury; and three box chronometers, two of them old and much worn. With these, observations were made which gave for the position of Camp Wilson latitude 35° 22′ 55″ north, longitude 94° 29′ west of Greenwich.

*July* 15—*Camp* 1.—We struck camp, and moved south-southwest 10 miles, to Ring's plantation. The survey was continued with railroad transit, chain, and spirit-level. Descending the bluff bank, we crossed the Poteau river at the ferry, and proceeded through the dense forest that covers the bottom lands of the delta between the Poteau and Arkansas rivers. Upon overtaking the surveying party, progress was found to be so slow, on account of the thick undergrowth, that it became necessary to replace the level by a barometer. Being still obliged, however, to digress from the road, the hope of bringing up the survey to camp before dark vanished, and at the approach of sunset we entered an ambulance to follow the train. We had not driven far when the tongue broke, compelling us to leave the wagon and proceed on foot. To increase our troubles a storm came up, with thunder, lightning, and a flood of rain. Mr. Albert Campbell and Mr. Jones were my companions, the latter not yet recovered from a severe attack of fever. As the last glimmering of twilight faded away we reached an Indian farm-house where camp was to have been pitched, and found that the train had been conducted by the wagon-master to Ring's house, two and a half miles beyond. Resuming our march, the darkness, except when relieved by vivid forks of lightning, was so intense beneath the dense foliage of trees that twined their arched branches overhead, that we were obliged at every turn

NOTE.—The special descriptions of the topographical features of the country with regard to the construction of a railroad have been omitted from the itinerary and embodied in Part II of the Report. The itinerary is intended to give only a general sketch of the field operations.

to wait for the next flash to guide us. Through mud and pools of water we actually waded up to our thighs. Approaching the plantation, the road emerged from the low lands, and we ascended a gravelly ridge. On reaching camp, it presented the appearance of a bivouac, no tents being pitched. Some of the party had taken shelter from the pitiless storm within the comfortable mansion of the proprietor. Here were awaiting ourselves also a warm supper, dry clothing, and beds, which our unexpected walk prepared us to enjoy.

*July* 16—*Camp* 1, *Ring's plantation.*—The surveying party returned to the point where work was yesterday suspended, and continued their operations; but the water and mud were so deep that little progress could be made. The soil of the low lands is exceedingly rich and fertile, producing nature's spontaneous growth in tropical profusion. It is usually moist, being occasionally overflowed by freshets of the Arkansas. The numerous cultivated patches upon the roadside give promise of abundant crops. The higher country, commencing at Ring's plantation, is undulating, and beautifully variegated with woodland and prairie.

The western boundary of the State of Arkansas is 100 feet east of Fort Smith, between the barracks and the city which bears the same name. Leaving the latter we enter upon the country ceded to the Choctaw nation, where no white man can in his own right acquire a land-title or residence without permission of the Indians and their agents. Ring married a Choctaw woman, and in her behalf possesses a valuable estate. His house is built in Texas style, with a wide piazza in front and rear, united by a broad, open passage-way through the centre of the building. Doors upon the right and left lead to inner rooms. Within the yard is a well 40 or 50 feet deep, with excellent water, resting upon the coal measures. For his cattle and sheep, which he raises in considerable numbers, are other wells or springs. Some of his cattle we purchased for beef, at $10 per head. Good sheep cost $2.50 each. It is probable that the prices we were compelled to pay for necessary supplies were considerably above their ordinary market value.

The spring wagon was sent back to Fort Smith to be repaired. This evening a courier arrived with the mail. A letter from Mr. White informs us that he has transferred our stores from the steamboat aground in the Ohio to another of lighter draught. There is, therefore, hope of his arrival by the next mail-boat at Fort Smith.

*July* 17—*Camp* 1, *Ring's plantation.*—This day being Sunday, we have remained quietly in camp.

*July* 18—*Camp* 1, *Ring's plantation.*—The mud and pools of water, produced by Friday's storm, having dried sufficiently to allow of it, the survey to-day has been brought up to camp. Geological and natural history examinations have proved quite interesting in this locality.

*July* 19—*Camp* 2, *Scullyville.*—The survey passed across a ravine and over a hill, well wooded with excellent oaks, to an elevated plain called Ring's prairie. This was the first of those anomalies of nature that we had seen. It was probably a mile and a half wide, and several miles in length—appearing as if it had been cleared amid the surrounding forests by the hand of man. It was covered with rank grass, upon which herds of cattle were grazing. Over the smooth slope towards the northwest stretched the road leading to Fort Coffee. Our own route lay westwardly; and, passing over gentle hills and through wooded valleys, six miles from Ring's plantation we reached Scullyville, the seat of the Choctaw agency. The village consists of about thirty houses, most of which are stores, where the Indian may supply himself with articles of use or ornament. A pretty brook flows through the centre of the place, bearing the same name as the town itself, Scullyville, derived from the Choctaw "Iskuli-fehna," meaning *money*. As they are accustomed to visit the agency to obtain their annuities, the name was naturally suggested. Returning to camp after a walk to the agency, we found our friend Dr. Bomford, from Fort Smith. He has an extensive practice among the Choctaws, who, attracted by his kindness of manner, seem desirous of substituting science for the rude ceremonies of their medicine men. An express rider had also arrived from Captain Montgomery, with the

mail, and a letter from Mr. White, informing us of his safe arrival at the fort with the wagons and camp equipage.

*July* 20—*Camp* 2, *Scullyville.*—The arrival of the stores at Fort Smith rendered it necessary for me to return there. Having passed Ring's farm, I took the right-hand road, for the purpose of seeing a different route, and of crossing the Poteau at the ford. After entering the low lands several roads branched off, and it became doubtful which should be followed. A trial of several proved them equally muddy and miry. At length I saw a sign-board at a fork, and eagerly sought the information which it might afford. The following is a true copy of the inscription upon it: "McReans Feary at Bills Ford theare will Bee no Feary at the Fill place unteel Fall." There being no indication as to which road might lead to McRean's ferry, and both appearing to be travelled, I took the left at a venture, and, after driving in an easterly direction half a mile, reached the Poteau. The road skirted the left bank, through forests of excellent timber, for a couple of miles, to the ferry. Here the stream was narrow, the banks on either side being from twenty to fifty feet in height. Beyond the Poteau the ground became more elevated, and at a distance of about a mile to the east was the so-called "Long prairie." Passing this, and traversing a hilly country for a few miles, I at length arrived at Fort Smith, and found Mr. White, with the stores safely landed.

*July* 22—*Camp* 2, *Scullyville.*—Having completed the arrangements with the quartermaster, Mr. White and myself took leave of our friends at Fort Smith, and returned to this place. We crossed the Poteau at a different point from before, where carboniferous shales crop out, and the stream runs upon a bed of solid rock. A more excellent site for a bridge could not be desired. For a railway, it would be better to follow the eastern bank of the stream to this point; cross, and ascend the left bank of a westerly branch which is said to lead near to Scullyville. Thus might be avoided most of the low lands, subject to periodical overflow, and the hills near the village, which would cause heavy work. Over all the different routes traversed are seen the same superb forests, yielding timber of the finest quality.

*July* 25—*Camp* 2, *Scullyville.*—While waiting for the escort and the stores brought by Mr. White, the various branches of the survey have not been neglected. Mr. Campbell has made explorations in the vicinity of the Poteau, to determine whether it may be possible to avoid the hills by which this place is surrounded. He finds the country much more favorable in that direction, and, connected with it, a valley extending far towards the west. The Indians and traders tell us that this wide valley sweeps uninterruptedly west-southwest to the Sans Bois river. If so, the cost of grading for a railway would be almost inappreciable for perhaps fifty miles.

A series of hourly barometric and meteorological observations has been made, similar to those taken at Cincinnati, Napoleon, Little Rock, and Fort Smith, to ascertain the conditions of the instruments, and determine base stations for the survey. There have been made, also, astronomical observations to determine the geographic position of the camp.

A party has visited Fort Coffee, situated on the south side of the Arkansas river, and distant from here about six miles. It is no longer a military post, but an academy for Choctaw Indian boys. It is at present under the direction of Methodist missionaries, and in a prosperous condition. The system of education there pursued is highly practical, agriculture being one of the branches taught.

Captain Cooper, the Indian agent, breakfasted with us, and gave many interesting facts regarding the people whose interest he has in charge. The number of Choctaws is from fifteen to twenty thousand. They seem to be an honest race, and are rapidly acquiring the habits of civilization. Their welfare greatly depends upon the character of the person selected by the government as their agent. In this respect they have been favored. Their former agent, Mr. Wilson, was, as they say, like a father to them; devoting all his energies to improve their condition, he won their admiration and respect, and it was with extreme reluctance that they parted with him. Captain Cooper has been with them but a few weeks, but they fully appre-

ciate his gentlemanly deportment and kind manner, and anticipate a rapid march in improvement during his administration of their affairs.

At Napoleon, we first met Indians calling themselves Choctaws. They said, as well as we could understand, that they had been to Little Rock to draw their annuities, and were on their return to their homes in Mississippi. If this were true, it would appear that some imposition had been practised upon the government. They had certainly obtained money somewhere, which was fast finding its way to the whiskey shops. They were a merry set, decked out in ornaments such as the half-civilized admire; the most popular being a tall beaver hat, with wide silver band. Several were in an advanced stage of intoxication. The effect was, not to make them quarrelsome, but to excite mirth and good humor. The next morning one pleasant looking fellow complained that while he had been asleep in the street, his pockets had been picked, and his money stolen. But he added that it served him right; "Indian a fool to get drunk."

At Fort Smith the Indian trade is of considerable importance. Whiskey unfortunately forms a large item, and has the effect of limiting the prosperity of the Choctaws, and of the city, which to some extent depends upon them. As the sale of intoxicating drink is prohibited within the Indian country, numerous grog shops line the western frontier of Arkansas. It would be a blessing to the Choctaws if this trade could be prohibited.

Among these Indians are well-educated and well-behaved men. Mr. McKinney, whom we first met at Fort Smith on his return from Washington, is of this class. He was educated at an academy in Kentucky, and now resides at Scullyville. Yesterday, after having taken dinner in camp, he asked us to visit him at his house during the evening. Mr. Marcou, Mr. Campbell, and myself accepted the invitation. A pleasant walk of a mile, along a road leading through a dark forest of oaks, and occasionally opening upon a beautiful field, or Indian farm, brought us to our friend's residence. The out-buildings had to be passed before a view of the house could be obtained. It was surrounded by a fence, enclosing a garden, corn-field and orchard. It was built of one story, in the usual style, with a wide open court or passage through the middle. As we climbed the fence, both dogs and master greeted us. Entering the house, we found the floor carpeted; and the curtains, bed, chairs, and tables showed a respectable degree of civilization. Our host introduced us to his wife and children, all of whom were well dressed; and, though possessing dark skins and Indian features, by no means ill-looking. They asked us to be seated, offered us fruit, and received us with great civility. The eldest son, a handsome boy of ten or twelve, attracted our attention by his pleasing manners. He told us that he attended the Choctaw high-school, which is supported at the agency by private subscription. His studies are algebra, geography, history, and the usual attendant branches. The younger brothers showed themselves quite proficient in the mysteries of the spelling-book. Mr. McKinney gave us much interesting information respecting his tribe. He says it is but a few years since the people have begun to be satisfied with their country. It has been supposed that water would be difficult to obtain, and they are gratified to learn, from our geologist, that wells fifty feet in depth will generally afford a supply throughout this region. They are just commencing to appreciate the wealth of the soil which they possess. When first transplanted here, chills and fevers attacked them severely. Lately, either from being acclimated, or better provided with houses, and less exposed to the malaria of the low lands, sickness has not been so prevalent. The Choctaw nation is divided into four districts, each with an independent chief. The country ceded to them extends from the western border of Arkansas, south of the Canadian river, to the boundaries of the State of Texas. For the privilege of residing upon a portion of this territory, the Cherokees have paid a handsome sum. This the Choctaws have invested in stocks; the interest, $15,000 per annum, being appropriated to the support of free schools and academies. The one located at Fort Coffee has been already referred to. At Scullyville is a school-house, situated at the edge of a grove whose wide-spreading oaks shade a charming playground. Here congregate boys and girls of various ages, reminding one of a country school in

the States. On Sundays church services are performed there by the Rev. Cyrus Byington, who is listened to by a large and attentive congregation. Neither blood-thirstiness, nor cruelty of any kind, is characteristic of this tribe. There is no new country upon the frontier where theft and robbery are less frequent—where human life is more sacred. Persons ride alone and unarmed without fear of molestation, from one end of the Choctaw nation to the other.

On our return to camp, we learned from Captain Cooper that the great chief would deliver a speech to his tribe that evening, and that we were invited to be present. At an early hour we joined a party; and, crossing the brook, ascended to the store in front of which the crowd was gathering. It was amusing to see the fantastic dresses which seemed to designate the various grades in the process of civilization. There were some with naked limbs, who might have been taken for wild savages of the prairie. A portion wore loose shirts, with ornaments of beads, feathers, and rings. Others were gaily attired in calico wrappers, confined by rich wampum belts of their own manufacture. There were wrought hunting-shirts, beaded moccasins, and high-crowned hats with silver bands. A few had adopted the American costume, and seemed perfectly at ease in black coat, pants, vest, polished boots, and beaver hat. They might have walked unnoticed through any of our streets. Good feeling was exhibited between these various classes; there was no envy displayed on one side, no apparent consciousness of superiority on the other. All mingled freely, conversing generally in their native language, though some are actually forgetting it. In the schools, English is taught to the exclusion of Choctaw, and public opinion seems in favor of acquiring our language with our habits.

It became dark, and a lantern was suspended from the piazza in front of the store where the people were slowly and quietly collecting. An animated conversation was started, regarding the route most advantageous for the survey to follow. They seemed deeply interested in our operations, and eagerly desirous to have the railroad built through their territory.

At length the assembly was called to attention, and the chief, with great dignity, took his place upon the porch. He commenced his address in a musical voice, and well-modulated tones. Persuasive in manner, without apparent effort, he held the crowd in silent attention. But we, unfortunately, not understanding Choctaw, soon grew weary, and returned to camp.

## CHAPTER II.

### *From Scullyville to Delaware Settlement.*

**Arrival of the escort.—A new recruit.—Departure from Scullyville.—Long prairie.—Illness and return of Mr. Jones.—Sans Bois creek.—Gaines' creek.—Singular alternations of woodland and prairie.—Chickasaw village.—Coal strata.—Shawnee village.—Account of the inhabitants.—Mexican captives.—Visit to Little River settlement.—Shawneetown.—Favorable route from Coal creek to Boggy river.—Headwaters of the Boggy.—Delaware mount.—Old Camp Arbuckle.**

*July* 26—*Camp* 3.—Lieutenant Jones having arrived with the escort, and the necessary arrangements being complete, camp was struck early this morning with the determination of progressing with the survey. To pack the wagons, for the first time, with all the appurtenances necessary for so long a trip, was a labor of no little difficulty. Few of the party had the experience by which alone the knowledge of such matters can be acquired. While employed upon this work, there drove up, in a wagon drawn by two horses, an odd-looking individual, who claimed protection. He said that he had travelled across the country from St. Louis, intending to proceed to Texas, where his son was residing. In his wagon were dry goods, and he had in his pocket several hundred dollars. He stated that he had been followed for a long distance by some white men, whose behavior was so suspicious that he feared for his life.

As our wagons were packed to the bows, and many indispensable articles still lying upon the ground, we offered to purchase his wagon and horses, and employ him as driver to California. He gladly accepted the proposition. His goods were deposited in a shop for safe-keeping, the wagon was loaded, and the driver, who had been, in his day, Methodist preacher, merchant, and pedler, entered upon his new career with great zeal.

When about to take leave of Capt. Cooper, the herdsmen informed us that an Indian woman claimed our best cow, and was standing guard, with a stick, before the gate of the enclosure within which the animal was secured. Mr. Ring, from whom the purchase was made, denied the woman's right, and desired that the cow should be driven away; but the herdsman disliked to use force without orders; and, besides, they were surrounded by a great number of Choctaws, who might have taken the woman's part. On riding to the spot, all parties were found in a state of angry excitement, but they were told to let the matter rest till it could be submitted to the Indian agent. He at once decided in favor of the woman, directing Ring to refund the purchase money, and leave the cow to her till a fuller investigation should be made. The decision was annoying to Ring, who felt himself placed in a false light, or a bad one, by the termination of the affair. It was, however, pleasing to see that the first desire of the agent was to protect the rights of the Indians. Taking leave of Capt. Cooper, we followed the train; reading some Cherokee and Choctaw newspapers that had been handed us. One side of each, however, was in English, enabling us to perceive that they contained some clever articles.

The road traversed a country of well-wooded hills, with gentle slopes, and fine grassy prairies intervening. Farm-houses, surrounded by corn-fields and gardens, were thinly scattered upon the route. Having travelled ten miles, we encamped upon the edge of a woodland, by a small stream, and near a meadow of luxuriant grass. The surveying party had been directed to proceed southwardly from Scullyville, to a branch of the Poteau previously surveyed; and thence to enter and follow the Long prairie westwardly to the Sans Bois. But, from some misunderstanding, a branch of the Poteau has been ascended to the midst of wooded hills, that form the dividing ridge. The work has therefore been tedious, and is not yet brought to camp.

The hills and plains abound in excellent timber, principally of oak. Small streams, or pools of water, are found in numerous ravines, and the meadows are covered with grass.

*July* 27—*Camp* 4.—The train moved on five miles, and encamped, to await the surveying party, which had returned to bring up the work from the point where it was left yesterday. The face of the country is unchanged, consisting of hills and valleys covered with patches of fine woodland and beautiful lawns. The forests were difficult to penetrate, and the operations of the survey are, therefore, still many miles in rear.

*July* 28—*Camp* 4.—Leaving camp stationary for the day, a party returned to the point where the survey had been suspended yesterday. We found it in a ravine between a pile of hills upon one side, and a sharp ridge upon the other. Crossing the latter, we entered the famous prairie that the Indians had so often described to us. It is several miles wide, and extends eastward, without interruption, to the Poteau, which receives the drainage of its waters. Pursuing it for about five miles westward, it terminated in a forest, though the same valley still continued. Here, however, it was confined between the Sans Bois range of mountains and the hills of "Piney Grove," and thereby contracted to two or three miles in width. There was no way of avoiding this dense woodland, and it was with great difficulty that we succeeded in carrying on our operations. In the midst of the valley flowed a stream, near which were many Indian farm-houses, surrounded, as usual, by patches of corn and gardens. The residents could not speak English, and hence we obtained little information from them. They were kind and civil, however, willing to share with us their scanty stores of food. Having arrived at the house of one John, from whom we learned that the forest extended some ten miles farther before opening to a prairie, we suspended work, and returned to camp, which has remained unmoved during the day. This enables us to obtain observations for latitude and time, at the same place, on two successive nights, affording results for correcting the rates of our chronometers.

*July* 29—*Camp* 5.—Mr. Campbell, from fatigue and exposure, is sick to-day. Unable to ride his mule, he was compelled to take a seat in the ambulance, as the train moved from camp. The surveying party returned to John's house, and resumed operations. The forest was dense, and thickets covered the numerous rivulets so closely that it was difficult to make one's way through them. Having, with difficulty, accomplished five miles of survey through the valley, at a late hour we took an Indian trail leading northerly, in search of the road and camp. The path led up a steep hill called Piney Grove, about 500 feet in height, from which we had a fine view—the Sugar Loaf and Cheviot hills in the distance; the Sans Bois mountains nearer; and below, the forest valley, through which passes the line of survey. At the northern base of this hill is a wide lawn, and beyond sweeps a meadow, through which flows a tributary of the Sans Bois. Its sources are springs that gush from the hill-side, where a farm-house is situated. Camp we found about half a mile distant, near other springs of good water. The spot chosen was in the midst of a noble grove, delightfully cool, though not a favorable place for astronomical observations. But the night being cloudy, they were not attempted.

Mr. Walter Jones, jr., was taken quite ill soon after his arrival at Fort Smith. He recovered sufficiently to enable him to undertake the journey, but finds his strength unequal to the task. To-day he is again quite sick, and, completely disheartened, proposes to return home. Upon consultation with Dr. Bigelow, the surgeon, he has concluded to stop at Johnson's house till he can be carried back by wagon to Fort Smith. He will take passage home as soon as his health is sufficiently restored.

*July* 30—*Camp* 6.—Leaving Mr. Jones in charge of a servant, and of Choctaw women, who seemed disposed to afford him every necessary care and attention, we moved camp, and continued the survey. After progressing a few miles from the point of suspension yesterday, the forest became somewhat broken—there being here and there a spot devoid of trees. The scenery was beautiful—just wild enough to realize our ideas of an English park. At length the woods receded upon either hand, and an extensive prairie opened, leading the survey to Camp 6, which was pitched at a distance of six miles beyond Johnson's house. The survey thus far

shows that there is no great difficulty in selecting ground for a railway where the expense for grading will be very slight. Building materials, timber, and stone are found in abundance, and nearly upon the spot where required. But the labor of making an instrumental survey, so as to follow the exact line which should be selected, retards the progress of the work so much that we have concluded to adopt a more rapid system. Hence, to-morrow, we shall allow the survey to follow the general route of the wagons as a base of operations; and, whenever the ground becomes unfavorable, make explorations to the right or left, till the route by which the obstacles may be avoided can be reconnoitred and sketched.

*July* 31—*Camp* 7.—The survey was to-day carried on as proposed, following near the wagon road. Our route differs from Marcy's trail, which passes over high ridges to the left. Better ground evidently exists in the direction of the great valley of woodland and prairie, which is said to extend uninterruptedly from our last camp, by a more southern course, to the banks of the Sans Bois. But as the route we followed presented no great difficulty, it did not appear worth while to interrupt the progress of the survey to make a detailed examination. At a short distance from camp were a few Indian farm-houses and a blacksmith's shop. Finding the smith, whose name was Fraser, to be an intelligent man, and able to speak English, we employed him to accompany us. He gave much useful information about the country beyond the line of our explorations; detailing the courses of streams and chains of hills and mountains. He says that in his shop he burns native coal, which crops out in several places in the vicinity.

Our camp is in the midst of a tall forest, which lines the banks of the river Sans Bois. This title appears to be a misnomer, for the neighborhood affords most excellent timber. The stream, now shallow and fordable, flows between high rocky banks, bearing marks of water some twenty feet above the present level. But the cliffs afford good abutments, and stone of excellent quality for building material.

*August* 1—*Camp* 8.—With great labor we crossed the Sans Bois, the banks of which were exceedingly steep and slippery from recent rains. Keeping upon the slopes of the hills, in order to cut off a bend of the river, we crossed Cooper's creek, passed a small Indian village, and, following the crest of a low ridge for a mile farther, encamped by a large field of maize belonging to an Indian farm near by. No difficulty was presented to the survey. Mr. Marcou, the geologist, whose health has for some time been delicate, is quite ill, and thinks seriously of returning. Our camp, eight miles from the last, is by the side of a densely wooded ravine, through which flows a brook to the Sans Bois. The adjacent prairie has been closely cropped by herds belonging to the farms; and, for the first time, grass is not abundant.

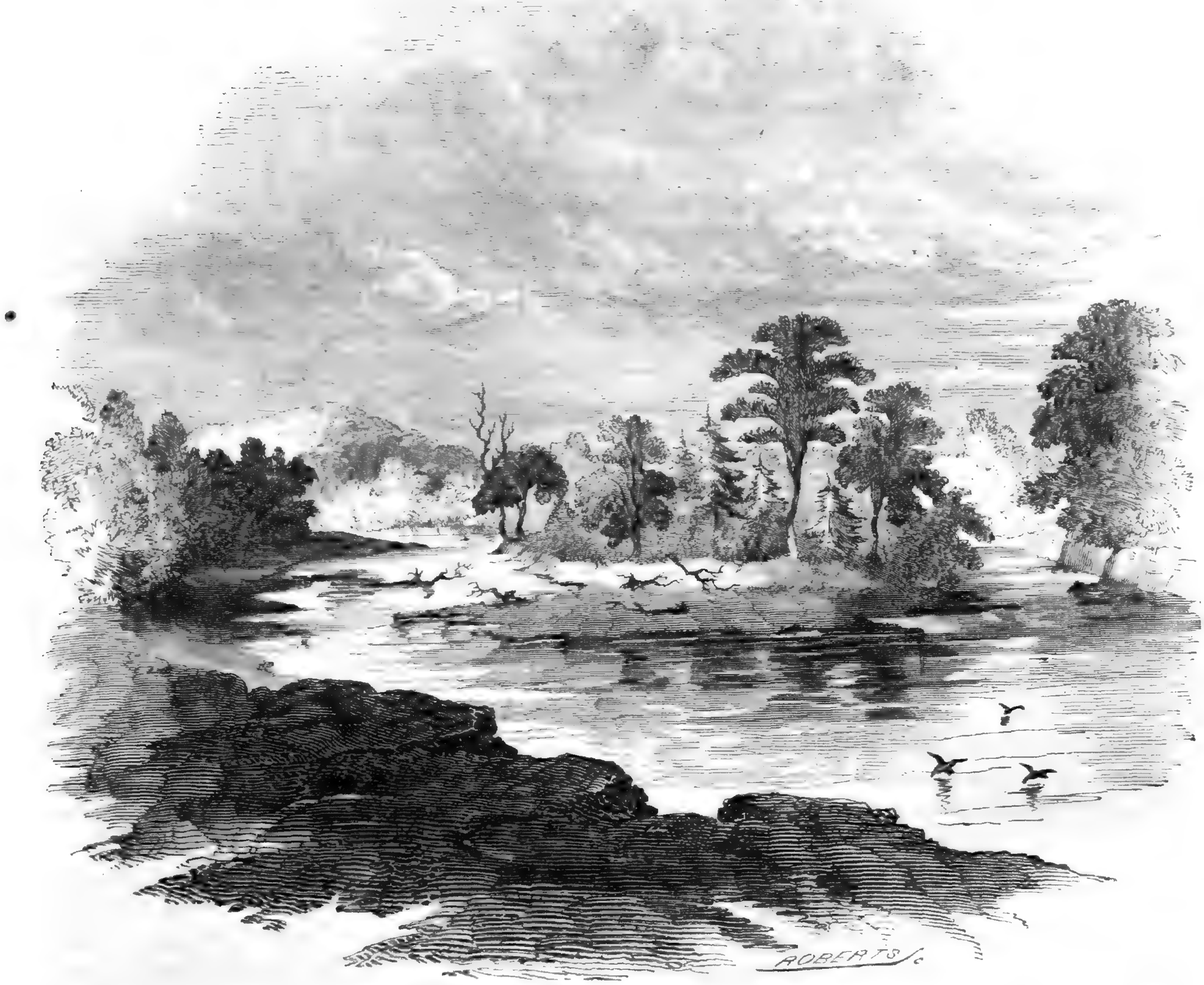
*August* 2—*Camp* 9.—Our route took us over eight miles of pleasant, well-watered, and fertile country. Choctaw settlements were frequently passed, indicating industry and thrift. Among them were several trading houses and stores, kept by Choctaws who speak no English. As we passed along, they stood by the roadside exhibiting various articles for traffic.

Near the termination of the day's march the road ascended a rocky hill, very steep, and several hundred feet in height. Keeping near the stream which flows around the southern base, the ascent could be avoided with no other inconvenience than that of passing through a thick chapparal.* That the road should have been chosen over the summit, instead of around the base, the distance being about the same, appears surprising. The reason probably is—and the same seems to have influenced the selection of most of the route from Fort Smith—that there was less timber to be cut away upon the hills than through the valleys; or the low lands were found soft and boggy during the rainy season.

*August* 3—*Camp* 9.—Our camp-ground being a fine one, upon a grassy prairie near a small creek called "Santa Rita," which, a few hundred yards below, empties into the Sans Bois, it was thought best to remain here during the day and make explorations. Some of the surveying and reconnoitring parties employed themselves in plotting their notes. The astronomical and meteorological assistants carried on their computations; while another division, taking the

* A term applied to a dense growth of bushes or small trees.

guide, explored in a northerly direction, twelve miles, to the Canadian river. Two ranges of mountains, or rather high hills, were crossed between camp and the Canadian. The valley of the river is several miles in width. The stream itself, at the mouth of "Long-town creek," supposed to be some twenty-five miles above the junction of the Canadian with the Arkansas, is about 360 feet broad. The water flows sluggishly; is of a whitish color, nearly clear, and less than knee-deep. In the valley are great numbers of large hickory trees, cedars, and oaks. An interesting collection of plants, shells, and fishes was obtained at this place.




Canadian river, at the mouth of Long-town creek.

*August* 4—*Camp* 10.—Desiring to make greater progress, we had the tents struck at daybreak, but to little purpose. The road proved exceedingly rough, being crossed by deep gullies, worn by the rains that had washed from the hills to the Sans Bois, upon our left. To repair it would have occupied too much time, and two wagons were broken while pitching down one of these hollows, producing a long delay. Passing into the bottom lands belonging to Gaines' creek, the foliage of the forest seemed too dense to allow the sun to warm the earth or evaporate the moisture, and the road was one long succession of miry sloughs and muddy pools. Having travelled seventeen and a half miles, we encamped upon La Honda, a branch of Gaines' creek. The survey had made good progress over ground favorable for a railway. The distances were

measured by odometer, and the party arrived at camp before dark. Being surrounded by tall trees that formed almost a canopy of foliage, the observations for latitude and time were few and unsatisfactory.

*August* 5—*Camp* 11.—Crossed La Honda, and a quarter of a mile beyond, forded Gaines' creek. Continuing through the forest, we passed a village of Choctaws, and camped at a walled spring near the farm-house of Stephen Perry. The country is beautiful, and the soil fertile. Wherever a seed is sown, it produces a rich harvest.

Fraser, the guide, learning that his child had been taken ill, took leave of us with a sad countenance to return home. At sunset, Stephen Perry arrived from the Perryville races. He speaks English fluently, and gave an amusing description of the festival he had attended. He is a complete Indian in color and features, but claims to be of mixed blood—Chickasaw, Choctaw, and white. Upon his farm are several negro slaves, who seem to have the principal management of the estate, buying and selling, and as close at a bargain as if the profits were their own. They appear healthy and happy; the children especially so. No work is required of them till they arrive at the age of ten or twelve, and even then their duties are light. This evening we were favored with a heavy shower, during which there fell 2.5 inches of rain.

*August* 6—*Camp* 12.—Finding a Shawnee Indian at Perry's store, we induced him to accompany us as far as the first Shawnee village, about 25 miles distant. He possessed a portly figure; and, upon the route, the only occasions upon which he seemed to deem his presence necessary with the train were during meals, when he never failed to claim his ration. He was so dignified and reserved, that it was some time before we discovered that he could speak English. The survey proceeded very well. A high ridge was crossed which might have been avoided by turning to the left. With this slight detour, the route for a railway would be nearly level.

*August* 7—*Camp* 13.—We moved on, six miles, to Long Pond creek, where we are encamped. The country traversed by the survey was quite hilly, though not decidedly unfavorable for a railway. Woodlands occur both upon the heights and in ravines. The prairies also are more undulating than they were east of the Sans Bois. The regular occurrence of these prairies throughout so great an extent of forest country, is a phenomenon which I have not heard satisfactorily explained. There appears to be no radical difference of soil to produce it. Their alternations with forest seem independent of locality or exposure to winds. They exist equally upon the hill-tops, the slopes, and in moist valleys. They occur too regularly, and are of too limited an extent, to have been produced by fires.

The stream upon which we are encamped, in its course towards Coal creek, is obstructed by ledges of rock, producing long and deep reservoirs of crystal water, abounding in fish. It makes a capital bathing place.

*August* 8—*Camp* 14.—Leaving camp, the road soon led us to bad hills. Mr. Campbell and myself rode several miles upon both sides of the trail to reconnoitre; and found that by keeping south, near a branch of Coal creek, a more level route could be traced. Arriving at a small Chickasaw village, we obtained, from an Indian, information about the country, which corresponded with our own views. He told us that he had lived in this place seventeen years; that the road had been opened over the hills and ridges for the purpose of avoiding the soft miry ground during the wet season upon the rich bottom lands near the streams. The trail followed by our wagons, therefore, presents features more unfavorable for a railroad than others that could be selected. Having surveyed ten miles by the road, we encamped upon a branch of Coal creek. This stream is rightly named, for the coal-bearing strata are seen throughout its course. The whole region from Fort Smith, being of the carboniferous formation, is believed to be rich in bituminous coal. The inhabitants speak highly of it; and, judging from use in our blacksmith's forges, it seems to be of excellent quality. Sandstone and limestone sufficient for the construction of bridges and viaducts occur in many parts of the route.

Our Shawnee traveller, "Wen-the-eh-bih," returned from the village, bringing with him a large deputation from his tribe, laden with fruits, melons, and other articles of traffic. Learn-

ing that there was an exceedingly bad hill a mile or two ahead, we accompanied him to examine it. The report was not exaggerated. A long ridge, five hundred feet in height, called the Shawnee Hills, was found, extending southwest from the Canadian. Upon a spur of this ridge the road ascended at an angle of elevation varying from thirty to forty-five degrees, over rocks and ledges of sandstone. The guide knew no way of avoiding it, but had been told by Shawnee hunters that it could be turned by traversing the forest south. Returning to camp through the edge of a wood, we encountered a flock of wild turkeys, the largest we had seen. There must have been many hundreds.

*August* 9—*Camp* 15.—Last evening a partial engagement was made with a Shawnee hunter to guide us south around the ridge, but this morning he was not to be found. Having therefore sent the train and the base line of survey by the road, Mr. Campbell and myself ascended a branch of Coal creek, north and northwest, to its source in the mountains. Thence we crossed, by the lowest divide we could find, a sharp sandstone ridge, to a small stream, which, crossing westwardly, joins Shawnee creek and flows into the Canadian. A heavy grade, and a deep cut or tunnel from 500 to 1,000 yards in length, would probably be required at this place to unite the two valleys. But all this might, doubtless, be avoided. Every indication corroborates the Shawnee report of the country to the south, between the waters of Coal creek and the Boggy; and the route examined was so unfavorable that we determined to find a proper guide, and make the reconnaissance referred to. Following the western slope of the hills, we found a trail which led us through thick woodlands, until, having crossed the valley of the stream, we entered the Shawnee village. A large peach orchard, whose trees were loaded with fruit, first met our view. Houses, surrounded by gardens, orchards, and fields of grain, were scattered along the banks of a clear rivulet. Upon reaching the road we found the advanced party of the survey; they were waiting for the train, and refreshing themselves with melons at a comfortable looking farm-house. The Indian men were robust and intelligent; and the women, dressed in neat calico frocks, with silver ear-rings, and brooches of Shawnee manufacture, were by far the best looking of their race that we had ever seen. Some of the young girls were almost white, with regular and pretty features. But an indication of the savage appears in the fact that the women perform the duties of the field as well as of the household. They break the soil, plant, gather the crops, and grind the corn. Most families, however, are provided with negro or Mexican slaves. In such case, these relieve the mistress of the more laborious duties. The Shawnee men hunt deer and shoot turkeys, but are too lazy and too proud to work.

Upon the arrival of the train we found that the road had proved even worse than had been anticipated. At one place the wagons had to be let down a precipice by ropes. One of them was upset, and an Aneroid barometer was broken. Proceeding about a mile beyond the village, we encamped upon the bank of a pleasant stream flowing towards the Canadian.

*August* 10—*Camp* 16.—Descending the bank of the stream, a wagon was upset, and the tongue broken. As it would take some time to repair it, a party travelled ahead with a Shawnee guide to examine the country. The way continued rough, though decidedly better than it was yesterday. The scenery was fine, and many settlements were visible from the roadside. Approaching some hills, there appeared a new road. The guide told us that it had been built by the Shawnees, and not only avoided hills, but was more direct. It proved to be about two miles long, passing various Indian farm-houses. It was cut through a dense forest, was nearly straight and level, with the gullies bridged over. We had not supposed that these Indians possessed the energy, skill, and public spirit necessary to construct so good a work. Having reached the old trail, we found a shady spot in a green valley, and there waited for the train to come up. Meanwhile Jim amused us by relating some of the habits and customs of his tribe. Afterwards he inquired whether the ground would burn; not the grass, nor leaves, he said, but earth and gravel; and stooping, he gathered a handful in explanation. He wished to know, to test the truth of a story that had been told him by a Delaware, who pretended to

have seen, towards the southwest, a burning mountain, from which smoke and flames had issued for three years. The story is, that the Delaware, while pursuing a bear, followed him into a cave; taking a torch with him, he planted it in a crevice, and, after shooting the bear, left it there burning. From this the ground took fire, and could not be extinguished, and the earth occasionally crumbles and falls in. If this be not an entire fabrication, it is probable that the cave penetrated a vein of bituminous coal.

The train came up, and after a march of 8.5 miles, we encamped upon a small creek. Here, through the kindness of Captain Montgomery, we received, by express, the mail from Fort Smith. Mr. Rogers accompanied it, hoping to obtain permission to join our expedition; but the party being complete, it was impossible to comply with his request. This evening, from the loquacious Jim, a vocabulary of the Shawnee language was obtained.

*August* 11—*Camp* 17.—Our route to-day passed over an interesting region; more thickly settled, and better cultivated, than any seen since leaving the Choctaw agency. A few miles from camp we left on our right the road leading to Little river, and soon afterwards were in a labyrinth of trails. We inquired of an Indian for the right road, but gained little satisfaction. We doubted whether he understood our wishes, for the few replies his taciturnity allowed him to utter seemed to denote that any one would answer our purpose. At length he intimated that we might as well follow him. He was mounted upon a spirited horse, and our poor mules were somewhat jaded, but we managed to continue a pursuit for about a mile, and then arrived at an opening in the forest where were cultivated fields and a few houses. Our Indian friend, being now at home, laid aside his dignity, and became quite communicative. He conversed fluently in English, but surprised us more by addressing a good looking lad in Spanish. Upon inquiry we found that the boy was a Mexican captive and slave. Speaking in Spanish, he told his own story in few words, for his master appeared jealous of his holding intercourse with strangers. He called himself Pablo. He is the son of Manuel Melendez, of the city of Durango. His mother's name was Guadalupe Gonzales. When very young he was stolen from his friends by Comanches. How long he remained with them he does not know; but three and a half years since, he was purchased from them by an Indian trader, and sold to this Shawnee. He appears to be ten or twelve years old, and is nearly as dark as an Indian. He speaks Spanish with ease. He seems quite happy in his present condition, but says he would prefer to return to his parents. Another "Spanish boy," as they are here called, lives with Johnson, a Shawnee. Several are owned by Jesse Chisholm, the famous Cherokee guide. One of these captive boys is valued at two or three hundred dollars. Nearly all of the more wealthy Indians of this country—Shawnees, Creeks, Chickasaws, Choctaws, Cherokees, and Delawares—possess either African or Mexican slaves.

Upon inquiring of our host the direction to Shawneetown he seemed nonplussed. After a while, however, he made us understand that we might already consider ourselves within its precincts. The numerous paths are, as it were, streets, uniting the various houses of this extensive if not populous place. From one house to another the distances vary from a few hundred yards to half a mile. Taking the direction indicated, we passed through the town, with its numerous cultivated fields and gardens, to a small rivulet, some miles beyond, where we found the train encamped. The road had proved rough and rocky, shattering the wagons and breaking king-bolts. One broken wagon was left behind for repairs. The distance from the last camp is but ten miles. Dr. Bigelow, Mr. Marcou, and some others made a detour of about a mile to the Canadian; and, crossing to the opposite side, visited the flourishing settlement and trading post called Little River. It is pleasantly situated upon the banks of the river where a stream bearing the same name as the town flows into the Canadian. Some interesting collections were made there. Fossil shells were found belonging to strata below the coal formation. In the vicinity are fragments of several Indian tribes. The "Quapois," according to Shawnee authority, are the remnant of a tribe formerly from Mississippi; but for some time they have lived a roving life, and lately moved hither from the West. Their lan-

guage differs from that of either of the neighboring tribes. To-day we saw two Indians quite unlike those previously noticed. They were Creeks. One was a lad, with face and features almost Grecian. He was dressed in a buckskin hunting-shirt, with a fringed wampum belt around his head. By the side of a clear rivulet, in a nook sheltered from the noonday heat, he was reclining upon the limb of an oak with perfect grace and Indian dignity, presenting an admirable subject for a sketch.

*August* 12—*Camp* 17.—Have not moved camp for various reasons. Wagons needed repairing. There were king-bolts to be made at Little River, and a guide to be sought. The people of the country seem to consider the latter indispensable to the success of our operations. Perceiving that great advantages might be derived from information such as a guide should possess, before leaving Fort Smith a messenger was sent to engage Black Beaver, a Delaware chief, who, however, declined the service. Since then we have sought for Jesse Chisholm, celebrated as a bold guide and good Indian interpreter. His services we hope to secure by waiting a day or two, in order to communicate with him. He has gone to hunt for lost horses, and is expected back to-morrow.

While the surveying parties were at work computing and plotting the notes, I rode to Shawneetown in search of a guide to accompany an exploration back from the waters of the Boggy, passing south of the Shawnee hills, to Coal creek; but no one could be found willing to undertake the trip. Having returned to camp, observations were made for latitude, longitude, and magnetic declination of the needle.

*August* 13—*Camp* 17.—Our wagons are not yet repaired, nor the necessary king-bolts made, so that we have been compelled to wait another day. The reduction of the field-notes has been continued. This afternoon an Indian came into camp who claimed to be a nephew of Black Beaver. He professes to be well acquainted with the country south of the Shawnee hills, and says that to-morrow he will conduct us by a smooth and direct route from our camp on the Boggy to Coal creek.

*August* 14—*Camp* 18.—The train resumed its march westward. The expected guide not making his appearance, Mr. Campbell, Dr. Bigelow, and myself returned to Shawneetown, hoping to find him; otherwise, intending to make the explorations to Coal creek by ourselves. We learned, however, that a Shawnee named Johnson, a great hunter, knew something about the country in question. Following such trails as were indicated through the forest, we at length reached Johnson's house, and fortunately found him at home. He agreed to accompany us, and we set out. We travelled for two miles down the valley of the Boggy, and turning eastward crossed several ravines and rivulets of that stream. Thence a gentle ascent led to the top of a ridge, from fifty to one hundred feet in height, which formed the divide. The country beyond appeared still undulating, with alternate woodland and prairie. Without difficulty we continued our route till, from an elevated spot, the guide pointed over an apparently level prairie to the line of Coal creek. Having verified our position and taken a sketch, we returned by a different and equally favorable route to Johnson's house, where supper was prepared, and we were hospitably entertained for the night. Johnson seems to be a good specimen of the Shawnee farmer. He has several fields of maize, squashes, and beans. Adjoining the house is a magnificent peach orchard, whose trees are bent down by their burden of fruit. The farm is well stocked with horses and cattle. We saw the Mexican captive boy before referred to, but Johnson refused to sell or part with him.

Our exploration had been perfectly satisfactory. By the route that we examined a wagon road could easily be cut, shortening the distance from Coal creek to the Boggy five or six miles, and avoiding the Shawnee hills. For a railway the country is highly favorable, both as regards grade and curvature. Light excavations and embankments will be required. Sandstone and timber are abundant. Were we again to traverse this region with wagons, it would be easier to construct a new road through the country specified than to follow the old trail.

*August* 15—*Camp* 19.—Our guide proposed to accompany us as far as the Delaware settle-

ment at Beaversville. At his suggestion, instead of following the train we kept the dividing ridge between the Canadian and the headwaters of river Boggy, in order to avoid bad cañons said to exist on that stream, and the hill at Delaware mount. Winding from spur to spur of this ridge, it appeared that with considerable labor of excavation and embankment, a route for a railroad, with light grade, might follow the ridge. Beyond, we reached an undulating prairie, which extends, with a generally level surface, to Delaware settlement. Night approaching, we sought camp. Turning south, we passed to the bluff edge of the high prairie, and enjoyed a fine view of the wide basin where several branches of the Boggy take their rise. Through the trees we had had frequent glimpses of the valley during the day, and saw no reason why it could not be crossed. Now it appeared like an extensive plain, watered and fertilized by streams fringed with trees, and stretching southeast to the blue horizon. Descending from the hills, we entered the trail, and followed it about three miles, to camp. The train had travelled twenty miles across the bottom lands, then ascended the Delaware ridge, about fifty feet high, to the prairie referred to. The survey had been quite satisfactory, and the route highly favorable for a railway.

From Shawneetown we have traversed the lower carboniferous formation. Delaware mount is composed of limestone, affording a beautiful building material and quick-lime.

*August* 16—*Camp* 20.—Travelled to-day about twelve miles, passing over a moderately hilly country, and crossing various small streams, tributaries of Topofki creek. The main stream itself bears evidence of being at times a large river. It is now but a thread, winding through a gravelly bed thirty feet in width. Most of the branches showed water only in pools. Passed in sight of the third Shawnee village. Many well-mounted Indians have been in camp, bringing the produce of their fields for trade. A sick soldier was sent to Fort Arbuckle, guided by an Indian. During this day's march the lower carboniferous group gave place to the new red sandstone or Trias.

*August* 17—*Camp* 21.—Soon after leaving camp we emerged from the woodlands and entered a magnificent prairie that seemed to extend north to the Canadian. For several miles the course was west, over an almost level plain. Beyond, the country swelled into gentle hills, with wooded ravines, one of which we followed to the site of old Camp Arbuckle. The troops have been removed to Fort Arbuckle, on the river Washita, thirty miles distant in a southwesterly direction, and have left their log houses in possession of about a hundred Delaware Indians, with Black Beaver for their chief. We halted upon a creek beside the village, fourteen miles from our last camp. On account of the dryness of the season, this stream, which usually flows north to the Canadian, now contains water only in pools. At the edge of a forest a mile distant, Black Beaver says there is plenty of good water.

## CHAPTER III.

### *Delaware Settlement to Oak Creek.*

Difficulty of procuring a guide.—Jesse Chisholm.—Accounts of the Delawares: their rites and ceremonies.—Remarks regarding the Comanches and other tribes.—Straying of animals.—Discovery of a comet.—Mexican captives.—A Delaware carousal.—Return of Mr. Gaines.—Prairie on fire.—Cross Timbers.—Huéco Indians.—Vincente, the interpreter.—Kichai guide.—Branches of Walnut creek.—Finely timbered valleys.—Fertility of the soil.—March interrupted by burning prairies.—A norther.—Deer creek.—Buffalo crossing.—Rock Mary.—Gypsum creek.—Bear creek.—Valley of False Washita.—Elm creek.—Comet creek.—Silver creek.—Marcou creek.—Oak creek.

*August* 18—*Camp* 21.—We have now traversed the whole extent of country occupied by the semi-civilized Indians of the Choctaw nation, and are upon the verge of the great western prairies, over which wild savages hold almost undisputed sway. We are informed that the season has been remarkably dry; many streams and springs, usually unfailing, being now waterless. The Canadian river is uncommonly low; and Black Beaver apprehends that we shall suffer on the trip before us, for the want of water. It is desirable, therefore, at this place to make every arrangement, and take every precaution, to avert such a calamity as might interrupt the operations of the survey. We shall, therefore, remain here till our mules, which are becoming tender-footed, can be shod, and a guide, if possible, be obtained. By the advice of the officers at Fort Smith, a messenger was sent to Black Beaver, some weeks since, to try to secure his services. He is the only Indian of the country who has traversed the route we propose to take, near the valley of the Canadian. But he is in ill health, and no inducement can prevail upon him to accompany us. Johnson, the Shawnee guide, who has given satisfaction thus far, refuses to continue the trip, for fear of the savages. Our only dependence, therefore, is upon John Bushman, a Delaware guide of some celebrity, and Jesse Chisholm, the Cherokee. Both have been sent for. Their knowledge of the prairies would doubtless enable them to find water in cases where the inexperienced would fail.

The various parties of the survey have been employed in computing and plotting their field-notes, and in making scientific collections. Meteorological and barometric observations are kept up during the day; and astronomical observations, as usual, at night. Bushman has arrived; and after much persuasion, agrees to accompany us for two dollars and fifty cents per day.

*August* 19—*Camp* 21.—Bushman has receded from his engagement. He says, "Maybe you find no water; maybe you all die." Impressed with this idea, no persuasion, no argument, no money can prevail upon him to undertake the journey. Chisholm, who has arrived, also declines the service. He is a man of considerable wealth, and extensively engaged in trade. In the prosecution of his regular business, he could realize twice the amount the government would be willing to pay for his services. His determination is to be regretted the more, from the influence he possesses with the wild tribes westward. He is a man of excellent judgment, and has travelled much among the western savages. At the great Indian council, held about six weeks since, he was selected as the general interpreter of all: Comanches, Kioways, Kichais, Creeks, Delawares, Shawnees, Chickasaws, and Choctaws. He has traded with, and been much among the Comanches, and understands not only their language, but their manners, customs, and ceremonies, probably better than any one not belonging to their tribe.

A vocabulary of Comanche words has been carefully compiled, according to his pronunciation.

Finding that Chisholm would not accompany us, we visited Beaversville to learn from its chief

what he might be able to communicate respecting the country we propose to traverse, and noted his remarks regarding the various springs and streams supposed to exist. His opinion was, that, generally throughout the year, water would be found in abundance upon this route; but, on account of the remarkable drought, our chance of finding a supply would be exceedingly doubtful.

There are said to be five hundred Delawares living upon the Canadian. Black Beaver admits that they are less advanced in civilization and arts than those of the tribe who reside in the country allotted to them; but he considers that region too cold. Considerable intimacy exists, and intermarriages occur, between the Shawnees and Delawares. There is also some resemblance in personal appearance, both wearing the moustache. A vocabulary of the Delaware language was obtained and verified as carefully as the patience of our interpreter would permit. Black Beaver pretended to know but little of the superstitions of his people, and did not have much faith in them. "In fact," said he, "sometimes I believe, and sometimes I don't." His tribe, like the Creeks, have their priests or medicine men; who, having been warned by a dream, put on the sacerdotal robes, and minister at the sacred fires. Once a year, with great ceremony, this fire is renewed. It is then constantly kept up by the priests, who are paid a sort of tithe; each man giving, according to his means, a horse, a cow, or of the produce of his fields. The medicine men pretend to cure diseases and foretell events.

*August* 20—*Camp* 21.—By the carelessness of the herders, the mules were allowed to stray, and fifty were reported lost. Parties were immediately despatched from camp in various directions to search the woods and prairie, and before night all but three were recovered. Mr. Gaines and the wagon-master are ill to-day. The former thinks his health too precarious to allow him to accompany us farther; and proposes to proceed to Fort Arbuckle, and there remain till he has sufficiently recruited to return home.

*August* 21—*Camp* 21.—The beef-cattle, purchased of Chisholm, broke from the corral and escaped from the herders last night. Another day was required to secure them. An ineffectual search has also been made for the three lost mules. White men make indifferent herders. For taking care of mules, one Mexican peon is worth half a dozen of them.

The official reports to the government have been put in charge of Mr. Warren, who returns from this place to Fort Smith. He also takes the zoological collection, to forward to the Smithsonian Institute. Arrangements have been made to enable Mr. Gaines to go to Fort Arbuckle for medical attendance.

This evening a comet was discovered about 15° above the horizon, and 12° north of west, with a vertical train directed towards the zenith. It was too low to allow its altitude to be taken by a sextant and artificial horizon, but its distances from Jupiter, Arcturus, and Polaris, were observed. The nucleus was about the size of Jupiter, but as faint as Venus after daybreak. The train was bright, extending about 1½ degrees.

During the regular astronomical observations many brilliant meteors were seen. For a few nights past we have noticed an increase in their number.

It has been already mentioned that Chisholm possesses several Mexican captives purchased from the Comanches. Their names are, Vincente, son of a man called Demensio, from Parras, and formerly of Tinaja; Mazimo, Guadalupe, Cidro Canales, and Mariana Transito. Besides these there are two young women whose names are forgotten. Vincente was a long time with his captors, and speaks the Comanche language perfectly. He is a bright, active, intelligent lad, and Chisholm is very fond of him; but on account of our need of an interpreter, he has kindly given him permission to join our party.

*August* 22—*Camp* 22.—Unable to remain longer, we commissioned Black Beaver to have a search made for the lost mules, promising a reward to any one who should restore them. Camp was then struck, and the party resumed the march and survey. Mr. Gaines and myself drove to Beaversville, where he proposed to obtain a guide to Fort Arbuckle. But as we approached the village, instead of the quiet heretofore noticed, a confused jargon of sounds issued from

every house. The first we entered was full of men and women, so absorbed in their own occupations that for some time we were apparently unnoticed. Several were brandishing bottles of whiskey, occasionally applying them to their lips, and singing the Indian "hī-hō-hí-è-ô," beating with hand and foot to keep time with a sort of flute that one was playing, while the women, with bunches of bells upon their ankles, were dancing to the music. All were in a state of drunken excitement, and never was witnessed a scene more wild and infernal. They at length surrounded us, presenting their bottles with shouts, yells, and a profusion of unintelligible words. At another house, intoxication was exhibited in a different but still more disagreeable phase. There were a party of gamblers, excited to madness over whiskey and cards. One cursed us in round English, and bade us begone. We thought proper to take no notice of this, but asked for the chief. The question sobered him somewhat, and he told us that the object of our search had gone to our late camp. Driving back to the camp-ground, we found Black Beaver, with Dr. Bigelow, awaiting us. He informed us that a party of Creeks had arrived the previous night with a barrel of whiskey, which was the cause of the disorder we had witnessed. Learning our wants, he immediately furnished animals and a guide, and we saw the little party safely started on its way to the fort. Mr. Gaines was provided with a revolver, that he might have the wherewith to defend himself if necessary. We were sorry to take leave of him, for his gentlemanly deportment and amiability had won strong hold upon our regard. Dr. Bigelow and myself followed the train. Overtaking it, we travelled over a fine undulating prairie for about eighteen miles, and encamped upon a rivulet, a tributary of the Canadian.

One of the party being ahead to-day, looking for water, discovered two Indians setting fire to the prairie. When they saw him, one hid himself in the grass. The other allowed himself to be approached, and, in reply to a question, made signs that there was no water beyond. They were probably Kichais, who live on the opposite side of the Canadian, at Chouteau's old trading-post. That tribe is neither numerous nor warlike; but taking advantage of their position, they form a sort of connecting-link between the wild Indians and the semi-civilized. They cultivate the soil, hunt, and are supposed to have no objection to plunder, whenever a favorable opportunity presents itself. The fire which had been kindled threatened camp, and we were obliged to burn a wide space around us for protection. At night its appearance was sublime. Huge waves of flame, with a roaring sound like that of the ocean, were rolling over the rank grass, and rushing onward with fearful rapidity. In camping upon the dry prairie, it requires constant vigilance to avoid the catastrophe of a conflagration. Many a party has, by carelessness in this respect, been reduced to a destitute condition.

Water was passed, to-day, in pools, at four different places. At the head of a creek, near camp, there is a fine spring. The water disappears a few hundred yards below. We encamped early, fearing that it might not be found for a long distance beyond. The route has been favorable, with a pleasant view extending for many miles on either side. The ravines were wooded, and patches of timber were scattered at irregular intervals along the route, forming detached portions of the Cross Timbers. We have pursued the trail of Capt. Marcy, which follows the almost inappreciable ridge that divides the waters of Red river from those of the Canadian.

The comet seen last night has been again observed. Its motion has been towards the east. It appears to-night much less distinct; but this effect is possibly due to the smoky atmosphere. Three stars have been observed in connexion with it, and observations made also for latitude and time.

*August* 23—*Camp* 23.—The water in the creek at the last camp was apparently undiminished, notwithstanding the great quantity consumed by the train. At 6½ a. m. the mules were driven from the rich grama, where they had been feeding; harnessed up, and by half-past seven the train was in motion. Turning from our general westward course, we proceeded northerly towards a distant grove, which may be Capt. Simpson's land-mark for the Kichai village at Chouteau's. After travelling ten miles over a smooth prairie, we encamped. Water occurs at various places to the right and left of the route. Springs are frequent. The one at camp issues

from a bed of marl, so soft that the mules cannot approach, and they have to be watered with buckets. The results of the survey thus far are highly satisfactory—the grades being light, and timber and water abundant. Burning prairies have surrounded us to-day, and the smoke has been so dense as nearly to obscure the sun. Two Indians, professing to be Kichais, came, this evening, into camp—the one tall and straight, the other ill-looking. Their dress consisted of a blue cotton blanket wrapped around the waist, a head-dress of eagles' feathers, brass wire bracelets, and moccasins. The outer cartilages of their ears were cut through in various places, and short sticks inserted in place of rings. They were painted with vermilion, and carried bows of bois d'arc three feet long, and cowskin quivers filled with arrows. The latter were about twenty-six inches in length, with very sharp steel heads, tastefully and skilfully made. The feathers with which they were tipped, and the sinews which bound them, were prettily tinted with red, blue, and green. The shafts were colored red, and said to be poisoned.

I have mentioned, that before leaving Beaversville, Chisholm placed at my disposal a Mexican boy named Vincente, from Parras. That place was surprised by the Comanches when he was a child; many of the inhabitants, including probably his parents, murdered; and himself, with a sister and several others, taken away as captives. For many years he was a slave among the Comanches, taking care of their horses and performing other services. Wandering about with them from place to place, he learned their language, and the signs they employ in conversing with other tribes. At length he was seen and purchased by Chisholm when on a trading expedition. He gave for him goods to the value of two hundred dollars. The sister was married to a Comanche, and is yet living with them against her will. Vincente is probably sixteen or seventeen years of age, but not larger than a well-developed lad of eleven. He has an oval face, black eyes, Spanish features, and a pleasing expression; he speaks English, Spanish, and Comanche. It is easy to see that his character has been formed among the savages, for he displays in a marked degree the apparent indifference and obstinacy peculiar to the Indian race.

After our two Indian visitors had eaten and smoked, Vincente was required to examine them. They understood neither Comanche, Spanish, nor English; but our little interpreter was by no means disconcerted at that. With occasionally a word in Caddo, which to some extent seems to be used by all the tribes of this region, and signs, such as are comprehended by the universal Indian race, a rapid conversation was carried on. The graceful motions of the hands seemed to convey ideas faster than words could have done, and with the whole operation we were highly amused and interested.

Our visitors now said that they were not Kichais, but Huécos, and that they were upon a hunting excursion; that their tribe numbered "plenty," and lived beyond the Washita river towards Texas. When they had received some presents, and a sketch of them had been taken, they left, well pleased with their entertainment. These Huécos wore neither beard nor moustache, so common among Shawnees and Delawares. Some of the Choctaws sport a heavy beard. The white blood among them may account for this manly development.

*August* 24—*Camp* 24.—As we were preparing to pursue our journey, another Indian rode into camp. He said he was a Huéco; and having seen us while hunting, came merely to ask where we were going. In Vincente's pantomime and Caddo, we inquired the direction to the old wagon trail, which being very obscure, we had unintentionally departed from. He offered to guide us to it. Following him down an affluent of the Washita, and passing through a strip of forest, we encountered a difficult ravine. Before us were the dense Cross Timbers, and a country cut up by numerous rivulets, and without the least trace of a road. While reconnoitring our position, the Indian guide deserted. We were proposing to retrace our steps, when another Indian, supposed to be a true Kichai, made his appearance. For a consideration, he showed us the desired route, which was upon the northern slope of the ridge intersecting the branches of Walnut creek. All these rivulets are finely-flowing streams, watering a large extent of beautiful country. We found one twelve feet wide, and several feet deep, which could

with difficulty be forded. The valley, as far as it could be seen, was from one to two miles in width, and luxuriant in timber and grass. While searching for a good place to cross, the quartermaster proposed to encamp, and allow the mules time to graze upon the green meadow-grass. Though the march had been short, the animals were weary from crossing the marshy streams; and, fearing that another as good camp ground might not present itself, we concluded to remain for the night. Having taken a portrait of the Kichai, and a vocabulary of his language, we gave him a shirt, a string of beads, a pipe, tobacco, and a dollar in money, and allowed him to depart. He said that he was afraid to sleep in camp, lest his friends might think we had killed him. So he went away, promising to return on the morrow, and guide us onward. We have had rain to-day, falling about one-eighth of an inch. The night being cloudy, no astronomical observations can be made. The cloud lifted from the west just sufficiently to show the comet, which has considerably increased in brilliancy and size. Its train is now turned to an angle of 5° from the vertical, and seems to be about 6° in length. The nucleus appears nearly the same as when it was first seen.

*August* 25—*Camp* 25.—Our Indian guide returned to camp early this morning begging for coffee. He says that he slept in a thicket near by; and some of our party think that it was he who created a disturbance last night among the mules. It is very possible that he may have desired an animal to ride home upon, but the sentinels were vigilant, and he will go as he came. While preparing to move on, a negro rode into camp, express from Capt. Montgomery and Mr. Aird, bringing the mail. Letters from our friends at this distance were an unexpected pleasure. Having bridged the stream, we passed through fertile valleys with groves of superb timber, ash, walnut, and oak, bordering the water-courses. Numerous lawns sloped down to the banks of Walnut creek upon the right, whose rich meadows were so mellow as to compel us to seek firmer ground on the swell of the prairie. Many rivulets, with crystal waters dancing in the sunlight, added to the beauty of the landscape; but, from the marly nature of the soil they traversed, greatly retarded our march. Having passed several branches, whose clear depths afforded new varieties of fishes, the trail conducted us at length to the bank of Walnut creek. To avoid the crossing we turned south, ascended the higher ground, and travelled along the edge of a belt of the Cross Timbers, whose small trees of live oak, post-oak, and black jack, were too thick to penetrate. Upon the opposite side of the Canadian, we could trace the long line of similar forest that borders the river. We continued a mile or two nearly south; then west and northwest. After travelling twelve miles we found two springs; one flowing into the Washita, the other towards the Canadian. Upon the latter we encamped. Though this is supposed to be the driest period of an unusually dry season, the country proves to be a land of springs and streams, watering beautiful and fertile valleys. The surface of the intervening prairies is what is termed "rolling," and a railway near our track would require a moderate amount of cutting through hills of compact gravel. But a more level route appears along the valley of Walnut creek. The banks of the Canadian itself, probably ten to twenty miles north of our trail, may offer still greater advantages.

The night is quite cloudy; but we have succeeded in making a few astronomical observations. The comet was visible for a while, covering, with its train, about six degrees of arc; but, perhaps from the greater brightness of the western horizon, it appeared somewhat less luminous than on the previous night. Its distances from Polaris and Arcturus were observed before it was obscured by a cloud.

*August* 26—*Camp* 26.—At early day a Huéco Indian came into camp. It appeared, from what he said, that the one who had endeavored to lead us astray by conducting the train southward towards their village had informed his friends that we wished to see the chief; who had, therefore, with a few followers, attempted to overtake us. But the night previous, the chief had abandoned the pursuit, and sent forward the messenger who had now reached us. It is probable that they were all lurking near camp last night, and at that moment were watching us from some concealed spot to witness his reception, according to Indian custom. They wished

to learn our strength, and the probability of being able to stampede our mules. We treated the man kindly, gave him something to eat and some presents. He understood a few Comanche words; and, with the aid of expressive signs, Vincente conversed with him easily. We obtained, therefore, a portion of the Huéco vocabulary, and then would have let him go, but he preferred to accompany us.

After travelling about five miles, our progress was suddenly arrested by a burning prairie. The grass was tall, thick, and dry. The wind had driven the widespread flames over the crest of a hill, directly towards us; and they now came leaping into the air, roaring in the distance, and crackling fearfully as they approached. There seemed to be no safety except in flight. The train, therefore, countermarched in double quick time, and took refuge behind a watery ravine, where the grass was too green to burn freely. Taking advantage of a comparatively bare spot, the flames were fought, and a temporary opening made, through which the train passed to the black-burned prairie, which we traversed in safety. Mile after mile we trod nothing but cinders. The Cross Timbers occasionally disappeared. The country became nearly level, and to the edge of the horizon presented a woodless, waterless, desolate field of black ashes. Here and there were solitary clumps of withered grass nourishing burning embers. It was a dreary prospect for the hungry mules, and we began to fear lest the Indians had adopted this means of accomplishing our destruction. At last some ravines appeared which had interrupted the flames, and protected fine fields of grass. By the edge of one containing large pools or springs of water we encamped, having travelled sixteen miles. A shower occurred during the afternoon. The evening was stormy and cold, rendering a fire indispensable for comfort. A single dead alamo, the only tree within sight, with a few low shrubs, furnished a scanty pittance of wood; and as the clouds and wind destroyed all hopes of obtaining astronomical observations, we early sought warmth under the covering of our blankets.

*August* 27—*Camp* 27.—Last night we were aroused by a confusion of sounds. A fierce "norther" was upon us, with wind, rain, and sleet. The whole camp seemed in an uproar; some shouting, some laughing, and others making the ground quake with blows of mallets, driving their tent-pins. After much ado, and a thorough drenching in the sleet, a few of our tents were preserved standing. Many were less fortunate, and morning disclosed a ludicrous assemblage of miserable half-frozen wretches, quietly shivering under prostrate canvass. There were puddles of water within and over their beds, and all were glad to avail themselves of the first light of day to stretch their benumbed limbs. The poor mules, gaunt with hunger and shrivelled with cold, were huddled together with their faces turned from the blast; but having been driven into the ravine, where they were partially sheltered from the storm, they grazed while we breakfasted. Then, seeing no escape from freezing but by exercise, we harnessed up and faced the tempest. Our Huéco guest, poor fellow, suffered terribly, even with the additional blankets that we loaned him; so, without compliments, at the dawn of day he took up his bed and departed. We did not see him again.

Recommencing our march, the long line of Cross Timbers soon varied the landscape. Gypsum appeared upon the surface of the prairie. Not far beyond, we entered the lovely valley of Deer creek, which bears the clear sweet waters of numerous tributaries to the Canadian. These rivulets are well-wooded, and irrigate wide valleys; which, for grazing or agricultural purposes, can scarcely be excelled. The soil is a rich loam, which makes the banks of the streams miry and difficult to cross. Having travelled, therefore, about fourteen miles, we encamped in a pleasant nook, bordering Deer creek. Upon the hill behind is an Indian village, not long since deserted. Below is a break in the thick border of timber that lines the creek; and here, deep-furrowed trails show a regular buffalo crossing. The river is rapid, clear, two and a half feet in depth, and six feet wide. Upon either hand, stately oaks cast deep shadows on tangled shrubs and flowers, and the mules grazing in the meadows are nearly concealed by the luxuriant grass.

The norther was broken at midday. At sunset the wind ceased, but clouds arose; so that

only imperfect observations were taken for time. For the same reason, the comet was invisible.

*August* 28—*Camp* 28.—Having crossed the creek, we found many Indian lodges upon the left bank, and remains of fires. After examining the latter, Vincente pronounced them to have been made by Kickapoos; the different tribes having peculiar arrangements for the sticks that compose their camp-fires.

Following the trail, we left Deer creek, and, having travelled north two miles to the "divide," turned westward parallel to the river Canadian, which appeared about two miles to our right. Water we did not search for; but ravines upon the left bore indications of it. At the end of thirteen miles, finding a spring supposed to be near the head of Deer creek, we encamped. Spurs from the ridge that divides the Canadian from Deer creek, rendered our route to-day moderately hilly. A railway, however, would keep the valley, it being not only level, but more direct. The night has been partially clear, affording good sextant observations for latitude and time. The comet appeared more brilliant than before, with a train about eighteen degrees in length.

*August* 29—*Camp* 29.—Have travelled to-day nineteen miles, passing "Rock Mary" and other mounds accurately described by Simpson and others. The first part of the march was

Rock Mary.

over a pleasant country, with occasional springs, and a view of the Cross Timbers to the left. But entering among the remnants of mesas called "natural mounds," we found ourselves in the midst of a desert of sand. The mounds looked like the evil genii of an evil place, and we became impatient to reach the end of this dreary waste. At length, after going about ten miles, grass began to appear, and a rivulet was found, affording a place for camp. There is no timber near, but sufficient wood for cooking purposes. The belt of Cross Timbers we have now left behind us. Upon the opposite side of the Canadian, however, the forest has occasion-

ally been seen to-day, appearing to extend still farther west. The night is again cloudy. Few astronomical observations have been made. The train of the comet is inclined about 8° to the south of the vertical.

*August* 30—*Camp* 30.—Gypsum in every variety of form—fibrous, laminated, and crystal—has now become abundant. Irregular caves appeared to-day to the right of the route, among huge masses of this rock, so large that we entered to explore them. Except to the geologist, however, they were of little interest. A want of trees and scarcity of grass characterized the level plain we have traversed. Sixteen miles brought us to a spring on the right of the road, where we encamped. The water is slightly brackish. Buffalo-bones are bleaching near it.

*August* 31—*Camp* 31.—A mile from camp we entered a pretty little valley watered by a rivulet, with pools abounding in fishes supposed to be of unknown species. We call the stream Gypsum creek, from being the first of importance in that formation. It is finely wooded with red oak, post-oak, alamo, and elm. The water is tinctured with magnesia, and is disagreeable to the taste. The channel is deep, leaving, at the present low water, high steep banks difficult to pass. At some seasons the water must be so high that a bridge or boat would be required for crossing. Four miles west, having passed a prairie spur which runs out from the low ridge that separates us from the waters of the Canadian, we enjoyed an extensive prospect. Spread before us was a wide basin watered by numerous well wooded rivulets, coursing towards a superb valley upon our left. There, from northwest to southeast, flows the Washita. As we descended to the first of these streams, two black bears issued from the wood, and rolled their ungainly bodies towards the prairie. The hunters lost their game, but the stream nevertheless acquired the name of Bear creek. Moving onward, somewhat south of west, across a prairie, three miles brought us to another stream about twelve feet wide and three feet deep, also flowing south to the Washita. As elms were thickly interspersed among the oaks and alamos on its banks, we named this Elm creek. The crossing was exceedingly bad. At high water it would not be fordable. The cañon in which it flows, however, is not more than forty feet wide, and therefore may easily be bridged. Crossing a ravine, within a mile we entered the beautiful valley of a river about twenty feet wide, and flowing from west towards the southeast, probably the main branch of the Washita. Having followed the left bank for some distance, we again ascended the elevated prairie to avoid ravines, and, four miles beyond, encamped upon the steep bank of another branch called, in honor of the splendid visitor which has for several nights been beckoning us westward, Comet creek.

Through a country like that we have been traversing, there can be no difficulty in selecting a route for a railway. There is plenty of material for its construction. The soil of the valleys is rich, and eminently adapted to agriculture, while the prairies afford abundant pasture for flocks and herds. Mills could be erected upon the streams, which seem to be unfailing. The water is slightly saline, but not decidedly unpalatable. Indian fires have been seen, and a bright light appears this evening to the northeast. We tried to observe the comet, but a thick haze in the west rendered it invisible till daylight was passing away, when it appeared in the horizon for a moment to bid us, probably, a long farewell.

*September* 1—*Camp* 32.—Having with much labor cut down the banks of Comet creek, and with branches of trees made a firmer road over the miry soil, the train crossed safely, and passed over rolling prairies, with fine views, to the left, of valleys, and streams fringed with trees. We came, to-day, to the lower bed of the cretaceous formation overlying the gypsum. Oolitic sandstone, limestone, and oyster-shells abounded, proving the theory of the geologist, that the sandstone we have passed is, like that of Lake Superior, the *new red*.

Leaving upon our left the great valley of the Washita, of which we have since had occasional glimpses, we passed over a long extent of prairie, and encamped upon Silver creek, a small tributary fifteen miles from Comet creek. Excellent water and grass are found near. Wood occurs upon the stream a little below. Astronomical observations have been obtained for latitude and time.

*September* 2—*Camp* 33.—Travelled about four miles and arrived at Marcou creek, where was a geological outcrop, which, contrary to expectation, proved to be gypsum. Five miles beyond we came to Wood creek, a similar stream, the crossing of which was attended with much trouble. Elms, cotton-wood, and oaks were growing near. Continuing two and a half miles over the prairie, we struck a stream with flowing water, and a fine wooded valley. Having ascended its oak-lined banks four miles, we encamped upon the west side. Burnt prairies now surround us, accounting for the bright fires seen lately at night. This is probably the work of Indians to prepare fresh grass for the herds of buffalo that will be slaughtered on their return from the north. Two carcasses of these animals were seen to-day, and the rich grama which bears the name of "buffalo-grass" also made its appearance for the first time. The water of Oak creek is but slightly brackish, though the banks are full of efflorescent salts of sulphate of magnesia.

# CHAPTER IV.

## *From Oak Creek to Rocky Dell Creek.*

**Buffalo creek.—Alamo spring.—Divide between the False Washita and Canadian.—Entrance to Canadian valley.—Antelope hills.—Grape creek.—Buffalo and other game.—Interview with Comanches.—Wolf creek.—Natural mounds.—Wine creek.—Vineyard.—Valley river.—Meeting with Kiowas.—Mexican traders.—Kiowa village.—Captives.—Council with the Indians.—Crossing of the Canadian.—Abandoned trading post.—White Sandy creek.—Shady creek.—Deserted Comanche encampment.—Red Bank creek.—Beautiful View creek.—Llano Estacado.—Encampment creek.—Rocky Dell creek.**

*September* 3—*Camp* 34.—Leaving Oak creek, we crossed a prairie country, and at the end of six miles reached Buffalo creek. This was a ravine with large cotton-woods and oak; but, somewhat to our surprise, it contained no water at the crossing. The dark green foliage of the trees indicated moisture not far beneath the surface. A species of grama called buffalo-grass being now predominant, and buffalo "signs" appearing on the prairie, the above name was suggested for the rivulet. A beautiful specimen of petrified wood was found in its bed. Nine miles beyond we came to Alamo spring, where the animals were watered. Thence, passing the divide, five or six miles led us to a spring, which, flowing towards the north, becomes tributary to the Canadian. This is the end of the emigrant "cut-off," and is supposed to be near Simpson's Camp 40. The trail which he followed along the Canadian here made its appearance. From the valley of the Washita to that of the Canadian, there are few engineering difficulties to surmount in the location of a railway. The elevation of the dividing ridge is 280 feet above the Canadian. By a deep cut, sixty feet could be taken off, and easy slopes on both sides would overcome the rest. The landscape has been uninviting, being a barren prairie, with unsightly gullies worn from the red hills by occasional rains. Trees generally filled the ravines, and water was sometimes found in pools, but there was no soil fit for cultivation.

The keen eyes of Vincente caught a glimpse to-day of a single buffalo feeding far off upon the hills. At once he darted off, with a pistol, in pursuit. The white pony seemed to partake of his master's ardor, and they were soon but a speck in the distance. The boy returned hours after, quite crestfallen, from an unsuccessful pursuit.

*September* 4—*Camp* 35.—We had proposed to rest to-day, but as the water, tasting like Epsom salts, proved disagreeable, we continued the journey. Crossing with some difficulty several ravines and intervening spurs leading from the crest to the river, at the end of about two miles we approached the Canadian. It did not appear the noble stream we had hoped to find, but flowed in various small channels over a bed about five hundred feet wide. The water in some places may have been a foot deep; and, though red with mud,* was found palatable to the taste. The valley, several hundred yards in width, is covered with a mellow soil containing efflorescent salts, like the banks of the Rio del Norte. Frequently spots are found without vegetation; but if the land were cultivated, the crops would probably be as excellent as in New Mexico. The contrast with the luxuriant valley of the Washita is not agreeable. Some allowance should be made, however, for the unusual dryness of the season. For about six miles we pursued the level surface of the valley, and then ascended the mesa† which bounds it. Our course was shaped for the Antelope hills which appeared in the distance, but, unexpectedly striking a creek of sweet water, we encamped twelve miles from Epsom spring.

*September* 5—*Camp* 35.—Our beef-cattle being sore-footed and fatigued, it seems proper to

* Prairie travellers clarify muddy water by dropping into the vessel containing it pieces of mucillaginous cactus.

† An elevated table-land.

allow them a day of rest. The men also need time to bathe and wash their clothing, and we have decided to remain in camp. Astronomical and meteorological observations go on as usual, and the notes of the survey are examined, reduced, and some of them hastily plotted. The day has been very hot; but, as a compensation, night has brought a norther, with a sprinkling of rain.

*September* 6—*Camp* 36.—The norther continued, but in a mild form, allowing the survey to proceed without interruption. We crossed several creeks flowing in deep, wooded ravines, and in one the spring wagon containing instruments was overturned, the Gay Lussac barometer broken, and the sextant and chronometers thrown upon the ground. The injuries they may have sustained will be determined by future observations. After seeing a broken swingle-tree replaced, and the carretela safely out of the sandy bed of the creek, which was a hundred and fifty feet wide, we rode on to examine the Antelope hills. These lie near the meridian of 100° west from Greenwich; and, serving to mark the boundary of Texas, are sometimes called the Boundary hills. They are composed of sandstones cemented with lime, and are of the mesa form. They are about a hundred and twenty-five feet high, and capped, as Simpson describes, "with a table of white vesicular sandstone, eighteen feet thick, and horizontally stratified." Upon the side of one was found volcanic scoria, but it was erratic. The train moved on, Dr. Bigelow and myself awaiting the surveying party, which for several miles had not been seen. For an hour and a half we wandered among the hills, searching for specimens of rocks and flowers, and viewing an expanse of prairie bounded on the south by the dim outline of the Witchita mountains. The line of the Canadian appears sweeping to the north, and the trail we follow was made to avoid the bend. We were becoming anxious about our friends, and on the point of going back for them, when they came in sight. An accident to the odometer had occasioned the delay. An Indian had been seen to cross the trail in front of them several times, but had kept at a distance. Five miles beyond the Antelope hills, we passed the sandy bed of a stream without water upon the surface. From the fruit that abounded in its vicinity, we called it Grape creek. Continuing our journey to another sandy arroyo, we followed its bank half a mile to the Canadian, and encamped.

The route to-day through the Antelope hills, over prairies, and across ravines, has been dry and sandy. The scanty grass appeared of an earthy hue, relieved only by red gullies and occasional ravines, showing the foliage of stunted trees. A few pools of water were seen. But the valley of the Canadian, near camp, displays green grass and patches of wood. The river is deeper and less muddy than before. Game has become plenty. Five buffalo were grazing near the trail, and the hunters pursued them, but without success. Vincente, however, brought down a fat doe, which he proudly dragged into camp. One party fell upon a flock of wild turkeys, lodged in a thicket near the bank of the river, and secured several. Two prairie dogs and an owl were sacrificed to science, and all seemed recompensed for a weary march. A large tiger was discovered near camp, but he escaped.

On the opposite side of the river is a long, white sand-bank, visible a great distance, and, therefore, a good landmark for travellers.

*September* 7—*Camp* 37.—After leaving camp, we crossed a succession of sandy arroyos; some dry, others containing small pools or streams of water. Prairie dogs were numerous, and barked with great energy to warn us away from their villages. They were, however, very cautious, dropping into their holes whenever danger approached.

Dr. Bigelow to-day wandered far from the train in search of new species of plants. Near the river he encountered a rattlesnake of such remarkable size that he determined to secure it for a specimen. He therefore went back to a ravine, obtained a club of proper dimensions, and returned. It is the habit of this animal neither to run from men nor to attack them unless molested. But, as the Doctor approached, the coiled reptile gave a rattle, warning him of danger. Another step nearer and he leaped erect, nearly to the full height of a man; his neck proudly curved, his head flattened with anger, and his protruding fangs swollen with

deadly venom. It was evident to the Doctor that, in Western parlance, "he had waked the wrong passenger." There was to be a struggle. It commenced; the Doctor trying in vain to mow down his wily antagonist. Keen eyes watched every motion, and as the strokes descended the agile form glided past, and sprang towards the assailant. For some time a lively contest was kept up, and it seemed doubtful which would gain the victory. At length, however, both became weary, and a successful blow placed his snakeship *hors du combat*. The Doctor then fired eight shots in rapid succession; whether to complete his conquest, or celebrate his victory, does not fully appear. But supposing him to be in a desperate fight with Indians, a party galloped off to his rescue.

The relief party, scouring the prairies, found a wounded buffalo, which one of them kindly pierced with a rifle-ball and put out of misery. It was the first killed upon the trip, and consequently a glorious achievement. A short distance beyond they came across a small party of well-mounted Comanches, whom they brought in prisoners. The Indians appeared wary, cautious, and watchful. Having told us that upon the other side of the Canadian there were large numbers of their tribe, they suddenly forgot all their Spanish, and by signs desired us to know that they could not understand a word we said to them. Indians think it undignified to speak other than their native tongue. Hence, all great chiefs have interpreters. We sought for Vincente, but, as usual when wanted, he was chasing buffalo or deer over the prairies. That is his passion. The Indians declined our invitation to camp. Before allowing them to depart we gave them a pipe and tobacco to smoke. They performed the operation in a singular manner. The first two* puffs, with much ceremony and muttering between, were sent towards the sun. The next, in similar manner, was blown down to the ground. When the artist had taken their portraits, they were allowed to go. Another was afterwards seen lurking among the hills, and watching our movements.

Having travelled about sixteen miles, we encamped near the mouth of Wolf creek. The natural mounds appear upon our left. The country across the prairie spurs is still dreary and barren. The ravines, however, are generally wooded and watered. The valley of the Canadian seems to offer greater facilities for a railway than the more direct route which we have traversed. The carretela which carries the instruments was again upset, and another barometer broken. One of the chronometers also must have been deranged, as it stopped this evening in the midst of the observations.

*September* 8—*Camp* 38.—Two miles' travel along the sandy bed of a creek brought us to the Canadian valley; at that place a mile in width, and appearing to have a good soil. On the opposite bank were sand-hills, and a border of trees. Following the edge of the valley for four miles, we reached the mouth of Dry river, the wide sandy bed of which bore upon its surface recent traces of water. Higher up was a flowing stream. We passed through some drifted sand-hills; and, to avoid ravines, continued to ascend the Canadian valley, which had nearly doubled in width. Having made about eighteen miles, we encamped near the mouth of Wine creek, where were acres of land covered with grape-vines, looking like a cultivated vineyard. The fruit, which covers the vines in magnificent clusters, is small, juicy, and of an agreeable flavor. It does not appear yet to be fully ripe. We have passed to-day hills similar in character and form to the Antelope hills. These appear to be the last mesa remnants of a llano, or prairie, which once covered the whole region. The other parts of the formation have been abraded and swept away, forming undulating prairies, valleys, ravines, and sometimes cañons.

*September* 9—*Camp* 39.—At our last camp grama grass was more abundant than usual. The water in the channel of the Canadian was probably three feet deep, and moderately clear. After leaving camp we crossed a spur of hills that approached the river, and again descended to the valley, which became wide and contained good grass and clumps of trees. Six miles brought

* Vincente, upon learning this afterwards, said they were medicine men, and very bad. He has great fear of their spells and incantations.

CANADIAN RIVER NEAR CAMP 38.

us to the mouth of a wooded creek without water flowing upon the surface. Here were the remains of an extensive Indian encampment, with "signs" quite recent. The crotched sticks of hundreds of wigwams had been left standing. The grass was closely cropped, and the trails to the river were large and fresh. Wild grapes were again abundant; tempting the men, some of whom had already suffered severely from eating to excess. Few, however, can set bounds to an appetite so seldom gratified upon the prairie. We soon entered a large Indian trail, which, leading through a deserted camp, brought us in sight of an Indian village. Great excitement was produced, each one being desirous to be among the first to encounter the strangers. The Indians met us at "Valley river," a rapid stream, flowing into the Canadian a hundred yards below. A curious scene was now presented. On one side of the stream was collected a crowd of wild Indians, apparently in great excitement; and on the other, our own party; each ignorant of the others and their designs. The Indians were evidently prepared for battle; decked out in their gayest attire, mounted on spirited horses; holding bows in their hands, and arrows between their fingers. As we advanced, Vincente thought proper to place a white handkerchief at the end of a ramrod, and wave it as a signal. Upon sight of the banner the Indians set up a shout, and rode rapidly to meet us. They called themselves Kái-ò-wàs, and professed friendship. They looked splendidly as they rode from point to point; their horses prancing, and their gay silver trappings glittering in the sun. The old fellow who appeared to be the chief, or probably medicine man, was on foot and almost naked. He begged to ride in the carretela; and, by the aid of Vincente, informed us that as friends we ought to encamp at the village, and hold a council with them. The road beyond he represented as being exceedingly bad; and said that a long succession of sand-hills for two days' journey would compel us to cross the river at this place. Thus accompanied by our new friends, we drove to the village, where, among a heterogeneous mass of old men, women, and children, were two Mexicans endeavoring to trade flour, biscuits, and sugar for buffalo robes and horses. They confirmed the Indian statement that there was no other place so good as this for an encampment, and that we would here be obliged to cross the river. They added that they were defenceless, with only three peons accompanying them; and, the Indians having robbed them of nearly all their goods, they wished to accompany us towards New Mexico.

The village contained about a dozen large conical tents, and as many wigwams. The tent-frames were of well-made poles, fifteen to twenty feet long, interlaced at the top, and intersecting the ground in a circle ten to fifteen feet in diameter. The whole were covered with buffalo robes, beautifully dressed, painted with curious figures, and carefully spread with the hair inside. To our surprise, we saw a good looking blue-eyed boy of three years old, and found that his mother was a Mexican captive. She said that her name was José Maria; that she was from Rio de Naces; had been captured by the Comanches when she was twenty, and had lived with them seven years. Her beautiful boy is the son of the chief; but she wishes to leave her hard masters and accompany us, in the hope of again reaching her home. She was watched, and dared speak but little with us. There are other captains; one a man by the name of Andres Nuñares, from Chihuahua; he has been a prisoner five years. On a pole in the centre of the village hung two scalps, sacredly guarded by an old woman, who made much ado if any one attempted to approach them.

We pitched camp on a slight eminence overlooking the village, and could not but admire their selection of ground. Valley river and the Canadian are at this point fringed with timber, and the wide meadows are covered with a thick carpet of grass. Scarcely were the tents pitched when the Kái-ò-wàs began to assemble for the counsel. A wilder-looking set can scarcely be imagined. Cunning, duplicity, and treachery, seemed stamped upon every lineament of their features. Men, women, and children—all, except the chiefs—were wrapped in fine blue blankets, which they said had been given them by their good father, the white-haired man whom they had met on the northern trail. They said that he had told them that the Americans would continue to make presents to them so long as they behaved well. This they had

apparently construed into a claim to receive tribute from every party of whites they might meet. Có-tat-sìn, (Caballo Alazan,) the great chief of the Kái-ò-wàs, is said to be upon a buffalo-hunt north. Some, who appeared to be sub-chiefs, with faces painted yellow, had colored the tops of their heads, where the long black hair was parted, with vermilion. Their noses were long and aquiline, chins beardless, and eyes small, bright, and sparkling. Their foreheads were retreating, and their cheek-bones high and ugly. They carried superb bows of bois d'arc, ornamented with brass nails, silver plates, and wampum beads. The arrows were about twenty-eight inches in length, with steel points and tinted feather trimmings. The quiver and belt, of wolfskin, were wrought with beads. They wore moccasins and buckskin leggins, covered with wampum and bead-work, and fastened with silver buckles. From the crown of their heads was suspended a queue of horse-hair, reaching nearly to the ground, ornamented with ten circular plates of silver, from one to three inches in diameter, and terminated by a silver crescent and wampum. They wore no pendants from the nose, but in their ears were brass rings, from which hung chains and bugle-beads of bone or iridescent shells, reaching far down upon the shoulders. Similar ornaments were worn around the neck. All had bracelets of brass-wire or silver bands. One of the chiefs had suspended from his neck a large silver cross, weighing half a pound or more, curiously wrought, and terminated with a crescent; a trophy, probably, from some Mexican church. Hanging upon a post in the village was a still more elaborate head-dress. It consisted of a cap, richly embroidered with wampum, with a pendant eight feet long trailing behind, ornamented with a row of scarlet-dyed goose quills, which, when worn, stand perpendicularly from the body. We tried to purchase some of these fine things; but the Indians said that they loved their ornaments, and could not part with them. Truly, in our whole train we had nothing to vie with them in magnificence to tempt an exchange. At length, the chiefs were invited to be seated in what they deemed the grand council. A pipe was passed around from hand to hand, and it was noticed that the first puff of each was directed towards the sun. The old chief then spoke. He said that at a short distance were two other camps, where immense numbers of Kái-ò-wàs were congregated. He boasted of their general good conduct towards Americans; claimed particular friendship with us, and closed by asking, distinctly, for the reward which he said the good Indian agent had promised them. We replied, that our Great Chief at Washington had sent us a long journey, through many Indian tribes, and had given us merely a few presents, to indicate, to the good people we might meet, his approbation, and that if they continued friendly to small parties of emigrants, government would protect and assist them. A red blanket, some beads and tobacco, were then given to each of the five chiefs. They looked disdainfully at the gifts, and said that the good white-haired father had led them to expect at least a blanket for each individual of the band, besides calico for the women and children, and that on these terms only could they be friends to Americans. They were told that the government gave free gifts only, and nothing upon compulsion; to return their presents if they were dissatisfied, and we would try what effect powder and ball would have towards preserving peace. Besides, we had another account to settle with them regarding certain Mexican captives, whom we wished to restore to their friends. This unexpected demand upon our part created great commotion. The old chief seemed almost convulsed with anger. The placid expression of his countenance was changed to one of black malignity. He said it was not the part of a friend to come among them and separate wives and children from husbands and fathers. We told him that none would be taken except such as wished to go. After a while he agreed that, if they wanted to accompany us, and we would give him a "heap of things," he would consent. But he begged that at least we would give them something to eat, as they were hungry. As the storm was lu led, and the fear of aggression was evidently upon their side, we thought we could afford to be generous, and gave them a cow for beef. Good humor was at once restored, and they proposed to kill the cow, as if she were a wild buffalo; so mounting their horses, and goading the animal into madness, they pursued and pierced her with arrows until she fell exhausted.

During the commotion in the tent Vincente was greatly frightened. He disliked their smoking to the sun, and said "they were bad men to do that; they were sorcerers, and were casting a spell to do us harm." Nothing could shake the boy's belief in the witchcraft he had seen practised among the Comanches. Desiring to learn more of the captives before taking any action upon their affairs, we sought Andres and took him to a tent. He had no special complaint to make against the Indians. He declined to go with us himself, being unwilling to sacrifice the property that he possessed. He was owner of twelve mules, broken to the saddle, and an unknown number of wild mares and colts. The captive woman, he said, would join us at our next camp, provided we would furnish a bridle-bit to guide her horse. He said that this would be more agreeable to them than to be taken by force. The bit was accordingly loaned for the service. He was asked why the Kái-ò-wàs smoked to the sun. He said it was to their god, whom they thus worshipped to invoke his blessing. When we had obtained from him a vocabulary of the Kái-ò-wa language, and given him some presents, he went away. It was now night, and he ran to the village leaping, shouting, and whooping like a full-blooded savage. At the same time the yelling of the Indians, and the plashing of their horses in the water, made known to us that a party was crossing the Canadian—for what purpose we could not conceive. After this, there was moderate quiet till morning.

*September* 10—*Camp* 40.—The Indian chief was in camp soon after daybreak, with an excuse for not sending the Mexicans with us. He led by the hand his blue-eyed boy, and begged a present for him. He thought, doubtless, that by showing a little paternal affection he might be saved from a separation. The mother soon followed—riding up to the tent on a vicious looking pony, with a thong for a bridle, and two strings for stirrups. The old chief seemed vexed at her coming, she being his third and favorite wife, and probably ordered her back, for she quickly left, scarcely speaking a word. The child soon followed. The woman looked very sad, and seemed to supplicate for freedom. While discussing the matter with Lieutenant Jones, one of the Mexican traders reported that the Indians had robbed him of several articles. The chief was directed to see them restored. He went to the village as if to obey; and, almost instantaneously their skins were packed, the lodge-poles tied to the sides of horses, and the whole party mounted, ready for a start. Secure in the fleetness of their horses, with their captives guarded, they quietly waited for our departure.

Taking the advice of the Mexicans, we crossed the Canadian—here a quarter of a mile wide, two or three feet deep, and full of quicksands. The difficulties encountered in this operation nearly banished the Indians from our thoughts. They entered the wood, probably to ascend Valley river, and join a party that the traders had seen in that direction. Following the north bank of the river two or three miles, and seeing no obstacle upon the southern side, we re-crossed and travelled fifteen miles to camp. We have passed many ravines, which are water-courses tributary to the Canadian. The one at the mouth of which we are encamped, called Spring creek, contains a rivulet of pure water, flowing beneath a grove of alamos. The valley abounds in grapes, which are sweeter, perhaps because riper, than those gathered below. Had they been cultivated, they could hardly have been produced in greater profusion.

José Garcia, the Mexican trader who has joined our party, says that the Kái-ò-wàs are a numerous tribe, scarcely inferior to Comanches, with whom they have a perpetual alliance. He tells us that both by Mexicans and Indians Red river is called "Rio Palo Duro;" Washita, "Rio Negro;" and the Canadian, "Rio Colorado." This confusion of names is doubtless one cause of the mistake of Baron Humboldt and Colonel Long in taking the headwaters of the Canadian for the source of Red river.

*September* 11—*Camp* 41.—We continued up the valley of the Canadian, which increases in width, receiving many wooded tributaries from the south. At noon we saw upon the opposite side of the river the adobe ruins of what the Mexicans call an American fort or trading-house. There, many years ago, whiskey was sold to the Indians, who, in a fit of intoxication, murdered the occupants and set fire to the establishment. It was a large building, finely situated

in a grove of trees, and containing a spring of water within the court. An acequia from the river insured the garden in front from the ill effects of a dry season. The place is now desolate, its only use being to designate a ford. At the next large valley from the south two Indians were seen; the Mexicans pursued, but could not overtake them. Passing through a little range of sand-hills, we crossed the bed of Bluff creek near its mouth. Upon the north bank of the Canadian a bluff of the Llano hung over the valley, with gullies cut in its deep red soil. In the bottoms below were groves of timber, streams, and meadows, presenting a pleasant landscape. Looking behind, a huge column of smoke was seen rising; and it was noticed that the surveying party, with the carretela, was not in sight. With great anxiety we were about to return, when they appeared, around a point of hills, approaching us. Indians were at the same time seen reconnoitring from distant heights, but they did not come near. Having travelled nineteen miles along the smooth valley of the Canadian, we made camp where a low ridge of hills from the south impinged upon the river. These are from fifty to a hundred yards in width, and it is the first place since entering the valley which would require the labor of a deep cut for a railroad.

*September* 12—*Camp* 42.—Seeing several Indians in the Mexican camp, we sent to inquire who they were. They returned with the messengers, to speak for themselves. They were Pueblo Indians from Santo Domingo, with flour and bread, to barter with the Kái-ò-wàs and Comanches for buffalo robes and horses. They were mounted on mules, wrapped in serapes, or Mexican blankets, and wore head-dresses, beads, and other Indian ornaments. There were six or eight of their party scattered over the prairie in search of Comanches. Thus far they had been unsuccessful, the majority of the wild tribes not having returned from their northern hunting tour.

Leaving camp, the valley of the river appeared wider as we ascended, and wooded ravines came down from the hills to unite with it. The sand-hills encountered yesterday have disappeared. We are now upon the upper new red sandstone, and many remnants of "mesas" appear, capped with dolomite. Here are good materials for masonry. At 10 a. m. we crossed Moale creek, flowing beneath a border of trees to the Canadian. Gypsum crops out from the red marl of the cliffs. Salt springs and efflorescent salts, supposed to be sulphates of soda, magnesia, and lime, abound in the wide bottoms of the valley we have traversed to-day. At noon we turned abruptly from the river, south, and followed a ravine, by the side of which we soon ascended a high bank to the prairie. This was once a portion of the Llano Estacado; but the upper strata have been worn and washed away, leaving the surface undulating, sometimes hilly, and cut into ravines which form cañons as they approach the Canadian. Our road was now good, and, after travelling five miles, we found a spring where we watered the mules and filled the canteens. We then proceeded nearly south to White Sandy creek, where, finding abundance of water in pools, we encamped. By the survey we have travelled eighteen miles, and ascended five hundred feet. The grass looks parched and dry; and, since leaving the river, scarce a tree has appeared to relieve the landscape.

*September* 13—*Camp* 42.—The mules needing rest, we concluded to remain for the day. The water in the creek is good; there is enough wood in the vicinity for camp purposes; and the grama, though apparently dry, contains nutritious juices, being, for the animals, better than corn. The nine Pueblo Indians and the Mexicans also remain, hoping to attract a party of Comanches to purchase their supplies.

*September* 14—*Camp* 43.—Took an early start, and travelled over rolling prairie, with a good road, twenty miles to Shady creek, where we encamped. This is the first waterless jornada encountered upon the survey. Artesian borings or common wells might probably afford a supply at various points near our trail. The beautiful rivulet upon which we are encamped is a flowing stream, bordered with trees, and fertilizing an extensive valley.

Our predecessors here were Comanches. The Teguas say that they left twenty days since, either for a buffalo hunt or for war. There appear to be not less than three hundred deserted lodges;

indicating a party of six hundred warriors. A thousand horses must have grazed the valley; and our mules would have but a scanty pittance, unless driven a mile or two down the stream. The lodges are temporary bowers, made of branches planted in the ground. The form is that of a horse-shoe, and the twigs are twined at top, affording a space inside to stand or lie screened from the sun. They appear scattered at random; but, without exception, face the north. Beside each wigwam are the remains of a small fire. This camp ground covers several acres upon either side of the stream.

In one place has been noticed a circular trench carefully dug with some sharp instrument; and, in the centre, ashes covering a space eighteen inches in diameter. The fire had been in the centre of the circular trench, which communicated with two arms, forming, with an embankment for the third side, nearly a triangle. Four sticks, about three feet high, were driven vertically into the ground; and a deep hole, perfectly cylindrical, was made by the side, six inches in diameter, and of the same depth. Upon the opposite bank of the stream, in a shady spot by itself, is a structure formed of saplings, oval arched, like an oven, three feet high, six feet long, east and west, and five feet broad. It had been covered with twigs and weeds. In the centre is a neatly made cylindrical hole, about eight inches in diameter, and six or eight inches deep. This appears carefully covered with a flat stone—showing evidence of having been heated—and surrounded by a circular trench. Near the western end stands a conical mound of earth, two feet in circumference, and a foot and a half high. Towards the east is another mound, symmetrical with the first, on which we found an Indian offering: a brass bracelet, strings of beads, and a piece of tobacco. A few feet farther east are the remains of a fire, where stones appear to have been heated. At a short distance a deer had been killed, and blood, by accident or design, sprinkled upon the nearest huts. Upon a different part of the grounds, probably a quarter of a mile distant, stands another structure, almost a fac simile of the one described.

*September* 15—*Camp* 44.—Leaving Shady creek and its pleasant valley, we traversed a rolling prairie eight miles to a small stream, where the mules were allowed to drink from large pools of good water. We then proceeded over a similar country to Red Bank creek, where we again watered and moved on; there being no wood upon the stream. Having travelled twenty miles, we encamped at Beautiful View creek. Water is plenty in pools, but wood scarce. The grass, though dry, is abundant. We have again met buffalo signs. On inquiring how far west they have been seen, a Tegua Indian stated that many years ago his father killed two at Santo Domingo. A Mexican from San Juan de Caballeros added, that in 1835 he saw buffalo on the Rio del Norte. Father Escalante, in a manuscript journal of a trip from New Mexico to the Great Salt lake, in 1776, mentioned having seen signs of their existence on his route; still, notwithstanding the location of the famed kingdom of Cibola by the early explorers, there do not seem to be any well authenticated accounts of the existence of those animals west of Rio Grande. Their range has been from the Alleghanies on the east to the Rocky mountains on the west; and now, driven from the haunts of white men, they are pent up upon the prairies between.

*September* 16—*Camp* 45.—While the sun was still twenty minutes below the horizon, an extraordinary refraction placed a crown of light in the east, of sufficient brightness to cast a shadow. Soon after a violent wind sprang up, and continued all day from the southwest. Our route passed two large pools of water before arriving at Rincon de la Crux, a cañon of the Llano Estacado. Here we encamped beside a spring and a natural vineyard of wild grapes. The fruit is as large as a hazel-nut, with thin skin and deep purple juice. It could be greatly improved by cultivation. Mr. Marcou thinks it would make an excellent wine similar to Port.

The wind went down with the sun; but rose again, somewhat to the disturbance of our astronomical observations. We have risen to-day, in twenty miles, about 400 feet; but the ascent has been quite uniform.

*September* 17—*Camp* 46.—All were roused this morning for an early start to cross the Llano Estacado. Not a cloud was visible; and the moon being full, created a pretty effect of light

and shade upon the distant peaks. Ascending about two hundred and fifty feet, in about a mile from camp we reached the top of the Llano. Here, for the first time, we saw what one might call an ocean prairie; so smooth, level, and boundless does it appear. It is covered with a carpet of closely cropped buffalo-grass, and no other green thing is to be seen. Mr. Marcou thinks that here, as upon the prairies crossed since leaving the Canadian, artesian wells might easily be made to afford plenty of water. Indeed, the numerous springs issuing from the sides of its bluff edges seem to prove the fact. Having travelled eight and a half miles, we arrived at a deep gorge with limestone cliffs, and a valley of grass and trees. In the rocky bed of the cañon were pools of water; and we stopped to breakfast. This is Agua Piedra of the Mexicans, and Simpson's Encampment creek. Los Alamitos, the spring where the Pueblo Indians proposed to encamp last night, we have not seen. It is probably at some distance to the right of the road. Having crossed the cañon of Agua Piedra, which might be headed by a detour south, we again rolled over the hard smooth surface of the Llano. The soil seems to be good, and, if it were possible to irrigate it, might be cultivated. It now furnishes excellent pasture for antelope and deer. At sunset we reached the edge of the Llano, where the road descended to Rocky Dell creek. Here we encamped, having accomplished nearly twenty-eight miles of survey. The wind has been increasing since noon, and this evening it blows almost a gale, seriously impeding our astronomical observations.

## CHAPTER V.

### *From Rocky Dell Creek to Anton Chico.*

Cave at Rocky Dell.—Pueblo Indian traders.—Violent storm.—Halt creek.—Antelope.—Staked Plain.—Fossil creek.—Tucumcari creek.—Plaza Larga.—Laguna Colorada.—Arroyo de Pajarito.—Arroyo Cuerbito.—Digging for prairie dogs.—Hurrah creek.—Rio de Gallinas.—Sheep spring.—Anton Chico.

*September* 18—*Camp* 46.—Beneath a cliff which overhangs the stream of Rocky Dell is a sort of cave, which the Indians have converted into a gallery of fine arts. The rocks forming the floor are elaborately carved, and the walls covered with paintings. Remaining at this place to-day to rest our animals, we have amused ourselves by copying some of the inscriptions. The immense number of carvings, etchings, and paintings—the newer often encroaching upon and sometimes covering the more ancient—has produced apparent confusion. But frequently one group can be distinguished from another which intermingles with it.

As we were making the nightly astronomical observations, the herders ran into camp saying that we were surrounded by Indians. Seizing arms, every one rushed for the mulada, the great source of anxiety, on account of the ease with which a few Indians may create a stampede. But, unmindful of the warlike demonstrations, our visitors came down from the hills, and walked boldly into camp. They proved to be traders from the pueblos of New Mexico, in search of Comanches, whom they expect to find at this season upon the Canadian.

*September* 19—*Camp* 47.—Leaving Rocky Dell creek, we travelled several miles beneath the bluff which forms the northern limit of the Llano, to a pool of water among the rocks. After proceeding some distance farther, we encamped at Cañada de Truxillo, near Halt creek; having accomplished twenty-three miles. We passed water at a pond three miles, and at Emigrant creek—called by the Mexicans Rincon de las Mujeres—nine miles west of camp; also at a branch one mile east of this place. The region traversed has been slightly undulating, and sometimes sandy. The Llano Estacado, upon our left, frequently jutted nearly to the road, then receding several miles. It is probable that most of these recessions contain ravines of water; which, sinking into the sandy soil, appears only in pools, at the crossing of the road. Wood has become scarce, there being hardly enough for camp-fires. Little has been seen except at Emigrant creek, where was a border of alamos. The day has been cooler than any preceding, rendered so by a dense mist that partially obscured the sun. Since night this has cleared away, and stars have presented themselves for the usual observations, though the wind has rendered the astronomical results somewhat uncertain.

*September* 20—*Camp* 48.—At about two o'clock this morning, camp was disturbed by a violent storm of wind and rain, which laid most of the tents prostrate. The rest were preserved only by the vigorous exertions of the occupants, regardless of bare feet and scanty attire. Such a sudden turning out of sleepers into the driving tempest produced a scene that was laughable in spite of our misery. There was no more sleep. At daybreak the storm subsided, and at sunrise ceased. The fall of rain was about an inch and a half. The wind shifted during the night from south to north, from which point it blew with violence. The thermometer, however, fell little below 50° Fahrenheit.

It was nine o'clock before we could re-commence our journey. The road traversed a region similar to that seen yesterday—sandy, and nearly level, sometimes intersected by a ravine con-

taining pools of muddy water. Halt creek, which the Mexicans call Arroyo de Barrancas, was the only flowing stream passed. Here the water, deeply tinctured with red marl, was about two feet deep and six feet wide. The Llano, still presenting salient points to within a mile or two of the road, is now capped with a higher plateau; and the detritus brought down by flooded creeks furnishes several varieties of cretaceous fossils. Hoping to reach Fossil creek, we travelled till after sunset, passing several sluggish streams. At length it became too dark to read the surveying instruments, and we were obliged to encamp near pools of muddy water. Upon the arroyo below have been found clumps of trees, pure water, and a pretty valley covered with excellent buffalo-grass. Antelope have been seen in considerable numbers every day since we ascended the Llano. To-day they have been unusually numerous. They graze upon the prairies in herds varying in number, usually from six to twenty. Upon sight of the train of canvass-covered wagons they lift their heads and gaze a moment as if in astonishment. Their next impulse is to collect in a body and run towards it, stopping to satisfy their curiosity at a distance of about three hundred yards. But they quickly detect a hunter approaching them, and then fly with great rapidity. They are fleet enough to defy pursuit, and we have not yet been able to secure a specimen. The cunning little prairie dogs that greet our entrance to their villages in a manner quite sociable and amusing, have also been quite difficult to obtain. Two, however, have been killed to-day. The collection of lizards, horned frogs, and snakes is quite numerous and interesting, new varieties of them being obtained daily.

Fossils of the cretaceous or jurassic formation were found in the creeks crossed to-day. The bluff edge of the Llano, here curving far towards the south, seems to turn and pass behind the Tucumcari hills, which appear about twenty miles westward from camp. These probably belong to the same formation, capped with an additional stratum. The northern slopes of the Llano, for about 150 feet above the basin which it encloses, are covered with a dense forest of cedars. Not a tree is elsewhere to be seen, except a dwarfish growth upon the sides of ravines. It seems that the prevalent southwest winds prevent the growth of trees upon the prairie. The nakedness of the Staked Plain is undoubtedly due, in part, to this cause. The want of water there and annual fires may contribute to the result. The belt of cedars upon the bluff will afford a large amount of good fuel. The trees seldom decay in this climate, but in drying become hard and durable. Clouds this evening prevented astronomical observations.

*September* 21—*Camp* 49.—The equinoctial storm is apparently near its close, though the atmosphere is still murky and raw. About three miles after leaving camp we crossed another arroyo containing water; and three miles beyond brought us to Fossil creek. In its bed were astrea similar to those collected yesterday. The soil is red sandy marl, retaining sufficient moisture to produce abundant grama, and preserve its greenness, though it is near the end of the dry season. The wide basin which extends upon our left to the border of the Llano is susceptible of cultivation. Should more water be required than what issues in springs and rivulets from its edge, wells could be dug, or a perpetual flow, probably, be obtained by artesian borings. We are four thousand feet above the level of the sea, and the climate is said to be as healthy and pleasant as can anywhere be found. Four miles west of Fossil creek was a flowing stream, five feet in width and six inches deep, with grass and a few low branching trees upon its banks. In the valley above appeared quite a grove. Proceeding we crossed first a branch, and seven miles above, the main stream of Tucumcari. Following the broad valley, which the Mexicans call Plaza Larga, we encamped in a beautiful spot three miles above the crossing. Here we met a Mexican bound for Comanche land to trade. He says there are fifteen of his party with flour, hard bread, and tobacco, who have come out to meet the Kiowas and Comanches on their return from the buffalo hunt. We had no previous idea of the extent of this Indian trade, or of the impunity with which defenceless traders could mingle with these savage and treacherous tribes upon their own soil. We are now near the spot where Captain Marcy first met Comanches in 1849. The Mexican says that they formerly ranged this far; but that now, rancheros of new Mexico sometimes send out large flocks of sheep, which graze securely in

the valley of the stream where we are encamped. The inference seems to be that year by year the wild Indians, like the buffalo, range over less space, and are gradually dwindling away.

Dr. Bigelow, this morning, rode over to the bluff, and ascended the escarped slope to the mesa of the Staked Plain, and was well repaid for his trouble. It was disintegrated and worn away into well defined terraces, reaching from the prairie valley to the summit; giving foothold and nourishment to a forest of small cedars and pinons. His herbarium was literally crammed with plants and flowers, many of unknown species. The rock was, as previously described, 200 feet lias, overlaid by the same thickness of cretaceous formation, with sandstone and limestone containing fossil shells.

Plaza Larga is famous in New Mexico for beautiful scenery, fertile soil, and charming climate. It extends from among the Tucumcari hills apparently to the Canadian; and, should this route be selected for a railway, offers every facility for a large settlement. Indeed, in a few years it may become the centre of a flourishing State. The sun has once more set in a clear and tranquil sky, an agreeable contrast to so many days of harassing storm and wind. There is a prospect for a good set of astronomical observations.

*September* 22—*Camp* 50.—A short distance from camp we encountered other parties of Mexicans and Indians, one numbering twenty-two persons, en route for the Comanche country. They report trouble at La Mesilla. General Trias is said to be there with troops, and Santa Anna expected with 5,000 men. The latter part is doubtless fiction; but the possibility of a collision with Mexico creates excitement among our party, and a desire to get nearer to the scene of action.

We continued up the valley of Tucumcari, which soon became a ravine, bounded on either side by the variegated bluffs of the Llano. Red marl, yellow and white sandstone, with cliffs of white limestone, contrast with the dark foliage of cedars occurring upon the slopes and filling every chasm. Occasionally, along the valley, we passed a rocky hill or mound which denudation had not yet removed. One isolated hill, detached from the Llano, stood nearly in our path, and, from its peculiar shape, was named the Pyramid. One side was nearly perpendicular, and all the strata of the Staked Plain were laid bare. Dr. Bigelow, Mr. Marcou, Mr. Sherburne, and others, prepared to mount to its summit while the train moved on. Following the valley, which is at first contracted by salient angles of the hills to a mile in width, and then opens to a junction with another stream, an almost imperceptible ascent led to Laguna Colorada, about nineteen miles distant from, and 350 feet higher than, the last camp. The Laguna is a pond of muddy water, which appears to be the head of a stream flowing in a northerly course towards the Canadian.

Those who ascended the Pyramid have arrived in camp delighted with their trip. The height by barometer above the valley was 500 feet. It appeared to tower slightly above the unbroken Llano towards the south. Mr. Marcou discovered two species of fossil oyster-shells, one remarkably long, and probably new. A sketch was made, to show the stratification. The Doctor was less fortunate in making collections there, but at camp he found a new opuntia. The head of a buck antelope was added to our naturalist's collection. The wind is still from the southwest, and has interfered to-night with our astronomical observations.

*September* 23—*Camp* 51.—Set out at 7½ a. m.; the morning calm and beautiful. The road ran along the southern base of a red sandstone bluff, worn into curious shapes resembling monuments, vases, and caves. This rock might easily be quarried, and would answer for building material. The sandstone and limestone of the Llano, however, would be harder and more durable. A short distance above appeared a forest of scrub cedars. We crossed the spur of a hill, which, by a detour to the right, might have been avoided, and entered a prairie interspersed with dwarfed cedars, cacti, yuccas, and mezquites. From the spur was a fine view westward, over mesa hills, to a blue sierra, said to belong to the Rocky mountains. Descending the hill, a rough and rocky road brought us to Arroyo de Pajarito. Here, eight miles from the last camp, was a large basin, nearly enclosed by hills, with good soil, water, grass, and tall reeds,

which mules are fond of. Passing this stream, and crossing a gently ascending ridge, we found a spring of good water, and plenty of buffalo-grass. Though the dense growth of cedars approaching from the hills completed the requisites for a camp, we proceeded three miles farther to Arroyo Cuerbito, and encamped, on brackish water, two miles from the woodlands.

A dog town being near, we selected a hole with freshest signs, determined to dig out the inmates; but the soil was so hard that we could make but little progress in excavating. We attempted, therefore, to explore its depths with long, pliant poles. The hole appeared to be about five inches in diameter, raised, moulded, and hardened with lime at the orifice. It was sunk spirally, at an angle of forty-five degrees for five feet, and then, with a sharp turn, entered a chamber four feet deep, communicating with cells or galleries. Into this hole, which which was coated with a white substance like a cement of lime, we poured six buckets of water. At first the surface of water was visible, but in about two minutes it disappeared, and our labor was vain. Neither the rattle of a snake, the hoot of an owl, nor the chirrup of a dog, gave token of life within. Nothing but a swarm of crickets seemed to have been disturbed.

*September* 24—*Camp* 52.—A great commotion was heard last night among the prairie-dogs. They doubtless thought that we had opened a regular siege; for on visiting the trench this morning, it was found that they had, during the night, repaired the breach, and stopped up the hole so as to cut off all communication by that entrance.

The morning was cool; the thermometer, at sunrise, standing at 43°. By an unusually steep ascent, we climbed a long, low ridge of hills to the crest of the summit dividing the waters of the Canadian from those of the Pecos. We were then nearly on a level with the top of the Llano, which appeared a mile or two to the left. Our observations showed that we were about eleven hundred feet above that part of it which we crossed a hundred miles back, east of Rocky Dell creek; but the rise from that point had been so gradual, that, without such proof, we would have seemed to be upon the same level. Over these plains antelope have been numerous, and the hunters fortunate—killing several. The artist took a sketch of a fine large male, and the skin was preserved as a specimen. The first herd we saw to-day numbered about thirty. Passing a pond of water bordered with green grass, we proceeded to l'Assisteros, thirteen miles, and encamped. This is the first affluent to the Pecos, and is styled by Simpson Hurrah creek. It flows through a fine valley of buffalo-grass, that appears to be now in its most perfect state. It is quite a rapid stream, eight feet wide, with cool, pure water. We camped at one o'clock, though there was no wood in sight, for the mules needed rest.

Near camp is a hill of sandstone, with masses broken into singular forms strewn upon the sides and at the foot. Among them are enclosures, and slight walls have perfected the seeming intention of nature—rendering the place quite a fortress. I believe that the New Mexican shepherds secure themselves and their sheep here from Indians and from wolves. The sandstone is the same as that at Rocky Dell creek, where were found such numbers of hieroglyphics; but we have sought in vain for similar representations. Weeks and months must have been idly spent among them by Mexicans and Pueblo Indians, and yet upon the whole field of rocks —their shelter from sun by day and from wind at night—there is not even the scratch of a knife or the trace of a coal. There were evidently special reasons for their labors at Rocky Dell creek. From Rio del Norte westward, between latitudes 32° and 33°, at almost every spring, and along the Gila to its junction with the Salinas, are found painted pieces of ancient pottery, metates,* and obsidian arrow-heads. But on the Canadian and its tributaries, on the Washita, and over the whole route to this point, such things have been searched for in vain. Not the semblance of a stone arrow-head has been seen upon the trip. A rude stone axe found at Comanche camp, on Rio Bonito, is the only evidence we have of utensils of that material having been used east of the Pecos, and that was too rough to be considered the work of design. Hence there seems no reason to believe that this part of the continent has ever been in the possession of semi-enlightened tribes such as existed west of Rio del Norte.

* A hollow stone, in which corn is ground.

*September* 25—*Camp* 52.—Our cattle becoming foot-sore and weary, to avoid leaving many of them behind, we determined not to move camp to-day, but allow them to rest. Dr. Bigelow immediately set out upon a botanical excursion. About four miles southwest he struck the bend of a river, probably the Gallinas, flowing in a cañon cut almost perpendicularly through the plain to a depth of about 500 feet. Following it down, he found cactaceæ and other interesting plants so numerous, that the time was beguiled away, and night came upon him unawares. We became alarmed for his safety, kindled signal-fires upon the hill, and discharged guns to direct him in the darkness towards camp. Finally a party went out to search, and met him on his return weary almost to fainting, with the weight of his herbarium. Numbers of fat antelope were killed to-day.

*September* 26—*Anton Chico.*—Took an early start; watching, as we went along, the varying tints of approaching day, so beautiful in this climate. A mile from camp we crossed the sandstone bed of the second branch of Hurrah creek, where there was water in pools. Commencing the ascent of a prairie ridge, we rose gradually, in three miles, about 400 feet, when we found ourselves upon the limestone surface of an extensive plain. For a mile or more the road was smooth, and then succeeded rolling prairie, beyond which was a forest of dwarf cedars. Fifteen miles of survey brought us to the Rio de Gallinas, a creek with pure running water, but with neither wood nor grass upon its banks. Passing over an undulating country, we reached the crest of a hill overlooking the Pecos at Anton Chico. An easy descent led to the valley, where we found a good crossing of the river, and proceeded to town. After leaving Rio de Gallinas, several pools of water appeared by the roadside, and one spring, "a las chupainas," (sheep spring); which waters a fertile basin five miles back, where the train was left to encamp to-night. Large flocks of sheep and many horses were grazing there as we passed by.

Anton Chico contains about five hundred inhabitants. The principal part of the town stands upon the west bank of the river, upon the first rise of ground above the irrigated fields. The valley is well cultivated and productive. Behind the town rise bluffs of high table-lands. The houses, as is usual in New Mexico, are built of adobes,* and are singularly festooned in front by strings of red peppers—the much prized "chili colorado"—intended less for ornament than use. Our entrance was greeted by wolfish-looking dogs—which, by-the-by, are celebrated for sagacity in guarding sheep—and a large number of children; the latter dressed in loose cotton robes, generally torn from the feet to the very neck, and gracefully flowing behind. Having no other covering, they looked cool, if not comfortable. Our object was to purchase corn, and obtain from the people information regarding the country westward. No old corn was to be had, but thousands of bushels of this year's growth were to be purchased at two dollars per fanega.† As this would be apt to injure grass-fed mules, we thought best to confine them to husks. Few of the people have travelled the road to Rio Abajo (Albuquerque), and we could gain little satisfaction upon that point. There are two traders residing here; one English, the other American. The alcalde civilly conducted us to the latter, Mr. Kitchen, who entertained us with great hospitality at his mansion.

* The adobe is made of an argillaceous earth, which is softened with water, and sometimes mixed with straw, and fragments of shells, or pebbles. It is pressed in a mould eighteen inches long, a foot wide, and six inches thick; and then turned out and dried in the sun. In building walls, the adobes are cemented together by a mortar made of clay.

† A trifle more than two and a half bushels.

## CHAPTER VI.

### *From Anton Chico to Albuquerque.*

**Pecos valley.—Sudden freshet.—Division of party.—Agua Negra.—La Cuesta.—Cañon Blanco.—La Laguna.—Town and river of Galisteo.—Los Cerritos.—Cienega.—Peña Blanca.—San Domingo.—Indian hospitality.—San Felipe.—Bernardillo.—Pueblo de Zandia.—Albuquerque.**

*September* 27—*Anton Chico.*—At 10 a. m. the train arrived, and camp was pitched near the village. Explorations were then made in the vicinity. The general surface of the country seems to have been, originally, an elevated table-land. Through this has been worn a deep chasm with bluff banks, which, above the town, rise directly from the river, and form a narrow cañon. As we descend the stream the bluffs recede, leaving a strip of valley and the fertile basin in which Anton Chico is situated.

*September* 28—*Anton Chico.*—Our cattle drivers yesterday took the wrong road from Sheep springs, and travelled towards Las Vegas. We sent after them, and late last night they arrived, after a drive of forty miles. To-day the animals are foot-sore and unable to proceed.

For the purpose of exploring two routes from here to Rio Grande it was proposed to divide the party, one portion to go immediately to La Cuesta, leaving Mr. Campbell to complete the examinations here, and then continue the survey towards Albuquerque. We sent for our mules, which were grazing upon excellent pasture east of the Pecos. The messenger returned reporting that a sudden flood of water had burst through the cañon, and swollen the river to such depth and velocity as to render it impossible to cross. It was nowhere fordable, and animals could not stem such a current by swimming. We have thus lost a day. At sunset, however, the water subsided, and the herd was safely driven to camp. Such freshets are frequent upon the Pecos; occasioned, probably, by rains among the mountains near its source. A whole family of emigrants, in attempting to cross, a short time since, were overtaken by a similar torrent and drowned.

*September* 29.—The party was to-day divided; the main portion proceeding with the survey direct to Albuquerque, while Dr. Bigelow, Mr. Marcou, Mr. Möllhausen, and Mr. Sherburne accompanied me to make certain detours north of that line. Following the road we ascended the bluff bank before referred to, and in less than seven miles rose six hundred feet. Upon our left was a rocky ravine, which probably cañoned near the mouth, preventing the road from following it. At Agua Negra, on the Pecos, thirty miles south, there is a new settlement, where the crossing of the river is said to be excellent. The idea that a railroad might pass that way was one great inducement for the establishment of the village. But it is so distant from the route we have thus far adopted, that it must be left for future examination. From the summit of the bluff our course led over a somewhat hilly prairie to the entrance of Cañon Blanco. We found that we had passed the trail leading to La Cuesta, which it was our intention to visit, and therefore turned back, taking a path which seemed to pursue a northeasterly direction towards that place. It was not a wagon road, though a few Mexican carts might have passed over it, and proved to be rocky and rough. The general surface, however, was level till we reached the edge of the bank overlooking the river and the town. The descent then, even by the road, was so precipitous that we were obliged to encamp at the top. The view from this point was singular and beautiful. A cultivated valley, about a mile wide, was enclosed between bluffs five hundred feet in height. The town, with its plaza and church, rested

H B Mollhausen

VALLEY OF LA CUESTA, RIO PECOS.

at the foot of the opposite cliff, and the tortuous river, with a border of trees, wound through rich meadows and fields of ripe corn. A sketch was taken by the artist, while some of us descended, sliding down on foot, at every turn catching at the rocks and bushes for support. The barometer escaped many dangers, and was read at the bottom, indicating, as stated, five hundred feet descent. As we entered the valley a loud clamor was heard from the nearest rancheros, and we found that the villagers had taken us for a band of Comanches; for this solitary spot is seldom disturbed from without except by those unwelcome visitors. When their apprehensions were quieted, and they found us to be Americans, they displayed a singular mixture of rudeness and civility, for they saw we were few in number and unarmed. They insisted upon our accompanying them to a ball in the village, but at the same time were heard talking to each other of the "Gringos,"* and joking regarding the outrages that had lately been committed by their friends upon Americans in Santa Fé. At length they carried their impertinence to such a pitch that a demonstration was made by our party which showed the villagers that we had the will to chastise any further displays of it. They immediately apologized, and afterwards treated us with respect.

Having bargained for ojas, (fodder for mules,) we separated; some to examine the neighborhood and admire the fine fields irrigated by acequias, others to clamber among the rocks for specimens of minerals and flowers. Many large crosses were noticed erected in the fields, probably marking the scenes of Indian massacres. At one of the ranchos was witnessed the operation of making syrup from cornstalks. The machinery was perfectly rude. A hollow log six feet long was placed on end to receive the broken stalks. Below was a grooved plank to lead the expressed fluid to a trough. Upon the stalks was placed a circular block of wood, and above a stick, upon which rested the trunk of a large pine tree, forming a lever for the press. The end of the tree nearest the tub was confined to a post by a pivot, and upon the other end were mounted the men and boys of the neighborhood, whose weight served as a living force to crush the stalks and separate the sap, which was afterwards boiled to the consistency of molasses.

*September* 30.—The mules having had plenty to eat during the night, we were enabled to leave camp at daybreak. Many Mexicans visited us even at that early hour, and were remarkably polite and communicative, not having forgotten the lesson we gave them. La Cuesta lies about two miles north of the main road, which we followed yesterday. This country having been so well delineated by Simpson and Abert, it seemed unnecessary to divide the astronomical instruments. We therefore left them with the train, trusting to the odometer, compass, and barometer to fix our points. From La Cuesta to Cañon Blanco the country is moderately level, and rather sparsely covered with small cedars and pines. The camp fires of the main party were found at the entrance to the cañon, where small pools of water had been discovered. The train had passed on before our arrival; proceeding through the gorge, and thence to La Laguna, where we overtook it and encamped.

This little lake is in a slight depression of the prairie near the summit dividing the waters of the Rio Grande from the Pecos. It affords sufficient water for trains, and for the flocks and herds grazing in the vicinity. In very dry seasons it has been known to fail for two months. A properly constructed tank at this place would receive a sufficient quantity of rain to render it a permanent reservoir.

As we approached La Laguna this evening, a storm sprang up on the Zandia; and, notwithstanding a strong easterly wind, soon enveloped us. The thermometer went down to 45° Fahrenheit, and the rain fell in large drops, mingled with hail. The poor mules, loosed from the harness, cowered before it. In two hours the shower had passed, but clouds, fog and wind remained the whole night. The sentinel and mules were sent to a thicket of cedars about a mile from camp for shelter. Eight thousand sheep passed here yesterday from Albuquerque,

* Gringos: a Mexican term of contempt.

to graze somewhere in the neighborhood during the winter, from which it may be inferred that a moderate climate, with little snow, characterizes this region.

*October* 1.—Our party was again divided; one portion carrying on the survey direct to Albuquerque, while another proceeded to make examinations towards Galisteo.

For two or three miles the latter route passed over an undulating country, and then led to a ravine, which conducted us for several miles in a straight course, along a descent inappreciable to the eye. An adobe house indicated permanent water near, and the name "Cañon Comanche" suggested a reason why the building was tenantless. Passing three trifling spurs, we traversed pleasant valleys among mesa heights to the head of a branch of Rio Galisteo. The stream at this place threads a narrow gorge, the road passing over a small rocky ridge fifty feet high. Descending, we crossed the brook, a few feet wide, and followed its bank. According to the Mexicans, it is five leagues from the crossing to Galisteo. Pursuing the valley three or four miles beyond, another branch coming from the left united with the former, making a good-sized stream, but so sluggish that its current was scarcely perceptible. At the junction of the creeks the country spreads out into extensive prairies, nearly enclosed by distant hills. We now saw the Gold mountains, west; the Santa Fé mountains, north; and towards the northwest the distant range of the Jemez mountains beyond Rio del Norte. Continuing along the wide valley, we came to a much larger affluent which was called Arroyo de la Xara, coming from the northeast. The distance between its bluff banks was from one hundred to one hundred and fifty feet, and a wide open valley seemed to extend uninterruptedly in a westerly course to the Rio del Norte. The lofty mountains beyond that river now stood in bold relief before us, not a hill intervening. Crossing a little ridge, we came in sight of a lake, beyond which were the brown adobe walls and white church gable of the village of Galisteo. The true Rio de Galisteo, proceeding from the north, washes the foot of the town, and soon after unites with Arroyo de la Xara on its course to the del Norte. We encamped near the plaza, and were soon after visited by Major Weightman and Judge Baird, direct from Albuquerque, on their way to the county court at San Miguel.

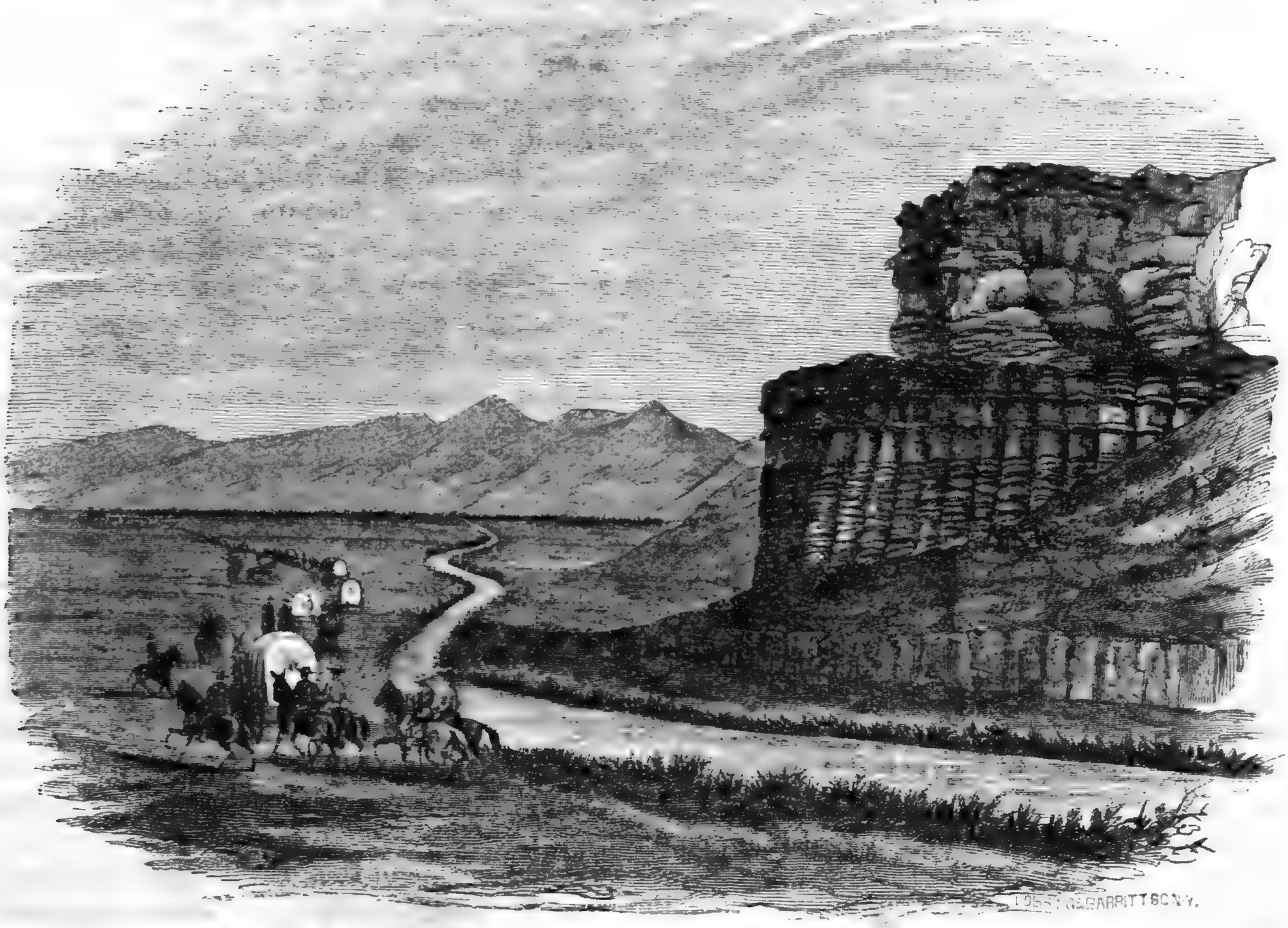
The country traversed to-day appeared to be an extensive plain; but by barometric observations, we find ourselves seven hundred feet below La Laguna. The distance is estimated at twenty-eight miles. Grass and water were abundant, but there was scarcely a tree to be seen along the road. Judge Baird says, that in the cañon from San Antonio to Albuquerque, through which he has just passed, there are beds of good coal. Timber is abundant upon the mountains.

The long storm which commenced on our arrival at Anton Chico has entirely passed away. The evening is calm and mild, the sky cloudless, and, as usual in this climate, meteors frequently shoot across the heavens, leaving behind long trains of light.

*October* 2.—Having despatched a messenger to Santa Fé with an official letter for the mail, we took leave of Galisteo. The main road to Albuquerque, or Rio Abajo, as it is here called, passes through the gold mines, San Antonio, and the cañon at Carnuel. Few have business leading them directly to the mouth of Galisteo river. Those who do, travel on foot or horseback, following a trail about thirty miles along the valley, which, cut up by small ravines, is not favorable for wagons. There was said to be a road, on the mesa to the right, commanding a good view of the stream, and this we proposed to follow. Crossing a creek, we ascended to a high prairie, and for four or five miles pursued a northerly course towards Santa Fé. Then, turning north 75° west, we continued fifteen miles farther to Delgado's rancho, called Los Cerritos, from the small rounded hills surrounding it. Near by are several springs boiling from the ground, and furnishing a perpetual supply of water. The basin in which they are situated proves, on examination, to be the crater of an extinct volcano. Here the road forks, and the one to the left, which we desire to take, is said to be impassable from some temporary cause. The other is very rough and more circuitous, it being five leagues by it to San Domingo. Therefore, as we could not accomplish the march before dark, it was thought best to

encamp. The day and night have been beautifully clear. The thermometer read at sunrise, 34°; at sunset, 54° Fahrenheit. Excellent melons and grapes are found here, said to have been brought from Rio Abajo.

*October* 3.—Leaving the basin, we ascended a ridge that overlooked a singular spot. Occupying the oval-shaped crater of another volcano was a village, in the centre of which were two lava cones sixty feet high, one of them surmounted with a stone tower, as a defence, we were told, against Comanches. The well-cultivated fields were surrounded by hedges, and watered by numerous springs. Adobe houses, strung, as usual, with chains of red peppers, were scattered among them, and gaily-clad Mexican rancheros could be seen sunning themselves in front. We descended a rocky declivity, and entered Cienega, or Cieneguilla, as it sometimes is called. Winding circuitously among the irrigated fields belonging to the ranchos, we then crossed a deep arroyo to the wagon trail, called by the villagers, as we thought improperly, "Camino Real." Along the banks of the arroyo were cultivated fields, a number of houses, and a church. At the end of three miles two branches came in, and the cliffs, three hundred feet in height, approached and confined us within a cañon. Pursuing a general southwest course three miles farther, upon the sides of the ravine we found trap, lava, and scoriæ, and upon the smooth faces of broken rocks were carved numerous hieroglyphics representing the sun, animals, foot-prints, &c. We also met with several new species of plants. At length we emerged into the open country we had not intended to leave, which stretches to the base of the Gold mountains, and is watered by Rio Galisteo on its passage to the del Norte. Cliffs at the terminus of the gorge were composed of coarse white sandstone, worn into the most perfect representation of a colonnade. Leaving the cañon, we had a level country to the valley of the Rio del Norte,



Entrance of Santa Fé river to the valley of Rio Grande, near Peña Blanca.

which we entered at Peña Blanca. Passing this town, we descended the valley about four miles to the crossing of the Rio Galisteo, three quarters of a mile above its mouth. According

to the barometer, the bed of the stream was here about one thousand feet below the village of that name. The channel is sandy, and several hundred feet wide, evidently bearing much water at certain seasons. The flowing stream is now only a few feet in width; but is said to feed the acequia that irrigates the cornfields, gardens, and vineyards of the Indian pueblo of San Domingo, which lies below the junction of the two rivers. This pueblo bears a strong contrast to Mexican towns; exhibiting, at a distance, considerable architectural effect. A good description of it is given by Lieut. Abert in his report on New Mexico. As we entered, an Indian came forward and offered us the hospitalities of his house; supper and a bed; and showed us fields where he said our mules could graze under their protection. Such hospitality is not uncommon among them. We encamped, and received a visit of welcome from the governor and numbers of his people; and afterwards returned some of their calls; having to climb ladders to obtain access to our friends' houses. They received us with great civility, generally offering us tortillas and melons to eat. We then visited the estufa. The building stands in an isolated spot, and in form is cylindrical, with a flat roof. Mounting to the top by means of a ladder, we then descended through a hole to a circular room some 30 feet in diameter. A fire-place with expiring embers, a candlestick, and something like a censer, were the principal contents. It is used as a council chamber, and for dancing; and here are performed all the mystical rites of their religion. To the simplicity of the estufa, the church offered a strong contrast. The massive doors were emblazoned with armorial bearings. The vigas of the roof were carved and gaudily painted. Above and around the altar were images of saints—some of fair proportions, others of Lilliputian dimensions, but in very good preservation. There were paintings of various degrees of merit. On many the hand of time had made severe ravages. The canvass had decayed, and the figures had faded into faint and undefined shapes. Under a fair name they would doubtless sell for a good price in the New York market. The most curious object noticed was an ox-skin banner, apparently very old, and painted to represent, in profile, a singular figure; with buckler and shield, visor, lance, and sword, complete; riding at full speed over prostrate warriors, whose upturned faces expressed great consternation. Below, somewhat defaced, was an inscription, but the governor hurried us away before we had time to copy it.

*October* 4.—We bade adieu to our hospitable friends, and after travelling a league had passed Covero, and were in front of the Indian pueblo of San Felipe. Standing upon the opposite bank of the river, it presented a pretty appearance; but we did not cross over to examine it. The church with two towers, and houses surrounded by fruit-trees, were similar to those of San Domingo. At this point, bluffs of diluvial drift approach the river on both sides, and were formerly united by a bridge. Upon the west bank a mesa, two hundred feet high, with a precipitous front, bounds the valley, and overhangs a lesser plateau, upon which the town is built. Thence it seems to extend south, nearly to the Jemez valley. On the eastern side a similar formation, coming down from the mountains, is broken into gravel-hills, and gradually diminishes to a spur which juts into the valley at a height of about fifty feet above the river, which here flows over a rocky bottom, good for foundations. There would be no difficulty, therefore, in selecting a route for a railroad from some point in the Galisteo valley to this place, crossing to San Felipe, and thence proceeding along the foot of the bluffs southwest to the river Jemez.

Following the left bank of Rio del Norte, or Rio Grande, as it is now generally called by Americans, we passed Algodones, a small Mexican town, and thence, through Bernardillo, celebrated for the excellent wine produced from its vineyards, to the Indian pueblo of Zandia, near which we encamped. A crowd of good-natured Indians soon appeared, offering for sale fruit and poultry at an extravagant price that would have astonished a Jew. But if they were hard at a bargain, they were honest and kind-hearted.

*October* 5—*Albuquerque.*—Took the upper road along the edge of the gravel hills, leaving the wide valley and numerous ranchos to the right. Ten or twelve miles from Zandia we entered the town of Albuquerque. The white wagons and tents of our advanced party were nearly as conspicuous as the village itself, and we drove towards them to meet our companions. All had

arrived safe and well. The surveying party report that they passed through a deep and narrow cañon at Carnuel; but that it would not be impracticable to cut through it a passage for a railway, and thence proceed to the Rio Grande near this place with a grade of eighty feet to the mile.

Albuquerque contains a less population than Santa Fé. Its situation, however, is more central with regard to the inhabited portions of New Mexico, and it has been selected by General Garland for the headquarters of this military department. Nearly the whole valley of Rio del Norte is capable of yielding good crops; but between Bernardillo and this place are the finest ranchos and vineyards to be found in the Territory. The number of inhabitants in Albuquerque and its environs, including the ranchos, is estimated at 2,500. This is exclusive of Atrisco, which lies opposite upon the right bank of the river. The houses are of one story, built of adobes, and the appearance of the town is similar to that of others in New Mexico. The presence of the troops, however, creates an unusual air of animation about it.

# CHAPTER VII.

## *From Albuquerque to Pueblo de la Laguna.*

**Detention upon Rio Grande for supplies.—Plotting of notes.—Information regarding the country west.—Sitgreaves' route.—Walker's route.—Aubrey's route.—Employment of guides.—Geological reconnaissance to Zandia mountain and to the gold mines.—Examination upon the Del Norte for a suitable place for a bridge.—Pueblo of Isleta.—Bosque de los Pinos.—Military post at Las Lunas.—Arrival of Lieut. Ives and party from El Paso.—Magnetic and astronomical instruments.—Remarks upon the mode of using them.—Division of the party.—Continuation of the survey via Isleta to Rio Puerco and the San José valley.—Direct route from Albuquerque to Rita.—Coal in the valley of Rio Puerco.—El Alamo.—Ruins of Rita.—Rancho Colorado.—Pueblo de la Laguna.**

*November* 7—*Albuquerque.*—Upon our arrival here, Indian depredations and anticipated troubles upon the Mexican frontier caused considerable excitement throughout the Territory. The troops were actively employed in scouts or in preparations for serious encounters. General Garland, the commanding officer of the department, being upon a tour of observation in the southern portion of the Territory, the acting commissary remaining at this post was unwilling to take the responsibility of diminishing the supply of stores on hand, by furnishing the subsistence required for our party for the remainder of the survey. Not being able to purchase elsewhere, we were obliged to await the return of the commanding general. He arrived on the 21st ultimo, and immediately directed every assistance to be granted us that his department could afford. Provisions have been received, and arrangements this day completed for our departure.

During the detention referred to, the party has been actively employed in operations incident to the work. The notes of the survey from Fort Smith have been plotted and sent to the department at Washington, thereby duplicating the work and diminishing the chances of losing the results of our labor. Our means of transportation have been made as complete as circumstances would permit. Information regarding the country we propose to traverse, has been derived from every available source. By the Topographical Bureau we had been furnished with a tracing from Captain Sitgreaves' map of a reconnaissance to Rio Colorado in 1851; and here we have had intercourse with persons from each party of white men known to have visited the region near the line of our proposed operations. Mr. Antony Thomas very kindly has made for us a sketch, from memory, of Mr. Walker's route in 1851, upon which extraordinary difficulties were encountered. Mr. Tully, a companion of Mr. Aubrey in his recent trip from California, has given a description of the country over which he passed. Mr. Aubrey himself has since confirmed the statements of his friend, cautioning us to avoid his trail as being unsuitable for our operations. We have conversed with José Manuel Savedra, a New Mexican who professes to have accompanied the Moqui Indians upon an expedition against the Mojaves; and also with the guide Antoine Leroux. The information derived from these sources regarding the country between Zuñi and the Colorado river is exceedingly unfavorable; but as no one has yet traversed the entire route designated in our instructions, it is possible that the difficulties encountered by other parties may be avoided by our own. In order to omit nothing that may contribute to success, we have secured the services both of Leroux and Savedra for the journey.

Several reconnaissances have been made during our stay here, in the vicinity of Rio Grande. The botanist and geologist passed through the cañon of Carnuel to San Antonio, and ascended to the top of Zandia mountain; which, from measurement by triangulation from Albuquerque, is found to be seven thousand feet above the valley of the river, and twelve thousand feet above

the sea. Afterwards they visited the gold mines, and thence proceeded as far as Santa Fé. The results of their examinations prove interesting. Indications of coal appeared in the cañon; jurassic fossils were found near the summit of the mountain, and they obtained many specimens of precious metals. Mines have been worked in other localities of this Territory; the principal are the gold placers near Taos, the copper mines of Santa Rita, and the silver mines of the Organ mountains near Fort Fillmore. The latter will probably be found the most valuable.*

* For a full and accurate description of this country, I would refer to a "Memoir of a Tour in Northern Mexico in 1846 and '47, by A. Wislizenus, M. D.," published by order of the U. S. Senate, in 1848. This document presents so clear a view of the general character and resources of the Territory, that it seems unnecessary to add further details. A few extracts bearing more particularly upon the subject under consideration, are subjoined:

"New Mexico is a very mountainous country, with a large valley in the middle, running from north to south, and formed by the *Rio del Norte*. The valley is generally about 20 miles wide, and bordered on the east and west by mountain chains, continuations of the Rocky mountains, which have received here different names, as Sierra Blanca, de los Organos, oscura, on the eastern side, and Sierra de los Grullas, de Acha, de los Mimbres, towards the west. The height of these mountains south of Santa Fé may, upon an average, be between six and eight thousand feet, while near Santa Fé, and in the more northern regions, some snow-covered peaks are seen that may rise from 10,000 to 12,000 feet above the sea. The mountains are principally composed of igneous rocks, as granite, sienite, diorit, basalt, &c. On the higher mountains excellent pine timber grows; on the lower, cedars, and sometimes oak; in the valley of the Rio Grande, mezquite.

"The main artery of New Mexico is the Rio del Norte, the longest and largest river in Mexico. Its headwaters were explored in 1807 by Captain Pike, between the 37° and 38° north latitude; but its highest sources are supposed to be about two degrees farther north in the Rocky mountains, near the headwaters of the Arkansas and the Rio Grande, (of the Colorado of the west.) Following a generally southern direction, it runs through New Mexico, where its principal affluent is the Rio Chamas from the west, and winds its way then in a southeastern direction through the States of Chihuahua, Coahuila and Tamaulipas, to the Gulf of Mexico, in 25° 56′ north latitude. Its tributaries in the latter States are the Pecos, from the north; the Conchos, Salado, Alamo, and San Juan, from the south. The whole course of the river, in a straight line, would be near 1,200 miles; but by the meandering of its lower half, it runs at least about 2,000 miles from the region of eternal snow to the almost tropical climate of the gulf. The elevation of the river above the sea near Albuquerque, in New Mexico, is about 4,800 feet; in el Paso del Norte about 3,800; and at Reynosa, between three and four hundred miles from its mouth, about 170 feet. The fall of its water appeared to be, between Albuquerque and El Paso, from two to three feet in a mile, and below Reynosa one foot in two miles. The fall of the river is seldom used as motive power, except for some flour mills, which are oftener worked by mules than by water. The principal advantage which is at present derived from the river is for agriculture, by their well managed system of irrigation. As to its navigation in New Mexico, I doubt very much if even canoes could be used, except perhaps during May or June, when the river is in its highest state, from the melting of the snow in the mountains. The river is entirely too shallow, and interrupted by too many sand-bars, to promise anything for navigation. On the southern portion of the river the recent exploration by Captain Sterling, of the United States steamer Major Brown, has proved that steamboats may ascend from the gulf as far as Laredo, a distance of 700 miles. Although said steamboat did not draw over two feet of water, yet the explorers of that region express their opinion, that 'by spending some $100,000 in a proper improvement of the river above Mier, boats drawing four feet could readily ply between the mouth of the Rio Grande and Laredo.' Whenever a closer connexion between this head-point of navigation and New Mexico shall be considered, nothing would answer but a railroad, crossing from the valley of the Rio Grande to the high table-land in the State of Chihuahua.

"The *soil* in the valley of the Rio del Norte, in New Mexico, is generally sandy and looks poor, but by irrigation it produces abundant crops. Though agriculture is carried on in a very primitive way, with the hoe alone, or with a rough plough, made often entirely of wood, without any particle of iron, they raise large quantities of Indian corn and wheat, beans, onions, red peppers, and some fruits. The most fertile part of the valley begins below Santa Fé, along the river, and is called 'Rio Abajo,' or (the country) down the river. It is not uncommon there to raise two crops within one year. The general dryness of the climate, and the aridity of the soil in New Mexico, will always confine agriculture to the valleys of the water-courses, which are as rare as over all Mexico—such, at least, as contain running water throughout the year. But this important defect may be remedied by Artesian wells. On several occasions I remarked on the high table-land from Santa Fé south, that in a certain depth layers of clay are found, that may form reservoirs of the sunken water-courses from the eastern and western mountain chain, which, by the improved method of boring, or artesian wells, might be easily made to yield their water to the surface. If experiments to that effect should prove successful, the progress of agriculture in New Mexico would be more rapid, and even many dreaded 'Jornadas' might be changed from waterless deserts into cultivated plains. But at present, irrigation from a watercourse is the only available means of carrying on agriculture. The irrigation is effected by damming the streams and throwing the water into larger and smaller ditches (*acēquias*) surrounding and intersecting the whole cultivated land. The inhabitants of towns and villages, therefore, locate their lands together, and allot to each one a part of the water at certain periods. These common fields are generally without fences, which are less needed, as the grazing stock is guarded by herdsmen. The finest fields are generally seen on the *haciendas*, or large estates, belonging to the rich property holders in New Mexico. These haciendas are apparently a remnant of the old feudal system, where large tracts of land, with the appurtenances of Indian inhabitants as serfs, were granted by the Spanish crown to their vassals. The great number of human beings attached to these haciendas are, in fact, nothing more than serfs; they receive from their masters only food, lodging, and clothing, or perhaps a mere nominal pay, and are therefore kept in constant debt and dependence to their landlords; so that if old custom and natural indolence did not prevail upon them to stay with their hereditary masters, the enforcement of the Mexican laws against debtors would be sufficient to continue their servitude from generation to generation. This actual slavery exists throughout Mexico, in spite of its



Mo. Bot. Garden
1909

To examine points for crossing Rio Grande, explorations have been made below Albuquerque. We first passed down the valley upon the left bank of the river. Opposite Pajarito, the arroyo of San Antonio comes down from the cañon of Carnuel. Its slope seems uniform, and the course direct from the gorge through which the survey passed. At Pajarito the river bottom is wide and

liberal constitution; and as long as this contradiction is not abolished, the declamations of the Mexican press against the slavery of the United States must appear as hypocritical cant.

"Besides agriculture, the inhabitants of New Mexico pay a great deal of attention to the *raising of stock*, as horses, mules, cattle, sheep, and goats. Their stock is all rather of a small size, because they care very little for the improvement of the breed; but it increases very fast, and as no feeding in stables is needed in the winter, it gives them very little trouble. There are large tracts of land in New Mexico too distant from water to be cultivated, or in too mountainous parts, which afford, nevertheless, excellent pasturage for millions of stock during the whole year; but unfortunately here, as well as in the State of Chihuahua, the raising of stock has been crippled by the invasions of the hostile Indians, who considered themselves secret partners in the business, and annually take their share away.

"A third, much neglected branch of industry in New Mexico are the *mines*. Great many now deserted mining places in New Mexico prove that mining was pursued with greater zeal in the old Spanish times than at present, which may be accounted for in various ways, as the present want of capital, want of knowledge in mining, but especially the unsettled state of the country and the avarice of its arbitrary rulers. The mountainous parts of New Mexico are very rich in gold, copper, iron, and some silver. Gold seems to be found to a large extent in all the mountains near Santa Fé, south of it in a distance of about 100 miles, as far as Gran Quivira, and north for about 120 miles up to the river Sangre de Cristo. Throughout this whole region gold dust has been abundantly found by the poorer classes of Mexicans, who occupy themselves with the washing of this metal out of the mountain streams. At present the old and new *Placers*, near Santa Fé, have attracted most attention, and not only gold washes, but some gold mines too, are worked there. They are, so far as my knowledge extends, the only gold mines worked now in New Mexico. But as I have made from Santa Fé an excursion there for the special purpose of examining those mines, I must refer the reader, in relation to them, to that chapter of my narrative. As to the annual amount of gold produced in New Mexico, I am unable to give even an estimate. But as nearly all the gold of New Mexico is bought up by the traders, and smuggled out of the country to the United States, I believe that a closer calculation of the gold produced in New Mexico could be made in the different mints of the United States than in Mexico itself. Several rich silver mines were, in Spanish times, worked at Avo, at Cerrillos, and in the Nambe mountains, but none at present. Copper is found in abundance throughout the country, but principally at las Tijeras, Jemas, Abiquiu, Guadelupita de Mora, etc. I heard of but one copper mine worked at present south of the Placers. Iron, though also abundantly found, is entirely overlooked. Coal has been discovered in different localities, as in the Raton mountains, near the village of Jemez, southwest of Santa Fé, in a place south of the Placers, etc. Gypsum, common and selenite, are found in large quantities in Mexico; most extensive layers of it, I understood, exist in the mountains near Algodones, on the Rio del Norte, and in the neighborhood of the celebrated 'Salinas.' It is used as common lime for whitewashing, and the crystalline or selenite instead of window-glass. About four days' travelling (probably 100 miles) south-southeast of Santa Fé, on the high table-land between the Rio del Norte and Pecos, are some extensive *salt lakes*, or '*salinas*,' from which all the salt (muriate of soda) used in New Mexico is procured. Large caravans go there every year from Santa Fé in the dry season, and return with as much as they can transport. They exchange, generally, one bushel of salt for one of Indian corn, or sell it for one or even two dollars a bushel.

"Not far from these salinas the ruins of an old city are found, of the fabulous '*la Gran Quivira.*' The common report in relation to this place is, that a very large and wealthy city was once here situated, with very rich mines, the produce of which was once or twice a year sent to Spain. At one season, when they were making extraordinary preparations for transporting the precious metals, the Indians attacked them; whereupon the miners buried their treasures, worth fifty millions, and left the city together; but they were all killed except two, who went to Mexico, giving the particulars of the affair, and soliciting aid to return. But the distance being so great, and the Indians so numerous, nobody would advance, and the thing was dropped. One of the two went to New Orleans, then under the dominion of Spain, raised 500 men, and started by way of the Sabine, but was never heard of afterwards. So far the report. Within the last few years several Americans and Frenchmen have visited the place; and, although they have not found the treasure, they certify at least to the existence of an aqueduct, about ten miles in length, to the still standing walls of several churches, the sculptures of the Spanish coat of arms, and to many spacious pits, supposed to be silver mines. It was no doubt a Spanish mining town, and it is not unlikely that it was destroyed in 1680, in the general, successful insurrection of the Indians in New Mexico against the Spaniards. Dr. Samuel G. Morton, in a late pamphlet, suggests the probability that it was originally an old Indian city, into which the Spaniards, as in several other instances, had intruded themselves, and subsequently abandoned it. Further investigation, it is to be hoped, will clear up this point.

"The *climate* of New Mexico is of course very different in the higher, mountainous parts, from the lower valley of the Rio del Norte; but, generally taken, it is temperate, constant, and healthy. The summer heat in the valley of the river will sometimes rise to nearly 100° Fahrenheit, but the nights are always cool and pleasant. The winters are much longer and more severe than in Chihuahua, the higher mountains are always covered with snow, and ice and snow are common in Santa Fé; but the Rio del Norte is never frozen with ice thick enough to admit the passage of horses and carriages, as was formerly believed. The sky is generally clear, and the atmosphere dry. Between July and October, rains fall; but the rainy seasons are here not so constant and regular as in the southern States. Disease seems to be very little known, except some inflammations and typhoidal fevers in the winter season.

"The *history* of New Mexico lies very much in the dark. The Spaniards, it seems, received the first information about it in 1581 from a party of adventurers under Captain Francisco de Levya Bonillo, who, upon finding the aboriginal inhabitants and the mineral wealth of the country to be similar to those of Mexico, called it New Mexico. In 1594, the then viceroy of Mexico, Count de Monterey, sent the gallant Juan de Oñate, of Zacatecas, to New Mexico, to take formal possession of the country in the

low as at Albuquerque. But the diluvial spur that limits the left bank of the arroyo, or ravine, stretches towards the southwest, forming a bluff bank that abuts upon the river opposite Isleta, an Indian pueblo about thirteen miles south from Albuquerque. The pueblo stands upon a gravel ridge that also terminates in a bluff twenty-one feet above the water's edge. These

name of Spain, and to establish colonies, missions, and presidios, (forts.) They found a great many Indian tribes and settlements, which they succeeded in christianizing in the usual Spanish way, with sword in hand, and made them their slaves. The villages of the christianized Indians were called *pueblos*, in opposition to the wild and roving tribes that refused such favors. Many towns, of which only ruins exist now, were established at that time; many mines were worked, and the occupation of the country seemed to be secured, when, quite unexpectedly, in 1680, a general insurrection of all the Indian tribes broke out against the Spanish yoke. The Indians massacred every white male, and the then governor of New Mexico, Don Antonio de Otermin, after a hard fight, had to retreat with his men from Santa Fé, and marched as far south as Paso del Norte, where they met with some friendly Indians, and laid the foundation of the present town of that name. It lasted ten years, until Spain recovered the whole province of New Mexico again. Several other insurrections took place after that, but none so disastrous as the first. However, the deep rancor of the Indian race against the white has continued to the present time, and in all the frequent and bloody revolutions of later years in New Mexico the pueblos generally acted a conspicuous and cruel part. There is constantly some distance between them and the rest of the Mexicans. They live always isolated in their villages, cultivate the soil and raise some stock, and are generally poor, frugal, and sober. Their different tribes, of which about twenty yet exist, are reduced to about ten thousand souls. They speak different Indian dialects; sometimes, too, broken Spanish. All of them know the old tradition of Montezuma, mentioned already in the account of the old Pecos village; but none have carried the veneration of their expected Saviour so far as this faithful tribe. For the regulation of their communities they select a chief or cacique, and a council, and in war a captain. Their religious rites are a mixture of Catholicism and Indian paganism; the Spanish priests themselves favored this combination, from policy. Their villages are built with great regularity; sometimes they have but one large house, with several stories, and a great many small rooms, in which the whole village is quartered. Instead of doors in front, they use trap-doors on the roofs of their houses, to which they climb up on a ladder, which is withdrawn in the night for greater security. Their dress consists of moccasins, short breeches, and a woolen jacket, or blanket; they generally wear their hair long. Bows and arrows and a lance, and sometimes a gun, constitute their weapons.

"The whole *population* of New Mexico was in 1793, according to a census, 30,953; in 1833 it was calculated to amount to 52,360, and that number to consist of one-twentieth Gapuchines, (native Spaniards,) four-twentieths Creoles, five-twentieths Mestizes of all grades, and ten-twentieths of pueblo Indians. In 1842, the population was estimated at 57,026, and at present at about 70,000 souls. * * * * * * * *

"The caravan started on the usual road, by Algodones, for the Rio del Norte. But being anxious myself to examine the celebrated gold mines of New Mexico, the old and new Placers, in a range of mountains southwest from Santa Fé, I intended to make first from here this out of the way excursion, and to join the caravan afterwards on the Rio del Norte, near Albuquerque. I started, therefore, in this direction, riding alone, and taking nothing along but my arms and a pair of saddle-bags.

"The distance from here to old Placer is about 25 miles; from Santa Fé, 27. In a southern direction, I rode through the valley that separates the mountains east of Santa Fé from the chain of the Placers. This valley is about 25 miles broad, very sandy and sterile, covered with artemisia, and nearer the foot of the Placer mountains with dwarfish cedars. Travelling along a low chain of hills that form an outward wall to the mountains of old Placer, I passed by two springs, on the first of which I found sienite; on the other a fresh-water limestone. Ascending afterwards to the hills, I met everywhere with a red and brown sandstone, looser or more compact, and with large masses of petrified wood. From here the ascent to the mountains is rather rapid, till a plain is gained, from which a fine retrospective view is enjoyed towards Santa Fé, and over the whole valley. Pine and cedar cover the mountains all around. Slightly ascending from the plain for some miles, a narrow ravine, between high walls of mountains, suddenly opposes further advance, and about twenty houses are seen hanging on both sides of the narrow valley. This solitary place is el Real de Dolores, or, as it is commonly called, old Placer. Several foreigners live here. The first one I saw was Mr. Watrous, a New Englander, but for many years a resident of this country. He received me very hospitably, and invited me to his dwelling. Some fresh skins of grizzly bears were spread out on scaffolds; the sure American rifle stood in the corner; and everything else bore the character of the backwoodsman; but, by his intelligent conversation, he showed himself a man of very good sense, and as an acute observer. Though Mr. Watrous had not himself been engaged in mining, he paid attention to his whole neighborhood, and showed me many specimens of gold ores, which, in his rambles through the mountains, he had collected. I took a walk with him to the nearest golden washes. The first instance of this operation I witnessed on the small creek that runs through old Placer. From the bed of the creek, which was in most places dry, they took up some of the ground, (gravel, sand, and earth,) put it in a spacious, rather flat wooden bowl, (batéa,) added water, removing first, by stirring with the hand, the coarse pieces of gravel, and then, by well balanced shaking, all the earthy and sandy particles, till at last nothing is left at the bottom but the finest sand, from which all the visible portions of gold are picked out. The poorer class of Mexicans are generally occupied with those gold washes in the creek; and they divide for that purpose the creek, with the water, amongst themselves, in lots, which often call forth as many claims and contests as the finest building lots in our cities. As the gold is apparently carried here by the waters of the creek from higher auriferous regions, the gain from these washings is different according to the season. The most gold is generally found in and after the rainy season, and it diminishes with the failing of water. Occasionally they discover a larger piece of gold in the sand; but generally the gold is so divided that a whole day's work will amount, on an average, to not more than a quarter or half a dollar. Every evening they sell their small gains to the storekeepers, and take provisions or goods in exchange, or receive cash for it, at the rate of sixteen dollars per ounce. This is the most common but least profitable way of gold washing. It may be practised on all the watercourses in those mountains, provided that there is sufficient water to wash with. In going from this to some other gold washes in the neighborhood, I took notice of the prevalent rocks in old Placer; they are white and yellow quartzose sandstone, quartz,

opposite points form good abutments for a bridge. The distance between them is about eight hundred feet. The bed of the river is sandy, and the depth of water three to four feet. The usual ford is about one hundred yards below. Few trees occur in the valley, except at Bosque de los Piños, five miles below Isleta, where the wide bottom lands are covered with quite a forest of

hornblende and quartz, sienite and greenstone, (diorit.) The second place where I saw the process of gold washing, was on a high piece of ground not far from a creek. They had opened here a great many pits, to the depth of from 50 to 60 feet, and raised the ground—a sandy earth, mixed with iron ochre—to the surface, where it was washed for gold in the same way, in batèas. These gold washings are said to be profitable, but they would, in my opinion, be more so, where a regular mining was done, by sinking a shaft, and by separating the gold by quicksilver, or in some other way than mere washing.

"On the next day I went to see a gold mine near the upper part of the town, belonging to Mr. Tournier, a French resident of the place. The mine lies between one and two miles west of the town, on the slope of some mountains. It was discovered several years ago, by Mr. Roubadoux, who commenced working it, but for some reason gave it up. Mr. Tournier had worked it for one year, and found it very profitable. The gold vein runs from SSE. to NNW., with a very slight dip. It is generally from two to four feet wide. Mr. Tournier has sunk a shaft already in the entire depth of 40 varas, and with the drift of about 30 varas, and the ore promises to hold out very fairly. The vein is found in sienite and greenstone; the gang consists of argillaceous iron ore, (yellow and brown iron ochre,) with which the native gold is very intimately mixed. A yellow or brown earth—a decomposition of the same rocks, and found among them—is considered peculiarly rich in gold. The ores are carried in bags to the surface, and on mules to the amalgamation mill, in town. After the ores have been ground, by hand, (pounding them with rocks,) they are put in the mill—a small circular basin, formed with rocks, with one or two mill-stones, which are constantly turned around in it by mule-power. These millstones are placed on their face, revolving round a centre-pole, which is turned by the animal. To the coarsely powdered ore, water, and then quicksilver, are added, and the amalgamation goes on in the usual way. Mr. Tournier told me that he worked in this way every day about two and a half cargas (750 pounds) of the ore, and that he draws, on an average, three-quarters of an ounce (about $12 worth) of gold out of it. Although the whole work, at present, is done on a very small scale, and would allow yet many improvements, Mr. Tournier makes, nevertheless, a smart business of it, and will soon turn his gold mine into real gold. Near Mr. Tournier's gold mine is a copper mine, (sulphuret of copper,) said to contain gold ore, and worked for some time, but now given up. Several other specimens of copper ore, from the vicinity, were shown me. A very rich iron ore I saw myself in the neighborhood; but neither of them is worked.

"The old Placer is a very promising place for mines. The gold ores there were discovered, by mere accident, in 1828, and gold washings established; but besides that the ground is barely touched, and will yet open rich treasures to the mining enchanter who knows how to unlock them.

"In the afternoon of the same day I left old Placer, to pay a visit to the other mining place, southwest from it, called new Placer, and about nine miles distant. I rode there with Mr. Nolan, a French resident of new Placer. Our way lay through fine pine timber, over steep mountains and through narrow ravines. The road is so rough that no wagons can pass it. After having reached the highest point, an extensive plain is seen towards the south; and towards the west a small valley opens, in which new Placer, or Real del Tuerto, a town of about 100 buildings, is situated. Several foreigners reside here, generally storekeepers. In the house of one of them, with Mr. Trigg, I found a kind and hospitable reception.

"The gold in new Placer is also got in two ways, by washing and by mining. The principal place for gold washing is about one mile southwest from the town, at the foot of a naked granitic mountain, the so-called 'Bonanza.' A cluster of houses, or rather huts, form here a small village, whose inhabitants live exclusively by gold washing, but look as poor and wretched as if they never handled any gold of their own. The whole place is excavated with pits, from whose depths they dig the same yellow auriferous ground as in old Placer; and they wash it also in the same way. Not a drop of water is found here; all the water for washing must be brought in barrels from new Placer. The wash-gold obtained from new Placer is generally considered inferior to that of old Placer, as being more impure. To ascertain the correctness of this opinion, I examined some wash-gold from new Placer, and found it to contain—

| | |
|---|---|
| Native gold | 92.5 |
| Silver | 3.5 |
| Iron and silex | 4.0 |
| | 100.0 |

"I am sorry that I have no wash-gold from old Placer at hand for a comparative analysis, but the above-mentioned result shows that if any difference exists between the two ores, it cannot be considerable.

"Two gold mines are worked at this time in new Placer; one by Mexicans, the other by an American. They are said to be very similar to each other. I visited but the nearest, belonging to Mr. Campbell, an American resident of new Placer. Mr. Campbell commenced mining only a short time since. His amalgamation mill was not yet in operation; but he had already collected heaps of gold ores, and invited me to see the mine that he had opened. It lies about one and a half miles southwest from the town, near the top of a high mountain, to which a rough and steep road leads, accessible only to pack-mules. The gold mine is found, as in old Placer, in sienite and greenstone. It runs horizontally from east to west. The gang is iron ochre and crystallized quartz. The vein was from eight to ten feet wide, and explored only to the length of about twenty feet, and to the depth of about ten feet. The ore seems to be very rich in gold, and the prospects it offers to Mr. Campbell are certainly very flattering.

"The new Placer adds to the attraction of the gold ores, which seem to be found in this whole range of mountains, that of a better situation as a town than old Placer, and of more passable roads. But many other mining places will no doubt spring up in this neighborhood, as soon as the state of the country allows it. Up to this time many causes have existed to prevent rather

mezquites and cotton-woods. From Isleta, the bluff, which bounds the valley, recedes towards the west-southwest, with a wide slope, affording a gradual ascent to the table-land between Rio Grande and the Puerco.

Having completed a series of observations at Isleta, we proceeded seven miles down the right bank of the river to Las Lunas, a military station commanded by Capt. Ewell, of the dragoons. That officer had a thorough knowledge of the country in this vicinity, and was kind enough to accompany us upon an excursion to look at the route esteemed favorable for crossing over into the valley of Rio Puerco. It was decided to adopt this course for the survey.

Lieut. Ives, with the party despatched from Washington before us with the design of reaching this place in advance of the survey, in order to make the necessary preparations for facilitating our progress westward, was detained in Texas for the want of an escort across the plains to El Paso, and therefore did not arrive here until the 6th of October. He succeeded in obtaining at El Paso the instruments loaned by the Department of the Interior, which have much increased the facilities for making scientific observations. Among them were an astronomical transit, and a "Fox" dip-circle, for measuring the elements of magnetism. The latter instrument was invented by Mr. Fox, of Falmouth, England, who has given instructions for

than to encourage mining enterprise. Though the law in New Mexico was generally very liberal in granting lots for mining, the instability of Mexican laws, and their arbitrary administration, have neutralized and annihilated it. When a New Mexican wants to work a gold or other mine, not yet occupied by another, he has to apply to the nearest alcalde, (justice of peace of the district,) who, according to the means and intended work of the individual, allows him a smaller or larger tract of land, measured only in front, and reaching in depth as far as the owner pleases to go. The price of the land is trifling; but if the owner does not work a certain portion of the mine every year, it falls back to the government. Foreigners were, in consequence of the eternal revolutions and new law-codes in Mexico, sometimes excluded, sometimes allowed to participate in this privilege. By taking a Mexican as partner, they obviated the law; but the most dangerous enemy was generally the avaricious Mexican government itself. Often, when a foreigner had opened a profitable mine, those trustees of justice interfered, for some reason or other, and ejected the owner of his property. Several instances of such proceedings are known. If we add to these causes the isolated situation of New Mexico, the thin population, the want of good mechanics and real miners, the hostilities and depredations of Indians, it will not astonish us at all that, notwithstanding the great mineral resources of the country, so few mines are worked at present.

"The annual production of gold in the two Placers seems to vary considerable. In some years it was estimated from $30,000 to $40,000, in others from $60,000 to $80,000, and in latter years even as high as $250,000 per annum." * * *

"At the conclusion of my journal, it may not be amiss to add some *general remarks in relation to northern Mexico.*

"New Mexico and Chihuahua, which I consider here principally, because they fell under my immediate observation, are neither the richest nor the poorest States of Mexico; but both of them have resources that never have been fully developed.

"*Agriculture*, as we have seen, is the least promising branch of industry. The want of more water-courses, and the necessity of irrigation, are the principal causes; but nevertheless, they raise every year more than sufficient for their own consumption; and failure of crops, with starvation of the people, is less common here than in many other countries, because the regular system of irrigation itself prevents it. Besides, there are large tracts of land in the country fit for agriculture, but allowing no isolated settlements on account of the Indians. Another reason, too, why farming settlements make slow progress is the large haciendas. That independent class of small farmers who occupy the greatest part of the land in the United States is here but poorly represented, and the large estates cultivate generally less ground than many smaller but independent farmers.

"As a *grazing country*, both States are unsurpassed by any in the Union. Millions of stock can be raised every year in the prairies of the high table-land and in the mountains. Cattle, horses, mules, and sheep increase very fast; and if more attention were paid to the improvement of the stock, the wool of the sheep alone could be made the exchange for the greatest part of the present importation. But to accomplish that, the wild Indians, who chiefly in the last ten years have crippled all industry in stock raising, have first to be subdued.

"*Mining*, another main resource of the country, needs to some degree, also, protection from the Indians, because valuable mines have sometimes been given up, from their incursions; and other districts, rich in minerals, cannot be even explored, for the same reason.

"The silver mines of the State of Chihuahua, though worked for centuries, seem to be inexhaustible. The discovery of new mines is but a common occurrence; and, attracted by them, the mining population moves generally from one place to another without exhausting the old ones. To make the mining more effectual, onerous duties and partial restrictions ought to be abolished, and sufficient capital to work them more thoroughly and extensively would soon flow to the State. New Mexico seems to be as rich in gold ore as Chihuahua is in silver; but yet, less capital and greater insecurity have prevented their being worked to a large extent.

"To develop all those resources which nature has bestowed upon these two States, another condition of things is wanted than at present prevails there: a just, stable, and strong government is, before all, needed, that can put down the hostile Indians, give security of person and property to all, allow free competition in all branches of industry, and will not tax the people higher than the absolute wants of the government require. Under such a government, the population, as well as the produce of the country, would increase at a rapid rate; new outlets would be opened to commerce, and the people would not only become richer and more comfortable, but more enlightened, too, and more liberal."

its use in obtaining the magnetic inclination of the needle, and relative intensity of magnetism at different points of the earth's surface. The transit was made by Troughton & Simms, of London, after a plan furnished by Col. Graham, of the Topographical Engineers. Upon three foot-screws rests a circular base, to which are attached, by movable screws, the vertical uprights forming the Y's. The telescope has a focal length of twenty-two inches. The whole is light and portable. We have had a pine stand made for it, the parts firmly fastened together with wooden pins. Iron was excluded, in order that it might serve also for the magnetic instrument. Lieut. Ives was directed to commence a series of observations at this place, to serve as a basis for comparison with succeeding stations. In none of our text-books can be found detailed instructions upon the mode of adjusting and using these instruments with the rapidity required for field service. As, hereafter, only slight notice will be taken of this portion of our operations, it may not be deemed out of place to insert the method which experience, upon similar surveys, had suggested as proper to adopt. It will serve also to show what value should be accorded to the results obtained from the observations.

### MODE OF DETERMINING THE ASTRONOMICAL POSITIONS AND THE ELEMENTS OF MAGNETISM AT TEMPORARY CAMPS.

Upon arriving at camp, usually from 3 to 5 p. m., a firm stool, about two and a half feet high, will be placed on solid ground, from whence a clear view of the heavens, and particularly of the meridian, can be obtained. A trench from one and a half to two feet deep will be dug surrounding the stand, about eighteen inches from the point beneath the centre, leaving an isolated column of earth, free from the vibratory motion communicated by the ordinary movements of the men and animals about camp. There should be a platform for the observer north and south of the stand, resting entirely outside the trench. It must be recollected that the value of the observations greatly depends upon the isolation of the instrument. Hence a flat rock should never be selected as a foundation, in case the observer is obliged to stand upon the same himself. Cooking-fires should be at least 300 feet distant, and to the leeward, that the smoke may not vitiate the results.

The stand being prepared, the "Fox" magnetic dip and intensity instrument will be placed upon it and adjusted; the recorder will take the note-book; the instrument-attendant his ivory disc, and the observer make the usual observations upon the needles and azimuth circle for the magnetic meridian, inclination, and intensity. This operation, and a record of the usual barometric and meteorological observations, will be completed at sunset. With the estimated latitude of the place, the telescope of the dip-circle will be set to the altitude of Polaris, which will be observed at the intersection of the two wires as soon as it appears, and the time of observation and readings of altitude and azimuth circles recorded. The telescope will be now depressed to the same angle below the horizon, and the star observed as reflected from an artificial horizon of mercury. The face of the instrument being set in the opposite direction, similar observations on Polaris will be recorded; first by reflection, and then direct. We have now, provided the error of chronometer be known, data for determining the reading of the azimuth circle when the telescope is in the true meridian; which, compared with observations previously recorded for the magnetic meridian, gives, approximately, the magnetic declination. The altitudes read will give the latitude of the place to the nearest minute.

The magnetic instrument, the adjustments of which have remained undisturbed during the preceding operations, now gives place to the astronomical transit. Polaris being visible, the first approximation to the meridian will be to direct the telescope towards that star. By the striding level the stand will be approximately levelled, and the telescope again directed towards Polaris, if supposed near its upper or lower culmination. If the error of the chronometer be entirely unknown, adjust the axis by the foot-screws, until the reversals of the striding level prove that the telescope moves in a vertical plane; then elevate, and observe the chronometer time of passage over the middle wire of the first known star near the zenith. The difference

between this time and the right ascension of the star for the night, will give the approximate error of the chronometer. Apply this error to the right ascension of the first known circumpolar star that approaches the meridian. The estimated latitude of the place, plus or minus the star's polar distance, according as the star happens to be above or below the pole, will give the altitude at which the vertical circle should be set, in order to find the star sought. This should be done several minutes before the computed time of the star's meridian passage. If the star does not then appear in the telescope, sight along the upper edge of the tube; and if it can be seen with the naked eye, one may judge whether the instrument needs to be moved in azimuth east or west. This motion should, if possible, be communicated by the micrometer screw attached to the Y. The star at length having been brought into the field of the telescope, the recorder, who watches the chronometer, states how many minutes are wanting to the time of computed meridian passage. The observer then turns the azimuth micrometer screw until the middle wire of the telescope is in advance of the star's place, about equal to the distance over which he imagines the star will move during the time specified. Now, if able, while awaiting the signal from the recorder, who repeats the distance from the meridian in minutes of time by the chronometer, the observer, by the aid of the striding level, makes the axis of the instrument horizontal. He then places his eye to the telescope; and, as the star approaches the meridian, turns the azimuth micrometer screw; and, as the recorder repeats successively, "two minutes," "one minute," "thirty seconds," "fifteen seconds," brings the middle wire closer to the star; and when the recorder cries "time," makes the middle wire bisect the star. The transit is now probably very nearly in the meridian. To test this, observe the passage of the next two known stars that pass the meridian; one high, near the zenith; the other differing thirty or forty degrees from the first in declination. If nearly equal differences be found between the observed times of passage of these stars over the middle wire, and their right ascensions, respectively—that is, if the difference between the AR. and time of passage of the first star over the middle wire agrees, within half a second or less, with the difference of AR. and chronometer time of the second star's transit—the instrument is sufficiently near the meridian for the night's work. The adjustments should not, therefore, after this be disturbed until a complete set of observations has been obtained. This set consists in a record of the times of transit of every Nautical Almanac, or well known star that approaches the meridian, until one high and one low star, or two circumpolar stars, one above and one below the pole, have been observed for deviation of instrument, and about five near the equator for time. A record of the readings of the level should frequently be made for data to correct for inclination of axis. Should the moon appear, her bright limb will be observed when tangent to the wires; and the culminators of the Nautical Almanac will be added to the list. The error in collimation of the optical axis is supposed to be small, before the commencement of the observation. To insure this, the telescope, when first set up and levelled, may be directed to some distant clearly defined point, and so adjusted that the middle wire may bisect and thread the object. The axis then being reversed, and the telescope again turned to the point, the apparent lateral distance of the wire from it is equal to twice the collimation error; which may be nearly corrected by the screws that hold the diaphragm. The residual error should be nicely determined, at leisure, after the night's usual observations have been completed. Polaris, or some other close circumpolar star, should be observed upon the first three wires, "A," "B," "C," with illuminated end of axis east; then reverse the axis in the Y's, and observe the star's passage over the same three wires "C," "B," "A," the error in level having been recorded for both positions of the axis. This operation will give data for the determination of error in collimation; for which, unless very small, the results for time should be corrected. The distance from each lateral to the middle wire, called the equatorial interval, should be obtained on first commencing the use of the instrument. Circumpolar stars are supposed best for this determination, because a small error in the time of noting the observation does not appreciably affect the result. Upon a clear night, and with a steady instrument, Polaris or some other star should be observed upon each wire consecutively,

from A to G, if the illuminated end of the axis be east, and from G to A, when reversed. The observed interval from a lateral to the middle wire, divided by the secant of the star's declination, will give the equatorial interval. The mean of several results should be taken in order to insure accuracy. Having the equatorial interval, a catalogue of stars should be constructed; giving, according to the declination of each, the true distance in time from each lateral wire to the middle wire. Having this list before him, the observer may at once convert the observation upon any one wire to what it should have been upon the middle wire itself. And there is also this advantage in acquiring thus by induction the mean of all the wires observed: that, in case an error has occurred in one observation, the rest will visibly combine to prove that it ought to be rejected.

The meridional transit observations having been completed, the observer will revolve his instrument ninety degrees,* and observe the transit of stars over the prime vertical for latitude. For this purpose, from an assumed approximate latitude of the place, should be prepared a catalogue of the zenith distances, and times of passage of stars over the first wire, on the prime vertical, east and west. To determine the deviation, it will be preferable to select stars that cross the prime vertical near the horizon. Only those that cross near the zenith will be used in the direct computations for latitude. Set the transit so as to catch the star to be observed upon; take four readings of the striding level, direct and reversed; and, should the instrument not be accurately placed in the prime vertical, the first wire may be made to bisect the star at its computed time of passage; the signal being given by the recorder. The illuminated end of axis being north, wire A will first thread the star; and afterwards will be accurately noted the times of passage over B and C. The motion of the star being slow, there will be time to reset the striding level, and have four more readings of level error recorded. The axis of the telescope will now be reversed, and four readings again taken with the level. The star will then be watched, and the times noted when it passes the same wires, C, B, A, with the illuminated end of axis south. With another set of readings for level, the observations upon the east prime vertical will be completed. At the same altitude as the last observation east, the telescope will be directed west, in time to catch the star upon the first wire; and the times of passage over A, B, and C will be noted, with level readings, as before, preceding and following the observations. Then reverse the telescope axis and repeat the operation; first with the level, then observing the star upon the wires C, B, and A; a final levelling completes the process, which will give three results for latitude. Observations should be made on several stars crossing the prime vertical near the zenith, and the mean of the results taken for the true latitude.

Latitude and longitude have been obtained by the preceding methods, with one transit instrument, in a single night. With a sextant and an artificial horizon of mercury, similar results may be accomplished as follows:

Place the artificial horizon where the meridian and prime vertical are visible from thirty degrees altitude to the zenith. Dig a slight trench to isolate the cube of earth on which the mercury rests. Watch for bright stars to attain nearly equal altitudes of from thirty to sixty degrees, near the prime vertical, east and west, upon which to observe for time; and upon the meridian, north and south, for latitude. In places between thirty degrees and sixty degrees north of the equator, Polaris will always, when not concealed by clouds or mist, be available for latitude. Upon a clear night the observer may, therefore, be employed in observing that star, whenever compelled to wait for others to arrive in position. He will place a stool south of the artificial horizon and move his seat, and the direction of the glass roof till the star appears reflected from the mercury. Then, with the sextant clasped in his right hand, and elbow resting on his thigh, he will look through the telescope at the reflected image. Keeping the plane of the sextant truly vertical, with a sweep of the index with his left hand, twice the angle of elevation of the star, he will bring also into the field of view its image, as reflected from the index mirror. These two images being brought by the tangent screw directly in contact, so as to

*The transit used would have been much more convenient for this purpose, had it rested upon an azimuth circle.

appear coincident, the signal "time" will be given to the recorder, who will be on the watch, and notice the instant required. Opposite to this record of the chronometer time, should be noted the double altitude or reading of the sextant. Fifteen such observations upon a star north, and a like number upon a star south, of nearly the same altitude, both taken within ten minutes of the meridian, should give the latitude within 10″ of arc. Another set of stars nearly equal in altitude, one east and the other west, will give a result for time; and hence, knowing the error and rate of chronometer at any other station, we obtain the difference of longitudes. The greater the number of pairs of stars observed upon, the more accurate will be the result. Index error should be observed each day or night. The diameter of the sun may be measured by bringing its reflected image tangent first upon one side, then upon the other; and half the difference of the readings will give the index error. Or the reflected image of a star may be brought in contact with that seen through the telescope; and the zero of the vernier will then indicate the point which should be the zero of the arc. Hence, the reading will denote the index error, to be added to the altitudes observed when the reading is off the arc, and *vice versa*.

If observations be made for latitude upon one star north, and upon another south of the zenith, of very nearly equal altitudes, and those observations, corrected for index error, be computed, the difference in the results should be due to eccentricity of the instrument. One half this difference may be adopted as the eccentricity for that angle, and may be applied to future observations.

### GENERAL REMARKS.

Polaris, being near the pole, may be observed for latitude at any hour of the night when visible.

All instruments should be handled lightly and delicately. No clamp screws should be tightly pressed. Every part of an instrument not absolutely necessary should be dispensed with; as, for instance, clamps on the vertical circle of a meridian transit, or bars to hold its axis in position. Sufficient care in the manipulation supersedes the necessity of such appliances.

Lists of occultations will be frequently examined; and if the moon is above the horizon at the time when the occurrence of an occultation is predicted, the large telescope, four feet focal length, will be mounted, and the moment of the disappearance of the star behind the moon's limb will be noticed. During the moon's first quarter, and until full moon, this occultation will take place behind the dark limb. Afterwards the star will be occulted by the bright limb, and the time of emersion from the dark side should then be marked.

The error of chronometer being determined at one station, and its rate approximately known, for the succeeding date and station apply the rate, and the estimated or measured distance due east or west, reckoning plus or minus four seconds of time to the mile. In this latitude, this will generally give the error of chronometer with sufficient accuracy to set the transit in the meridian by a circumpolar star.

Formulæ and methods of computing the results of the foregoing observations may be found in the "Tables" prepared by Capt. Thomas J. Lee, Topographical Engineers, for the use of the corps. This admirable and comprehensive work contains almost all that is necessary for field and office computations, and is now an indispensable companion of the topographical engineer.

*November* 8.—Our party has to-day been divided; one portion of it continuing the survey. It is conducted by Lieutenant Ives; Mr. Albert Campbell and Dr. Kennerly accompanying him. They will proceed by the way of Isleta, so as to bring that point into the main survey, and thence, passing the ridge westward, determine the practicability of crossing the valley of Rio Puerco in that direction.

*November* 10.—Taking leave of our hospitable friends at Albuquerque, with the rear division of the party we recommenced the journey westward. Fording the river, we passed through the village of Atrisco, and encamped in the valley at a rancho four miles from Albuquerque.

Packing up and crossing the river we regard as satisfactory progress for the first day. The bed of the stream is about five hundred yards wide, with a channel upon each side from three to four feet deep, and a temporary island of sand and clay in the centre, occupying about one third of the width. In one or two places there were quicksands sufficient to make the passage laborious. The current of the stream is rapid. According to the observations of Dr. Wislizenus, the fall of the water between Albuquerque and El Paso is from two to three feet in a mile. Our own observations make the fall five feet per mile at this place. We propose, with compass, barometer, and odometer, to examine the country near the direct route to Zuñi; and to unite with the main survey somewhere upon Rio San José, a branch of the Puerco.

*November* 11.—We soon left the river valley to climb the ridge which bounds it. For the first six miles the ascent was gradual, averaging, probably, eighty or ninety feet to the mile. We then reached a steep bluff, about 200 feet in height, leading to the top of the mesa. For eight miles from thence the surface was generally level. A ravine led us gently to the valley of the Puerco, which is 300 feet below the summit of the dividing ridge, and at this place quite wide. We expected to find the bed of the stream dry, but it contained pools of water. The soil looks rich, but is barren for want of moisture. If it could be irrigated by artesian wells, as the geologist believes to be practicable, or by reservoirs for the surplus water of the rainy season, this region would be worthy of cultivation.

We encamped here. Two of the beef-cattle strayed last night. Men were sent to-day in search of them, but returned late at night unsuccessful. The high table-lands passed over exhibit scoriæ and volcanic hills. A few miles below, a vein of coal crops out. We have been shown large fragments of it, apparently of good quality. The dragoon blacksmith at Las Lunas makes use of it in his forge. From what is now known of the valley of Rio del Norte, and the obstacles to be encountered upon both sides, it seems probable that of the two practicable passes of the Rocky mountains examined by us, the one by Galisteo and San Felipe would be more economical than that by the Carnuel cañon and Isleta. Crossing the river at San Felipe, we would follow the slope of the bluff southwest, cross Rio Jemez and ascend to the table-land. Thence could be selected favorable ground for a descent to Rio Puerco.

*November* 12.—Our route led us to a low ridge, from which we soon descended to the border of the fine wide valley of San José. Different portions of the stream have received different names: Rio de Gallo, Rio de la Laguna, and Rio Rito. We prefer to retain one appellation for the whole, and Rio San José is now generally understood to apply to it throughout. After travelling twelve miles, and passing the spurs of some hills, we reached "El Alamo," sometimes called Sheep springs. The water seems to issue from beneath a sandstone ledge, but is neither palatable nor abundant. The mules were driven three miles across the valley to drink at the river. The bluff bounding the Puerco valley upon the west is capped with dark jurassic clay, indicative of the presence of coal. At the Carnuel cañon, coal is said to be found in the same formation. Gypsum, the new red sandstone, and lias have been seen upon the route to-day. The weather since leaving Albuquerque has been pleasant. The days are warm, though there are occasional chilly winds from the mountains. At night the atmosphere is peculiarly serene and pure, affording an excellent opportunity for astronomical observations.

*November* 13.—Leaving El Alamo, we followed the border of the San José valley, which lies south of us, several miles in width. The bluffs on our right were of new red sandstone, with gypsum frequently cropping out below, and white jurassic sand occasionally appearing above. Twelve miles from camp the valley was contracted between the sandstone bluffs, and upon a mesa hill of black lava fifty feet high was the ruin of an old Mexican town called Rita. This place has been deserted, possibly on account of Indian depredations. The want of water has been suggested as the cause, for the stream that now flows by the foot of the hill is narrow, and, a short distance below, shows strong symptoms of sinking below the surface. The banks are covered with a rich soil, which, in some places, is white with efflorescent salts. Ascending the narrow valley, the stream became larger. A mile above Rita, in a pleasant nook, we found

Lieutenant Ives with the surveying party encamped. They had proceeded to Isleta; examined the proposed site for a bridge; crossed the heights; descended to the Puerco; and thence, by the way of Rio San José, arrived at their present camp. Mr. Campbell tells me that the ascent from Rio del Norte was obtained at a grade of about fifty feet to the mile, and the descent to Rio Puerco need not exceed thirty feet to the mile. Thence the valley of San José leads to this place.

Opposite Lieutenant Ives' camp is the point of a red sandstone bluff, one hundred and fifty feet high, upon the top of which are perched the dilapidated stone houses of Rancho Colorado. Several of our party climbed the cliff and examined the ruins. The houses, as Captain Simpson describes, had been converted to sheep-folds; but how sheep could have clambered up the nearly perpendicular walls, appearing to be nowhere less than fifteen or twenty feet in height, none could understand. In one spot a pit like a grave had been cut into the rock, to the depth of several feet, but no remains could be discovered in it.

It being Sunday, the surveyors were resting from their labors. Leaving them there, our little party ascended the valley, crossed the creek, and followed the road over a chain of hills about two hundred and fifty feet above the valley. A short distance north, the river was crowded into a cañon; above which a little valley opened and revealed Laguna. As we approched the town, the Germans of the party almost imagined themselves in "Fatherland." The western sun shone upon the place through a haze, which softened the outlines and rendered the view strikingly similar to pictures of Dutch cities. The town stands upon a rocky eminence, rising from the river, and the crowded houses with terraced stories seemed actually piled upon one another. The river flows at its foot and irrigates below a well cultivated valley. This is one of the old Indian pueblos, probably but little changed from the condition in which it was found by the Spaniards in the sixteenth century. It is now said to contain one thousand persons. The inhabitants are reputed honest, sober, and to a certain degree industrious. Encamping near by, we visited by invitation the family of the Rev. Mr. Gorman, a missionary of the Baptist persuasion, who has established himself among this singular people. His school for children is well attended. Adults also listen respectfully to his instructions.

In the centre of the pueblo is a plaza, or sort of court, surrounded by houses facing inwards, and so closely built as to give admittance by two crooked alleys only. Here the Indians collect upon certain festivals which no Mexican is allowed to witness. Americans, however, are freely admitted; because, they say, facetiously perhaps, we are of the same race and people with themselves. Here the ancient buffalo dance is performed, as well as superstitious rites regarding Montezuma. Near by stands the church, a venerable pile of building, partly in ruins, where services are occasionally performed by a Catholic priest. The interior of the main building is used as a cemetery. At a funeral, the body, wrapped in ordinary wearing apparel, is laid in a shallow grave; with bread and a vessel of water placed upon it. Heavy stones are then thrown on with such violence as often to crush the bones; the object being, it is said, to drive out evil spirits. The space is so limited, that, in digging a new grave, it is an ordinary occurrence for a body previously interred to be turned up; in which case it is taken out and thrown into a little enclosure adjoining the church, where there is now an immense pile of bones, skeletons, and carcasses. Our naturalist, for the cause of science, succeeded in abstracting a skull. From the top of the church, a view of the valley showed an opening far into the cañon below, through which the river seemed to force its way. A short deep cut, therefore, through the hills over which we passed, would suffice to carry a railroad across, with very little change of grade. Coal and jet are found near. An excellent bed of the former crops out near Cebolleta, furnishing fuel for blacksmiths' shops in the vicinity. There has long been a sort of tradition, among the Mexicans, of a burning mountain forty miles farther north. Captain Ker, late of the dragoons, states that when he was upon an expedition in that vicinity, the guide conducted him to it. There he found deep fissures from which smoke was issuing, leading to the inference that it proceeded from a burning coal bed.

For the greater part of the distance from Rio Puerco to this place, the soil appears to be good; but little cultivated for want of moisture. The small stream of San José can supply acequias for irrigating only a portion of the wide valley which pertains to it. By common wells enough water might be obtained for the ordinary uses of a population. The country seems also favorable for the construction of artesian wells. If, by this means, sufficient water for irrigation could be procured, many fine valleys would be placed under cultivation.

The night is clear. Astronomical observations have been made.

# CHAPTER VIII.

## *From Pueblo de la Laguna to Zuñi.*

Covero.—Navajo depredations.—Disturbance at a fandango.—Mount Taylor.—Hay Camp.—Lava bed.—Division of party.—Camino del Obispo.—Forests of Sierra Madre.—Agua Fria.—Acoma Indians.—Summit of Sierra Madre.—Inscription Rock.—Ojo Pescado.—Ancient ruins.—Coal.—Rio de Zuñi.—Sacred spring.—Visit to Zuñi.—Smallpox.—Caciques.—System of government.—White Indians.—Party from Fort Defiance.—Campbell's Pass.—Tradition of the flood.—Visit to Old Zuñi.—Sacred altar.—Arch spring.

*November* 14—*Camp* 64.—Lieut. Ives' party overtook us soon after starting this morning, and we proceeded together for twelve miles from Laguna westwardly—the general course of the valley of San José—till opposite Covero. Then, leaving the river-side, we turned north two and a half miles to the town, where we encamped. The valley of the river was, however, examined some miles farther, to the point where the Zuñi road again strikes it. The detour by Covero appears to have been made for the convenience of the inhabitants, rather than of those travelling towards the west; but the road is so fine that the increased distance is not complained of. Most of the valley along our route is cultivated by Pueblo Indians. The stream, as we ascended, bore a greater volume of water; forming lagunas, and fertilizing some very broad bottoms. Covero is within one of the valleys that lead from San Mateo or Mount Taylor to Rio San José. It is a Mexican town, containing about sixty families, and is situated upon a sandstone ledge, on one side of which is a narrow fissure, from whence gushes a rill of clear cold water. Below this trickling stream are small cavities in the rock, from which the town draws its supply. By the side of the fountain stands a singular column of sandstone, from twelve to fifteen feet high, somewhat in the form of an urn, with a hole worn at its base so as to admit of a passage through it.

This being a frontier Mexican settlement, the people have suffered greatly from incursions of the Navajoes.* Occasionally they have been driven from their village to take refuge among the neighboring cliffs, where are defiles and difficult passages favoring both concealment and defence. Many have been taken prisoners by the Indians, and ransomed after years of servitude. One of the men showed a Navajo shield, called "chimal," which he had won as a trophy in battle. It was of raw hide, circular, about two feet in diameter, with an image of a demon painted upon one side, and bordered with red cloth, the ends of which hung in long streamers trimmed with feathers. The Navajoes are not always hostile. They have frequently visited the village on friendly terms, and probably the inhabitants, by trade with them, have made as much in peace as they have lost in war. It was once the boast of these Indians, that, if they desired, they could exterminate the Mexicans; and that they only spared them to save themselves the trouble of cultivating corn and raising sheep. Last night two Navajoes were in our camp at Laguna. They were from Caravajal's band, which is now not far off, and were supposed to have been sent as spies. This Caravajal seems to be a man of great enterprise and cunning. It is said that, formerly, he was accustomed to hover about the settlements, till, seeing a fair chance for pillage, he would communicate the fact to some band in the vicinity prepared to improve the opportunity; and then, turning informer, put the Mexicans upon the trail of the plunderers—claiming a reward from both sides.

The fandango this evening was interrupted by a great disturbance outside. People rushed out to see what was the matter. Everybody, as is usual among Mexicans whenever there is

* Pronounced Nāh-vāh-hōes.

the slightest cause, seemed to be in a high state of excitement. Menacing words were bandied, knives flourished, and pistols drawn. The whole town was in an uproar, and no one seemed to know what it was about. At length it was ascertained that one of our herders, named Torrivio, had been recognised as a peon, and a man wished to seize and imprison him till he could be restored to his original state of servitude. The Mexican had tasted freedom, and was manfully defending it. The claim was only fifteen or twenty dollars; so the money was advanced, and order immediately restored. Had it not been paid, this little debt might have kept the poor fellow bound to his master for life.* In New Mexico the system of peonage has been abolished in law, but not in practice. Written statutes are a sealed book to the laboring classes, and nearly a dead letter to the alcaldes.

The night has been favorable for making astronomical observations.

*November* 15—*Camp* 65.—Preparing to start this morning, there was great delay, which, upon inquiry, was found to be due to a lack of herders and packers. It appeared that this was the home of the greater part of them, and that their female friends were begging them to stay. It seemed doubtful for awhile which would prevail—duty or love; but at length, a month's pay having been advanced for them to leave behind, their families became somewhat reconciled, and allowed them to depart.

The route passed within six or eight miles of Mount Taylor. This mountain is of volcanic origin, and rests upon sedimentary strata whose horizontality is still undisturbed. Four miles over a smooth road led us again to Rio San José, here a pretty brook rushing impetuously over a bed of lava. Having followed the edge of the valley eleven miles, we stopped at what is called by Americans "Hay Camp." It is a pleasant spot. The valley spreads out into a wide vega,† covered with an abundance of grama, which is occasionally cut to supply hay for the military posts. The whole length of the valley followed to-day has been threaded by a sinuous stream of lava. It appears as if it had rolled down a viscous semi-fluid mass, had been arrested in its course, hardened, blackened, cracked, and in places broken, so as to allow the little brook to gush out from below and gurgle along by its side. The lava bed is frequently a hundred yards in width, the cross-section being a semi-ellipse, in the centre probably thirty feet high.

*November* 16—*Camp* 66.—A short distance above Hay Camp the road divided—one branch, the Camino del Obispo, leading to Zuñi; the other being the new route by Ojo del Oso to Fort Defiance. There was also a trail, between the two, ascending the river to Ojo del Gallo, and thence crossing through a gap in the mountains to Zuñi. The latter is noticed by Capt. Simpson in his report of Col. Washington's Navajo expedition. In order to examine the two other routes, our party separated; Mr. Campbell taking the northern branch, while the train and main survey followed the southern. Lieut. Jones also, accompanied by Leroux and a small party, set out for Fort Defiance. An additional escort being ordered from that post, we hope it may be prepared to join us at Zuñi, or at least upon the Colorado Chiquito.

With the train, our course for some distance was west, till we had, not without difficulty, crossed the lava stream that has been mentioned. Having reached the base of the mountains, the road turned gradually towards the south and southwest, rising at the rate of about sixty feet per mile along the smooth slope which bounds the valley. Having travelled eighteen miles, we encamped. The average ascent for the march was fifty feet per mile. Our camp is in a grassy, park-like spot, without water, but in the midst of a forest of spruce and pines. The trees are tall, straight, and, almost without exception, appear to be perfectly sound. For railroad ties they would afford good material, and in this climate might be durable without the expense of kyanization.

Rather an amusing scene occurred when the men came into camp. The day having been warm, some of the teamsters became thirsty, and finding a keg of spirituous liquor in one of

* Of all the Mexicans who accompanied us, no one was more efficient than Torrivio. He was killed by Indians while in the discharge of duty that had been assigned him.

† An open plain or valley.

the wagons, helped themselves to a drink. One or two of the servants were invited to join them, but they declined, knowing that the keg contained alcohol for preserving zoological specimens, and retaining also a vivid recollection of an order given at the Choctaw Agency that the spirit should be drugged with arsenic. The news was not agreeable to the drinkers, and their anxiety was increased by very soon becoming painfully sick. They entered camp, feeling that they must die, or send for the doctor and expose themselves; but love of life proving stronger than fear of punishment, they applied to him for relief. They were informed that the spirit itself was the only poison they had taken, and the ipecacuanha it contained would soon relieve them of that. The fright and subsequent jokes of their companions will probably prevent similar depredations in future.

*November* 17—*Camp* 67.—Started at daybreak; ascended a hill seventy feet high, and thence proceeded by a gradual rise eight miles to Agua Fria. The barometric profile gives a grade greater than that of yesterday, the mean being seventy-five feet, and the maximum ninety feet, per mile. This could be reduced by increasing the distance. The whole march has been through a beautiful pine forest, affording timber in abundance. Game is plenty. Antelope, black-tailed deer, hares, squirrels, and small birds, having been noticed. Our hunters were successful, and have added several interesting specimens to the zoological collection.

Agua Fria is a permanent spring whose waters gush from a broken bed of lava, flow about half a mile, and then hide themselves again among volcanic rocks. This is the last stream upon our route that seeks admission to the Atlantic. Its source is near the summit of Sierra Madre, 7,760 feet above the level of the sea. We met here a party of Acoma Indians. They had been hunting in the mountain forests, and the quantity of game they had killed spoke well for their archery. They wanted merely to sell us venison, of which we had plenty, and did not seem disposed to be particularly sociable. We tried to write a vocabulary of their language, but the words given were so long and so difficult to pronounce, that we gave up the task. A few flakes of snow fell to-day.

*November* 18—*Camp* 68.—Leaving Agua Fria, we turned around the point of a hill and ascended a ravine to the foot of a bluff ridge about two hundred feet high, leading to the summit of the Sierra. The usual odometer survey followed the road in its passage over the crest. With compass and barometer, a reconnaissance was also made by going up the cañon to its head, climbing the narrow divide, passing into a similar ravine upon the western slope of the Sierra, and rapidly descending to the level at which we commenced. By a deep cut of a few hundred yards, a railroad might be brought to the head of the cañon; thence a tunnel, with a slightly ascending grade, would open into the opposite ravine. The distance by the reconnaissance was about a mile; but, judging by the courses taken, it cannot exceed three quarters of a mile from the foot of the ridge upon one side to the corresponding point upon the other. The rock could be easily excavated, as it is a soft though compact limestone. From the mouth of the proposed tunnel, a very regular slope, averaging for eight miles fifty feet per mile, led to a wide valley in which we found "El Moro," called by Simpson Inscription Rock. Here we encamped. This side of the mountain is also covered with timber. The view towards the southeast shows an apparently unbounded forest. The mesas and valleys westward appear comparatively barren, though there are scattered clumps of trees and dwarf cedars among the ravines and upon the slopes. No water was met with till we reached our present camp, about eighteen miles from Agua Fria.

El Moro is the Inscription Rock so minutely described by Simpson, in 1849. Approaching its northeast corner, which is rectangular, the cliffs appear truly vertical and smooth to the height of nearly two hundred feet. Here are found the Spanish inscriptions and the Indian hieroglyphics. Upon the eastern face the rock projects somewhat like a bastion. At the re-entering angle there is a semi-cylindrical recess, slightly shelving, and as smooth as if a cascade had poured for ages over the top. Below is a spring or pool of water supplying the camp; but affording barely sufficient for the mules and cattle. The summit of the rock, which is of white

sandstone with a yellowish tinge, is broken, so as to present at a distance the appearance of turrets, like a Moorish castle; from which its Spanish name was derived. Desiring to see the ruins upon the top, we walked around the projecting cliff of the eastern face, and at some distance south found a point where with difficulty we accomplished the ascent. To Simpson's description of this singular place little remains to be added. The walls of the dilapidated pueblo, when not concealed by rubbish, bore evidence of having been built with considerable skill. In some places they still remain perfect to the height of six or eight feet, vertical, straight, and smooth. A pocket-compass placed upon the principal face, gave for its direction N. 75° E., which, the magnetic variation being applied, corresponds nearly with the prime vertical. I have since found that this observation disagrees with that of Simpson, who represents it as perpendicular to the magnetic meridian. The masonry is well done, the stones being of uniform size, about fourteen inches in length, and six inches wide. The layers are horizontal, and each successive stratum, with some appearance of regularity, breaks joints with that below. The beams, whose ends seem broken by a stone axe rather than cut with a sharp instrument, are of cedar, in excellent preservation. A piece was procured for a specimen. Scattered about in great profusion were fragments of pottery quite similar to those among ruins upon the Gila. Arrow-heads of obsidian were also found in the pueblo, affording another link to connect its founders with those who built the Gila cities. East of Rio del Norte, it has already been stated that, not an arrow-head of stone nor a piece of painted pottery could be discovered. Here both abound. Upon the opposite side of a deep gorge we saw another dilapidated fortress; and, by a detour to the right, climbing like goats, and sliding down the broken surface of the rock, we at length found ourselves within it. The walls were rectangular, and the one upon the north side—which was near the edge of the precipice—in good preservation, at one or two points, to the height of eight feet. Its direction did not correspond to the cardinal points. The question arises as to how people could subsist thus upon a naked rock. Two pools of water have been discovered at its base, beneath overhanging cliffs. They are doubtless springs; and, if freed from the sediment they contain, would afford sufficient water for the ordinary uses of the inhabitants, but none for irrigation. It seems probable, therefore, that they were a pastoral people, or that game was abundant, and that they built here for protection from powerful tribes of roving Apaches. As we passed the Sierra to-day a light cloud scudded across the sky, bearing a momentary squall. It soon passed away, and the weather became delightful as before. The nights, however, are cool. New specimens of mistletoe, cactus, and lichens were found. Astronomical observations have been made this evening.

*November* 19—*Camp* 69.—The wind last night blew for a while violently. The morning was cold, with a stiff breeze from the west, but the sun's rays soon created a pleasant temperature. Ever since leaving Albuquerque, by day, and frequently at night, there has been a westwardly wind. We had expected to find, upon this side of the Sierra, a change in this respect.

There was a little time, before starting, to examine the inscriptions. We passed by the more modern records of Spanish origin, from 1620 to 1736, which have been so well represented by Simpson. Many of them are beautifully carved, and though doubtless faithful in their statement of date, seem but slightly affected by atmospheric action upon the rock. The Indian hieroglyphics, which we examined more carefully, are, however, much time-worn and defaced—some scarcely traceable. Comparing the freshest of those with Spanish inscriptions dated about 1690, the obliteration of age upon the former seems at least twice as great as upon the latter. The place must have been a ruin since the Spaniards first commenced to record upon the rock their passage to and from Zuñi. The inscriptions do not refer to it; neither do the relations of old Spanish explorers, back to the expedition of Coronado in 1540, describe any such pueblo, unless indeed it be included among the seven cities of Cevola. Some of the sculptured hieroglyphics are just discernible, almost wiped out by the finger of time. The plainest were copied; but, on subsequent comparison, proved identical with those figured by Simpson.

Upon leaving camp the train passed over a low ridge, which might have been avoided by a

detour to the right; and, entering a long valley whose bed was upon lava, now mostly covered with a grassy soil, rolled along fourteen miles to the charming valley of Ojo Pescado, where we encamped. This spring bursts from a broken point of the lava bed, and at once becomes a pretty stream, glittering with great numbers of the finny tribe which gives name to it. The circular wall which once enclosed the fountain head is now partly broken down. Upon either side, and almost tangent, are ruins of pueblos so ancient that the traditions of present races do not reach them. Probably at the conquest they formed a portion of Cevola, the seven towns of which, Coronado says, "all stand within four leagues of each other." Below, there is a deserted town of more modern date. Even now it is occasionally occupied in summer by Zuñi Indians, while cultivating the well watered valley. The two old pueblos of the spring are nearly circular in form, and of equal dimensions. One measured three hundred and fifteen short paces, about eight hundred feet, in circumference. They were of stone; but the walls have crumbled, leaving only a heap of rubbish. The pottery is similar to that found at the Moro; painted with bright colors, in checks, bands, and wavy stripes. Many fragments show a beautiful polish. A few pieces were discovered of larger size, inferior in color and quality, but indicating a more fanciful taste. United, they formed an urn with a curious handle; a frog painted upon the outside, and a butterfly represented upon the inner surface. This is supposed to be of Zuñi manufacture. It is a singular fact, that, although some of the most time-worn carvings upon rocks are of animals and men, ancient pottery contains no such representations. Upon one fragment, indeed, found upon Rio Gila, was pictured a turtle, and a piece of pottery picked up near the same place was moulded into the form of a monkey's head. Those appeared to be ancient, and afforded exceptions to the rule. These remains having been examined, we followed a footpath which led to another fissure of the lava bed, where a sparkling stream, somewhat similar to the one described, leaped from its subterranean chasm into life. The lava cliff rises twenty feet above the fissure, and a vertical wall joining two points of it, served to enclose the fountain. Upon the summit stood the ruins of another pueblo, strongly walled around. Near the centre was a mound, with evidences of a circular tower upon the top. Crossing the valley, we explored among the sandstone bluffs and boulders for hieroglyphics. Upon one rock were quite a number of inscriptions and figures, some of which were copied.

By penetrating to the foot of the lava bed, water may probably be found throughout the valley we have traversed to-day. A few thin veins of bituminous coal were discovered, cropping out from the bluffs near camp. The specimens seem good, but the quantity is probably small. Salts, believed to be potassa, effloresce in considerable abundance from seams in the rocks. The soil watered by the springs is a black loam, very fertile. The Indians of Zuñi come hither every year to cultivate vegetables or grain.

In one of the old pueblos were found four nicely cut sticks, three and a half inches in length, stuck into the ground, and united by a cord, forming a square. Feathers of various colors were tied by thongs of bark to the top of each. This had been evidently the scene of some mystic rite, but whether of Zuñians or Navajoes we could not learn. At 8 p. m. the strong west wind suddenly veered round, becoming milder and more pleasant. A gentle breeze now fans the camp fires. The sky is cloudless, and the atmosphere so pure that stars gleam with a brilliancy unknown upon the Atlantic coast.

The fish caught in Ojo Pescado prove to be of a new species. Dr. Kennerly, of late, has been quite successful in collections of birds, fishes, and quadrupeds.

*November* 20—*Camp* 70.—Morning broke upon us bright, clear, and cold, the thermometer at sunrise reading 9°.7 Fahrenheit.

Following Rio Pescado, about two miles from camp the recent ruins, before referred to, appeared upon our right. Allowing the survey to pass on, two of us crossed the rapid stream, and ascended stone steps that led to the plaza. The village was compactly built, but the houses were of ruder construction than any before seen, being composed of loose stones piled up singly without mortar. Some were yet entire, and evidently used by herders and laborers of the

valley. The plaza was converted into numerous corrals* for sheep and goats. The entrance to the dwellings was by a ladder, or rather post, cut into steps, and inclined to rest upon the roof. From thence, through a hole, a similar stair led down to the interior. Some of the contiguous buildings contained a second story, having a door to communicate with the neighboring azotea,† and a fireplace above, the room below being for the stores of grain, &c. The walls were thin, the vigas (rafters) small; and the pueblo, though perhaps containing a hundred houses, showed nothing of the labor and skill displayed in the construction of the ancient strongholds at the springs and at the Moro. Fragments of pottery were strewn around, differing but little from those previously described. A piece of volcanic scoria was found, ground into a symmetrical form, probably a metate—the first seen among the ruins; also an axe made of greenstone, nicely grooved and beautifully polished, like those found at Chichilticale and the Casas Montezuma, on Rio Salinas. These had doubtless been gathered from the ancient ruins, and seemed, like the pottery, to link the wanderers of this region to those who journeyed farther south.

Leaving this place, we descended the valley of Rio Pescado—which was soon lost beneath the lava—eight miles, to where it reissued as Rio de Zuñi, augmented by Rio Nutria from the north. Passing a fertile basin, we encamped at its entrance into a gorge; where, twelve miles from Ojo Pescado, spurs from the mesas came down to the river. The descent was four hundred and twenty feet, averaging thirty-five feet per mile. For the last two days no timber has made its appearance. Scrub cedars and piñons upon the mesa slopes have furnished sufficient fuel.

Upon the brow of the northern mesa, which terminates in cliffs of black metamorphic rock, with large masses of the same piled up in the valley below, stand what are called the ranchos of Zuñi. In construction and appearance they resemble the deserted town upon Ojo Pescado. Nothing of interest was found there. They seem to be used merely as a watch-tower, and a shelter for shepherds and their flocks. The view is extensive; overlooking the table-lands in every direction. Westward sweeps the wide valley of the river, and at the distance of about a league is seen the dark pueblo of Zuñi. Towards the south a lofty mesa, with precipitous cliffs apparently encompassing it, lifts itself proudly from the plain to the height of a thousand feet. There, it is said, are the ruins of old Zuñi.

Below the ranchos, upon both sides of the valley, springs issue from the rocks, and water numerous patches of cultivated gardens. A few hundred yards above, a singular fountain was discovered: it was from ten to twelve feet in diameter, and of a greater depth than we had the means of measuring. Enclosing it was an adobe wall, about four feet high, upon the top of which were ranged a row of inverted jars; that, glistening in the sunlight, first attracted our attention some half a mile distant. Many of them were white, well proportioned, and of elegant forms. Upon their inner and outward surfaces they were curiously painted to represent frogs, tadpoles, tortoises, butterflies, and rattlesnakes. All were brittle from age; some being divested of the plaster ornaments which they had possessed, and others covered with a coating of lime that nearly concealed the painting. The artist made a sketch of the place, and some of the vases were taken to be preserved as specimens.‡

*November* 21—*Camp* 70.—It being necessary to await the arrival of Lieut. Jones and Mr. Campbell from Fort Defiance, the computations and plots have been recommenced. The botanist and geologist employ the time in making explorations in the vicinity, though little of interest seems to reward their labors. The surrounding mesas are of new red sandstone. It is not the season for flowers, and even the cactaceæ droop. The naturalist, however, is reaping a rich harvest, finding new varieties both of birds and fishes.

The governor of Zuñi has paid us a ceremonial visit. We made inquiries regarding the country west from Zuñi, and towards the Moqui nation; telling him that our government

* Enclosures for animals.

† Flat roof of a house.

‡ We afterwards learned that the Indians considered this spring sacred.

H.B. Mollhausen

Lith. by A. Hoen & Co. Balto.

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desired them to furnish us a guide, and such information as might be in their power. He listened attentively to the explanations of the object of our expedition, of the general course we proposed to follow, and of the requisites necessary to make the exploration satisfactory. Then, with dignified reserve, he replied that he would communicate this request to the caciques, and afterwards make known their decision upon it.

*November* 22—*Camp* 70.—Savedra has been sent with a party to explore the route towards Moqui, in order to ascertain whether water can be obtained in that direction. He has been in that region before and professes to know it well.

*November* 23—*Camp* 70.—This morning the thermometer at sunrise read 16° Fahrenheit; while the sacred spring gave a temperature of 10° Centigrade, equal to 50° Fahrenheit, which is probably the mean temperature of the year at this place. In order to learn the oscillations of the barometer, and also whether the hourly changes in magnetism are so great as to allow them to be read upon the vernier of our instrument, Lieut. Ives has been occupied in making a series of meteorological and magnetic observations—a complete set of readings having been taken by him once in every fifteen minutes during the last twenty-four hours.

A small party visited the pueblo to-day. The road passed over a ridge, but we preferred keeping along the stream. Threading an opening between rocky bluffs, we passed the rancho gardens; and, a few hundred yards below, entered the valley, several miles in width, which leads to Zuñi. The soil seemed light; but where cultivated, it produces fine crops without the aid of irrigation. Not an acéquia was seen ; and an Indian, who accompanied us, said they were not resorted to, as sufficient moisture for the fields was derived from rain. Within the valley appeared occasionally towers, where herders and laborers watch to prevent a surprise from Apaches. Near the centre of this apparent plain stood, upon an eminence, the compact city of Zuñi. By its side flowed the river which bears the same name. It is now but a rivulet of humble dimensions, though sometimes said to be a large stream. The Zuñian was very communicative by the way, and pointed out the various places where he had displayed valor in skirmishes with Navajoes. Of the ruined pueblo upon the mesa, called by Simpson "old Zuñi," he told a tradition which he said had been handed down by the caciques from time immemorial. In the most ancient times, ("tiempo quanto hai,") their fathers came from the west, and built the present town. There they lived till, one "noche triste" at midnight, there came a flood of water rolling in from the west. The people fled in terror; some to the mesa, and escaped; the rest perished in the deluge. The water rose to near the top of the mesa, and there remained. During this time the pueblo was built crowning the hill. To appease the angry spirit that had brought this calamity upon them, a man and a maid were thrown from the cliff into the sea, which then subsided, leaving the individuals sacrificed statues of stone, as they remain to this day. The people then returned to the valley.*

Upon reaching the town of Zuñi, a most revolting spectacle met our view. Smallpox had been making terrible ravages among the people, and we were soon surrounded by great numbers—men, women, and children—exhibiting this loathsome disease in various stages of its progress. Passing beneath an arch we entered a court, which they said was consecrated to Montezuma dances. This ceremony is described as being of a most singular character. The performers dress in costume; some imitating beasts with horns, all as wild and fantastic as their ideas of the subject of these orgies. The corn-dance also is a very curious annual festival. This court was entirely surrounded by houses of several receding stories, which were attained by means of ladders leading from one to another. Pointing to a house three stories in height, the governor said it was the dwelling of a cacique, where frequently met at night all the officers of the government in consultation. The caciques are the chief of these. They are four in number, and their offices hereditary. Son succeeds father whenever the latter dies or becomes too infirm to perform the duties of his station. These have a general superintendence over all that pertains to the public welfare, and have the power of making war and peace. They appoint

* For further remarks upon Zuñi traditions see Indian report.

two chief captains, whom they consult upon all occasions: one is the war-chief; the other, a sort of superintendent of police. The latter, mixing intimately among the people, selects the most active and intelligent, whom he nominates to the caciques for the appointments of governor and subordinate officers. Should any one of these prove avaricious and exacting, the people complain to the higher powers, and the offender is displaced. The caciques are supreme; although deferring upon occasions to the will of the people. The present governor, Pedro Pino, however, seems to have things pretty much his own way. He is probably the most cunning, if not the most intelligent, among them, and exercises control by an iron will. Ancient relics being asked for, they brought us several of the "hachas" (stone axes), such as are frequently found at Chichilticale, and among other ruins. We ascended to the house-tops, climbing ladder after ladder, and encountering successive groups of miserable wretches, bearing unmistakeable signs of incipient or waning disease. Here were many tamed eagles. They are caught in the cliffs when young, and become quite domesticated. The people are not willing to part with them. From the top the pueblo reminds one of an immense ant-hill, from its similar form and dense population. The number of inhabitants is estimated at 2,000. Going down from the outer side into the street, we encountered five stories of descent. There are said to be in Zuñi white Indians, with fair complexions, blue eyes, and light hair. The prevalence of the smallpox prevented us from seeing them. A sort of tradition among the New Mexicans, too vague to be worthy of credence, accounts for this phenomenon, by a story that many years ago—centuries perhaps—a company of Welsh miners, with their wives and children, emigrated hither; and that the Zuñians killed the men and married the women. There is a striking similarity between some of the words of the Zuñi language and the English. "Eat-a" is *to eat*. "Eat-on-o-way" signifies *eaten enough*. To express admiration of a thing they exclaim, "Look ye!" or sometimes "Look ye here!" These facts, known by the Americans of the country, are probably the cause of the origin or the revival of the Welsh legend. But the Zuñians deny that it has any foundation in truth.

*November* 24—*Camp* 70.—Lieut. Jones and Mr. Campbell have joined us; having completed the reconnaissance through the northern pass of the Sierra Madre to Cañon Bonito (Fort Defiance), and thence to this place. Mr. Campbell reports the route from Ojo de Gallo—the head of Rio San José—by the way of Ojo Azul to Ojo del Oso, which empties into Rio Puerco of the west, quite favorable for a railroad. Indeed, so gradual was the ascent and descent on either side of the pass, not exceeding thirty feet to the mile, that without a careful survey the summit might be passed unperceived. Thence to follow Rio Puerco of the west, seemed to him perfectly practicable. The only obstacle to apprehend is a scarcity of water upon the surface, as the stream soon sinks. Savedra has also returned, reporting that he has found a level route to La Jarra, and water at Carriso, thirty miles distant. But the country is covered with such dense thickets that much labor will be required to cut a road through them.

*November* 25—*Camp* 70.—The repair of our wagons is to be completed to-day. A hasty report of our operations has been prepared for the department, and a profile of the route from Fort Smith to Albuquerque enclosed; the principal object being to duplicate the work already performed; so that, in case by any unforeseen accident our notes should be lost during the march westward, this much may be preserved.

*November* 26—*Camp* 71.—As the train unwound itself, stretching along in the direction of Zuñi, some of us cast our eyes wishfully towards the legendary table-land that stood about a league upon our left. The Zuñi captain, who had promised to conduct us thither, not appearing, Dr. Bigelow, Mr. Parke, and myself, determined to go by ourselves and trust to good fortune for success in finding the path leading to the top. We took a trail and proceeded two miles south, to a deep cañon, where were springs of water. Thence, by a zigzag course, we led our mules up to the first bench of the ascent. Here, hollowed from the rock, was an Indian cave, and looking down into it, we saw lying in the centre six small birds ranged side by side in two rows. As nothing else was visible within the apartment, some superstitious rite was probably being

enacted. Beyond this place, upon the sandy slope, were orchards of peach trees. Although the soil appeared dry, and there was no means of irrigation, they looked flourishing. Above, the projecting summit of the cliffs seemed inaccessible, and as Indians were here gathering fuel, we endeavored to engage their services. They were young men, and evidently fearful of showing us the way, lest they might offend their elders. At length an old man, crippled by age, took our money and pointed to the road. The young Indians then led, and leaving our mules we followed a trail which, with great labor, had been hammered out from seam to seam of the rocks along the side of the precipice. At various points of the ascent, where a projecting rock permitted, were barricades of stone walls, from which, the old man told us, they had hurled rocks upon the invading Spaniards. Having ascended, according to our estimate, one thousand feet, we found ourselves upon a level surface, covered with thick cedars. The old man had been left far behind. Our young guide, who understood no Spanish, led us to the opposite side of the mesa, and pointed to the stone pillars, which we recognised as the reputed statues of the pair that had been sacrificed at the flood. They were isolated columns of sandstone, about five hundred feet in height, and remarkable enough in appearance to perpetuate a legend among this singular people. Imagination could easily trace a resemblance to human beings of colossal size. The top of the mesa was of an irregular figure, a mile in width, and bounded upon all sides by perpendicular bluffs. Three times we crossed it, searching in vain for the trace of a ruin. Not even a fragment of pottery could be found, and we were about to give up the vaunted pueblo as a fable, when the old Indian, to our surprise, made his appearance at the top of the cliff. He probably gave the guide permission to conduct us, for he led us immediately to a spot which, on inspection, showed traces of art. A few very small fragments of pottery were lying upon the ground, and with some difficulty we could distinguish the remains of a thick wall in the figure of a V. But the guide hurried us on half a mile farther, where appeared the ruins of a city indeed. Crumbling walls, from two to twelve feet high, were crowded together in confused heaps over several acres of ground. Covering every mass of rubbish were vast quantities of tall cacti, opuntia arborescens, tipped with bright yellow fruit, that gave the place, at a little distance, the appearance of a flower garden. The Doctor was particularly delighted, as this opuntia had not been seen before west of the Del Norte; and, by a direct comparison with it, he has proved another variety growing in the valley to be new. Upon examining the pueblo, we found that the standing walls rested upon ruins of greater antiquity. The primitive masonry, as well as we could judge, must have been about six feet thick. The more recent was not more than a foot, or a foot and a half, but the small sandstone blocks had been laid in mud mortar with considerable care. Having taken a few specimens of painted pottery, abundant as usual in such places, and an obsidian arrow-head that was found, we again followed the guide. Entering a forest of cedars, a secluded nook presented a scene the most interesting of all. It was a Zuñi altar, such as Pedro Pino had previously described to us. An oval basin had been scooped from the ground, seven feet in length. Near one end stood a vertical shaft, two feet high, neatly trimmed with feathers, and a circular net-work of cord. Symmetrically placed upon the other side was a cedar post, about two and a half feet high, quaintly carved, as represented in the accompanying sketch. Shells were suspended from the centre, and below was inserted a grooved horizontal piece, decorated with beads and shells. Between and around them was a forest of feathered sticks, ranged generally in rows, and united by twine. Behind these stood a thin board, two or three inches wide and three feet in height, with seven angular notches at the top; while in regular order below were representations of a star, the moon, the sun, a T, and two parallel lines. Back of all lay a flat rock, apparently intended for an altar, though there were no appearances either of a fire or a sacrifice. Upon this rock were piled a great number of sticks, cut precisely like those before described, all partially decayed, and some in the last stage of decomposition. It was evident that they had once in their turn occupied places in the basin. Judging from the soundness of cedar ties at El Moro, some of these remnants of carved pieces of wood indicated great antiquity. Although many sea-shells and

other ornaments were lying around, the guide would not allow us to take away the slightest thing. When we had left, he took from his pouch a white powder, and muttering a prayer, blew it three times towards the altar. He then followed us, intimating by signs that upon other table-lands east, south, and west, there were similar consecrated spots. The white powder he had used we found to be pinole, the flour of parched corn. The object he said was "pidiendo fortuna," asking a blessing from Montezuma and the sun, and praying for his "daily bread." Passing through Zuñi, we pursued the train eight miles to Arch spring, where it was encamped.

# CHAPTER IX.

## *From Zuñi to the Little Colorado.*

Council of Caciques.—Offers of guides and assistance.—Mexican deserter.—Ancient manuscripts.—Cultivation of corn.—Departure from Zuñi.—Jacob's well.—Estimates of population.—Navajo spring.—Messengers to Moqui.—Carriso creek.—Lithodendron creek.—Petrified forest.—Adaptation of the country for raising sheep.—Colorado Chiquito.—Return of Zuñi guides.—Accounts of the Navajo Indians.—Proposed reconnaissance to San Francisco mountain.—Ruins.—Stampede of the animals.—Arrival of Lieut. Tidball and escort from Fort Defiance.

*November* 27—*Camp* 71.—A cold storm commenced last evening, and showers continued during the night. About ten this morning the rain ceased, and a party was sent out on Savedra's route to cut away the low cedars sufficiently to allow the train to follow.

Arch spring issues from the foot of a red sandstone cliff. Upon the smooth faces of the rock are great numbers of hieroglyphics, evidently old, and as much like symbols of connected ideas as any we have seen. There is a vaulted recess near the spring which gives name to the place. The high table-lands adjoining are covered with ruins. This, at the time of the Spanish conquest, must have been another of the seven towns of Cibola.

At noon the Zuñi war chief arrived to inform us that a council upon our affairs had been held the preceding night by the caciques and governor. They approved of the objects of our expedition, and determined to afford all the aid in their power. They knew of a better route to the Colorado Chiquito than that which Savedra proposed, and offered to send guides to show it to us. No recompense was asked. This illustrates a trait in Indian character—to act with deliberation, and not from impulse.

*November* 28—*Camp* 72.—The Indian guides arrived, according to promise, to pilot us by the new route to Rio Colorado Chiquito, and the train turned back, by their direction, to follow a short distance the Zuñi river. Last night a Mexican herder deserted, and as the survey was being retraced, we returned to Zuñi in search of him.

We could not well spare his services; and, besides, should he escape, his example might be followed by others. No trace of him could be found till the governor was requested to search the town. The church-bells were sounded, and the chiefs of police then passed through the streets proclaiming the order. The fugitive was soon dragged from his hiding-place, and sent under escort to the train, where he was delivered to the safe-keeping of the guard. The promptness and success with which the governor performed the duties of his office, spoke well for his power of maintaining discipline among the people. Having heard that some curious manuscripts were in possession of the chief cacique, we went to his house to see them. Climbing a ladder, we entered a comfortable room where the old man and his family were seated by a fire. The papers were sent for, and after a long delay brought in by a very good-looking boy about twelve years old, with auburn hair, blue eyes, and a fair complexion. He was a son of the cacique, and claimed to be of pure Indian blood. Glancing at the manuscripts, they were found to contain a correspondence between the governor of New Mexico and certain priests that had officiated at Zuñi. One was dated 1757. The old man declined giving them to us, saying, that a long time ago they had been found in a corner of the old church, and had since been handed down from generation to generation, till now they were considered as insignia of the cacique's office. Besides, they were sacred, and to part with them would bring evil upon the pueblo. He consented that they might be copied, but time for that could not be spared, as it was necessary to join the train.

We descended the valley of Zuñi a league, and then, turning from the river, entered a wide and fertile ravine which led westward to our present camp, about twelve miles from the pueblo. Lieut. Jones had encamped thus early in order to allow the mules to be driven back to the Rio Zuñi for water. The grass is excellent throughout the valley, and even upon the mesas and hill-sides adjoining. Upon each side are quite extensive forests of small cedars and piñons. As an indication of the fertility of the Zuñi country, it may be mentioned that the corn produced there by Indians without the labor of irrigation is sufficient not only to support a large population, but to supply Fort Defiance. Besides, we have been furnished with seven or eight hundred bushels, and there still seems to be plenty remaining in town.

José Maria, Juan Septimo, and José Hacha, were the guides sent to us by the caciques. They described the country to the Colorado Chiquito as being nearly a level plain, with springs of permanent water at convenient distances. This is their hunting ground. Of the country west of that river they know nothing. Moqui Indians are, however, supposed to have a knowledge of the region, and we intend to seek among them for a guide. José and Juan are to go as bearers of despatches to the Moqui nation, with the understanding that, after having accomplished their mission, they will report to us upon the Colorado Chiquito.

We have now passed through the ancient country of Cibola, described by Marco de Niça in 1539, and by Vasquez de Coronado in 1540. We have seen much to verify the accuracy of their journals. The relation of Coronado regarding the people of Cibola is for the most part applicable to the Zuñians of the present day. The city which he calls Granada is Zuñi itself.

The astronomical observations to-night have been rendered less satisfactory than usual, by the condensation of moisture upon the artificial horizon. This is the first time dew has been observed since leaving Albuquerque.

*November* 29—*Camp* 73.—This morning, Captain Ker, the sutler at Fort Defiance, who had accompanied our party thus far, took leave of us. He returns to Albuquerque, doing us the favor to forward our letters for the States. We have now broken away from all communication with the civilized world; and, for the first time upon the trip, have entered a region over which no white man is supposed to have passed. Rising gradually to the plain, we traversed a country moderately level to the crest of a sandstone ridge, where we abruptly descended some forty feet. Thence, with a gradual fall of nearly four hundred feet in six miles, we entered a fine large valley, and encamped at Jacob's well. The Indian name for it is "*Wáh-nùk-ái-tin-ái-è.*" This spring is a curiosity. In the midst of the valley, which resembles several we have passed during the day, is a conical pit, about three hundred feet wide at top, and one hundred and twenty-five feet deep. At bottom lies the pool of water, some thirty yards in diameter, and apparently quite deep. It is bordered by a fringe of tall rushes. An old and well beaten path leads spirally along the side of the tunnel down to the water. Navajo trails radiate from it in various directions. We are now twenty-thee miles from the last watering place on Rio de Zuñi, and the firm road seems to the eye, except at the previously mentioned sandstone ridge, nearly level. The soil passed over is good, and grass abundant. On each side extensive thickets of cedar may furnish a plentiful supply of fuel. Water could probably be obtained at various points we have passed by sinking common wells to the depth of about one hundred and thirty feet. A finer grazing country could scarcely be desired. Grama-grass is luxuriant and nutritious during the whole year. The climate is excellent. For raising cattle and sheep, and producing wool, this region seems peculiarly adapted.

To-morrow, José Maria and Juan Septimo leave our trail, and proceed to Moqui. At our request they traced a sketch of the Moqui country and the route they propose to travel. They say that the population of the seven towns of Moqui has been greatly diminished lately, and now is about the same as that of Zuñi; that is, according to our previous estimate, 2,000 persons. But it is a difficult matter to determine satisfactorily the population of an Indian pueblo, without an examination more minute than would have been agreeable to us in Zuñi during the prevalence of the smallpox. The houses are so piled upon each other that they cannot be

counted, nor does any one seem to know how many families occupy the same dwelling. Different authors, therefore, vary in their estimates for this place from 1,000 to 6,000 persons. Mexicans say that in joining them in expeditions against the Navajoes, there have been known to turn out 1,000 warriors. Leroux agrees with me that this is doubtless an exaggeration. Navajoes are said to be more numerous. José Hacha thinks they number five to one of the Zuñians. Gregg and Simpson estimate their number from 8,000 to 10,000; but by Leroux's standard there are less than 1,000 warriors, and not more than 5,000 persons in all. Speaking of Navajoes reminded our Zuñian warriors of their battles, which they recounted with great spirit. Five years ago their pueblo was threatened by a large body of Navajoes from the east. The Zuñians met them at the ranchos near our Camp 69, and fought from sunrise to near sunset. But the crafty enemy had laid a snare to destroy the pueblo, and while the braves were engaged at a distance, a stronger force approached by the Moqui trail, thinking to enter the town without resistance. But our war-chief told us, with pride, that the women and children successfully defended their homes until the return of the men at night.

*November* 30—*Camp* 74.—Leaving Jacob's well, we proceeded about 5° north of west, eight miles to Navajo spring, a fine pool of water which breaks out at the surface of a valley. The Indian guide had no trail to follow, but pursued a course so straight as to pass over several small ridges that might as well have been avoided by a very slight detour to the right. But the country was good, and the road for wagons excellent. Two of the guides left, as was arranged, this morning, to convey our message to the caciques of Moqui. They seemed highly impressed with the importance of their mission, and it is hoped that they may succeed in obtaining for us a guide. At camp are relics of extensive ruins. Pottery, painted in stripes, broken into very small fragments, and much decayed, is strewn about the spring. Upon the first hill is a circular depression, forty paces in diameter, like one seen last year at the junction of Rio San Pedro with Rio Gila. Around it are pieces of glazed pottery, and arrow-heads of obsidian, agate, and jasper. The structures were probably of adobes, which would be likely to leave only faint traces of their existence.

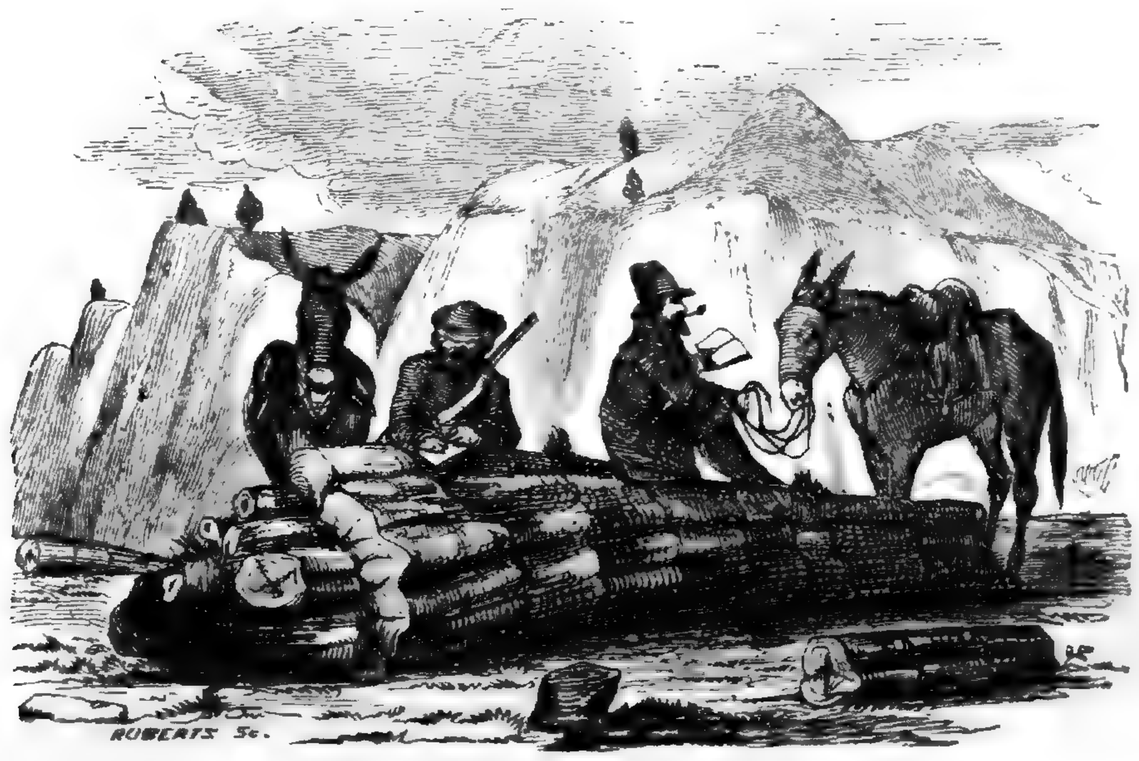
At sunset a smoke was seen in the distance, and, soon after, two Navajo Indians rode into camp. They said they were hunters from the Cañon de Chelly; but, learning that we were lately from Zuñi, they were afraid of taking the smallpox, and soon left.

*December* 1—*Camp* 75.—The first day of winter opened bright, with an elastic exhilarating air, though it was the coldest morning we have had. Since leaving the base of Sierra Madre, disagreeable winds have ceased to annoy us; the atmosphere has generally been clear, and the temperature charming during the latter part of the day and in the evening.

Our course has been nearly west. Five miles from Navajo springs we crossed the wide valley of Rio Puerco of the west, and an arroyo dry except in pools. Thence, passing another ravine and prairie, we entered the valley of Carriso creek; where, twelve miles from our last camp, we halted. The bed of the river contains pools, but the water does not flow above the surface. The road has crossed two prairie ridges about one hundred and thirty feet above the sandy bed of the arroyo. By deflecting the course they may be passed with light grades. Thus far we are agreeably impressed with the character of the country on the Pacific slope of Sierra Madre. We have not yet encountered waterless deserts such as have been supposed to exist in this region. The distant peaks of Jemez, northeast, and of Sierra Mogoyon, south, appear to be tipped with snow. There are no indications of a cold climate elsewhere within view.

*December* 2—*Camp* 76.—Leaving Carriso creek we proceeded nearly west, over a prairie intersected by open valleys from the northeast, to bluffs bounding Lithodendron creek. Here the steep sandstone rocks were difficult to descend, and the ascent westward looked still more formidable. We therefore turned towards the south, and after following the mesa about five miles encamped upon the ridge separating two valleys; Lithodendron upon the right, and a smaller valley a short distance to the left. The banks of Lithodendron creek are forty feet in height, and composed of red sandy marl. The width between the bluffs seems nearly a mile. The

country westward still looks rough. Near camp are found ruins of stone houses, and fragments of painted pottery. Half a jar curiously indented was shown to Savedra, who pronounced it more ancient than the rest. In one place the crumbling banks expose a well-built wall that must have been founded several feet below the present surface. Quite a forest of petrified trees was discovered to-day, prostrate and partly buried in deposits of red marl. They are converted into beautiful specimens of variegated jasper. One trunk was measured ten feet in diameter, and more than one hundred feet in length. Some of the stumps appear as if they had been charred by fire before being converted to stone. The main portions of the trees have a dark brown color; the smaller branches are of a reddish hue. Fragments are strewn over the surface for miles.




Petriñed tree near Lithodendron creek.

Now the soil produces no timber; the scrub cedars even have disappeared. For the last three days dry twigs of chamisa have been the only fuel available for camp fires.

*December* 3—*Camp* 77.—Having passed about three miles farther along the crest, the banks of Lithodendron creek afforded a passage into its wide sandy bed. For about half a mile we followed the stream, which flowed beneath a surface of wet quicksands, in which our wagons often sunk to the hub. This was the most fatiguing part of the journey. Some distance below there were indications of a more favorable crossing. Should it be required to bridge the creek there are plenty of sandstone slabs, quarried as it were, and fit for use. Following the right bank for half a mile we emerged from the sandstone cañon, and found ourselves upon the edge of an immense valley—that of the Colorado Chiquito—extending towards the south and southwest apparently twenty or thirty miles. The soil appeared of dark loam, covered with grass. A few miles below was seen a line of alamos, indicating the junction of a stream from the northeast, which we supposed to be Rio Puerco of the west. Doubtless this should have been followed from the place where we crossed it, although Savedra says that it passes through a cañon. For a railroad it appears that, from this point eastward, the route should ascend the Puerco to near its head at Ojo del Oso; thence, turning the heights of Sierra Madre by Campbell's pass, pursue Agua Azul to Rio San José. The country we have travelled is probably superior in richness of soil and abundance of water; but, as regards the grades, the other would be preferable.

From the entrance to the wide valley referred to we turned westward, and eight miles beyond the crossing of Lithodendron creek, finding numerous lagunas of fresh water and good grama, we encamped. With water for irrigation, such as in this region artesian wells might afford, the soil would yield abundantly. This valley is at the same altitude as that of Rio Grande at Albuquerque. Hence there is probably less rain here than at Zuñi, aud crops would require artificial watering. The advantages of this country for grazing, however, cannot well be surpassed. With two hundred mules, besides beef-cattle and sheep, we are able to camp where

we please, without fear of the want of grass. Formerly New Mexico, according to Gregg, exported annually 500,000 sheep for mutton alone. Twice that number could doubtless have been sheared. The wool, allowing two pounds per fleece, and that it is worth forty cents per pound, would be worth $800,000, and would pay every year to a railroad company a handsome freight. An improved breed of sheep would produce wool of more value, and there scarcely need be a limit to the number that may graze upon this region. Nature has furnished grass, sufficient water, and a climate most favorable to this purpose.

Many petrified trees have been seen to-day, their woody texture faithfully preserved in silex, producing jasper variegated with rich and bright colors. Many specimens have been collected by members of the party for seal rings.

*December* 4—*Camp* 77.—This has been a day of rest. Lieutenant Tidball, with the additional escort from Fort Defiance, not having yet overtaken us, it seems proper to move slowly. Mr. Campbell discovered upon the low lands near camp traces of ruins quite similar to those on Rio Gila. Among them he found an arrow-head of jasper, and a sort of earthen amulet. The buildings must have been of adobes, differing in that respect from the walled pueblos previously seen upon mesa heights. Those of Moqui are said to be upon hills more than a thousand feet above the surrounding plains. Barricaded passes, like those at old Zuñi, lead to the top. It was probably a powerful enemy that drove the people from watered valleys to arid heights, notwithstanding their strange tradition of a flood.

*December* 5—*Camp* 78.—Another bright morning, calm and cloudless, followed a cool night. The water in the lagunas of Lithodendron creek was abundant, though deeply colored with red marl. Taking an early start, the pack-train following the guide and the wagons as usual in rear, we proceeded about eleven miles over a slightly undulating prairie, covered with grama de china, to the bed of a river coming from the north, to which we gave the title of Leroux's fork. By a gradual descent we crossed this stream, and encamped near its junction with Colorado Chiquito. The valley of the last named river is very wide, reminding us forcibly of the bottom land upon Rio Gila. Like that, the soil is good, and, with irrigation from the river, might be cultivated to advantage. The barometer shows our present camp to be eighteen feet below Albuquerque. The day has been uncomfortably warm for travelling; the thermometer at 3 p. m. reading 65° Fahrenheit. Camp is beautifully situated in a cotton-wood grove, upon the bank of Rio Colorado Chiquito. This stream was called "Rio del Lino" (Flax river) by Coronado, in 1540. Mezquites of small growth line its banks. A porcupine of an unknown variety was secured to-day by Dr. Kennerly, our zealous naturalist. José Hacha took leave of us this morning to return to Zuñi. He had despaired of meeting those sent to Moqui, but this evening they came prancing into camp. Every one was glad to see them, and their arrival created quite an excitement. Their mission had been performed, but no Moqui guide could be obtained. The smallpox had swept off nearly every male adult from three pueblos. In one remained only the cacique and a single man from a hundred warriors. They were dying by fifties per day; and the living, unable to bury the dead, had thrown them down the steep sides of the lofty mesas upon which the pueblos are built. There wolves and ravens had congregated in myriads to devour them. The decaying bodies had even infected the streams, and the Zuñians were obliged to have recourse to melons both for food and drink. The young of the tribe had suffered less, few cases among them having proved mortal. Juan Septimo brought for us several excellent robes of wild-cat or tiger skin, such as the Moquis wear in winter.

*December* 6—*Camp* 79.—Our Zuñi guides left us this morning to return, and the survey proceeded along the right bank of the river for fifteen miles. Several dry ditches were crossed, the banks of which it was necessary to cut down, thus creating a few hours' detention. It was dark when camp was reached. The valley of the river continues to be several miles in width, and the soil, like that of Rio Gila, would doubtless be excellent for maize or cotton. The stream is now small, but rapid; its waters are fresh and clear, and sufficient for the irrigation of a considerable portion of the low lands that border it. Its sinuous course through the bot-

toms is marked by a line of small alamos. The gravelly prairies that bound the valley are in some places thinly spread with grama; in others, barren. Great quantities of broken pottery have been found. A portion appeared to have been water-worn, as if from a flood, and the patterns were somewhat different from any we have before noticed. Some were ribbed in parallel lines; others wavy, but not in points. Arrow-heads neatly made of jasper were found entire. The foundations of houses were also sometimes traceable.

*December* 7—*Camp* 80.—We pursued a course a little north of west, still traversing the wide valley, towards the snowy peaks of San Francisco, which for several days have been visible. Sand and light soil, like ashes, rendered the journey heavy for the wagons. Finding a favorable spot we encamped early, having made but 8½ miles. Mr. Marcou says we are now below the Jurassic and Lias formations, and that geological indications are in favor of the development of coal-beds south of our route.

A spur of the Mogollon mountains, which lies nearly southwest from us, is said to be peopled by warlike Yampais. Our guide, Savedra, has recounted various reminiscences of their bravery and daring. A few years since he joined a party of Moquis and Mexicans for the purpose of stealing children for slaves. Upon entering this country, they were met and attacked with such fury by the Yampais that the whole party fled.

In passing through the Navajo country the natives have kept quite aloof from us. Therefore, as one of our Mexican herders from Covero understands their language, a vocabularly of it has been obtained from him. A few years since, while he was playing at Covero spring, he was captured by Navajoes. For nine months he was a prisoner, and followed the Indians in their wanderings. He accompanied a party of one thousand warriors through the Moqui country, and afterwards spent much time among their rancherias in the famous Cañon de Chelly. Their fields are numerous, though cultivated by women alone; no man ever condescending to lend a helping hand. Their numbers, he says, no one can tell. They are thickly spread from Cañon de Chelly to Rio San Juan, and he believes them equal to the whole population of New Mexico. These statements are noted as they were given, without vouching for their accuracy. One ought to deduct an allowance for the exaggeration usual among this people. It is very probable that the size of the tribe exceeds the usual estimate. Their wealth, by his account, consists of immense flocks and herds. Some of the rich men own one thousand horses each, besides mules, cattle, and sheep.

*December* 8—*Camp* 81.—Plodding along through sand and light soil—sometimes threading the wide valley, at others crossing gravel ridges that bounded it—we made five miles, and encamped. We had crossed the deep bed of a well-wooded tributary flowing from the northeast, called Cotton-wood creek. Nearly opposite could be seen the junction of an affluent from the southeast. The Colorado Chiquito here branches into a net-work of channels, all bordered with alamos. Below camp is quite a forest, extending about four miles down the valley. From a high hill two miles back from camp the river can be seen making a great bend, and sweeping northward. There we propose to commence a reconnaissance westward towards the southern slope of San Francisco mountain, hoping to avoid the circuitous course by the river.

*December* 9—*Camp* 82.—At the usual hour we left camp, and proceeded a mile and a half, near to the great bend of the river, where we encamped. Near by is the remnant of a ruin as extensive as any yet seen. An isolated hill of sandstone is the foundation of this ancient pueblo, which was doubtless similar to those at Ojo Pescado. In few places are the faces of walls visible above the débris of stones, vigas, and pottery. The colors of the latter are black, red, white, and yellow, worked into a variety of figures, but representing no animals. The indented kind, said to be so very ancient, is here found in many patterns. A stone axe and several pretty arrow-heads of obsidian or carnelian were picked up from the ruins. The pueblo, as well as could be ascertained, was rectangular, one side nearly east and west, 120 feet in length; the other, 360 feet, nearly in the true meridian. The walls were in some places ten feet in thick-

ness, with small rooms inserted within. Scattered around were timbers of pine, which resembled rafters. Two posts, about twelve feet in height, were still standing in good preservation.

The camp-fires are bountifully supplied with fuel from piles of drift-wood of pine, such as grows in this country only upon mountain slopes. It must, therefore, have been brought by freshets from spurs of Sierra Mogoyon, among which the Colorado Chiquito takes its rise.

*December* 10—*Camp* 82.—Last night there occurred that dreaded calamity of the prairies, a stampede of the mules. The herd was quietly grazing, when suddenly a pony took fright; and, creating a panic among the animals, all fled. Their heavy tramping awoke us; and, seizing arms, we rushed out, thinking that Indians were the cause of the disturbance. The night was so dark that nothing could be seen at a distance, and we followed the sound. At length a body of mules was overtaken and brought back. The whole herd was supposed to be recovered; but at daybreak it was found that many were missing. The ground about camp exhibited no trace of Indian footsteps; and at length it appeared that the animals had taken the back track at full run towards Zuñi. The swiftest were gone; only the tired and lazy remained. But a party, without waiting for breakfast, was quickly mounted and in pursuit, hoping to overtake them before they might fall into the hands of the Indians. If not driven, it was not supposed the mules would run far without halting, but they did; and, as time passed without tidings, party after party followed the trail. For thirty-two miles they continued the pursuit; and then, overtaking the frightened horses that led the herd, turned them back. One of the mules had broken a leg in leaping an arroyo. Another had wearied herself out. The rest were driven to camp.

*December* 12—*Camp* 82.—We have been obliged to await here to allow our mules to recover from the fatigue of their stampede. This has enabled Lieut. Tidball to overtake us with the escort from Fort Defiance. He arrived this afternoon, bringing letters for many of us; a favor as welcome as it was unexpected.

# CHAPTER X.

## *From the Little Colorado to New Year's Spring.*

**Departure of reconnoitring party.—Cañon Diablo.—Pine forests.—San Francisco mountain.—Leroux's spring.—San Francisco springs.—Cosnino caves.—Return to the train.—Leaving the Little Colorado.—Christmas in the mountains.—Proposed routes to the Colorado.—Another reconnaissance.—Bill Williams' mountain.—New Year's spring.—Extensive view towards the west.—Black forest.—Continuance of explorations.—Return to New Year's spring.—Arrival of the train.**

*December* 13.—Lieutenant Jones, Dr. Bigelow, Mr. Campbell, Mr. White, Mr. Hutton, and myself, with thirteen soldiers, started on the reconnaissance. Crossing to the left bank of the Colorado Chiquito, a course nearly west led us through a fine portion of the valley, where were groves of cotton-wood, and vestiges of an old acequia. But the river soon turned towards the north, and we passed directly over a ridge to an extensive valley, with an ill-defined bed of a stream; the water, except during freshets, passing beneath the surface. This arroyo comes from the southeast; and, according to Leroux, there is water above, and plenty of beaver. But trappers have seldom ventured to explore in that direction, on account of the great numbers of Indians in the vicinity. A short distance beyond, we came upon a broken country, generally prairie, but interspersed with dry ravines and cedar thickets. About twelve miles from camp we stopped in one of the pleasant groves, beside a horizontal ledge of sandstone, which in cavities contained water. There we took supper, and grazed our mules till dark; then continued the journey, trusting to have a bright moon for a guide. But evening produced flying clouds and showers, and the rain concealed the mountains, by which we desired to direct our course. After travelling an hour and a half as nearly west as occasional glimpses of stars would admit, the storm triumphed: so we tied our mules to bushes; and, for the night, threw our blankets upon the lee side of one of the sandstone cliffs, which form a singular feature in the landscape of this region. They are high table-rocks—like little islands in the plain, the remnants of horizontal strata—twenty to thirty feet above the general surface of the prairie.

*December* 14.—At four o'clock this morning the full moon showed the earth about us mantled with snow. The storm, however, had passed, leaving the sky clear, and the atmosphere cold. Having proceeded four miles west, over prairie, we were all surprised to find at our feet, in magnesian limestone, a chasm probably one hundred feet in depth, the sides precipitous, and about three hundred feet across at top. A thread-like rill of water could be seen below, but descent was impossible. There was not the slightest indication of a stream till we stood upon the brink and looked down into the cañon. For a railroad it could be bridged, and the banks would furnish plenty of stone for the purpose. Beyond, upon the course where we wished to explore, the country looked like a nearly level prairie, to the foot of the southern base of the San Francisco mountains. But, finding no means of crossing the cañon with our pack-mules, we followed the right bank for a passage, proceeded to its junction with Rio Colorado Chiquito, and encamped, about twenty-five miles northwest from where we left the wagons. The valley is here wide, and thickly covered with good-sized alamos. The river, which we crossed in order to find a better camp-ground, is two and a half feet deep, and from ten to twenty yards wide. It flows rapidly, furnishing plenty of water for irrigation. The cañon which interrupted our march to-day has been named Cañon Diablo. Near its junction with the river valley was seen a great quantity of dark volcanic ashes, and it is possible that the channel, seemingly cut in a level bed of dolomite, may have resulted from the decomposition of a trap-dike.

*December* 15.—Having sent messengers to the wagon camp, desiring Lieutenant Ives to conduct the survey by the river to this point, we recrossed Colorado Chiquito, and turned again westward, towards the peaks of San Francisco mountain. From the edge of the prairie which bounds the river bottom, by a generally gradual ascent, we passed a mesa, and at midday reached a glen, one side of which was lined with dolomite, the other by a bed of lava. Beyond we traversed a sort of tufa, sometimes nearly knee-deep to the mules. Within the next eight miles we rose in regular steps upon wave after wave of volcanic rock, and then entered a system of conical peaks, beautifully regular. One among these had a broken crest, and a stream of lava which once poured out from it had been arrested and cooled in its serpentine course. A short distance beyond, a few branching cedars furnished shelter and fuel for a bivouac. Grama-grass has been excellent and abundant over nearly the whole of the route traversed to-day. All were fatigued with the march, and as we had brought with us water for the men, and the snow covering the ground was sufficient to satisfy the mules, we felt independent of springs, and encamped.

*December* 16.—The largest of the volcanic hills referred to yesterday appears five hundred feet high, with a crater at top. A well-beaten Indian trail winds up the side, showing that there must be water in the basin above, or some other special attraction upon the summit. We continued our course westward for two miles, and then climbed a volcanic hill where we had a fine view of the mountains, now free from clouds. Between the southern base of San Francisco and a long spur stretching northwest from the Mogoyon, the same gap or opening that we saw from Camp 82 was again apparent. We therefore turned southwest in that direction. For some distance thickets of cedar had skirted our road; now we entered a forest of pines extending over a large tract of country from south to north. It is a species of yellow pine, called by the botanist *Pinus brachyptera*. The trees are tall, straight, and sound; from one to three feet in diameter, and from sixty to one hundred feet in height. They are the same that are used for timber throughout New Mexico. In that dry climate no complaint is made of its want of durability. Now we are evidently in a region of more moisture; and *Douglass spruce*, which is also abundant upon the sides of the mountains, would afford a better material for railroad ties. Having travelled fourteen miles, we encamped in the pine forest, near the edge of a beautiful patch of grassy prairie that swept into a valley eastward. Beyond, no hills seemed to intervene between us and the point where, three days since, we turned to descend the Cañon Diablo. The grade from thence is apparently quite regular, and would probably average from thirty-five to forty feet per mile. We have found no water since leaving Colorado Chiquito. Snow yet lies upon the ground to the depth of about an inch, and supplies the present need. A large herd of antelope was seen yesterday, and to-day we have followed the trail of at least one hundred. Upon the hill behind camp a broken jar has been found, the only recent trace of Indians yet seen. Tufa and volcanic scoria are still abundant. The rocks are metamorphic sandstone. The hills are covered with *Corvania Stansburyania*, a shrub which Mexicans call "Alusima." With them it is a valuable medicine, used particularly in complaints of hemorrhage.

*December* 17.—At 9 a. m., leaving our bivouac upon the hill-side, we followed a wide, valley-like opening southwest, towards the southern point of the San Francisco mountain. Having gradually ascended two hundred feet in five miles, we found ourselves upon the dividing ridge separating the waters of Colorado Chiquito from those flowing into the Gila. Thence appeared a smooth, grassy valley sloping towards the south; and beyond, a magnificent view of a vast forest, covering a wide space, and extending as far as we could see, probably fifty miles distant. Towards the east were several volcanic hills, generally isolated like those we passed among yesterday. Looking back, we saw the same generally plain surface which appeared so inviting from Camp 82. At such a distance, it is true, minor depressions would be invisible; but there was every indication to warrant the belief that, in that direction, fewer difficulties would be encountered than upon our trail. In the course sought at first appeared a long valley and none of the volcanic hills around which we have wound.

San Francisco mountain, so often referred to, is a huge volcanic pile, with several conical peaks near the centre, elevated to the heignt of at least a mile above its base. From the east, its axis appears to extend from northwest to southeast about ten miles, where it is terminated by a gigantic mass of granite. The steep slopes are everywhere covered with a dense growth of timber, spruce and pine, extending nearly to the highest pinnacles. From the base eastward, are alternate groves and prairies broken by numerous volcanic hills. Upon old Spanish maps the San Francisco mountain is represented as belonging to the continuous Mogollon chain, which comes from the east-southeast, and was called Sierra de los Cosninos, the name of a tribe of Indians inhabiting this region. We now find a division between the two ranges affording the desired passage. To search for water, this being our third day without it, we turned the southwest point of San Francisco mountain, and, avoiding the valley on the left, kept upon the spurs close at its foot. After travelling about seven miles, we reached a permanent spring that poured from a hill-side and was lost in the grassy plain below. In honor of the guide it was called Leroux's spring. It is the same to which he conducted Captain Sitgreaves two years since, but by a different route, passing around the north and the western base of the mountain.

The grass is covered with snow, except in spots among rocks on the hill-sides, and the poor mules can scarcely satisfy their hunger. From our last bivouac we have passed through groves of magnificent pines, intermingled with cedars and dwarf oaks. Some of the latter may be large enough for railroad ties, and perhaps might be found more plenty in other parts of this extensive forest region. The spruce trees would afford a supply for this purpose. The cedars are of a new species, and are frequently two feet in diameter. They bear a sweet berry which Indians gather for food. Upon the more elevated mountain slopes, beside the Douglass spruce, there are tall pines of a species different from those that grow upon the plains below.

*December* 18.—Two years ago, when Leroux was here with Captain Sitgreaves, the hills were covered with savages, who occasioned them considerable annoyance by hostile demonstrations. But thus far, since leaving the Navajo country, we have not seen the fresh track of a wild Indian. The snow is untrodden, except by beasts and birds, which afford plenty of game. Antelope, deer, hares, and turkeys, are abundant; also a singular species of striped squirrel, which Dr. Woodhouse was the first to find in this region.

Well content with the results of the exploration, at 1 p. m. we turned back for the train. Following the course of the open, meadow-like valley, irrigated by the waters of Leroux's spring, we passed southeast and east about four miles, and discovered a small stream flowing towards the great southern valley, and forming probably the main branch of Rio Verde.* It is fed by springs. The barometer indicated a descent of two hundred feet from Leroux's spring. From the San Francisco springs we passed over a spur from the hills, and encamped near the southeast point of the mountains, having travelled about six miles.

Snow upon the hill-sides is much less than yesterday, many spots now being bare. Grass is therefore not so scarce. Our bivouac is somewhat elevated upon the slope from the foot of the mountains, and looks over the dark forest before mentioned. Leroux thinks he can distinguish in the distance, south, blue peaks of mountains lying near Rio Gila.

A breeze renders the air chilly, but with a semicircle of green boughs, and a blazing fire in front, we do not feel the need of tents.

*December* 19.—At 9 a. m. we continued our backward march, to a point near the bivouac of December 16. Here we turned more to the right, and, from the prairie valley before mentioned, found an arroyo leading eastward towards Cañon Diablo. Turning from this, we crossed a low lava ridge and entered a grassy meadow. Skirting a forest of cedars and pine, we descended the arroyo to a sudden breaking away of the rocks, which produced a fine place for a waterfall, and a short cañon below. Water was still standing in pools above, and beneath

* This stream was called by Leroux Rio San Francisco, from the mountain near which it takes its rise, and it is thus designated in the report of Captain Sitgreaves. The early Spanish explorers gave it the name of Rio Verde, which is still retained among the Mexicans of the present day, and appears upon modern maps. As there is another affluent to the Gila known as the San Francisco river, it would seem proper, if only to avoid confusion, to preserve the original appellation.

Lith of SARONY, MAJOR & KNAPP, N.Y.

SAN FRANCISCO MOUNTAIN.

from Leroux's River.

appeared to be springs. As grass and fuel were excellent, and as there were good trees for shelter, we encamped, having made ten miles.

Descending one side of the fissure which forms the cañon, we found within the rock quite a number of caves in the shape of ovens, opening towards the stream. They showed unmistakeable signs of volcanic origin. The cavities were regular, and covered with a vitreous substance, hard, and brownish-black, like iron. They had been artificially plastered, and some of the largest were divided by walled partitions into separate apartments. The principal rooms were ten feet across, and where the adobe floor was not covered by débris, the height was about six feet. Within, and communicating with these, were smaller caves still more like ovens, and doubtless used as dormitories. The walls were laid with care, and the plastering of the ceiling, which remained in patches, seemed to have been done rather skilfully. Upon the rocky hill above, and in the cañon, were fragments of pottery, some painted black and white, others indented. The caves seem to have been unoccupied, except perhaps by an occasional visitor, for a long period. The entrances to several are choked by heaps of disintegrated rock. Nevertheless, we call them "Cosnino Caves," after the tribe that roams over this region. The fresh trail of a small party of them has been seen to-day.

*December* 20—*Camp* 87.—Taking a course about north 60° east, we crossed the arroyo, and recrossing below at a large water-hole, passed a small ridge into a valley apparently descending, by a gradual slope, north 50° east to Rio Colorado Chiquito. We kept more to the right, and after traversing a nearly level prairie, made an abrupt descent over precipitous banks to the river, which we reached after a march of seven hours from Cosnino Caves. We struck the river at a deserted camp of our party, and were surprised to find that the trail from there turned backwards. They had returned a mile and a half to a better place for camping, and were there awaiting our arrival. Lieutenant Ives had brought the survey about thirty miles down the river, from Camp 82, where we had left the train. The party was in good spirits. Another stampede of the mules had occurred. One dark night they took fright, and ran six miles before they were stopped. In their flight, some plunged headlong over each other into Cañon Diablo, and the men in pursuit narrowly escaped breaking their necks.

We passed to-day a rocky eminence where were found stone enclosures, apparently intended for watch-towers and for defence, similar to those formerly seen near Ojo de la Vaca, between Rio del Norte and the Gila. Broken jars were also found, painted in stripes. At the wagon camp below are hieroglyphics upon the rocks, representing men and beasts—one of the former having a snake about his head. Among other symbols, is one resembling the notched stick found at the ancient Zuñi altar.

*December* 21—*Camp* 87.—We have remained in camp to-day in order to rest the weary mules. Good grama-grass is found upon the high table-lands.

Dr. Kennerly has labored hard to catch a fish in the Little Colorado, and has at last been rewarded by a single specimen. Fortunately it is of a new species.

*December* 22—*Camp* 88.—Turning our backs upon Rio Colorado Chiquito, we travelled south 60° west nearly direct towards Cosnino Caves. The ascent was gradual, with a generally uniform slope, eleven miles, to a point of lava, where we encamped, having risen nearly six hundred feet above the river. Our loaded wagons passed without difficulty, and made an excellent road. Around camp grama-grass is abundant, and nutritious as usual. The decomposed black lava, called in Mexico "mal pais," affords the best soil for the production of this grass. Our camp is without water, though a few miles beyond is an arroyo with alamos and willows, generally indicative of a flowing stream.

*December* 23—*Camp* 89.—We continued our march in the midst of a snow-storm. It was a day of toil for the wagon mules, as snow gathered in balls upon their feet, causing them to slip and stumble badly. We passed a few small hills, and after fourteen miles' travel arrived at Cosnino Caves, which proved to be between seven and eight hundred feet above our last camp. The

road which the wagons made was very hard and good. If there were no snow, a train following could make the march from Colorado Chiquito, twenty-five miles, in one day, with ease.

*December* 24—*Camp* 89.—Having a sheltered spot on the edge of a forest, with plenty of water and grass, it was deemed necessary for the welfare of the mules, upon which we are so dependent, to rest till Monday. The weather in the morning was very cold, the thermometer at sunrise reading 3°.5 below zero. Later in the day the sun's rays were warm and powerful, melting the snow upon the southern slopes. Several of the party went out to hunt turkeys and other game, thinking to have a feast, but were quite unsuccessful. They found plenty of tracks in the snow. One young hunter got upon the trail of a bear; but the foot-prints were so enormous that he preferred to return to camp.

Christmas eve has been celebrated with considerable éclat. The fireworks were decidedly magnificent. Tall, isolated pines surrounding camp were set on fire. The flames leaped to the tree-tops, and then, dying away, sent up innumerable brilliant sparks. An Indian dance, by some *ci-devant* Navajo prisoners, was succeeded by songs from the teamsters, and a pastoral enacted by the Mexicans, after their usual custom at this festival. Leroux's servant, a tamed Crow Indian, and a herder, then performed a duet improvisatore, in which they took the liberty of saying what they pleased of the company present—an amusement common in New Mexico and California, where this troubadour singing is much in vogue at fandangoes. These last entertainments are interesting to a stranger from their singularity. The plaintive tones of the singers, and the strange simplicity of the people, lead one's fancy back to the middle ages. In this state of society, so free from ambition for wealth or power, where the realities of life are in a great measure subject to the ideal, there is a tinge of romance that would well repay the researches of a literary explorer. Their impromptu ballads alone would make an interesting collection.

*December* 25—*Camp* 89.—Christmas dawned upon us with the thermometer nearly at zero; but the day has been pleasant, and the snow is rapidly disappearing. Nineteen mules strayed last night, but all have been recovered. No fresh signs of Indians appear since the late snow. Cosninos are said to roam from Sierra Mogoyon to the San Francisco, and along the valley of the Colorado Chiquito. Their number has been estimated by trappers at ten thousand—probably a great exaggeration.

*December* 26—*Camp* 90.—The morning was again clear and very cold. The pool of water in the cañon below the caves seems to be supplied from a spring. It has afforded sufficient for our large herd, above 200 mules, and appears to suffer little diminution. The fact of a good-sized Indian village having been established in the vicinity, is in itself a strong indication that the water is unfailing.

At 9½ a. m. we struck tents, and pursued our journey; the surveyors, as usual, in rear of the train. The route was nearly the same as that pursued in returning from the reconnaissance, and was quite easy, except the passage of the narrow ridge before described. Twelve miles led us to the southern base of the San Francisco mountains, where we encamped, from five to six hundred feet above Cosnino Caves. The intention was to have gone on to the San Francisco springs, some three and a half or four miles farther; but, by some mistake or misapprehension, the advanced party encamped here without water.

*December* 27—*Camp* 91.—Travelling through the crusted snow became so fatiguing to the mules, that it was necessary to add to the force of some of the teams. This could be done only by abandoning a wagon, and one was therefore left behind this morning. We crossed a narrow spur from the mountain some fifty feet in height, and in two hours reached the springs of San Francisco. Water there was abundant, flowing rapidly south, through an extensive grassy basin, towards the great valley of forest before mentioned. Thence we ascended a ravine, which, in one place, narrowed to a cañon, and, after travelling six miles, reached Leroux's spring. In the cañon, fallen trees and rocks obstructed the passage for wagons. To avoid them, the guide led the way over a rocky hill from sixty to seventy feet in height. In a day our party could have rolled away the rocks and made a good road. For a railway, it would be necessary to cut

through two salient points, or it might be more economical to keep nearer to the foot of the mountain, so as to avoid the cañon entirely. A short distance south the whole country looks level, and may, perhaps, be still better adapted for the location of a railway. Leroux says that we can neither proceed west nor southwest, on account of successive mountains and cañons. He desires us to follow the route by which he led Capt. Sitgreaves' party two years ago, or to go even farther to the north. There, he says, we may keep upon the dividing ridge until we reach the mountains that border the Colorado upon the west, pass thence, and enter the valley. Savedra has crossed over that country, and represents it as a barren and nearly waterless prairie. There seems to be another objection to this route—the very advantage that Leroux ascribes to it—viz: the "keeping up" for so long a distance. We must now be about three degrees of longitude east from Rio Colorado, and nearly seven thousand feet above the nearest point. A uniform slope the whole distance would require a grade of forty feet to the mile. To keep upon the ridge, as he proposes, would diminish the distance at so great an expense of grade as to be objectionable. We therefore propose to follow Bill Williams' fork, which Capt. Sitgreaves has represented as rising near this place, and flowing west-southwest into Rio Colorado.

The hill-sides are now nearly divested of snow, and there is plenty of grass for the mules.

*December* 28—*Camp* 91.—Our weary mules again requiring rest, we have not moved camp to-day. A small party made a reconnaissance four or five miles southwest to a volcanic peak, 700 feet by barometer above its base, from which the view was extensive. Towards the north and northeast were Mount Kendrick and Mount Sitgreaves. Southwest we saw Bill Williams' mountain, where the stream of the same name is said to take its rise. Towards the south was a range of hills, which seemed to form the western boundary of the great valley of Rio Verde. Westward were lesser hills, with plains between, and dim mountains in the distance, all white with snow. But there we are determined to explore for a passage to the Colorado. Turning back towards camp, the snowy peaks of San Francisco, towering, like spires, above a huge pile of mountains, looked grand and imposing. Dense forests of pine surrounded the base. Spruce and pine covered the slopes near to the foot of the conical spires, where appeared to be a pretty well defined curve, supposed to be the "limit of pines," found, by measurement, to be 4,169 feet above the valley at Leroux's spring.

*December* 29—*Camp* 91.—There being several cases of varioloid in the party, and the surgeon deeming it imprudent to remove the sick, we have remained in camp another day. This morning, the summit of San Francisco being visible, the triangulation commenced yesterday was completed. The height above Leroux's spring was found to be 4,673 feet, making it about 12,000 feet above the level of the sea. At noon, the temperature of the spring, where it issues from the hill-side, was measured. The immersed thermometer read 48°.4; 3°.2 higher than the surrounding atmosphere. That is probably the mean temperature of the place. The water pours, in several streams, down the ravine, producing a fringe of green herbage. The valley below has a dark loamy soil, luxuriant in grass. It would make a superb plantation. This spot could easily be irrigated, should not the climate prove sufficiently moist to render that process of watering unnecessary. The hill-sides are covered with excellent grama, and tufts of it are now beginning to appear above the snow on the plain. Neither last night, nor to-day, has the temperature been below the freezing point.

*December* 30.—Dr. Bigelow, Mr. A. H. Campbell, Mr. White, and myself, with Leroux for guide, and Lieut. Tidball escorting us, set out upon a reconnaissance westward. We passed from Leroux's spring, north of our reconnoitring peak, and crossing a wooded ridge 150 feet in height, descended gently into another prairie, where at the foot of a grassy hill we bivouaced for the night. Our distance from Camp 91 is eleven miles. The barometer places us eleven feet below that station. Snow covers the ground to the depth of eight inches, with a crust upon the surface, which is the only real obstacle our wagons can encounter thus far upon the march. For a railway the country is excellent. With a slight cutting at the summit of the ridge, which, near reconnoitring peak, divides two valleys—one sloping east, the other west—the road would be nearly level

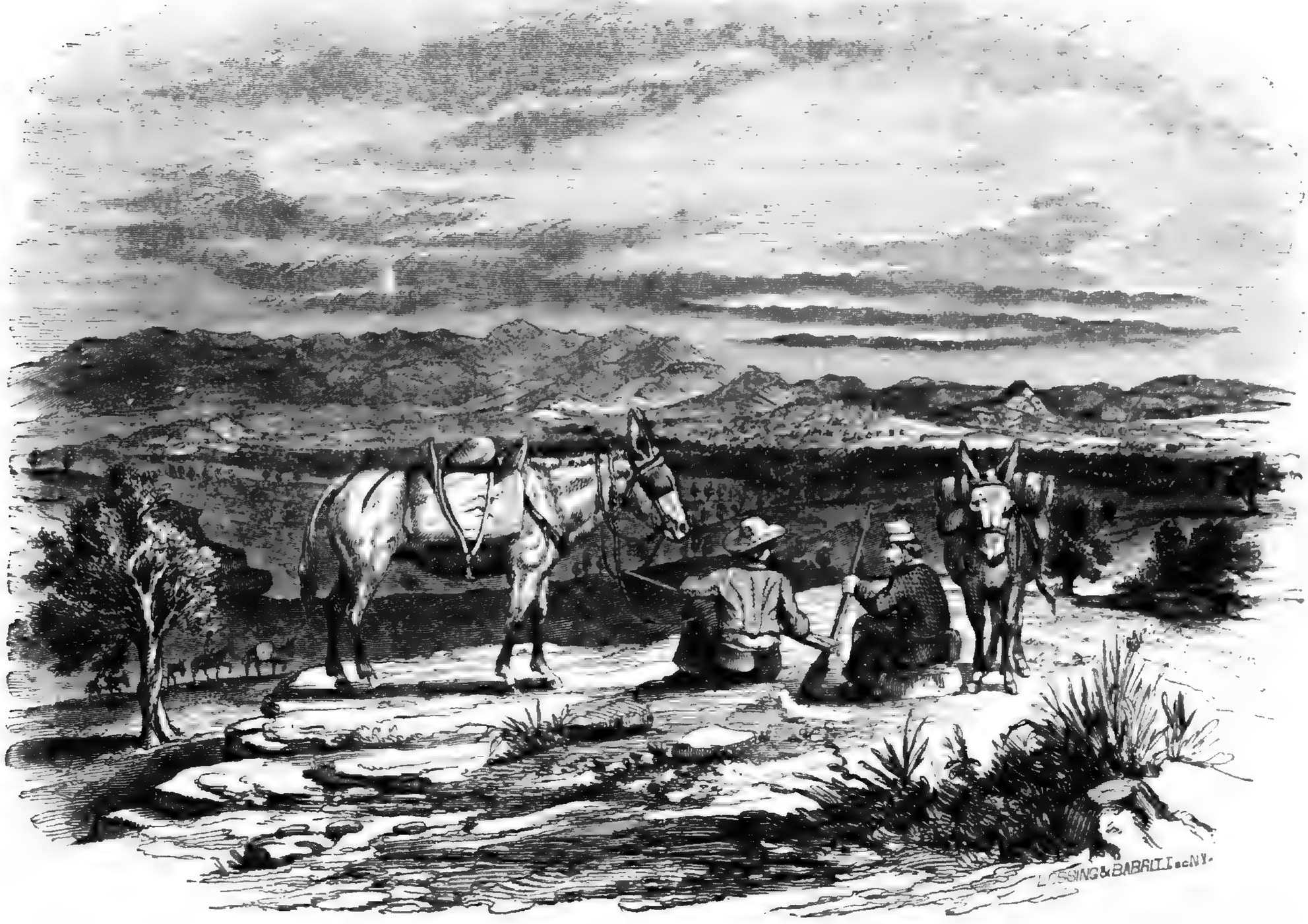
for the whole distance. On the hill above us an extensive view is obtained; north-northwest, hills and plains are seen, destitute of snow.

*December* 31.—We continued our march through the long prairie that we crossed yesterday. It is surrounded by pine forests, and nearly enclosed by volcanic hills. The snow being from three to eight inches in depth, and covered with a hard crust, our mules, for several hours, made slow progress. Afterwards we entered a forest of pines and dwarf oaks, with large cedar trees bearing sweet berries. The snow becoming soft and less deep, we progressed more rapidly, and at 2½ p. m. bivouaced upon a hill-side, where abundance of bunch-grass, quite green, and cedars for shelter and for fuel, afforded a fit resting-place for the night. From the top of the hill we could distinguish the vicinity of Leroux's spring, lying due east at a distance estimated at twenty miles. The surface between is nearly level. Looking west and southwest appeared an open country, with imperfectly defined valleys, among a dense growth of cedars; but it was difficult to say in what direction was the slope. A blue mountain range some fifteen or twenty miles distant limited the view. From south to south-southwest, about ten miles from us,.was Bill Williams' mountain, the highest in this vicinity. North and northwest were black volcanic hills, and a high prairie devoid of snow, and nearly destitute of trees. Below the hill where we stood was a ravine, in which were indications of water. Men were sent to explore, and soon brought the agreeable news of having found a spring. This was of service to the mules, as snow does not satisfy their thirst. This last piece of good fortune determined us to send back to Lieut. Ives, desiring him to continue the survey, and bring the train to this place. The barometer places us about four hundred feet below Leroux's spring. We therefore seem to be truly on the slope towards Rio Colorado.

*January* 1.—The morning was bright and clear. Upon leaving camp, we visited "New Year's spring," about a mile west. It was a pool ten or twelve feet in diameter, with water twenty inches deep, below a stratum of ice three inches thick. The amount of water was not perceptibly diminished by what the mules had drunk during the night. It therefore appeared to be a permanent spring. Proceeding southwest towards Bill Williams' mountain, we overtook our pack-train, which had been watered from another pool said to be larger than the first, about half a mile from last night's bivouac. Five miles beyond were indications of other springs to the right, with many Indian trails leading in that direction. After travelling about twelve miles, we spread our blankets beneath a cedar tree three miles west of Bill Williams' mountain. Good grass and timber are found here; but we have failed to reach the waters of Bill Williams' fork. From a hill west of camp, we saw a valley upon the right of our trail which looked like a favorable route, provided it should be necessary for the train to go down to the stream we are in search of; but the long range of mountains west, extending from northwest to southeast, still seems to be unbroken.

We are now near the trail of Capt. Sitgreaves, who passed around the southern base of Bill Williams' mountain, and thence proceeded towards the west-northwest, in the direction of Yampais creek. Lieut. Tidball has taken a sketch showing the Sierra de la Laja and Picacho, some twenty-five miles distant, between which the trail crossed. A chain of blue hills appears in the distance, and extends towards the south-southeast; its crest evidently preserving nearly the same altitude; but the descent of the valley along its foot causes the southern portion, represented in the sketch, to appear a formidable range. The drainage of the ravines is towards the Picacho, through a generally level country, containing prairies mingled with copses of piñons and cedars. The soil being of decomposed volcanic rock, is rich; and, judging from the vegetation which covers it, must be well watered. Capt. Sitgreaves, according to Leroux, found this region to be a plain intersected by numerous and difficult ravines. The country beyond proved to be an elevated prairie, considerably broken, and nearly devoid of water and wood, forming a dreary jornada. The grass, though nutritious and abundant, was parched, indicating a long drought. The soil was so light and porous, that there appeared little chance of finding water in pools. After a laborious and uncomfortable march of eighty miles, on the fourth day they

reached two small springs, to which they had been conducted by a Yampais Indian, captured by them a short time before. These springs furnished but a scanty supply of water, and no more was found till their arrival at Yampais creek, twelve miles beyond. A difficult range of mountains, besides two barren and extensive plains, were crossed, and a second range ascended, before a view of the Colorado was obtained; the descent to the river being then very abrupt. From Leroux's description, it would not appear that this route offers many facilities for a railway.




Black Forest, Pichaco, and mountains north of Aztec Pass.

The region from San Francisco mountain to this place contains much volcanic sand and scoriaceous rock, quickly absorbing rain, and melting snow. Springs doubtless exist in many places, but being now covered by snow and ice, cannot easily be found. Pine forests, interspersed with prairies, seem to extend towards the south to the blue mountains that are just visible above the horizon. The appearance is somewhat similar to the Cross Timbers upon the Canadian. Our camp is on a dry branch of Bill Williams' fork, and, according to the barometer, 400 feet below the bivouac of last night.

*January* 2.—Turning south and southeast along the channel of an arroyo, in half an hour we found pools of water. Willows growing upon the banks seemed to indicate that it was permanent, though melting snows have probably added to the usual quantity. Keeping our course three miles over a prairie which sloped from the southern base of Bill Williams' mountain, we again found water which supplied the train. We then followed Leroux in search of the main stream, to a point which he recognised as being near Capt. Sitgreaves' Camp No. 21. Here we saw the ravine in which the creek flowed south, and followed a branch about four miles to a point of hills, where we again encamped. The stream below us flows in a cañon 150 feet deep. Ascending a hill half a mile south, we saw an immense and beautiful valley, into which the creek enters from the mouth of the cañon, about four miles distant. The valley is striped with

timber and prairie, and extends from north-northwest to south-southeast. It seems to be a well-watered region, and a winter retreat of Indians, for several smokes were seen there. Upon the slopes of the hills we find in the vegetation an agreeable change from that of the higher country we have left. Agave Mexicana is quite abundant. It is the beautiful American aloe, or Century plant, called in this country mezcal. The Apaches roast it for food; Mexicans distil from it a spirituous liquor.

The weather is warm, and the snow has nearly disappeared, but the gravelly soil is everywhere so saturated with moisture as to make travelling difficult. The mules sink in the mire at almost every step, half way to their knees.

The barometer places us a thousand feet below Leroux's spring.

*January* 3.—A stampede of the mules took place last evening, indicating the approach of Indians or wild animals; therefore, although we regained the mulada, the night was passed with watchfulness and anxiety lest our neighbors might make another attempt to leave us on foot; but we were not again disturbed.

A mile west from our bivouac No. 4, we ascended a ridge called Topographical hill, where we had a view still more extensive than that noted yesterday. We can now trace the great valley, as well as the western ridge of mountains which bounds it, far towards the north-northwest. A mesa mountain towards the southeast has been named Sierra Tonto. South-southwest is Sierra Prieta, with indication of passes upon both sides of it. From thence, northerly, extends a range with a snowy peak near the centre. Nearly west is seen "Picacho." Intervening is a low ridge, covered with a dense growth of dark cedars and piñons, which we call the "Black Forest." This seems to divide the drainage of the valley—one system of streams flowing south-southeast to Rio Verde; the other towards the west and southwest, probably to the Colorado. That upon which we encamped last night belongs to the first system, and therefore may not be Bill Williams' fork, as at first supposed. At all events, it passes far towards the south. Our bivouac No. 3 was upon a branch which appeared to flow westerly, more in the direction of our route. Therefore, to explore it, we took a course north 70° west, descended into the valley, and, after travelling about ten miles, encamped upon a creek where were large pools of water. Small alamos and willows cover the banks. Grama-grass is abundant in the vicinity. We now seem to be below the region of pines, and of the sweet-berried cedars. Red cedar is, however, abundant; larger and finer than before seen. There are also numerous piñons with esculent nuts, affording food for wild beasts as well as for Indians. We have seen to-day black-tailed deer, rabbits, and quails; also foot-prints of many antelope and bears. The barometer gives our camp nearly the same altitude as the valley of Rio Colorado Chiquito, and of Rio del Norte at Albuquerque.

*January* 4.—Proceeding in a generally northwest course, we crossed several arroyos, one of which contained deep pools of water; and, after travelling about fifteen miles, encamped near the head of a dry ravine, among hills of red sandstone. Volcanic rock, or "mal pais," as it is appropriately called by Mexicans, has entirely disappeared. Upon our left is a valley leading around these hills, and the indications seem favorable there for the passage of the wagon train, supposed now to be encamped at New Year's spring. We therefore ascended the ridge, and endeavored to communicate with the main surveying party by preconcerted signals. But hills intervened, and prevented our smokes from being seen.

*January* 5.—Leaving our dry bivouac, we passed up the valley mentioned, and ascended a higher hill to reconnoitre. From that point we had an extensive view in the direction towards New Year's spring, but saw no indication of camp-fires. We then turned eastward, followed up a long valley, crossed a low ridge, and from a ravine ascended to the hills, in order to catch, if possible, a view of smoke, which might at least direct our course to the train. Soon the forest became so dense that, not only could we not see beyond, but could scarcely make our way through. At length, having travelled about fifteen miles, we came to the end of the range, and saw Bill Williams' mountain before us. To the east-northeast were several volcanic hills,

and at the foot of one of them was New Year's spring. Here again, at sunset, we made the usual signal, but fruitlessly, as before. Unable to account for this, we had many misgivings with regard to the safety of our friends. The loss of mules by an Indian stampede is the great danger to be apprehended in a country like this. A plan for that purpose, well concerted by savages, is almost sure to succeed; and, however strong the sufferers may be, pursuit on foot is hopeless.

In a ravine at the foot of the hills we bivouaced. All the arroyos crossed to-day were dry; but as we have ascended some eight hundred feet, there is now snow upon the northern slopes, supplying water sufficient for our men. Some mules, when thirsty, eat snow readily; others will not.

*January* 6.—A cold sleet was blowing into our faces this morning, and it awoke us before daybreak. The cedars in this instance proved less comfortable quarters than tents would have been. Having again made signals from the hill, and watched in vain for smoke of camp-fires, with considerable anxiety we turned eastward. On the way, water was found in cañons of the valley; but without stopping, we travelled over broken ground, frequently strewn with pedrigal, fourteen miles, to New Year's spring, where, to our delight, we found the main body encamped.

The peaks of San Francisco mountain are again white with snow. A sheet of the same also tips the summits of Mt. Kendrick and Mt. Sitgreaves. But the valley westward, with its grassy slope and border of pine and cedar forests, forms a pleasing contrast to the wintry-looking region which we are now prepared to leave behind. During the eight days we have been absent from the main party, we have travelled, according to our estimates of distances, only ninety-six miles;* but the labor in wading through snow and soft gravel has been greatly fatiguing to the mules. We have, however, examined a large extent of country. The long mountain range that lies west of the Black Forest remains for a subsequent exploration.

*January* 7—*Camp* 94.—The day was passed in camp to rest the mules and have them shod. A triangulation was made to fix the positions of mountains and hills that can be seen from this place. The usual series of magnetic and astronomical observations were taken.

Savedra has returned from a three days' reconnaissance to the northwest, upon the trail that he thinks he followed when he accompanied the Moqui Indians some years ago. He reports that he has now travelled thirty miles in that direction without finding any indication of water.

* Subsequent examinations proved our estimates about one third too small.

# CHAPTER XI.

## *From New Year's Spring to Pueblo Creek.*

**Lava spring.—Cedar creek.—Partridge creek.—Game.—Reconnaissance towards Picacho mountain.—Picacho springs.—Val de China.—Turkey creek.—Pueblo creek.—Aztec mountains.—Aztec Pass.—Return to Pueblo creek.—Ruins of ancient pueblos and fortresses.—Arrival of train.**

*January* 8—*Camp* 95.—Having resumed our journey, we proceeded over a country with a generally uniform slope; appearing beautifully smooth at a distance, but cut up by ravines which made rather laborious work for the train. At a distance of ten miles from New Year's spring, at the head of a cañon formed by the breaking up of a bed of lava, we found a magnificent pool of water, and there encamped. The basin was about thirty feet in diameter, and covered with ice half a foot thick. Holes were cut to allow the mules to drink; and a pole eight feet long inserted to measure the depth, but the bottom was not reached. In furnishing the supply required for camp, no visible depression was made. It was not so with New Year's spring. During the four days that the party was encamped there, the water was several times consumed, and snow was melted to aid in furnishing a supply.

The average descent to-day has been about fifty feet per mile. With moderate cutting and filling the grade could be made uniform. The wagon road, now that it is broken, would be quite good for a train following. The astronomical observations were interrupted by clouds. This was particularly regretted, as thereby was lost an occultation of Saturn by the moon.

*January* 9—*Camp* 96.—Our course from Lava spring, nearly west, was for three miles over a country similar to that travelled yesterday. We then commenced the descent of an arroyo; which, soon entering a rocky ravine, compelled the train to ascend the side of a hill, about one hundred and thirty-five feet, to the summit of a ridge. A dense growth of tall cedars and piñons covered the ground, and while most of the party were scattered through it in search of a gradual slope for a favorable descent, the train moved on and rushed down the steep side of the ridge, nearly upsetting some of the wagons. It would have been easy to have passed by a ravine that was found to the right. Having travelled ten miles, we encamped in the valley, near a cedar grove, where we found good grass as usual, and a patch of snow upon the hillside which supplied us with water. The geologist found iron pyrites to-day; also fossils, in carboniferous limestone. As coal lies between this formation and the new red sandstone, which occurs a few miles distant, it is possible that a bed of that useful mineral may exist in this region. The total descent in ten miles has been 500 feet.

*January* 10—*Camp* 97.—We traversed the fine valley of Cedar creek, and passed westwardly over an almost inappreciable ridge into a wide ravine; which, by a gradual descent, led into the great basin of the Black Forest. Thence four miles south brought us to large pools of water in a rocky glen called Partridge creek. It is believed that water exists here at all seasons. Our camp ground is excellent; possessing, as usual, rich grama-grass, and large cedar trees for fuel and shelter. Game is abundant. A black-tailed deer and many partridges were killed to-day. The latter have been seen in great numbers. Upon their heads are tufted plumes, like those of the California partridges. Tracks of deer, antelope, bears, and turkeys are numerous. Hares and rabbits are frequently started from their hiding-places upon our trail. Singularly colored gophers, rats, and mice are found in hollow trees and crevices of rocks.

The volcanic hills and streams of lava we have traversed put our magnetic instruments to great confusion. To-day, a compass having been placed upon a small boulder of compact lava,

the needle was completely reversed, the south end pointing north. Astronomical observations were taken with the transit, moon culminations being observed. There has been a descent of 560 feet in the thirteen miles from last camp. Carboniferous sandstone was to-day passed over. As this should be contiguous to the coal formation, beds of the latter may exist in the vicinity, cropping out or covered by volcanic rock. Fossils have been found by the geologist.

*January* 11.—It appeared necessary to leave our late reconnoitring trail, and again explore towards the southwest. There seemed to be a break in the mountain range near Picacho, and it was decided to examine in that direction. Fearing, however, to move the whole train, with the uncertainty of finding water; with ten men for an escort, we recommenced the reconnaissance. Following Partridge creek, nearly south, six miles, we found large pools of water at distances of a quarter of a mile from each other, with numerous recent Indian lodges along the banks. The ravine turned eastward, and appeared, after making a long, semi-circular bend, to follow the northern base of the Black Forest ridge towards Picacho; we therefore bivouaced under wide-spreading trees upon the banks where we were; determined on the morrow to pass directly over the wide level prairie to that mountain. As this place is excellent for a camp, we have despatched a trusty Mexican to conduct the train hither, where it will await other messengers or signals from us as we advance.

*January* 12.—The water-hole at last night's camp, though smaller than many seen, was from two to three feet deep, some twenty feet long, and three or four feet wide. The botanist found there, and at other pools upon Partridge creek, the water-plant "Polygonum amphibium," which, he says, never grows except in places permanently moist. He believes that now the water is in its lowest stage. All the old hunters and trappers of the party find signs leading to the same conclusion. This is an important fact. Only springs or tanks can be depended upon for a supply of water in this region of volcanic rock.

Leaving Partridge creek, which flows south 65° east, we turned towards the southwest and west over a smooth prairie, about eleven miles to the southeast base of Picacho. There finding pools of water, we again bivouaced among our favorite cedars. Within the last two miles we have crossed several arroyos, containing water in holes, which, about a mile below, seem to unite. From a spur of the Picacho the view is very extensive and beautiful. This mountain proves to be indeed the southern terminus of the range to which it belongs, and beyond is a broad smooth valley sweeping towards the south-southeast, and extending in that direction to the verge of the horizon. Westward of this is the long range of mountains which was before noticed from the head of Bill Williams' fork. We can now, as then, trace it from Sierra Prieta, without apparent interruption, to where it seems to be blended with high mesas towards the northwest. The ridge of the Black Forest bounds this valley on the east, and separates it, for a long distance at least, from that in which flow the streams that rise at the base of Bill Williams' mountain. Between that ridge and the Picacho is an opening, the outlet of the great plain we have crossed, and where the streams which water it converge. By this opening we may enter the broad valley above mentioned; but how to pass the western chain of mountains is yet to be determined. Towards the south-southwest there is a conical peak that appears volcanic, and near by are mountains, apparently of stratified rock, as if overlapping. Although no gap can be seen from any point of view we have had, yet it is possible that a nearer approach may show some break in the chain. The smoke of Indian fires proves at least that there is a likelihood of finding water in that vicinity. The conical peak we call Mt. Hope. Leroux proposes to keep up towards the north-northwest, believing we may find an easy passage over the ridge in that direction. Although this will probably lead us to Captain Sitgreaves' trail, which he reported as mountainous and without water for eighty miles, it was determined, for the first exploration, to follow the guide. As plenty of water had been found near by, we wished the rear party with the train to follow and await us here. Upon the hill, therefore, we made a smoke, as we had agreed upon, for a signal; but saw no sign in reply. Much game has been seen to-day; antelope being particularly numerous.

*January* 13.—From the hill we again raised a huge column of smoke, but, as no answering signal was seen from the wagon-camp, two soldiers were despatched to conduct the train from that place. Leaving Picacho springs we entered the great valley, several miles in width, and ascended it ten miles towards the west-northwest. The hills here closed in, contracting the width to about half a mile. After having travelled a short distance in what appeared to be a sort of gorge uniting the main valley to another seen beyond, our mules became weary, and we stopped for the night. This is the most dreary camp-ground we have had. There is neither water nor wood. Our blankets, with saddles for pillows, have been placed in the middle of the valley, to be as far as possible from any ambitious Indians that might desire to practise archery at night from the hills. There is not a rock nor a bush near us from which a sheltered and home feeling can be derived. To add to the dreariness of the place, clouds seem to threaten rain. The rich black loamy soil we have passed over is covered most luxuriantly with the excellent grama-grass, so often referred to as being abundant throughout this region, called by Mexicans "de china," from which the valley derives its name. It is now grazed by numerous herds of antelope and deer, and would furnish pasturage for thousands of cattle and sheep. We have found no water in it above the streams that enter south of the Picacho; but the soil seems so moist of itself, that probably, without irrigation, it might be cultivated to better advantage even than the Zuñi valley. If so, the amount of grain that it could produce would be sufficient for a very large population.

*January* 14.—Moving onward, the valley soon opened into a sort of plain stretching towards the north-northwest, bounded upon the east by high sandstone mesas, and upon the west by the mountain chain we had seen from Picacho. On the way Savedra thought he recognised a point on the route he pursued with the Moquis twelve years since, and a few of us followed him to the top of a high hill to reconnoitre. He was entirely lost. Westward, far as we could see, were piles of mountains extending north and south, without any indications of a passage through them. Returning to the plain, we followed Leroux for several miles northwardly, until, finding a patch of snow upon the hill-side, we determined, as the mules were weary, to encamp. Mr. Albert Campbell, Dr. Bigelow, Mr. White, and myself then climbed to the top of a hill, by barometer measurement twelve hundred feet in height, which afforded an extensive view towards the north. We could trace the rapidly-ascending plain, with red cliffs of mesas upon the east, apparently at about the same height as ourselves; and upon the west, the still more elevated mountain range, but with sides less precipitous. There it is supposed the trail of Captain Sitgreaves passed, and the country looks, as it has been described, exceedingly barren and waterless. Neither Leroux nor Savedra can give us encouragement of finding water for several days upon that route, even should we succeed in passing the mountain with the train. Besides, there is already before the department a report of that country, and if we fail, it must be in the effort for new discoveries. It has been, therefore, decided to return to Picacho, and from thence explore towards the southwest.

By indication of the barometer, we are now four hundred feet above the bivouac at Picacho spring.

*January* 15—*Camp* 99.—Turning our faces towards the southeast, we descended the broad sloping prairie to Picacho spring, where we found the main party with the train. They had been here two days, and the mules were literally rolling with satiety in the luxuriant grass of the valley. New species of pouched rats, an owl, and magnificent antlers of a mountain sheep, had been secured, and many fossils, also a specimen of what appears to be silver ore, collected.

*January* 16.—As camp near the pools was exposed to the full sweep of the wind, it was moved about a mile to a more sheltered spot in Val de China. We then reformed the reconnoitring party and travelled south 20° west, traversing the valley ten miles, to a dry arroyo upon a slope of the hills, where we stopped for the night. During the march we were obliged to face a bitter storm of sleet. Our bivouac is somewhat sheltered from it by a cluster of cedar

BIVOUAC, JAN. 26.

trees. The soil of the valley where crossed to-day proved no less fertile than it appeared from Picacho. It may be denominated a rich meadow bottom, although the surface and several water-worn channels were dry.

*January* 17.—Continuing our march, we passed a spur of granitic hills, and in two miles southwest struck a clear and rapid stream flowing southeast. Its banks were lined with rushes, and a basin-like valley was covered with a thick growth of timber—cotton-wood, walnut, and ash. A large flock of turkeys was hunted in the grove, and one killed. This suggested the name which was given to the stream, "Turkey creek." Here were huts and trails, and stone ovens where mezcal had been recently baked; seeming to indicate a near approach to the winter homes of Indians. As we proceeded, about three miles from south to southwest we encountered another stream, somewhat larger than the last, also flowing through a fine valley towards the southeast. We ascended its left bank two miles. Here two branches formed a fork, within which was a smooth grassy hill about fifty feet high. Upon the top were remains of an ancient pueblo. It commanded a fine view. Above was a wide bottom-land, bearing faint traces of former cultivation, although now partly covered with a beautiful grove of ash trees. Below, timber of walnut and oak fringed the stream, rendering the spot a pleasant site for a settlement. Upon each side flowed a clear sparkling rivulet, forming the delta of the valley. One appeared to come from the southwest, taking its source in the region of Mount Hope. The other proceeded from the west, and seemed to divide, by a narrow gap, the range of stratified mountains north, from the pile of volcanic-looking peaks that could be traced thence southwestwardly to Mount Hope. Although other mountains overlapped, the quick eye of Mr. Campbell at once marked those features as promising a passage through the range. We then noted the course of the streams, and the spurs of hills that bounded the valley below. We saw where the ridge became less, probably forming an entrance for Turkey creek; and where some six miles distant it disappeared, allowing Pueblo creek to unite with Partridge creek, in Val de China. There was a possibility that this valley, having collected its affluents, might yet break through the Sierra near the Black mountain, some twenty miles south, and, forming the headwaters of Bill Williams' fork, flow towards Rio Colorado. To decide that point, we determined to continue the reconnaissance farther south. Proceeding to the bottom, with some difficulty we made our way through rank grass and thick willows, about a quarter of a mile, to the right-hand branch. Having forded this, we ascended the bank to a high hill, which overlooked the pueblo. Upon the summit we found a square redoubt, five paces in the clear. The mass of stones forming the walls was six feet thick, and still several feet in height, although in ruins. Broken pottery and obsidian were abundant. Part of an arrow-head of amorphous quartz was found. Before broken it must have been two inches and a half in length. Farther from the river we passed a few deserted huts, constructed most rudely by stretching bark over the broken limb of a tree. Crossing low spurs from the eastern base of the mountains, we continued our exploration south-southwest about six miles, and bivouaced near pools of water that oozed from granite hills. Then, ascending to a high peak, we had a view of Val de China, extending still far towards the southeast. Upon the left was the Black Forest; and upon the right were mountains, which, on account of the ruins found at their base, were called the Aztec range. The slopes all appeared to tend in the direction of that valley, destroying our hopes of reaching the Colorado by any stream that we had crossed. However, near the Black mountain, some twenty miles distant, there seemed to be an overlapping of two ranges, denoting a break in the Aztec chain, and the probability of a good passage through it. But the time which its examination would cost us, we could not now afford to lose; and much as we desired to make that reconnaissance, it was deemed better to return to Pueblo creek, and first explore that stream to its source. It is evident that if we can find a passage to the western slope of this mountain range, we must discover streams flowing into Bill Williams' fork.

*January* 18.—Turning back, we reached the old pueblo. It being a good place for camping, we sent back to Picacho, with orders to Lieutenant Ives to bring the train to this place, deter-

mining meanwhile to explore for a pass westward through the Aztec range. Pursuing the main fork, seven or eight miles, we encamped near the headwaters of the creek, where grass and wood were abundant. Before us was a sharp ridge that seemed to close the passage. Mr. Campbell and myself walked to the top, and found ourselves upon the summit dividing the waters flowing west from those of Pueblo creek. The western slope was not steep, but wide and smooth, descending to an open valley that appeared to extend far towards the west-northwest. Upon the right was the abrupt southern termination of the lofty granitic range, from whence came down the low spur, about a mile in length, upon which we were standing. The stream of Pueblo creek passed down a rocky glen, some 500 feet in a third of a mile, to camp; whence to the old pueblo the slope was gradual, probably eighty feet to the mile. But the course was nearly direct, due east; and to the ravine in which it flowed, there was a gradual slope from the foot of the northern mountains, which seemed to have been cut down by some convulsion of nature, in the formation of this passage. Upon that slope, it would not be difficult to select such a line for a railway as, proceeding from Val de China by a spur, could keep a favorable grade at a height that would enable it to pass the summit without a tunnel. The granitic mountain referred to was crowned by variegated red sandstone in horizontal layers; and below it, in the perpendicular cliffs, was seen an immense vein of gold-bearing quartz, fragments of which were scattered through the valley. No gold has been discovered in any of these, but one piece was found to contain a metal which resembled silver.

Turkeys and deer have been plenty since leaving Picacho. We have followed to-day a fresh Indian trail. It passes over the summit westward.

*January* 19.—We found this morning that three inches of snow had fallen during the night. Crossing the ridge described yesterday, we travelled about four miles down a valley of gentle inclination, and stopped to graze the mules and look around us. The ravine which came from the pass here contained pools of water. For some distance back, it had threaded a wooded valley, with indications of fertility. Beyond, towards the west and northwest, it seemed to pass into a wide prairie of considerable extent. Having now provisions but for one day, it was necessary to retrace our steps towards the train, and returning to our bivouac of last night, we again encamped. North of us comes down a narrow ravine from the mountain, separating the dividing ridge we have passed from the long slope previously described as forming the northern boundary of Pueblo creek.

*January* 20.—The morning was bright, but cold and windy. Continuing down the creek for a mile and a half, we came to an affluent not before referred to. It was from the southwest, and nearly the size of the main stream. Above, as well as below this junction, the valley we traversed was rocky, and in one place too much so to admit of the passage of wagons without ascending some distance upon the mountain slope. Having continued the descent to the pueblo, we encamped to await the train. A person was sent to make signal-smokes from a high point of the ridge, which here bounds the valley, and found upon the summit the dilapidated walls of a tower. The ground-plan was an ellipse, with axes twenty-five and fifteen feet, partitions dividing it into three apartments. The walls must have been large, as they yet remained five feet in height, and six feet wide. The hill is two hundred and fifty feet above the river. This has been the coldest day we have had, the thermometer at noon reading 21° Fahrenheit. The barometer indicated a descent along the bed of the creek of about eighty feet to the mile. These streams seem to be fed by many springs at a higher temperature than that of the atmosphere, inasmuch as no ice has formed upon the surface, even as low down as the pueblo.

*January* 21.—The rear party not having yet arrived, two Mexicans were despatched on foot to meet it, and conduct it to us. They were instructed to proceed east of the direct line, where the sloping spurs from the mountains appeared to afford a more favorable passage. A few hours after their departure, Lieutenant Ives, with the train, arrived. He had left Picacho on Thursday, having seen our signal-smoke upon the evening previous. During the storm of that day he crossed the great valley to the entrance among the cedars, where the men we had

first sent met him. The next day the survey was carried on as far as Turkey creek. On the way the guide became bewildered, and led the train over rough and rocky ground up a wrong arroyo. It was obliged to go back several miles. One wagon was broken and abandoned. From Turkey creek to this place, four miles, it was necessary to cut away cedars and cross a ridge of hills, but no further difficulty was experienced. The two Mexicans sent on foot this morning for the train have to-night returned. They walked to the wagon-camp of night before last, (No. 101,) upon the edge of the China valley, finding among the low hills an excellent wagon route. Water was found in Partridge creek, several miles below Picacho spring.

We are in the pleasantest region we have seen since leaving Choctaw territory. Here are clear rivulets, with fertile valleys and fine forest trees. The wide belt of country that borders the Black Forest, and probably extends along Rio Verde to the Salinas and Rio Gila, bears every indication of being able to support a large agricultural and pastoral population. The valley of Rio Verde, which we saw from the source in San Francisco mountains, is magnificently wooded with firs and oaks, affording excellent timber. Ancient ruins are said by trappers to be scattered over its whole length to the confluence with Rio Salinas. We therefore seem to have skirted the northern boundary of a country once populous, and worthy of becoming so again. Besides the advantages already enumerated, the mountains in this vicinity bear indications of mineral wealth. A specimen, apparently silver, has been found upon the surface; and, according to my understanding of the account of Coronado's expedition in 1540, a gold mine that was said to have been discovered west of Cibola is located near San Francisco mountain. Among the Mexicans of the present day there is a tradition of its having been found in later times; but the hostility of Indians, and the difficulty of obtaining supplies, have prevented it from being worked to any extent. Some of the tributaries north of the Gila are known to contain gold. As late as 1850 or 1851, a party of Americans was organized in New Mexico for the purpose of working placers which were said to exist upon Rio San Francisco; but that name has been applied to so many tributaries of Rio Gila, that I am unable to point out the locality of the one referred to. I think, however, it was that which rises among the Pinal Leño mountains, east of the Salinas, and empties into Rio Gila about twenty miles above the mouth of the San Pedro. One of that company was afterwards employed in my party as a teamster upon the Mexican boundary. He stated that they really found a quantity of gold; but, being surrounded by troublesome Indians jealous of the advance of Americans into their country, and many of the adventurers desiring to proceed to California, the party soon became disorganized, and abandoned their search.

Lieutenant Ives and Dr. Kennerly to-day ascended a peak three or four hundred feet high, the last in the ridge that bounds and overlooks the valley of Pueblo creek, some three miles below camp, and found upon the top an irregular fortification of stone, the broken walls of which were eight or ten feet high. Several apartments could be distinctly traced, with crumbling divisions about five feet thick. From thence to the pueblo, upon the gravelly slopes that lie slightly elevated above the bottom lands of the creek, there are, as has before been noted, vast quantities of pottery, and what appear to be dim traces of the foundations of adobe walls. It would seem, therefore, that in ancient times there existed here a large settlement, and that the inhabitants were obliged to defend themselves by strong works against attacks from a powerful enemy. This agrees with the accounts, previously referred to, which the Indians gave Marco de Niça of the people of Totonteac. But this race appears to have degenerated into wild Tontos—a rude people living in huts, ignorant of labor, and subsisting only upon game, mezcal, berries, and other supplies which nature affords unassisted.

It has been already remarked that, at the old pueblo, two branches unite to form the stream that flows eastward to join Partridge creek. That which comes from the southwest has been explored to-day. It is but a small brook, which takes its rise among high hills at the foot of Mount Hope.

# CHAPTER XII.

*From Pueblo Creek to the mouth of Rio Santa Maria.*

**Bill Williams' fork.—Gemini mountain.—Reconnaissance westward.—Aquarius mountain.—White Cliff creek.—Indian breakfast.—Yampais Indians.—Cactus Pass.—Arrival of the train.—Reconnaissance resumed.—Big Sandy.—Big Horn spring.—Junction of Big Sandy with Bill Williams' fork.—Cactaceæ.—Rio Santa Maria.**

*January* 22—*Camp* 104.—Striking tents, we followed the creek westward. For the first four miles the road was good. Above, to avoid a rocky ravine, we were obliged to ascend the slope which came down from the foot of the mountain upon our right. That was not difficult; but, in crossing an arroyo, which was rough, two wagons upset, thus creating a long delay. Then, having passed around the narrow gorge, we descended to the banks of the stream, and encamped. The barometer indicates an ascent of 560 feet in seven miles.

*January* 23—*Camp* 105.—Continuing our march something more than a mile, we arrived at the foot of the summit ridge, where we had twice made our bivouac. To avoid the rocky ravine, the train, with the survey following, wound around to the right, ascended towards the foot of the mountain, and passed the dividing ridge about 250 feet above the point previously described as separating the waters which flow west from those of Pueblo creek. To obtain a still more extensive view, Mr. Campbell climbed a steep hill, several hundred feet above the ridge of the pass, formed by a short spur from the abrupt termination of the northern mountain chain, and found upon the top ruins of another fortification. Its length was one hundred feet. It was twenty-five feet wide at one end, and twenty at the other. The wall was well built, four feet thick, and still remaining five feet high. It commanded a view of the pass, and, with proper armament, was well situated to defend and keep possession of it from an enemy. The entrance, six feet wide, was from the steepest side of the hill—almost inaccessible. From a fancy founded on the evident antiquity of these ruins, we have given the name of Aztec Pass to this place.

Descending the smooth slope westward four to five miles, to a wooded valley, we found water,* and encamped. Here, as upon the eastern side of the mountains, good grass is abundant everywhere along the route. With an easterly breeze, the day has been warm, rendering our second march through Aztec Pass less uncomfortable than the first. Clouds and mist partially obscured the heavens; but Lieutenant Ives has succeeded in making observations for magnetic inclination, declination, and intensity, as well as for latitude and longitude.

*January* 24—*Camp* 106.—We moved onward, following the well-beaten Indian trail—magnetic west-northwest—over what appeared to be a plain, but was rendered undulating by spurs from the hills. We thus cut off a bend of the creek; which, not far upon the left, pursued the same general course as ourselves. South of the valley was a swelling ridge, and a remarkable mountain rising 2,000 feet above its sides, clothed with dark cedars, and, in the centre, cut as it were into two equal peaks; hence called the Gemini. A stream of lava could be traced along the division far down into the valley. After travelling six miles, camp was formed near the creek, in which sufficient water was found. From this point the course of the valley is but a few degrees west of north, which would seem to be the direction towards Yampais creek. We had hoped it would lead to Bill Williams' fork. To ascertain what is before us, it will be necessary again to proceed with a small exploring party in advance of the wagons.

* This stream, which had its source at Aztec Pass, was afterwards called Bill Williams' fork.

The day has been warm. Scarcely a patch of snow can now be found, except upon northern slopes of hills. It has melted so rapidly as to cause the ground to be quite soft, and bad for the march of the train.

*January* 25.—Last night three stampedes of the mules took place, and this morning forty were missing. They were at length found, and we prepared for our contemplated exploration. With a small party we resumed a westward course. The creek we crossed where it contained large pools of water separated by a bed of worn pebbles. A few hundred yards below were green willows, denoting springs of water. Leaving to our right the pleasant valley of this stream, we passed a low ridge, and in a general course north 45° west, approached a mesa, which, from its form, was called Cross mountain. At its base we found the creek we had left, bent from its previous course, and flowing in a cañon nearly south. Having followed it two miles, we encamped upon a sort of island in the bed of the stream, whose steep banks were about seventy-five feet in height. Water occurs in large basins, and is not yet found flowing above the surface. Cedar forests and excellent grama furnish, wherever we please, the elements of a good camp ground.

We are now twenty miles from the summit at Aztec Pass, with an average descent of fifty or sixty feet per mile. For the last fifteen miles the slope has been nearly uniform. Below Cross mountain, a short distance from camp, is an arroyo, coming in from the northwest. Savedra thinks that it is the same in which, twelve years ago, he saw a flowing stream farther north. The weather is warm, and the grass begins to assume a brighter color. The botanist has found some pretty umbelliferous flowers, called by Mexicans gamote. They have a fragrant odor, and the root of the plant is much prized by Mexicans and Indians, as food. The formation traversed to-day was frequently intersected by beds of lava or trap. About ten miles south of our route is a range of mountains, with snow upon the summits, 2,000 feet above the valley, and about twelve miles in length. This has been termed Cygnus mountain.

Signals were made this evening for the train to move on to the bend of the creek at Cross mountain. There they can easily cross the cañon, and await the result of further explorations south.

*January* 26.—A light fall of snow was produced last night by the wind shifting from south to southwest. It seems that moisture brought from the Gulf of California is precipitated by the mountain peaks in this vicinity, producing rain and snow, and creating springs in moderate abundance. Farther north, upon the route traversed by Captain Sitgreaves, the country becomes an elevated table-land, parched by winds; which, in their passage over more pointed summits towards the coast, are deprived of moisture. Hence the barrenness of that region.

At 10 a. m. we followed the direction of the cañon nearly south ten miles, to the southeast point of a small range of mountains, which, from the numerous streams flowing from it, was called the Aquarius range, where again we spread our blankets under the cedars. From an elevated point we had a view back to where we left the train. The general surface of the country, which consists of great beds of lava and trap dikes, overlying or intersecting limestone and granite, appeared like a plain. But in various directions it is cut into small cañons, through which flow rills of clear water. One branch, bearing a fine stream from the northwest, joins the main creek near this point of Aquarius mountain, the bed being 280 feet below the banks which bound it. The sides of these deep ravines are frequently perpendicular cliffs, forming narrow chasms which might easily be bridged. Occasionally the banks recede, affording a declivity by which a train may effect a passage. Towards the southwest is a break or gap through a low mountain chain, where it is evident that the creek leaves the cañon and enters an open valley. The general course of the stream is direct, and we desire to follow the cañon to its termination, but there is no hope of taking the wagons through. At the northwest point of Aquarius mountain, beyond a wide stretch of apparent plain, has been seen a puerto that looked favorable for a passage, and it is decided to examine it first. Afterwards we propose to return to the stream we have been following, now determined to be Bill Williams' fork.

Our camp is upon one of the numerous rills with which this region abounds. The vegetation continues to be grama-grass and cedar trees. Cactaceæ are becoming more abundant. Three new species have been found at this place—a cereus, an opuntia, and a mammillaria. Within the last two days we have seen but slight traces of Indians. Upon the banks of streams we occasionally come across a metate. Some appear to have been recently used. A fresh arrow was found lying near camp, where it had probably been lately shot at a black-tailed deer, or some other game with which this creek abounds. The arrow is of reed, pointed with a stem of hard wood, and winged with four strips of feathers, between which it is painted green and yellow, and carved, perhaps with the private mark of the original owner. The length is two feet eight inches. It is bound with sinews and artistically made.

*January* 27.—Leaving the east end of Mount Aquarius we travelled eight miles northwest, to the other extremity of the same range, crossing numerous spurs that formed rivulets tributary to Bill Williams' fork. Desiring to proceed as directly as possible we traversed a succession of hills and valleys, some so steep that we were obliged to allow our mules to pick their own way, ourselves following on foot, making the march a weary one. We encamped upon the stream we had expected to find; which, rising at the north or northwest base of Aquarius range, flowed nearly west through a pretty valley where were willows and fine alamos, the first seen for many days. Fresh tracks of Indians and of horses were seen upon the borders of the creek. The rock here changes from porphyritic trap to a coarse breccia cemented by lime. The northern ridge which bounds the valley is broken into white cliffs of fantastic shapes; hence the stream is called White Cliff creek. At camp were found rough pottery and a wide metate. The weather continues clear and warm.

*January* 28.—We were favored with another charming morning, mild and without a breeze. Following an Indian trail down White Cliff valley, we soon came to a projecting rock, beneath which were walled partitions, with remnants of fires, showing signs of having been recently occupied. Coarse pottery and white quartz, pure like semi-opal, were scattered around. A short distance beyond, Indians were seen upon the hills. Five were counted. They would not come to us, nor allow themselves to be approached. After half an hour spent in vain efforts to induce them to hold friendly intercourse, we pursued our way down the creek. The valley was covered with dense groves of cotton-wood, beneath which flowed the prettiest brook we have found since leaving Pueblo creek. Its rapid waters were clear and sparkling; its course was direct; and, although we followed a trail over a spur to avoid dense thickets, the banks seemed favorable for a road. Deserted Indian encampments were frequently seen. At one, from which a party of perhaps twenty had evidently fled in haste upon our approach, was a fire and the remnants of their breakfast. Their fare was somewhat novel, and had been dressed in novel style. A large Echino cactus, a species which grows abundantly in this region, furnished not only a portion of the food, but also the sole culinary apparatus. It was three feet long and two in diameter, cut upon one side and hollowed so as to make a trough. Into this were thrown the soft portions of the pulpy substance which surrounds the heart of the cactus; and to them had been added game, and plants gathered from the banks of the creek. Mingled with water, the whole had been cooked by stirring it up with heated stones. They probably owed us no good will for disturbing their meal, but nevertheless kept at a respectful distance. At 2 p. m. we reached the point where White Cliff creek emerged from the hills, and found ourselves entering a wide valley, bounded on the west by a range of mountains before seen from Aztec Pass, and named Blue Ridge.

The stream, turning southerly, appeared a short distance below to join a wide arroyo from the north, called Big Sandy. There the water sunk below the surface of loose gravel. The trap dikes, calcareous cliffs, and masses of broken and worn sandstone, that we had successively passed through since leaving Bill Williams' fork, gave place to granite, leading us to expect few cañons beyond. It therefore became desirable to bring the train to this point. In returning, instead of ascending White Cliff creek to its source, we proposed to proceed farther north,

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and explore among the sandstone and granitic mountains, which are smoother and less broken into cañons than the volcanic region we have traversed. We therefore grazed the mules, filled our canteens, and then followed an Indian trail by a northerly course, up a dry ravine. After winding among granitic hills about two miles, we entered a higher step of the valley, which looked smooth and nearly level for an immense distance towards the north. But we turned to the right around the base of the mountain, and two miles beyond took possession of a grassy spot among the cedars for a night's rest. The Indians are still lurking about us. They have been seen and tracked to the mountains, where was found a curious sandal, made of willow twigs interlaced and bound with sinews. Leroux supposes these Indians to be Yampais, who range to the junction of Rio Virgen with the Colorado. Towards the northeast are the Cosninos. South of them, and to the Gila, the Tontos are supposed to roam. No one that I have seen appears to have any very definite idea of these tribes. There is probably a close affinity between them.

The weather is spring-like. Vegetation begins to conform to that of Rio Gila. Canotias* are mingled with cedars upon the dry arroyos, and mezquites with cotton-wood upon the flowing streams. Numerous varieties of cacti also abound, from the huge Echino cactus of Wislizenus, to humbler mammillaria.

*January* 29.—While at breakfast an Indian whoop was heard, and turning towards the hills, we saw two tawny figures looking down upon us. A couple of Mexicans were sent out to parley and bring them to camp. Our ambassadors bore a white towel pinned to a ramrod, as a flag of truce, but evidently placed less faith in this token than in the pistols which they endeavored to conceal beneath their coats. After a long series of gesticulations and signs, one of the Indians took a firebrand† from behind a bush where it had been concealed, and produced a little column of smoke as a signal of peace. Slowly and cautiously the Mexicans continued to approach, and were at length received by one of the savages with great dignity. The other seemed to be facetious. Without ceremony he converted the towel into a breech-cloth, and transferred the ambassador's hat to his own head. We saw from their continued vehement gestures that they were not likely to come to camp, so Leroux and myself went to them. The Indians greeted us by placing their hands upon their breasts; and saying "Hanna," "Hanna," invited us to be seated by the fire which they had kindled. By signs they told how they had watched and followed us, fearing to approach camp lest we should kill them. They examined Leroux pretty closely, and then pointing towards the northwest, indicated that they had seen him before in that direction. The accused blushed, but stoutly denied the fact; at the same time pulling his hat over one side of his head to conceal a wound they had given him there two years ago. But the subject was quickly changed, and we inquired for the route to the Mojave villages. They pointed nearly due west, across valleys and over low ridges, to a blue mountain chain, at whose western base, they said, flowed the Colorado. The distance was from two to three long days' journey for them on foot, reckoned seventy miles; and there were three small springs of water on the way. The return would be more difficult, and would require at least three or four days of Indian travel. Although, to the base of the far mountain, the country looked moderately level, smooth, and practicable for a road, for that very reason we feared this route the more. It was on an elevated table-land, bounded by a mountain chain, which all agreed we should be obliged to surmount, and thence necessarily have a difficult descent of several thousand feet to the Colorado. Therefore, independent of the want of water for so large a train, which the Indians' three small springs would seem to imply, it was deemed better to hold to the valley and stream of Bill Williams' fork, and run the risk of increasing the distance.

Our new friends confirmed our ideas regarding the locality of some of the Indian tribes. Cosninos, they said, roamed towards the northeast; Pai-Utes lived northwest, upon the farther side of the Colorado. They professed to be Yampais; or, as they pronounced it themselves, "Ya-

* This is the Mexican name of one species of the thorny "green-barked acacias."

† This circumstance reminds me of the custom which Alarchon found to prevail among the Indians on the Colorado—that of carrying a firebrand. Hence the name which that river at first received, viz: Rio del Tizon. See Indian Report.

ba-pais." They were broad-faced fellows, with Roman noses and small eyes, somewhat in appearance like the Dieginos of California. The language also seemed to resemble theirs. The first word they uttered, "hanna," meaning *good*, was recognised by us as an old acquaintance, learned several years ago from the mission Indians at San Diego. Two other words—"n'yatz," *I;* and "pook," *beads*—were also familiar as the language of the Cuchans, ("Yumas,") and of the Coco Maricopas. Their hair was rudely clipped in front to hang over the forehead, in the fashion of the Gila and Colorado Indians. Their back hair hung down nearly to the waist, and was bound with variegated belts of Pima manufacture; a custom which prevails, but is not universal, among all the tribes that trim in front. For costume, our friends were not remarkably distinguished. The breech-clout was, of course, the principal item. Besides, one had a blue woollen shirt, and the other a Navajo blanket, which they said were obtained from the Moquis. Their moccasins were of buckskin, of home manufacture, and one had leggins made from the skin of a mountain sheep. He had, also, a skin quiver, upon which the soft hair of that animal still remained. Upon his neck he wore strings of white and blue beads, which he said were obtained from Mojaves. Both had their faces painted with red ochre, such as we saw yesterday ground upon a metate. Although there seems to be considerable evidence that the Yampais are allied to, and form a sort of connecting link between the Gila, Colorado, and Pueblo Indians, they do not possess the fine muscular development and intelligence generally exhibited among those nations, or else the specimens we have seen are not fair samples of their tribe. As this question seemed an interesting one, we wished to obtain further data upon which to decide it. But before attempting to puzzle them with signs, for a vocabulary of Yampais literature, we endeavored to tame them somewhat by presents of trinkets and tobacco, and an invitation to camp. We therefore laughed at their forcibly expressed fears lest we might entice them into our power for the purpose of knocking them upon the head, and left them. As we expected, when they saw themselves free to act their pleasure, they followed us.

Having eaten, and received a present of a blanket apiece, they were in excellent humor, and allowed us to purchase their best bow and a quiver of beautiful arrows. The bow was of cedar, strung with sinews. The arrows were made of reeds, fledged with feathers, tipped with a wooden stem, and pointed with a head of stone. Some were of white quartz or agate, and others of obsidian; all exquisitely cut and well finished. As lapidarians, these Yampais would seem to excel other tribes. Our mules being now saddled, the Indians offered to conduct us to water, of which they thought we had need. They led very cheerfully to the side of the mountain, where was a spring with a slightly sulphurous taste; and, near by, a stream trickling through willows in a rocky ravine. A short distance below, it passed beneath the coarse gravelly soil. This service done, our new friends took leave in great haste, promising to see us again. Having watered our mulada, we travelled five miles east-northeast up a dry arroyo, to its head; and thence climbed a steep ridge several hundred feet high, to the lowest summit we could find, north of the pass which White Cliff creek makes through Aquarius mountains. Thence we could look eastwardly over a great plain to Cross mountain, near which, upon Bill Williams' fork, the main party was awaiting our signals. The gentle slope towards th east afforded a stream which turned southerly, forming one branch of White Cliff creek. The descent by it appeared gradual and without a formidable cañon. Hence, it may be inferred that there is no obstacle to prevent the construction of a road, with a regular grade, to the point where we left that stream yesterday. But, as we have seen, there are rough and rocky places in the ravine which would make the passage difficult for wagons. Therefore, we will await the train here, and take it over the higher ridge and down the steep descent, to pursue the route by which we have returned. From the peculiar vegetation of this place, we propose to give it the characteristic name of *Cactus Pass*. Having found a bivouac among the cedars, we made signal smokes, and then despatched a guide to meet the train. The weather continues warm and pleasant.

*January* 30.—Indian signal-fires were seen this morning towards the west. The hill near

camp had evidently been used for the same purpose previous to our arrival. At the spring, near by, are signs of a late encampment, with large quantities of corn-cobs. One of them measured, exclusive of stem, nine inches in length, and had ribs for twelve rows of grain. It was an indication of fine crops somewhere in the Indian country.

As coyotes stole the remnant of our mutton last night from the camp-fires, we have lived to-day on game—partridges, rabbits, and black-tailed deer. The hunters of minerals also have been successful, having found magnetic iron ore and a vein of quartz containing metal which resembles silver. Leroux has washed for gold—he thinks, successfully.

*January* 31—*Camp* 110.—While awaiting the wagons, we made use of certain fragments of axes we had to cut trees and bushes, so as to form a road down Cactus Pass. The descent is abrupt, like that in Guadalupe Pass, on Cook's road, over which emigrants travel when taking the Gila route to California, for the first three miles averaging about 400 feet per mile. The steepness of the declivity precludes the idea of adopting this pass for a railway route. For that we d epend upon following the course either of White Cliff creek or of Bill Williams' fork. Before sunset the train arrived. The officers report the country from where we left them as generally level, and favorable for a road. Melted snows, however, have now saturated the gravelly soil so completely as to cause mules and wagons to sink to the depth of about a foot, rendering their passage exceedingly difficult and greatly fatiguing to the animals. The first day they travelled, from where we left them, twelve miles to the cañon. Yesterday they made eleven miles, and encamped upon a fine running stream, supposed to be one of the head branches of White Cliff creek. Ten miles to-day brought them to this place.

Dr. Kennerly has been fortunate in collecting new specimens of birds, pouched rats, lizards, &c. He has found, also, a skull, supposed to be that of a Yampais. Some of the party, it appears, were not satisfied with a simple skull, but having seen two Indians lurking about camp, captured them. The poor fellows were doubtless frightened, though one of them, to conceal his emotion, pretended to be highly amused at the occurrence. Some of the party endeavored to prevail on him to sing. It is the custom among these tribes to compel an enemy to sing his death-song preparatory to being shot or burned. It was not surprising, therefore, that he should attempt to regain his freedom. Though surrounded, he broke through the circle, ran, and escaped. The other was caught and tied. He took it quite stoically; and though expecting, of course, to be killed at once, seemed perfectly indifferent. By signs he was desired to tell the distance to Mojave village. With much ingenuity he explained—placing five stones at certain distances apart, to denote that number of marches; the last a long one. Four water-holes were laid down; and beyond, a long channel filled with water, to represent the course of Rio Colorado. With sticks he indicated huts upon the river bank, to show the position of the Mojaves. Such was a Yampais map; and it was really an intelligible one. When they had gained from the artist all the information they desired, the officers loaded him with presents—a blanket, shirt, sheepskin, tobacco, and a leg of mutton—and allowed him to go. Through the whole scene the captive illustrated the characteristic stoicism of his race. Not for a moment did his countenance show a trace of emotion. Fear for his life, hope of escape, despair at being caught again, gratitude for presents and for freedom, changed not a muscle of his features, nor affected the quiet dignity of his deportment.

*February* 1—*Camp* 111.—It was with much difficulty that the train made its way through Cactus Pass, notwithstanding the wagon loads were lightened. But from the foot of the ridge we travelled rapidly, passed the Yampais springs, and encamped on White Cliff creek where we left it a few days since, eight miles from the pass. In arranging the loads this morning, the Mexicans got into confusion, and left several packs containing our blankets and tents. A party has been sent back for them. We have descended, to-day, sixteen hundred feet in eight miles, some five or six hundred being almost precipitous. But if we look back to Camp 109, we find that there we were upon the headwaters of White Cliff creek, 1,200 feet above this point; and though the travelled distance was eighteen miles by the stream, which is more

direct, it would have been reduced to fourteen miles, giving a grade of eighty-six feet per mile. This, however, is only a rough approximation. Careful computation of the notes will probably modify this estimate considerably.

As the water of White Cliff creek sinks a short distance from camp, it was thought best to continue with a reconnoitring party in advance, Leroux still thinking that we ought to abandon the stream and proceed due west to Mojave. It would shorten the distance, without doubt, but at a great sacrifice of grade. Therefore, our bedding and provisions having arrived from last camp, at 2 p. m. the explorations were renewed. Moving southwest along the dry bed of the creek to its junction with a large sandy arroyo, supposed to be what Walker named "Big Sandy," we then travelled south, through the centre of a wide valley, and, after a march of six miles, encamped without having found water. Notwithstanding the dry surface, the soil is not deficient in vegetation, such as occurs in the vicinity of Rio Gila, viz: grama-grass, larrea Mexicana, cacti, and Spanish bayonets. Bordering the sandy bed of the creek there is a fringe of dwarf oaks. The day has been pleasantly warm.

*February* 3.—Proceeding onward nearly south, we soon struck into an Indian trail which led over a ridge into an arroyo from the mountains upon our left. There we found, at the foot of a white feldspar cliff, a fine spring of flowing water, sheltered by alamos, willows, and an acacia which bore a new variety of mistletoe. Some "bighorn" mountain sheep were frightened away from it at our approach. They were magnificent animals, with skin of silky hair like an antelope, and horns of remarkable size, curled like those of a ram. It is said that when pursued by hunters they throw themselves from lofty precipices, and striking upon their horns, escape uninjured by the fall. Those that we had started disappeared among the mountains;* and as a prize had been offered for a specimen, some of the men followed with perseverance, which, however, was not rewarded. Having watered our mules, we turned down the steep and rocky ravine to its junction with Big Sandy, and continued the march south in the dry bed of that stream. The hills upon the right and left of our trail were of coarse granite, containing much feldspar, and, like those passed yesterday, covered with spring vegetation. The valley was about half a mile wide, and upon the surface of the washed arroyos were traces of recent water. About twelve miles below Big Horn spring, and twenty from White Cliff creek, we reached the junction of Big Sandy with Bill Williams' fork. The latter stream, which flows from Aztec Pass, here escapes from a ridge of volcanic hills and trap dikes, to enter a wide and fertile valley. It is now a clear rivulet fifty feet wide, and from a foot and a half to two feet deep. It flows nearly direct, in a southwest course from Camp 108, where the wagon trail crossed it, distant about thirty-four miles. Below this point Bill Williams' fork takes a southwestwardly course, and bids fair to lead us, by the southern base of Blue Ridge, directly to the Colorado. We have therefore concluded to adopt this route for the survey, and have sent back a messenger to Lieut. Ives, desiring him to advance and follow us with the train.

Our camp is upon a gravel ridge near the mouth of Big Sandy, where grama is abundant. In the valley below are groves of mezquite trees which shelter a luxuriant crop of young grass. A fringe of the same borders the rivulet, quite in accordance with the delightful weather we have experienced. The thermometer at noon stood at 80° Fahrenheit. Around our bivouac are great quantities of "fouquiera." It is a singular shrub, with many thorny stalks shooting from the same root, and growing without branches nearly straight from ten to fifteen feet in height. When in blossom it is exceedingly beautiful. In winter, while the circulation of the sap is suspended, it seems to be saturated with an unctuous substance that causes it to burn with a brilliant light like fat pine; at night, therefore, it serves as a torch.

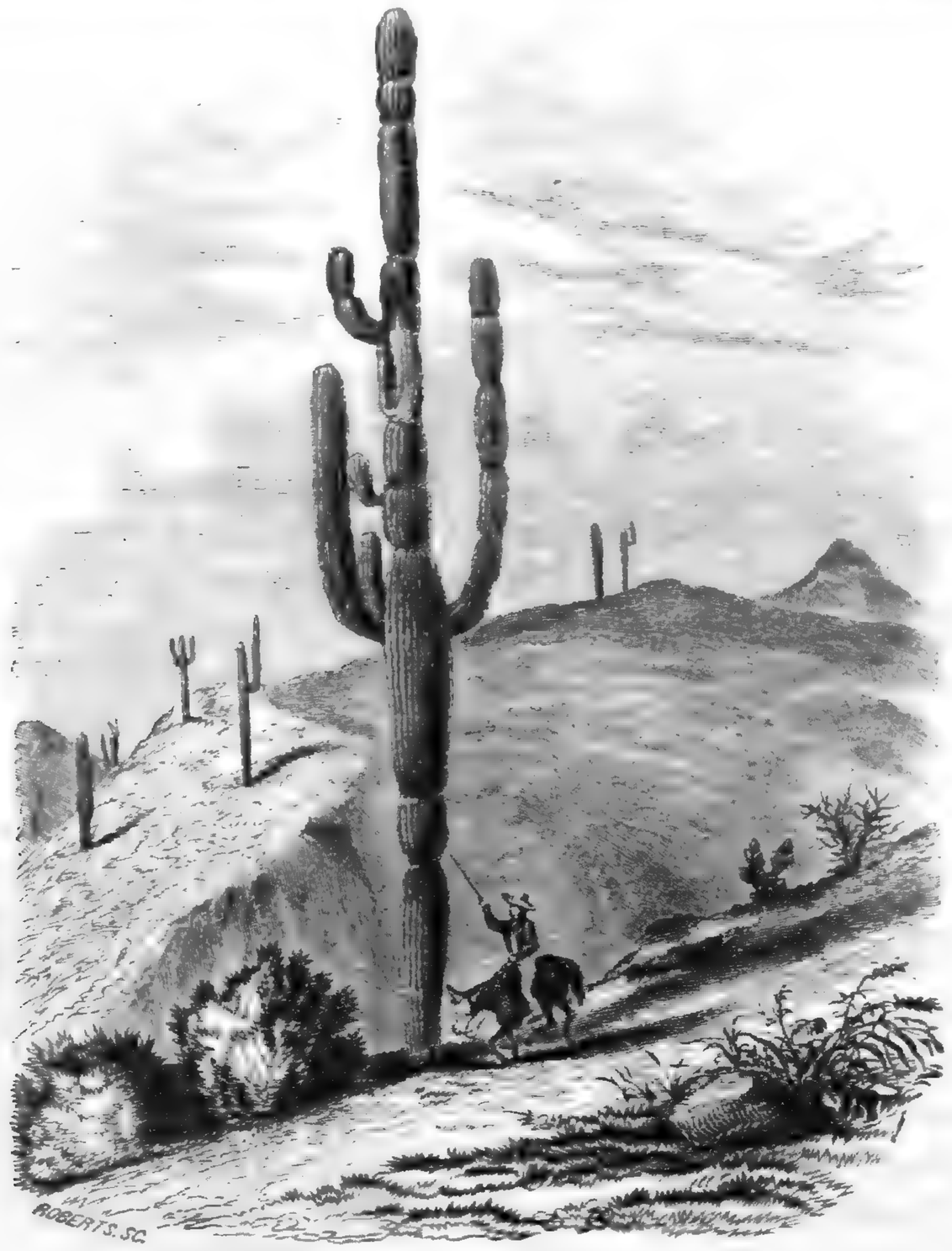
To-day we have found a new species of cactodendron, called *chuq*. It grows in extensive patches to the height of eight to ten feet; a confused mass of angular joints, whose sheathed

* These form part of a chain which was afterwards called "Big Horn," or "Cēr-bât" range. Cēr-bât is the Coco Maricopa and Mojave name for this animal, called Cimarron by the Mexicans. Their hair is supposed to be too coarse to be woven; but, nevertheless, I doubt not that these were the "wild beasts" referred to by the Gila Indians, in describing to Father Marco de Niça, in 1539, the woollen cloth made by the Totonteacs. See Indian Report.

spines at a distance glisten beautifully in the sun; but a near approach requires caution. The joints, about three inches in length, are so fragile that, for some distance around, the ground is covered with them; and the sharp barbed spines, now difficult to avoid, wound severely the feet of men and beasts. The joints thus broken from the parent stem do not decay, but, wherever chance has thrown them, take root and propagate with a facility seldom found among useful plants.

Big Sandy creek abounds in antelope, deer, rabbits, and partridges, feeding upon the rich grama-grass, and the seed which it yields. Wolves (coyotes and lobos) are also numerous, and live by preying upon their weaker neighbors.

*February* 4.—Pursuing the reconnaissance for about ten miles nearly south, the direction in which the water flows, we passed along the valley of Bill Williams' fork, which averages probably two or three miles in width, while the sandy bed of the stream is frequently a quarter of a mile wide. For some three miles below the mouth of Big Sandy creek there flowed a clear rivulet, which then, to our surprise, disappeared beneath a sandy bed that seemed to have been washed by arroyos from the hills. After traversing a mile or two of sand, it gushed out from the channel like a magnificent spring; flowing and fertilizing its banks for a considerable distance, then sinking again to reappear below. Several kinds of beautiful fishes were found in this rivulet, and one was caught. It was quite different from any before seen; had a large head, was apparently without scales, with black back, white belly, and a red stripe upon each side extending from head to tail. An owl and a black-tailed deer were obtained to-day; the latter a long wished for addition to the zoological collection. The botanist, too, has found new forms of interest to him in the vegetable kingdom. Varieties of the cactus family have been discovered, and the famed Cereus giganteus is scattered upon the hills which bound the valley.




Cereus Giganteus, on Bill Williams' Fork.

I think it has never before been seen except in the vicinity of Rio Gila. The singular appearance of the tall columns, sometimes shooting out one or more branches, communicates a strange

effect to the landscape. An idea of barrenness is associated with the whole cactus tribe, detracting from the delight with which we witness the rare and beautiful forms here developed. Yet the valley itself, except where sand has buried the stream, presents a refreshing prospect of fertility. Willows, alamos, and large groves of mezquite, grow in such dense profusion as sometimes to render it difficult to find a passage through them. Beneath the trees, and bordering the water-courses, there is a crop of fresh grass, and occasionally a few spring flowers. Upon the hills, or among the ravines which pass through them, there are patches of grama for the mules.

*February* 5.—After breakfast we mounted and rode onward. Our course was near the stream, generally in the valley, but sometimes crossing spurs to avoid a thick undergrowth of trees. We travelled nine miles, and encamped within a cañon, which, broken through spurs from Blue Ridge, formed a passage for the river. From point to point upon this march something new was developed to awaken interest in the exploration. A few miles below our last camp the stream changed its character, from alternate fertilizing rills and beds of sand, to a continuous rivulet, clear, rapid, and several feet in depth. Many fresh beaver dams existed upon this portion of the river, enlarging it so as to make the crossing difficult. For a while we threaded a well-trodden Indian trail, till at length it was lost amid the mazes of a thicket. This, with the traces of a few diminutive camp fires, and a rough metate found upon the water's edge, was the only visible sign of Indians.

Six miles from last night's camp the river turned a spur from the mountains, and, entering a rocky ravine, pursued a westward course among hills of granite and trap, which were occasionally broken into cañons. The width of this pass varied from 300 yards to half a mile. A road could be constructed through it to the spur upon which we have bivouaced, either by cutting off a few sharp points of its sinuous course, or by tunnelling through them for a few hundred yards to maintain the uniform grade of the valley. The wagons, if they follow our trail, will be obliged to pass through thickets and over sand-beds and marshes. But pioneers can doubtless select a route where, by moderate labor, the way may be made good. Cactaceæ become still more abundant as we proceed. Our path to-day has truly been a thorny one. There are mammillaria, with crimson fruit, just rising above the surface of the ground; opuntia, of many varieties: some with wide leaf-like joints, others of shrubby form and woody fibre, which the botanist proposes to name Cactodendron; various kinds of Echino cactus, the most conspicuous being that named Wislizenus, and sometimes called the "Turk's Head;" and Cerei, from the little Cloranthus to the Giganteus, inclusive. The latter occur, as upon the Gila, in groups upon the hill-sides; sometimes without branches, and, when full grown, average about thirty-five feet in height. Ducks, partridges, and deer are numerous upon the river. A badger was seen, but, unfortunately, not killed. Near camp, upon the hills, the grass is good, and under the spreading mezquite is a green carpet such as has been previously described.

*February* 6.—Descending the river the pass soon grew wider, and the hills seemed to recede; leaving a fertile valley, watered by a stream fifteen feet wide, and from a foot to two feet deep. Our course varied from south 15° west to south 10° east. We travelled ten miles, and encamped near the river, where it flows through a range of volcanic mountains. Grama is still found upon the hills. Rushes are mingled with the green grass that borders the stream. Numerous Pitahaya* add to the picturesque effect of rugged hills, sprinkled with shrubs and green-barked acacias. Another beautiful addition to the scenery appeared to-day; groves of tall and branching Yucca, with shining leaves, radiating like a wide-spread fan. They are twenty or thirty feet high, with trunks from a foot and a half to two feet in diameter. The leaves grow upon the extremities of the branches, and each year are folded back to give place to a new set. It is in this way that the trunks attain their great size. A semi-compact substance is formed by the interlacing of the leaves, which, when dry, makes pretty good fuel for a camp fire. The

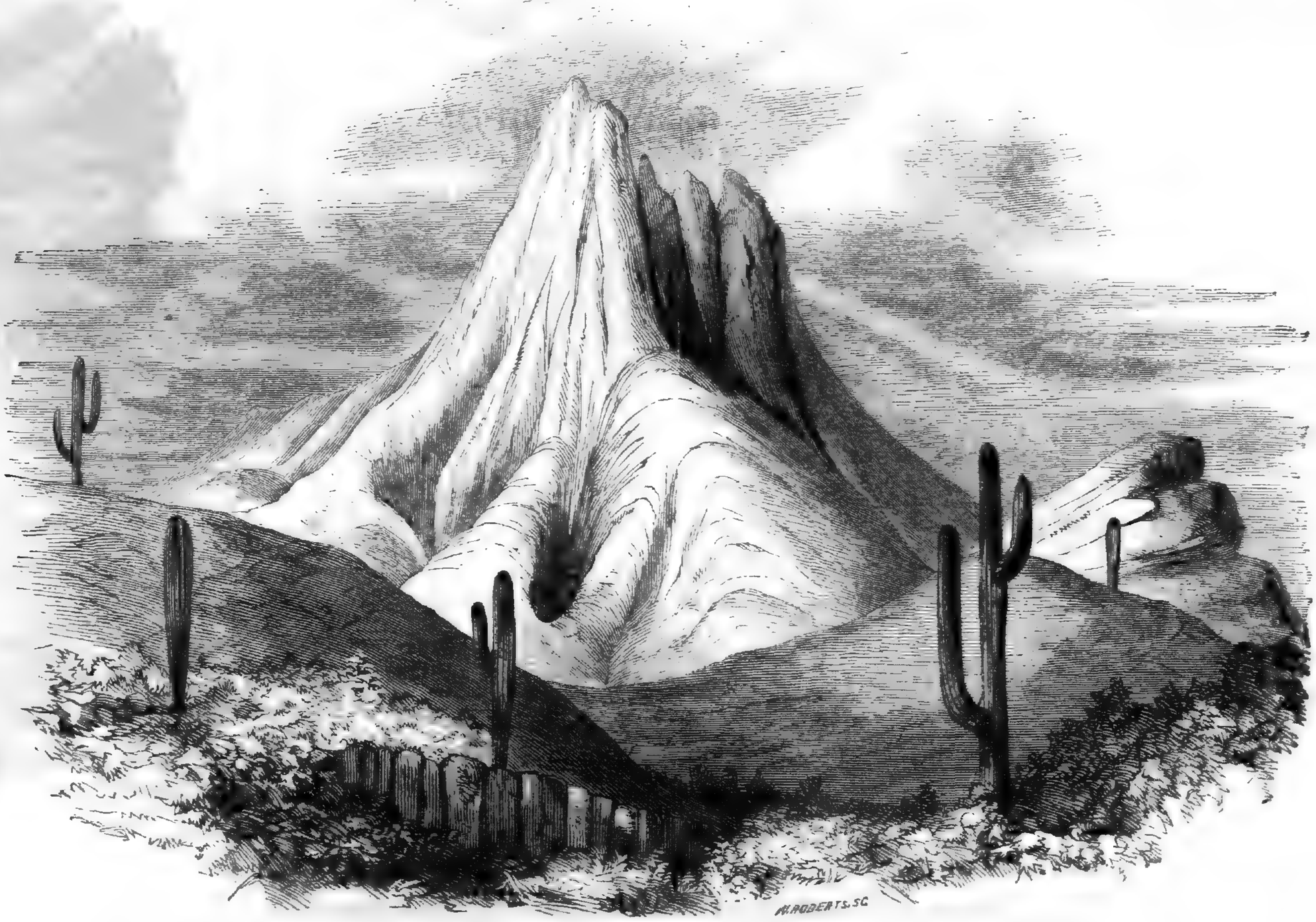
* Name by which the Cereus Giganteus is known among Mexicans and Indians on Rio Gila.

J. C. Tidball U. S. Art.

Lith. of SARONY & Cº New York.

descent to-day has averaged thirty-five feet per mile. The principal obstacle encountered upon the march was quicksand in crossing the stream.

*February* 7.—Passing onward we threaded the valley of the river nearly south eight miles, to a point of a metamorphic range of mountains where the stream turned westward. Here entered from the east a river, with a wide valley, in all respects equal to that we have followed from the mouth of Big Sandy. Looking east, the stream appeared bordered with a long line of cotton-wood trees, and large thickets of mezquite covered the bottom-lands. It flows, doubtless, from the western slope of the Black mountain, and may be the main stream of Bill Williams' fork. We call it Rio Santa Maria, a name which early Spanish map makers applied to the whole river. Had we been able to extend our reconnaissance farther south in the great grass valley which was called "Val de China," it now seems highly probable that we should have discovered a passage through the Aztec range south of Mount Hope, to the head of this stream; and thence would have followed it by a direct course to this place. All the indications we have seen appear to mark this route as highly favorable. The dividing ridge near Black mountain appeared lower than Aztec Pass. It is probable, therefore, that the valley of Rio Santa Maria is less obstructed by cañoned banks than the branches we have followed. It is a source of great regret that we were unable, from want of time, to make this examination. An interesting region is therefore left for future explorers. The river, for the day's march, has rolled upon a wide and sandy bed, occasionally with fertile soil upon its banks. Rocks, volcanic, metamorphic, and red sandstone, were piled upon each side of the valley in fantastic shapes. Upon the right was a volcanic cone called "Artillery Peak." Vegetation has been




Artillery Peak.

as unique and beautiful as yesterday. Pitahaya, from thirty to forty feet in height, with huge branching arms; Echino cacti, with rose-tinted spines; the glittering *chug* cactodendron, and a new fructescent variety, have rendered the scenery picturesque. We bivouaced about two

miles below the confluence of Rio Santa Maria; where, upon the hills, is found green grass which the Mexicans call "gallete." Much of the water of the river is lost in the sand, but a channel is still left, ten or twelve feet wide and a foot deep. It is a clear stream, flowing rapidly. The day has been uncomfortably warm.

# CHAPTER XIII.

## *From mouth of Rio Santa Maria to Chemehuèvis Valley, on the Colorado.*

Continuation of the reconnaissance down Bill Williams' fork.—Coming up of the train.—Cave in a cañon.—Ancient drawings and inscriptions.—Colorado river.—Country near mouth of Bill Williams' fork.—Difficulty of ascending the valley.—First meeting with Colorado Indians.—Abandonment of wagons.—Party of Chemehuèvis.

*February* 8.—We continued the exploration down the river ten miles, and encamped without a sight of the Colorado. Soon after starting, we entered a chasm cut through a dike of greenstone, with horizontal veins of granite and white quartz. The vertical section was variegated like jasper. The rock, though hard, was cracked; and sometimes broken into prismoidal blocks, affording good materials for constructions. The general course of the cañon, five miles in length, was nearly west. There were a few sharp turns which would require excavation to reduce the curvature to 1,000 or 2,000 feet radius. The rock in some places rose in vertical planes to the height of 300 feet. Upon the top it was broken; presenting, sometimes, a fancied resemblance to gothic architecture. In each crevice where they could find foothold grew flowering shrubs, the prim agave, or the pink-spined Echino cactus of Wislizenus. Partridges, ducks, and small birds abound in the valley among thickets of mezquite and willows. A recent Indian trail led along the banks of the stream. Not far from last night's bivouac was a collection of deserted huts, made of bent willow twigs, and crowned with leaves. Three small stones showed where an earthen vessel had been placed upon a fire for cooking purposes, and near by was a metate for pounding mezquites. We found also a fishing net, made of willow twigs bound together with thongs, and a small ring of twine, such as is used in one of their athletic games. The remnant of their fire consisted of the most minute pieces of charcoal. Even where wood is plenty, as at this place, the Indians ever show the greatest parsimony in its use. Their favorite fire is made of a few sticks the size of one's finger, around which they huddle in a circle to warm themselves. For the want of clothing, they frequently make their beds in dry sand that has been heated by the sun. Heavy rains and freshets occur but seldom in this climate; but when they do, all vestiges of these abodes are swept away. Below, we found other huts similar to those described, though less upon the Lilliputian order. A man could stand upright within them. Upon our way we found occasionally mesa spurs projecting from the hills to the river. The tops were level as a lake, and covered with shining pebbles of black lava. Upon one, over which we passed by an Indian trail, appeared a circular trench three feet in diameter; and within, a conical pile of small stones. Several objects of interest have been added to our collections—among them a centipede, a lark, and an owl; also flowering shrubs of a new species. Ducks upon the river are innumerable, and the hunters are able to add to our scanty supply of rations.

*February* 9.—From the top of a high hill, a great valley filled with smoke, supposed to be that of Rio Colorado, seemed to proceed from the northwest and unite with Bill Williams' fork, about fifteen miles west from the point of observation. But our provisions being exhausted, we were unable to proceed. To meet the train, we turned back; and as a low pass was visible among the hills north of the striped cañon threaded yesterday, we proposed to examine it, and thus attempt to cut off a bend of the river. We followed a well-trodden Indian trail that led up an arroyo. Upon the right and left were numerous Pitahayas, by the sides of which were frequently seen long poles, forked at the end, for the purpose of dislodging the fruit. Many

arrows were sticking in the top, showing that the Indians, while laboring for food, had frequently amused themselves at archery.

Having travelled four miles, we entered a narrow chasm, the precipitous walls of which grew higher as we proceeded. We therefore despaired of being able to make an exit from its head; and turning, ascended the mountain ridges. Crossing them with much difficulty, at sunset we reached our bivouac of February 7th. Some of the party who explored the chasm to its head, found there a spring of cold water; and near by, a cave covered with Indian paintings. Mountain sheep were enjoying this cold retreat; but, frightened at the approach of men, with the fleetness of deer they fled to the mountains and escaped.

*February* 10.—We conclude to await here the arrival of Lieutenant Ives with the surveying party. Leroux returns to conduct the train through portions of the valley where the reconnaissance shows fewer obstructions than by the trail we have followed. Towards evening a shower came up, and, to protect ourselves, we built huts of chamisa boughs, after the fashion of an Apache village; and as our provisions were exhausted, we imitated the Indians in another respect, and lived upon game—ducks, rabbits, and deer.

The cañons upon this river remind one of the chasms through which the Gila flows among the Pinal Leña mountains. That is longer, deeper, more rugged and angular, but the rock is of similar metamorphic formation. The Salinas also, according to the accounts of Lieutenant Beckwith and Dr. Randall, who tried to follow its course, on their way to Zuñi, to the Gila, in 1849, threads a chasm of the same nature, and is as impassable with pack-mules as that near Mount Turnbull. They were obliged to leave the stream, and make their way over high and rough mountains. It seems probable, therefore, that the spurs which are broken through by Bill Williams' fork extend in a general east-southeast course, forming one great chain, intersected also by the Rio Verde, Salinas, and Gila. Southeast from the junction of Bill Williams' fork with Rio Santa Maria is a wide, arid-looking prairie, apparently cut into deep arroyos. It may extend to the Pima village, cross the Gila, and thence form the Jornada to Tucson. If this be not the great valley mentioned by Mr. Aubrey, in his report, none has yet been seen to answer his description.

*February* 11.—Much rain fell during the day. Towards evening a messenger arrived from the train, bringing provisions. The rear party will not reach us until to-morrow, as their mules are quite weary from breaking a road through the alternate sand and marsh that cover the banks of the river.

*February* 12.—Received another message from Lieutenant Ives, stating that, on account of the thickets upon the banks, the train was obliged generally to follow the sandy bed of the stream, rendering progress slow and fatiguing. He therefore proposed to abandon one or two wagons, and thus increase the strength of the remaining teams. Lieutenant Jones and Mr. White finding that the surveying party would not overtake us to-night, went back to meet it.

*February* 13—*Camp* 121.—At 2 p. m. the train arrived, having met with no serious difficulty during our absence. The mules, however, from ten days' successive travel with loaded wagons through soft earth or sand, need rest.

The night is clear, affording an opportunity to observe moon culminations and an occultation of Mars.

*February* 14—*Camp* 121.—To facilitate our movements, as we are already reduced to half rations of flour, we decided to leave three of the wagons, and lighten the rest, by abandoning such things as could be most easily spared. The day has been occupied in making arrangements for this purpose.

*February* 15—*Camp* 122.—The train and survey followed the valley through the striped cañon, traversed and described a few days since, while Dr. Bigelow, Mr. Mölhausen, and myself took an Indian trail, which led through a pass among the hills. On the way the artist sketched several singular trees and shrubs, which Dr. Bigelow supposes have never been described. Ascending an arroyo, we passed a summit without difficulty, and entered a ravine

which led westward. As it descended rapidly into chasms, with precipices which the mules could not easily pass, we found ourselves compelled to ascend the hill-sides to avoid them. After several miles of rugged way, as the Indian trail had been lost, we again entered the cañon, below the spring of which we were in search. Now ascending a few hundred yards, we found ourselves enclosed by high walls, nearly perpendicular, with the thorny vegetation of this region growing in every crevice of the rocks. Springs of water were issuing from beneath the ledges, flowing a few feet only, and then sinking into the sand. Here, leaving our mules, we climbed a water-worn and polished rock, about thirty feet high, and entered a basin, walled in by lofty precipices. At the upper end, a projecting cliff formed a cave. Beneath flowed a little rill of water, which first filled a beautiful pool in the hollowed rock, and then trickling down into the valley, ran to the cascade below. Above the fountain the cave was covered with hieroglyphics, painted red, purple, and white. The figures were somewhat similar to those found at Rocky Dell creek, near the Llano Estacado. A streak of red, bordered with white, formed an irregular arch over the whole, and may have been intended to represent the patron of the place, a serpent. Below were various figures, more or less regular in form. High upon a cliff on the opposite side of the gorge, plainly seen but difficult of access, were a variety of other inscriptions, apparently ancient. Some of the most interesting among them were sketched by the artist. The question of their origin is sufficiently obscure. The secluded nook and the fountain of water may have thrown a charm around the place, causing the Indian medicine men or priests to select it for a retreat sacred to the ceremonies of their craft. Such are said to be the habits of Indian soothsayers; and there is a sombre aspect about this spot suggestive of superstitious rites. Having satisfied our curiosity, we descended the cascade, mounted our mules, and followed the arroyo four miles, to the river. Turning, we ascended the stream two miles, and found the train encamped at the mouth of the cañon, having advanced nine miles during the day.

The grass, last night, was said to be plenty, but the mules this morning greedily devoured dry sticks and leaves, thereby telling a different story. Hence it is not surprising that the strength of several failed on the march, and that they had to be left by the wayside.

*February* 16—*Camp* 123.—We marched several miles down the valley of the river, and encamped near the last bivouac of the reconnaissance. The surface was somewhat sandy, but made a tolerably good road. Ducks were very numerous. A single person killed a dozen, one of them believed to be of a new variety. Smaller birds also are abundant.

*February* 17—*Camp* 124.—We continued to travel westward along the valley, having a fine stream by our side for several miles. At length the water sank below a bed of sand, and did not again make its appearance. Having surveyed seven miles, we found a large patch of coarse grass, and were constrained to encamp by it; for the rich grama heretofore so abundant has disappeared from the hills, obliging us to depend upon the herbage of the valley. This, unfortunately, is frequently salt, and contains little nutriment. Hence, for the last few days, notwithstanding the shortness of the marches, the mules have been failing in strength.

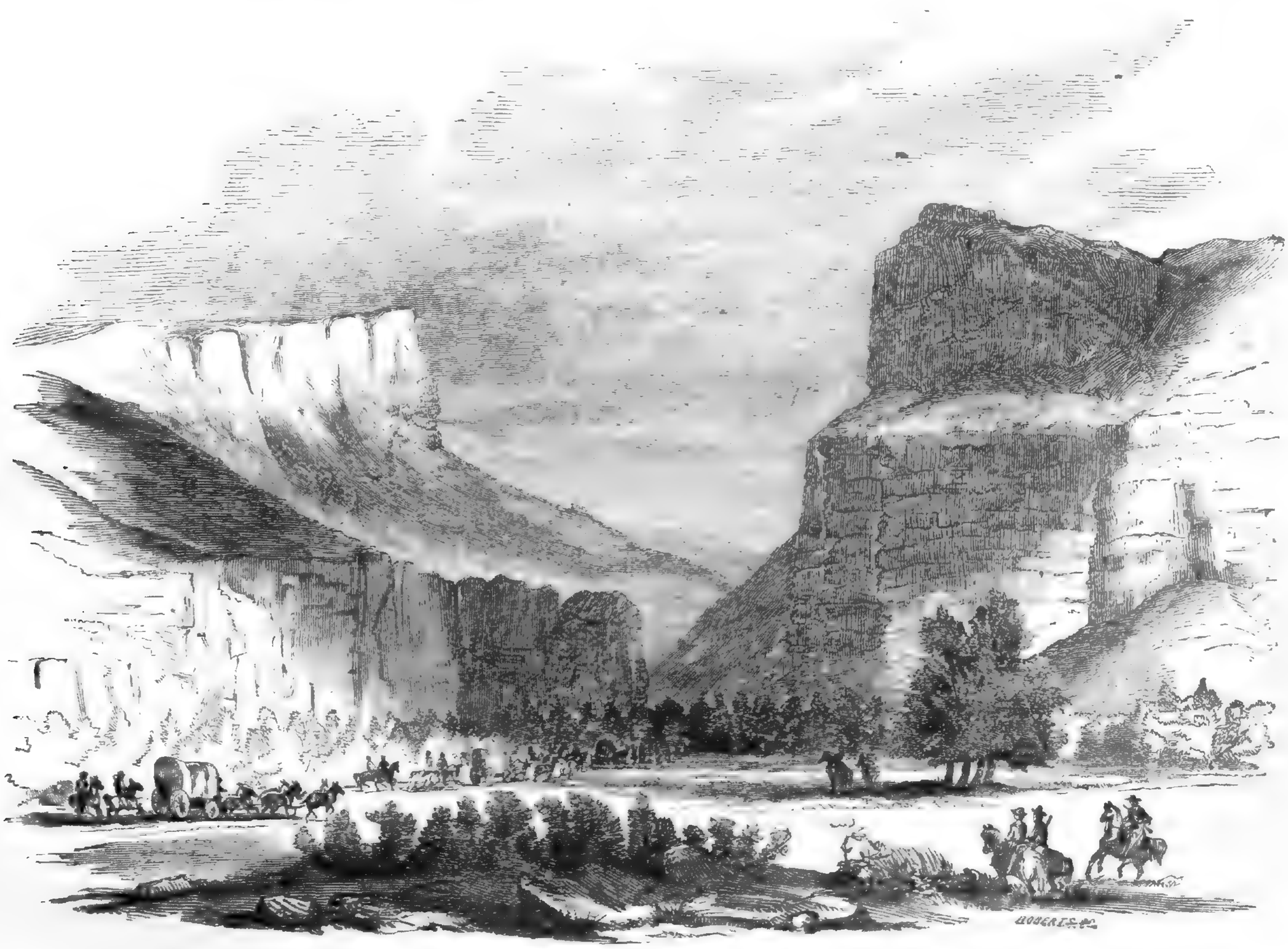
The rain, which has been falling since noon, still continues, making the ground muddy and camp disagreeable. However, it has filled some hollows in the rocks, furnishing a moderate supply of water for use. The air is chilly and raw. The moon, at rising, broke the clouds, and seemed to make an effort to dispel the storm, but without success.

*February* 18—*Camp* 125.—A mild spring-like morning. We made an early start, and at 10 a. m. had passed four miles along the dry bed of the valley. Here water again appeared, flowing in a good-sized rivulet; and as grass was found upon the hill-sides, we stopped to refresh the mules. The soil seemed fertile again, cotton-wood and willows filling the valley. While resting, a party which had been sent ahead to explore returned, with the advice that we should spend the night where we were, as little grass was found beyond within marching distance. We have therefore encamped. The view westward is exceedingly picturesque. A volcanic ridge, with sharply serrated profile, stands before us. Midway is a gorge, through which the

river flows, its banks densely covered with shrubbery and trees. Through another gap towards the northwest is seen the lofty Colorado range, with a few patches of snow upon the summits.

Astronomical observations were made and roughly computed, showing us to be in latitude 34° 14′, south of the point where we expect to unite with the Colorado. But there seem to be indications of a near approach to that stream. Ducks continue abundant, and white gulls appear diving for fishes in the rivulet below, having made a long journey from the Gulf. The botanist has found a new species of wild squash or gourd, also singular flowers and plants.

*February* 19—*Camp* 126.—Having abandoned two more wagons, on account of the weary condition of the mules, with the remainder we continued the journey. Two miles from camp we were in the narrowest part of the cañon, about four hundred yards wide. The stream became deeper, and about twelve feet broad. The cliffs upon either side were nearly perpendicular, varying from two hundred to four hundred feet in height, being composed of conglomerate, capped by a huge mass of basaltic trap, assuming various fantastic shapes.



Cañon of Bill Williams' Fork.

Soon after entering the cañon there was a break in the hills to the left, indicating the course of a small affluent from the south. As we proceeded the stream increased in magnitude, and the valley, varying from one fourth to half a mile in width, continued to be covered with a tangled mass of alamos, willows, and vines, considerably impeding our progress. It was with much difficulty that a way was cut for the survey. The general direction of the gorge was west, without any sharp turns. Upon the cliffs, even where no soil was visible, Echino cactus abounded. But seldom did a Cereus giganteus appear. Having travelled nine miles, we found a large field of grass upon the high grounds, and an abundance of green herbage fringing the stream, and therefore encamped. Near by is an enclosure of trees and brush, which seems to have been thrown up within a few years, probably by trappers, as a breastwork for defence. In the muddy soil are fresh tracks of five Indians, who appear to have ascended the valley yes-

terday till they saw us, and then returned. The Mojaves may have heard of our approach from Yampais, and sent this party to reconnoitre.

We have learned this evening the cause of the sudden failure of the mules. The Mexicans say they are dying of hunger; not because of absolute scarcity of grass, but on account of the unwise manner of herding them. The sentinels, unaccustomed to the care of a large mulada, have deemed it their sole duty to prevent them from straying, and have kept the whole in a mass near the same spot all night. Consequently, when morning comes, and again they are harnessed for the fatiguing service of the day, they are suffering for the want of food. Since learning this fact Lieutenant Jones has given such orders to the soldiers as will probably rectify the error.

*February* 20—*Camp* 127.—Continuing the survey westward, we followed the now wide and fertile valley of the river four miles, and found ourselves at its junction with the Colorado of the west. Ascending the gravelly ridge which separated the valleys of the two rivers, a fine view was obtained. The Colorado came from the northwest, meandering a magnificent valley, and having received the waters of Bill Williams' fork, entered a chasm among a pile of black mountains below. Upon both sides of it were chains of mountains. That upon the right bank seemed to recede towards the west-northwest, leaving a wide opening, and an extensive view in that direction.

Bill Williams' fork, at the junction, is twenty-five feet wide, and two feet deep. Its clear and sparkling stream, deflected slightly from the general course of the valley above, unites with the chocolate-colored waters of the great Colorado at nearly a right angle to its course. The latter is here about two hundred and fifty yards wide, with a current of probably three and a half miles per hour. Above it appeared wider, deeper, and less rapid. On both banks are strips of bottom lands, from half a mile to a mile wide. The soil is alluvial, and seems to contain less sand and more loam than is found in the valley of Rio del Norte. But here, as there, are occasionally spots white with efflorescent salts. A coarse grass grows luxuriantly upon the bottoms. Bordering the river are cotton-woods, willows, and mezquites, or tornillas,* but more sparsely scattered than in the watered part of the valley of Bill Williams' fork. Larrea Mexicana and chamisa cover the gravelly ridges that bound the valley.

At the junction we halted for awhile to make examinations in the vicinity. Astronomical and magnetic instruments were set up, and observations made to determine the latitude, longitude, and magnetic elements at the place. Having completed these operations, we entered a well-beaten trail, and by a northwest course ascended the Colorado valley four miles and encamped in a mezquite grove near a late Indian lodge. There were around numerous fresh tracks of bare feet, and the remains of frugal fires. The grass of the valley had been burned at this place a few weeks since, and now shooting from the roots fresh and green, formed good grazing. The day has been remarkably fine; the atmosphere warm and summer-like.

*February* 21—*Camp* 128.—We proposed to make an early start; but, upon collecting the mules, four were missing. They had taken advantage of the new system of herding, and wandered among the hills, in search of better grass. Half the day was lost in hunting for them. A mile and a half from camp the Indian trail, which we still followed, passed a ridge of granite hills that came down to the bank of the river. With some labor we levelled a space wide enough for the wagons, and turned around the point of it, making a pretty good road. Having proceeded thus four miles, a black, metamorphic spur from the mountains, with a serrated profile like a saw, crossed the valley to the very bank of the river. As the trail again ascended the hills, we were convinced that there was no natural passage for the wagons upon this side of the valley. To cross the river would be difficult, and we had no time to devote to the construc-

* The tornilla is a mezquite, bearing fruit twisted like a screw, from the Spanish of which is acquired its name. The bean it bears is highly saccharine, and, like the common long-pod mezquite, is ground by the Indians into flour, called pinole, from which bread is made. The fruit is highly saccharine, and I have been told by emigrants that when boiled an excellent syrup and sugar may be obtained from it. The tree bears a gum, which is supposed by Dr. Shumard to be equally valuable with gum arabic.

tion of a road. Stopping the train, Mr. Leroux, Mr. Stanley, and myself proceeded to reconnoitre. We rode several miles over gravelly hills, so steep as to be nearly impassable with wagons, till we arrived at the foot of the black ridge. Between the bluff and the river was a slight berme; where, with some labor, it appeared that a road might be constructed. The trail followed a dark ravine, where were caves recently deserted by Indians. The path beyond led to a cliff some twelve feet in height, by the side of which the ascent was made along a worn crevice, which afforded uncertain foothold even for mules. We then entered an arroyo, where, with little difficulty, wagons might proceed, if once they could pass the ledge; but not having time nor means at hand to construct a road, we concluded to abandon all the wagons except the light spring-carriage—almost indispensable for the conveyance of instruments—and proceed with the survey through this narrow gorge. Upon turning back towards camp, we heard loud whoops from the high precipices which almost enclosed us. Looking up, we saw, standing in bold relief, several Indians, apparently much excited. They clapped their hands first upon their naked thighs, and then upon their mouths, as they shouted, producing the wild and startling sound known as the war-whoop. After much parleying, and many signs, some came down from the high rocks, and meeting two of us, received from our hands a present of tobacco; the rest looking on from the summit. This friendly act produced kind feelings at once. They spoke no Spanish; but Leroux's knowledge of signs, and our recollection of a few Yuma words, enabled us partially to understand them. They professed to be Mojaves, but declined our invitation to accompany us to camp, saying they must first go and tell their great chief, who would meet us to-morrow. As we turned and left them unmolested, their confidence in our good intentions was increased, and two of them volunteered to follow us. Professing themselves "ahot'-k a hánàc"—that is, *very good*—they marched along, chatting as complacently as if they supposed we could understand them. We could only make out that war, or some other calamity, had visited all the Indians of the Colorado from the Gulf upwards, viz: the Cocopás, Comoyéis, Cuchans, Ya-va-páis, Chem-e-huè-vìs, Mac-há-vìs, Ca-hual-chitz, Mat-hát-e-vatch, and Hual-páich. They have suffered greatly from want of clothing and food, which, during the troubles, they had not been able to produce. The Americans themselves, they said, had been reduced to mule-meat. They talked much about "the Major"—gone to California, they said; but whether Major Heintzelman or Major Kendrick, we could not tell, although the reference to mule-meat seemed to indicate the latter. As they walked along, their muscular and well-proportioned limbs, without covering, showed to great advantage. They were tall and erect, with a step as light as a deer's. Their faces were painted black, with a red streak along the nose, according to the custom of the Yumas on going to battle. There was a resemblance to the latter in other respects. Their black and glossy hair was similarly cropped in front, along the line of the eyebrows, so as just to cover the forehead. Behind it fell in a superb mass over the shoulders, and was trimmed so as to hang evenly at the girdle.

When we came in sight of the train and camp, which had been pitched during our absence, our two new friends instantly sat down, and refused to proceed. With another small gift, telling them to meet us on the morrow, we passed on, and, as we expected, they followed us again. One could now see, from the expression of the eye and lip, that they had made up their minds to encounter the dangers and run the risks, whatever they might be. They stalked into camp with the dignity of princes, but with somewhat of a "who's afraid" air, like a schoolboy with his courage screwed up to the sticking-point. Everybody treated them with distinguished consideration: one contributed a shirt, another a coat, a third furnished a hat; and the strangers were soon rigged out in most fanciful style, evidently to their entire satisfaction. When told to bring into camp whatever they might have to exchange for clothes, they started off, and, in less than half an hour, returned with maize, beans, and squashes. We have not yet seen any cultivated fields whence such a supply could be obtained. At sunset they left camp in great haste. About 9 o'clock another Indian was found by the herders, and brought to the camp-fire. He, too, was naked, except a ragged cloth about the loins. His face and body were

painted less carefully than those we had before seen. He looked as if from a long journey, and told us that he was a Cuchan, on his way from Fort Yuma. Instead of being taciturn, as were his predecessors in camp, he was excessively talkative. With vehement and not ungraceful gestures, he delivered an oration. But as he seemed to have forgotten his periods, we were obliged to stop him ourselves. Whether his volubility was the result of fright or impudence, was not apparent. Our orator was placed under the charge of Mexicans till morning. But at midnight, probably frightened by the quarter-hourly call of the sentinels, he came to our tent, and awoke us, saying, "Atcoberquec n'ye-moom," which, interpreted, signified that he wanted to go home. But being informed that the sentinels would shoot him if he went out, he again laid himself down by the fire, and was quiet.

The weather is warm and pleasant. Flowers are quite numerous upon the hills. A new cactodendron has been discovered. A trout, like those of the Rio Gila, has been caught in the Colorado, and new and beautiful varieties of lizards and horned frogs added to the collections.

*February* 22—*Camp* 129.—The wagons, as well as private baggage and a few articles that will scarcely be needed upon the remainder of the journey, and cannot be packed, were abandoned this morning. The scientific collections and instruments necessary for service were carefully preserved. The spring-carriage, with odometer, barometers, &c., placed under the pilotage of Lieutenant Stanley, the quartermaster, was again despatched upon the survey. We followed the trail examined yesterday, ascended the cliff before mentioned, and threaded the ravine, which seemed cleft through the ridge of eruptive rock. Beyond were gravel hills, and a devious track eight miles to their termination, where, upon a field of good grass, we encamped. The labor would not be great to construct a wagon road near our trail. Upon the river, doubtless, the few points of hills that intersect the bank might be easily cut off, so as to afford space both for a wagon road and railway.

Upon entering the ravine, Indians sprang up on all sides; some armed with bows and arrows, others without weapons, and many carrying things that we had abandoned at the last camp. We now felt the advantage of having established friendly relations with them, for in the difficult passes they could seriously have annoyed us by interrupting the survey, if not our progress. They professed to be Chemehuèvis, a band of the great Pai-Ute* nation, and spoke a language bearing no resemblance to that of the Cuchans, or of the Mojaves, met yesterday. Near camp we crossed a field of wheat, which the owner guarded with praiseworthy zeal. There was no acequia, and irrigation did not appear to be resorted to. The village and principal fields of these Indians are upon the opposite side of the river, too far off to allow us to distinguish the style of building and mode of culture.

In camp were probably fifty Pai-Utes. The chief, preceded by Leroux, who understands the language, and followed by a long train of his warriors, approached to pay his respects. His portrait may be taken as characteristic of his tribe. He was short, muscular, and inclining to corpulency, his face of an oval shape, and pleasing, though painted in black and red stripes. His black hair was cropped in front and clubbed behind, although some of his people wore it in plats matted with mud, and cut squarely to hang to the middle of the back. His nose was wide and slightly aquiline; his eyes small and oval, and surrounded with large blue circles of paint. The dress in which we found him consisted of an old blue flannel shirt, instead of the simple apron worn by his subjects; but he was soon decked by us in gay costume. This excited the desire of his people for similar clothing, and they brought in for trade considerable quantities of maize, wheat, beans, and squashes, affording dainty fare for the whole camp.

At night the chief furnished a vocabulary of his language. He also drew a sketch of this country, giving the Pai-Ute names of tribes, and the rivers where they dwell.

*In old Spanish manuscripts this name is spelled "Payuches," which also answers to the Indian pronunciation. Moderns have corrupted it into "Pah Utahs."

# CHAPTER XIV.

## *From the Chemehuèvis to the Mojave Valley, on the Colorado.*

**Progress up the river.—Mojave band and chief.—Trading for provisions.—An old acquaintance from the Gila.—Mojave country.—Ceremonial visits from the Indians.—Their dress, ornaments, dwellings, &c.—Crossing the Colorado river.—Assistance of the Indians.—Council of the Mojaves.—Offer of a guide.**

*February* 23—*Camp* 130.—The beautiful valley of the Chemehuèvis Indians is about five miles broad, and eight or ten miles in length. As we ascended the eastern edge, we saw numerous villages and a belt of cultivated fields upon the opposite bank. Great numbers of the natives swam the river, and brought loads of grain and vegetables. The chief begged us to encamp again within the limits of his territory, to enable his people to trade; but, as we could not, the poor Indians were obliged to turn homewards with their heavy burdens. The chief alone accompanied us; and, after travelling between eleven and twelve miles, we encamped upon the coarse but abundant grass of the valley.

Waiting at this place was a Mojave chief, with his band of warriors, to welcome us to their country. With eyes cast to the ground, and in silence, he submitted to the ceremony of an introduction. With apparent indifference he received the few presents that were offered, and then quietly watched the trading of his people. It was now evident why the Chemehuèvis would not follow us with their articles of traffic to camp. They feared to encroach upon the privileges of the Mojaves. The trade commenced by the offer of a basket of maize for three strings of white porcelain beads. No sooner was the bargain concluded, than the whole multitude crowded in to dispose of their produce at the same price. Delighted at their bargains, they were exceedingly merry. But the acting quartermaster, not wishing to dispose of all the beads, hid a part, and tried to induce them to trade for other things. They understood the operation, refused all offers, and were silent for half an hour. Then they rose *en masse*, took up their grain, and were about to leave; when, after an explanation, the spirit of trade was restored, and calico being established as currency, became as popular as beads had been. We purchased in a short time about six bushels of maize, three bushels of beans, and considerable wheat, besides squashes and peas. At sunset the Indians seemed happy as possible, and made arrangements for passing the night with us. But their acquaintance was deemed of too short duration to entitle them to such confidence, and all, except the chief and a few of his friends, were driven reluctantly from camp. Some of them were considerably exasperated, but they went quietly enough and built their fires just beyond the line of sentinels. Those remaining did not once lie down during the whole night, but sat at the fire using wood at the cook's expense. Indians always expect to be waited upon by the servants of white people.

During the evening there came into camp a young fellow, asking for the captain. At the first glance he was recognised as an old acquaintance, from the Algodones below the mouth of Rio Gila, where I had seen him a year since. He is a Cuchan; and, at that time, his people were at war with our troops, and kept aloof upon the opposite side of the river. But José, (that is the name he assumed,) putting confidence in us, swam the river, and led our train to the place where were boats for crossing the Colorado. We found him a shrewd lad, and he proved of considerable service to the party.

The sky has been partially overcast, but the usual set of astronomical and magnetic observations were taken. Near the termination of the day's march, the trail passed among hills where a little work would make a wagon road. A better route would doubtless follow the bank

Lt J. C Tidball 2d Artv

CAMP SCENE IN THE MOJAVE VALLEY OF RIO COLORADO.

of the Colorado. These hills are scarcely worth mentioning in connection with the prospects for a railway, as it would be easy to pass along the base of the bluffs that border the river.

*February* 24—*Camp* 131.—The Indians seemed to have recovered from the annoyance of being turned from camp last night, and again became lively and good-humored, cheerfully answering our questions regarding the way before us. A short distance from camp was seen a second mountain spur, intersecting the valley, similar to the one where we had deserted the wagons. The chief told us that the trail traversing it was rough, and impassable for the spring-carriage. After much consideration, the natives informed us that, by turning to the right, the ridge could be entirely avoided; and two of them consented to act as guides, to conduct the surveying party by that route. With the pack-mules we kept the old trail, that led through ravines, and over hills, to avoid the bluffs upon the river-bank. The path in some places passed through deep chasms, and over precipices of porphyritic rocks. The mules tumbled headlong, became weary and dizzy, and four were left upon the roadside. Having travelled about ten miles, we emerged from the hills, descended by an arroyo to the river, and were gladdened by a sight of the great valley of the Mojaves. Ascending it a short distance, we joined the surveying party, and encamped; Lieutenant Tidball, with a portion of the escort, being still in advance. Again we have experienced the advantage of having cultivated a kindly feeling with the natives. Our parties to-day have necessarily been scattered widely, and an attack by Indians would have proved disastrous to the expedition. But instead of impeding our operations, they have rendered good service, giving valuable information and faithful guidance. The trail of the surveying party conformed strictly to the account given by the guides—passing over a smooth prairie country, without encountering a hill. But to avoid the circuit which it made, a road might be constructed along the bank, to a narrow gorge, where the spurs upon either side came down to the water's edge. There the position is favorable for bridging the river, and from thence the valley would be ascended upon the west side.

We have had, to-day, violent wind from the north. It filled our eyes with sand, and added much to the labor of driving the mules, and replacing the oft-broken packs.

*February* 25—*Camp* 132.—We continued the survey about a mile along the border of the fine valley, to Lieutenant Tidball's camp. Here, finding a large field which had been burned, and fresh grass springing from the roots, we turned our mules loose, to graze and rest from the fatigue of yesterday's march. Indians collected, and we were informed that one of the great captains was coming to visit us. A few hundred yards distant was seen an assemblage, and soon a long procession of warriors approached, headed by the chief and his interpreter, our Cuchan friend José. The latter with great formality introduced the distinguished dignitary of the Mojave nation, who returned our salutations with gravity becoming his rank. He then presented his credentials from Major Heintzelman; who stated that the bearer, Captain Francisco, had visited Fort Yuma with a party of warriors, when upon an expedition against the Cocopas, and professed friendship; but he advised Americans not to trust him. The parade and ceremony were not, upon this occasion, as vain and useless as might be supposed, for without them we should have taken this great chief for the veriest beggar of the tribe. He was old, shrivelled, ugly, and naked, except a strip of dirty cloth suspended by a cord around his loins, and an old black hat, bandless and torn, drawn down to his eyes. Judging from his half stupid, half ferocious look, one might suspect that there had been foul play towards the former owner of the hat. But his credentials being satisfactory, he was received, and seated on a blanket at our right. The pipe was passed around; the object of our visit explained, and a guide asked, to conduct us to the intersection of the Mormon road with the Mojave river. He replied that it was all well; none of his people would commit depredations upon our property, but would afford all the aid in their power. A few trinkets, some tobacco, and red blankets cut into narrow strips for head-dresses, were then presented for distribution among the warriors. As the chief would accept nothing for himself, the council was dissolved. Then commenced the trade for grain, and the scene suddenly changed from grave decorum to boisterous merri-

ment and confusion. Savedra counted six hundred Indians in camp, and probably half of them had brought bags of corn or baskets of meal for sale. The market was established; and all were crowding, eager to be the first at the stand, amid shouts, laughter, and a confusion of tongues—English, Spanish, and Indian. The result was, the acquisition by us of about six bushels of corn and two hundred pounds of flour, and the supply was not exhausted. There must have been at least ten bushels of beans for sale, and great numbers of pumpkins, some two feet in diameter, and weighing perhaps twenty-five pounds. They receive, in exchange, in order of preference, small white or large blue beads; red blankets cut into strips six inches wide; white cotton cloth; and calico, in pieces three or four yards in length. Other articles and trinkets they esteem of no value. When the trading was concluded, they ranged about camp in picturesque and merry groups, making the air ring with peals of laughter. Some of the young men selected a level spot, forty paces in length, for a play-ground, and amused themselves in their favorite sport with hoop and poles. The hoop is six inches in diameter, made of an elastic cord. The poles are straight, and about fifteen feet in length. Rolling the hoop from one end of the course, two persons chase it half way, and at the same instant throw their poles. He who succeeds in piercing the hoop wins the game.

Target firing and archery were then practised—our own people firing with rifles and Colt's pistols, and the Indians shooting arrows. Fortunately, the fire-arms were triumphant; and finally an old Mojave, in despair at their want of success, ran in hot haste and tore down the target. It is said that several sad-looking fellows in the crowd are slaves, prisoners taken in the last expedition against the Cocopas. In the military code of this people, a captive is forever disgraced. Should he return to his tribe, his own mother would discard him as unworthy of notice. There are only two Cuchans here, José and his friend; others are said to be on their way hither. The chief, Manuel, informs us that the object of their visit is to obtain a fresh supply of provisions, their own grain and vegetables having been exhausted in trade with the troops at Fort Yuma.

Notwithstanding the unity of language, the family resemblance, and amity which exists between Cuchans and Mojaves, there is exhibited on the part of the latter a jealousy similar to that witnessed among Pimas and Maricopas towards each other. An instance of this feeling occurred this evening. A woman caught her little son endeavoring to conceal some trinket that he fancied. She snatched the article from him with a blow and a taunt, saying, "Oh, you Cuchan!" Some one inquired if he belonged to that tribe. "Oh, no," she replied, "he is a Mojave, but behaves like a Cuchan, whose trade is stealing."

These Indians are probably in as wild a state of nature as any tribe now within the limits of our possessions. They have not had sufficient intercourse with any civilized people to acquire a knowledge of their language or their vices. Leroux says that no white party has ever before passed them without encountering hostility. Nevertheless, they appear to be intelligent, and to have naturally pleasant dispositions. The men are tall, erect, and finely proportioned. Their features are inclined to European regularity; their eyes large, shaded by long lashes, and surrounded by circles of blue tint that add to their apparent size. The apron or breech-cloth for men, and a short petticoat made of strips of the inner bark of the cotton-wood for women, are the only articles of dress deemed indispensable. But many of the females have long robes or cloaks of furs. The young girls wear beads. When married, their chins are tattooed with vertical blue lines, and they wear a necklace with a single sea-shell in front, curiously wrought. These shells are very ancient, and are esteemed of great value. A few were in camp to-day, mounted on spirited horses. They scrupulously avoided all superfluous clothing, but were neatly painted and decked in their most fashionable ornaments. Their bodies and limbs were tinted and oiled so as to appear like well-polished mahogany. Dandies paint their faces perfectly black. Warriors add a streak of red across the forehead, nose, and chin. Their ornaments consist of leather bracelets, trimmed with bright buttons, and worn upon the left arm; a kind of tunic made of a buckskin fringe hanging over the shoulders;

beautiful eagles' feathers, called "sormeh," sometimes white, sometimes of a crimson tint, tied to a lock of hair, and floating from the top of the head; and, finally, strings of wampum, made of circular pieces of shell with holes in the centre, by which they are strung, often several yards in length, and worn in coils about the neck. These shell beads, which they call "pook," are their substitute for money, and the wealth of an individual is estimated by the amount he possesses. Among the Cuchans, in 1852, a foot in length was worth the value of a horse. Divisions to that amount are made by the insertion of blue stones, such as by Coronado and Alarçon were called turkoises, and are now found among the ancient Indian ruins. Frequently blue beads are substituted for the more valuable stones. Turkoises and bone ornaments are also worn by chiefs, suspended from the nose. All the men of the Mojaves, Cuchans, and Maricopas have the cartilage of the nose bored, but none except men of note wear the pendant. They have also two holes bored in the rim of the ear, from which hang strings of small beads. Infants especially are decorated in this last fashion, having absolutely nothing besides upon their persons. Among the articles seen, which may be ranked as curiosities, were a bronzed medal, a clay image, and a net for catching rabbits. The former being of Spanish origin, was probably taken from the mission of San Pablo, which was founded by Father Pedro Fort at the junction of Rio Gila with the Colorado in 1780, and destroyed by the Indians the same year. It represents a cardinal, with an image of the sun and a motto. The clay image is about six inches in length, and reminds one of South American idols, such as are represented by Prescott, Ewbank, and others. The formation of the eyes, nose, and mouth indicates some imitative skill. Its body terminates without legs or feet.

Notwithstanding the great numbers of Indians in camp, no village is seen near us. But we are upon a lagoon some distance from the river, and the valley is so wide that huts upon either bank would be invisible from our present position. Those who were in camp yesterday were of Captain Manuel's band. The present party is that of the chief Francisco, and we are told that there are three other chiefs, of equal importance, that will meet us as we advance. Towards evening the greater part of the Indians left for their homes. Francisco and a few of his friends remained, and being hungry, asked for a sheep, which was given them.

*February* 26—*Camp* 133.—With the chief Francisco for guide, and José for interpreter, preceded and followed by great crowds of Indians, we continued our survey up the magnificent valley of the Mojaves. The soil, for miles from the river, seemed of exceeding fertility, and was sprinkled with patches of young wheat and fields of corn stubble. There were no acequias Irrigation had not been resorted to; although, without doubt, the crops would have been benefited thereby. We frequently passed rancherias surrounded by granaries filled with corn, mezquite beans, and tornillas. The houses are constructed for durability and warmth. They are built upon sandy soil, thirty or forty feet square; the sides, about two feet thick, of wicker-work and straw; the roofs thatched, covered with earth, and supported by a dozen cotton-wood posts. Along the interior walls are ranged large earthen pots filled with stores of corn, beans, and flour for daily use. In front is a wide shed, a sort of piazza, nearly as large as the house itself. Here they find shelter from rain and sun. Within, surrounding a small fire in the centre, they sleep, protected from cold. But their favorite resort seems to be upon the top, where we usually could count from twenty to thirty persons, all apparently at home. Near the houses were a great number of cylindrical structures, with conical roofs, quite skilfully made of osier twigs. They were the granaries referred to above, for their surplus stores of corn and the mezquite fruit. The latter is highly saccharine, and, when ground to flour, is a favorite article of food with the Indians of the Gila and Colorado rivers. Its flavor is similar to that of pinole,* and this name, taken from the Spanish, is sometimes applied to it. Among the most curious articles of household furniture noticed were the pestle and mortar for grinding flour.

* Pinole is much used by the people of Mexico, especially by soldiers on a campaign. It is made by mixing sugar and spices with the flour of parched corn. By the addition of water only, it is prepared to be eaten or drunk as the individual may prefer, and is exceedingly refreshing and nutritious. It would be a capital addition to our own army ration.

The latter was of granite, the cavity worn with beautiful regularity into a conical form, six inches wide at top, and from a foot to eighteen inches deep. The pestle of polished greenstone, also, was perfectly symmetrical, being oval-shaped, a foot and a half long, and four inches in central diameter. Judging from the slight difference in price between grain and flour, it would seem that the labor of grinding is esteemed of little account.

As we passed these rancherias, the women and children usually watched us from the house-tops, and the young men, for a moment, suspended their sport with hoop and poles. There would then take place an animated discussion with our guide, as to whether we should follow the trail to the right or left, so as to avoid trampling upon the numerous wheat-fields. At first, only a small portion of the villagers seemed inclined to join us; but at length, rising an eminence, we looked back, and our little train appeared swelled to a grand army a mile in extent.

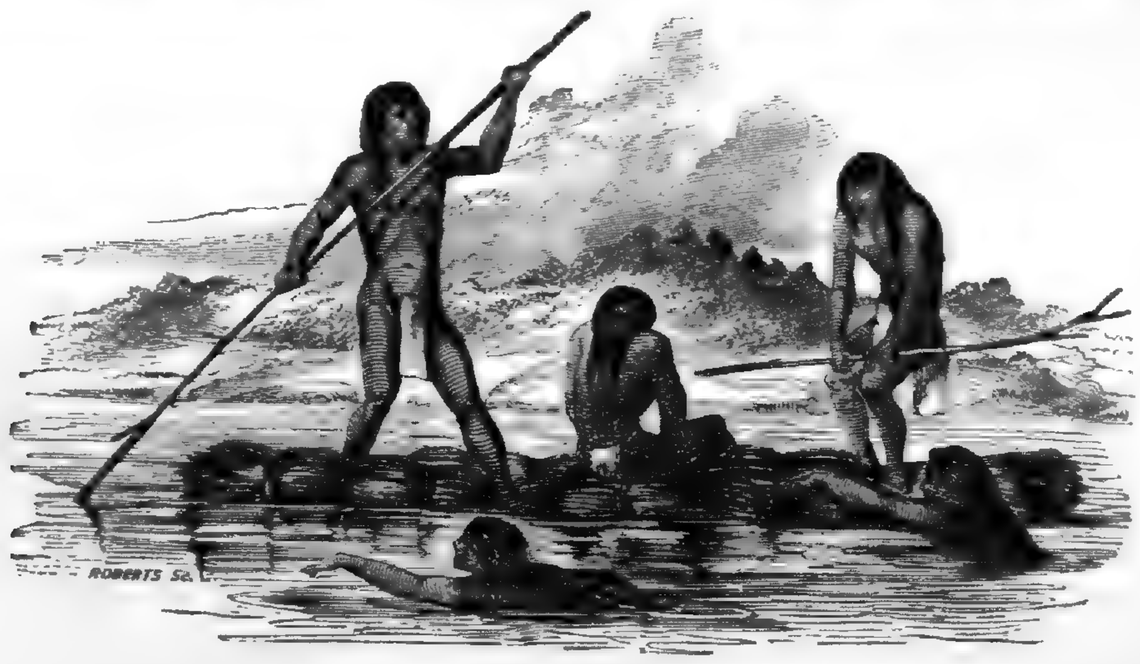
Having travelled about ten miles in a generally northwest course, we descended from the cultivated fields and cotton-wood groves to the sandy shore of the willow-bound river, where we encamped. There was little grass in the vicinity, and the mules were sent to browse on bushes. But soon the Indians brought bundles of green rushes, and large quantities of corn and mezquite beans, to be exchanged for shirts, pieces of red flannel, &c., so that at night the mules fared sumptuously.

The day has been warm and pleasant, and the evening clear. Astronomical observations were made, to fix the position of camp. Under the directions of Lieutenant Ives, preparations were commenced for crossing the river. An old and much worn India rubber pontoon, brought from New Mexico, was inflated, and the body of the spring-wagon fastened upon it. The vessel was then launched, and sat upon the water like a swan. The Indians were greatly disappointed, for they had hoped to ferry us across themselves, and be well paid for it. They all left camp at dark. Some think this deviation from previous custom looks ominous. But being now near to their lodges, they are doubtless only seeking warmer shelter than our inhospitable camp affords them.

*February* 27—*Camp* 134.—We were favored with a clear and calm morning, and hastened to take advantage of it for crossing the river. Upon examining the pontoon, two of the cylinders were found collapsed, and the wagon-body filled with water. Lieutenant Ives, who had been the master-builder, viewed its distressed condition with considerable anxiety, but the case was not hopeless. Many of the holes in the canvass were mended, the air was replenished, and the pontoon again danced lightly upon the water. Long ropes, brought for the purpose, were attached to the two ends—one held upon the bank, the other taken by swimmers across to an island about 150 yards wide, near the centre of the river. Upon either side was a channel from six to twelve feet deep, and about 500 feet wide, making the whole distance from the left to the right bank of the river nearly 500 yards. The current was at this place about three miles an hour. By letting out the cord from the main land and drawing in the other extremity, the first load passed safely across to the island. The second trial was less successful; the rapid current, and the weight of the long ropes, destroyed the equilibrium of the gondola, and upset it in the middle of the stream. During the excitement attending this misfortune, we were advised by an Indian messenger that another great chief was about to pay us a visit. Turning around, we beheld quite an interesting spectacle. Approaching was the dignitary referred to, lance in hand, and apparelled in official robes. The latter consisted of a blanket thrown gracefully around him, and a magnificent head-dress of black plumage covering his head and shoulders, and hanging down his back in a streamer, nearly to the ground. His pace was slow, his eyes cast downward, and his whole demeanor expressive of a formal solemnity. Upon his right hand was the interpreter, upon his left a boy acting as page, and following was a long procession of his warriors, attended by a crowd of men, women, and children. Having arrived within fifty yards, he beckoned his people to sit down upon the ground; while, with interpreter and page, he presented himself before us. Taking from the boy a paper, he offered one of the stereotyped credentials given by Major Heintzelman at Fort Yuma. That having been pro-

nounced "a-hot'-ka" (good), he took a seat upon the blanket spread for him, and smoked with us the pipe of peace. This done, we made the usual explanations of the object of the expedition; the wishes of our great Captain, the President of the United States; and the benefits that would result to them from opening a highway for emigrants, or a railroad, and thus creating a market for the produce of their fertile valley. The chief replied by a long and vehement speech, in which he expressed his satisfaction at the prospect of establishing a system of trade with the whites, whereby their nakedness would be clothed and their comforts increased; and promised that, not only should our mules and other property be sacred in their sight, but that they would afford us every assistance in their power to accomplish the objects of our mission. Then, after gifts of tobacco, blankets, and trinkets, had been presented, and by the chief distributed to his people, the council of state was turned into a general trading community. The Indians were decked in their most valued ornaments, and a furor possessed all of our party to obtain some trophy. Therefore trinkets and garments were bought and sold upon both sides; although civilization seemed at a discount, and the relics of barbarism vastly above par. Shell beads and necklaces would be sold, perhaps, for a blanket and shirt; while a fine bow and quiver of arrows would command several of them. The Indians were shrewd, and would part with no article without a really valuable compensation. Tobacco they would accept as a gift only, and then sell it to the soldiers. There is a species of wild tobacco which grows here, and is used by the natives. I presume they prefer it to the best Havana. Vermilion, oil-paints, glass and coral beads, we could scarcely give away. White cotton cloth, calico, blankets, and white porcelain beads, would have purchased probably a thousand pounds of flour, and hundreds of bushels of grain.

Fortunately, this sudden accession of visitors did not impede the busy and difficult operation of crossing the river. We left the gondola, as it was called, bottom upwards; men beneath it, entangled among boxes, and struggling for life. The revolution of the boat had been so rapid, that most of the baggage was caught by the top of the wagon body, and there suspended. The men also were supported by the same. After a desperate struggle they disentangled themselves. The boat was pulled ashore, unloaded, righted, and once more set to work. By using increased caution, we succeeded in passing to the island without further accident. To reach the western bank we had a channel to cross still more rapid and deep, and were more unfortunate even than before—our loaded barge three times casting its contents into the river. Mr. White and a little Mexican boy were nearly drowned, before the exertions of Mr. Möllhausen succeeded in extricating them from beneath the boat. The Indians, who are capital swimmers, plunged in, and aided us in saving much of the property. Many of them had brought rafts to the spot, in



Mojave Raft.

the hope that they might be required. These were of simple construction, being merely bundles of rushes placed side by side, and securely bound together with willow twigs. But they were light and manageable, and their owners paddled them about with considerable dexterity.

It was night when finally the great work was accomplished; the crossing of the Colorado

completed, and camp formed upon the right bank. But our joy in the event was considerably tempered by the accidents that had befallen us. Some things were lost; others wet and ruined. Our mules swam across and landed safely, a piece of good fortune that all appreciated. The sheep were brought over by our rather officious, but exceedingly useful Mojave allies. By no fault of theirs, but from bad management of the boat-rope, several sheep became entangled in the cord and were drowned. These were given to Indians, who swam out for them. Two more sheep and two blankets were awarded to the pilots of the flock. We landed upon a field of young wheat, for which the owner claimed damages; but his charge was moderate, and through the chief the matter was satisfactorily arranged.

José Maria, the fifth and last great chief of the Mojaves, here appeared with his warriors for the customary parade, and smoke, and speeches, and gifts. The whole five, Manuel, Francisco, Joachin, Oré, and José Maria, at length came in a body, desiring papers to inform succeeding parties of their civility to us. They were given, all containing warnings to afford no good cause of offence, and to be watchful.

Our gifts had now exhausted the stock for trade; large quantities of grain were in camp for sale, but when told we were too poor to buy, the Indians expressed no disappointment, but wandered from fire to fire, laughing, joking, curious but not meddlesome; trying with capital imitative tongue to learn our language, and to teach their own. Few remained in camp after sunset.

The day has been very fine; a better for our operations could not have been desired. The evening is clear, calm, and mild.

*February* 28—*Camp* 134.—The mules and sheep were grazed last night in charge of a few herders several miles from camp. Our Indian neighbors did not disturb them.

To-day we have remained in camp, endeavoring to remedy yesterday's misfortunes, by drying the books and papers, and cleaning and readjusting the instruments. Some of the less valuable of the latter, found ruined, were condemned and abandoned. To a great portion of the stationery and books of reference was awarded the same fate. All of the straps belonging to the pack-saddles were missing, and search for them, by diving in the river, was in vain. Fortunately, the spring-wagon, with odometers, and sufficient instruments for surveying and astronomical purposes, reached the shore in safety, and none of the field-notes nor scientific collections were injured or lost.

Indians all day have been numerous in camp. They have not the habit of begging; but each one comes supplied with a bag of meal, or a basket of corn, which he desires to trade for cast-off clothing.

*March* 1—*Camp* 135.—The saved portion of our property having been packed, we moved on, slightly west of north, three miles, and encamped upon a long lagoon or bayou of the river, the low banks of which were covered with tall rushes. We were attended, as usual, by a train of Mojaves, and the camp became to them a scene of festivity. The chief Francisco came in without parade, and condescended to take a smoke, and look pleased without presents. It is but just to remark, that no one of the chiefs reserved for himself any of the ceremonial gifts. They were looked upon in a national light, to be received only to distribute among the people.

There was no trading to-day, except now and then by individuals, to obtain corn for a favorite riding-mule, or some curiosity of Indian dress and manufacture. Our stock of blankets and shirts was so far reduced as to compel us to endeavor to drive hard bargains; but the Mojaves were more than a match for us. They were cool and determined, and had a fixed value for our things as well as for their own. We were obliged to pay their prices, or lose the trade. A bivalve shell, curiously carved, and suspended from the neck as a sort of charm, cost a fine blanket. So great was the regret, even then, for having parted with it, that the friends of the woman who sold it would have given seven-fold to have had it restored. Other women, possessing the same ancient relics, clung fondly to them; and as the men were particularly resolute that they should do so, it seems probable that they may have been wedding presents. Strings

of small sea-shells, much prettier than the last, were easily obtained for a dollar. They have suddenly learned the value of money. In order to facilitate this knowledge, we have made a point of taking the few shillings they have offered in trade; giving shirts, and such articles as they desired, in exchange.

Generosity is not a distinguishing trait in Indian character. Instances of hospitality, however, have sometimes been noticed. The Cuchans are evidently welcomed by Mojaves wherever they go. The Pinal. Leñas, when we were with them two years since, seeing us without an escort, nearly defenceless, and with a scanty allowance of provisions, generously gave us, from their winter's store of food, pine nuts and mezcal. Similar examples could be cited from most of the tribes we have met.

Every day these Indians have passed with us has been like a holiday fair, and never did people seem to enjoy such occasions more than the Mojaves have done. They have been gay and joyous, singing, laughing, talking, and learning English words, which they readily and perfectly pronounce. Everything that seems new or curious they examine with undisguised delight. This evening a greater number than usual remained in camp. Placing confidence in our good intentions and kindness, all reserve was laid aside. Tawny forms could be seen flitting from one camp-fire to another, or seated around a blaze of light, their bright eyes and pearly teeth glistening with emotions of pleasure. They exhibited Indian character in a new phase, giving an insight into the domestic amusements which are probably practised around their firesides at home. Mingling among the soldiers and Mexicans, they were interested in games and puzzles with strings, and some of their own suggestions were quite curious.

The chiefs came to-day with the interpreter to say that a national council had been held, at which they approved of the plan for opening a road to travellers through the Mojave country. They knew that upon the trail usually travelled by the Pai-Utes towards California the springs of water were small, and insufficient for our train; that on the journey our mules therefore would perish from thirst, and the expedition fail. Hence they had selected a good man, who knew the country well, and determined to send him to guide us by another route, where sufficient water and grass could be found. They wished us to report favorably to our great chief, in order that he might send many more of his people to pass this way, and bring clothing and utensils to trade for the produce of their fields.

The guide presented was our old friend, a sub-chief called "Cai-rook," who had so successfully conducted the instrument wagon and the surveyors around the mountain spur which intersected the Colorado valley between the country of the Chemehuevis and that of the Mojave Indians. He professed his willingness to accompany us to the junction of the Mormon road with the Mojave river. Pointing to the position which the sun would have in the sky at the commencement and end of each march, and closing a finger to mark each day, he clearly described the route, and the time it would require to perform the journey. He also made a trace of it upon the ground, laying down the position of each stream and spring, and stating whether much or little water would be found at the several points. To different persons his explanation was the same, and would never admit the possibility of encountering more or less obstacles than he had at first denoted. The price of his services was to consist of a blue blanket, a Mexican serape, a shirt, and a few strings of white beads. At his request a dragoon overcoat was added. The serape was presented at once. The remaining articles were to be given at the conclusion of his services. Cai-rook then left camp, promising to be with us early on the morrow.

# CHAPTER XV.

## *From the Colorado river to the Mormon road.*

Leaving the Colorado river.—View from the bounding ridge.—Springs.—Pai-Ute creek.—Rock spring.—Division of the party.—Marl springs.—Desert.—Soda lake.—Arrival at Lieutenant Ives' camp.—Mojave river.—Remarks on the Mojave Indians and the Colorado valley.—Mexican herder missing.—Statement of the guide in regard to the continuance of the Mojave river to the Colorado.—Search for the lost herder.—Pursuit after the Pai-Utes.—Return of the Mojave guides.—Mormon road.

*March* 2—*Camp* 136.—Our guide presented himself, according to promise, and we commenced the march. No sooner had we left the great valley of the Colorado, and ascended the gravelly ridge which bounds it, than, looking back, we saw a huge column of smoke rising from our late camp; while from point to point, down the river, in rapid succession, the signal was repeated. It was probably a telegraphic notice of our departure, extending to the Chemehuèvis, and perhaps to the more distant Yampais. The scene presented from this point was one of the most beautiful witnessed upon the route. The river is a noble stream. The valley is wider, more fertile, and better wooded than that of the del Norte. Beyond, in a direction south 75° east, could plainly be seen the wide opening represented by Captain Sitgreaves, towards the junction of Santa Maria with Bill Williams' fork. If allowed to judge from so distant a view, one would suppose that, with reference to grade, no difficulty would be found in constructing a railroad by that course to the point mentioned. If this be so, the intermediate route would be considerably less than by our trail.

Following an old foot-path nearly west, we crossed a gravelly plain, and entered the dry sandy bed of a stream, supposed to be the Mojave, four or five miles above its mouth. This we ascended, and finally left to our right, where it turned around the western base of a mountain which formed the southern termination of a chain extending north, probably to the celebrated cañon of the Colorado. Gradually rising a long slope, at the end of nine and a half miles from camp we reached the first springs of water. There were several oozing from beds of marl at the base of small hills, with patches of young grass surrounding them. Our mules were not thirsty, and we moved onward. With a new course north 35° west, we travelled twelve miles farther, and encamped at dark; finding in an arroyo a little grass, but no water. Wood also is very scarce, and for camp-fires we used the dry stalks of yuccas. We are still upon the slope of the great valley upon our right, which looks green and inviting in the distance, but is probably waterless and barren, as where it was crossed this morning.

The day had been very cold, with flying clouds and wind from northwest. Cai-rook, the guide, shivered under the piercing blasts until the promised dragoon overcoat was furnished to cover his naked body; after which he walked very proudly ahead of the train. Many of his companions followed us the whole day. They knew that we had nothing more to give, and yet they seemed to regret our departure. Our policy has been to treat them as reasonable beings; asking only what was right, and submitting to no wrong. We cheerfully paid what they considered fair damages for wheat-fields accidentally destroyed, but gave no presents that could be construed into a tribute for passing through their country. A trade was established, which taught them the value of their own agricultural labors, and the advantage to be derived from future parties of emigrants which might follow us. The effect was to make them pleased with themselves and with us. Therefore, instead of annoying the party, as they frequently might have done, and especially during the crossing of the river, for trifling rewards they rendered great assistance. Although the vigilance of guards and sentinels was not relaxed, still we slept as free from care in the midst of six hundred Indian warriors as we would have done in any city of the

Union. In the accomplishment of this result, great praise was due to the officers of the escort, and to the good conduct of the soldiers under their command.

*March* 3—*Camp* 137.—Continuing the survey northwest about nine miles, over the smooth gravelly slope, we reached, at the point of a mountain, Pai-Ute creek, a finely flowing stream of water. Finding good grass also, we encamped. A little basin of rich soil still contains stubble of wheat and corn, raised by the Pai-Utes of the mountains. Rude huts, with rinds of melons and squashes scattered around, show the place to have been but recently deserted. Upon the rocks, blackened by volcanic heat, there are many Indian hieroglyphics. Some of the more simple have been copied. Others are too complicated or too much defaced by time to be deciphered. They are somewhat similar to those upon Inscription Rock on Rio Gila, below the Maricopa villages.

Full sets of magnetic and astronomical observations have been taken at this place.

*March* 4—*Camp* 138.—At 8 a. m. we filled our canteens and started. For the sake of the instrument wagon, the guide led up the creek to a deep ravine, from which he ascended and passed over the crest of a sharp dividing ridge to a plain of great extent. He afterwards told us that the pack-train should have kept the ravine, and saved the hill. The reconnaissance showed a favorable route for the survey through a valley upon the north of the hills leading from the great basin before mentioned, which sweeps around towards the northwest. Upon the left also, west from the little springs encountered on our first day's march from the Colorado, there is a wide prairie with an ascending slope, unobstructed by mountains beyond. This is supposed to be the direct and ordinary route of the Indians to the vicinity of Los Angeles, without other disadvantage than the want of water.

The great plain which our route traversed was found to be covered with good grass, thus confirming the statement of the guide. Moving onward by an ascent so gradual as scarcely to be appreciated by the eye, we proceeded nearly thirteen miles to the dry bed of an arroyo, where grass and wood were abundant, and encamped without water. The sand is moist, and the grass fresh and green; but our spades being lost, we have no means of ascertaining whether water can be obtained by digging.

*March* 5—*Camp* 139.—The mules were driven up for an early start, but upon examination about forty proved to be missing. It was difficult to say whether they had strayed or been stolen; either being probable enough, for the vast plain surrounding us was sprinkled with yuccas and clumps of larrea, which, by moonlight, could not well be distinguished from the

Yucca.

herd. It was easy, therefore, to lose the animals, and difficult to find them. Parties sent in search were a long time absent, but at length returned successful.

Passing over the prairie, nearly seven miles west, we arrived at a spring of water oozing from a rocky ravine. A few pools were formed among the rocks, and below, the water sank into the sand. During freshets a small stream had been formed, turning the base of an isolated hill, and flowing east-southeast towards the Colorado. Having hollowed a basin, water flowed in rapidly, affording sufficient for the animals and the uses of camp.

Our Mojave companions are now reduced to the guide and his friend Irreteba, who propose to accompany him to the Salt Lake road. The rest have returned to their homes.

*March* 6—*Camp* 140.—Having been told by the Indian guides that at the next pools we will not find a supply of water sufficient for the whole of our large train at once, it was proposed to divide the party into three divisions, to follow each other successively, in order to give time for the springs to be replenished during the intervals. The surveying party, under charge of Lieut. Ives, and escorted by Lieut. Tidball, set out early this morning to proceed in advance. The Mojave guides accompanied them.

In the springs at camp, water is flowing, giving a bountiful supply for the train. The hill-sides and ravines are covered with excellent grass, and though the weather remains unchanged, threatening a snow-storm, the mules are partially sheltered, and will gain strength by the delay.

*March* 7—*Camp* 141.—This morning we were up betimes, and prepared for a long march. The mules had been well supplied with grass and water, and looked in excellent condition for the journey. Instead of taking the road made by the instrument wagon, which passed around the hills, we followed an Indian trail through the ravine in which the spring occurs. The sides of this ravine, and probably the whole mountain, are composed of compact sienite, of the same quality as the so-called Quincy granite. It is excellent building material, and, if required, could be obtained in great quantities. Leaving Rock spring with at least as much water as we found in it, we passed over to a higher step of the same great plateau that for several days we have been so gradually ascending. With a still gentle acclivity, it led us westward five miles to the foot of a ridge, which at a distance looked like a formidable obstacle. To our surprise, however, upon reaching a point of hills without an abrupt change of grade, we entered a dry arroyo which led through the mountains, forming an excellent pass for a road. When we had fairly gained the western side of the range, the arroyo assumed the character of a rugged ravine, and for a railway it would be necessary to traverse the hill-slope upon the right, and descend to a wide and smooth valley which swept around to the southwest. Instead of following this valley, which, after turning the base of a high hill, pursued a westwardly course, our guide informed us that it was necessary to ascend a similar slope upon the opposite side to proceed in the direction of the spring. Looking back upon the ridge we had passed, it seemed to extend to a considerable distance west of south, showing peaks with a light covering of snow, two or three thousand feet in height above the level of the valley at its base. But there appeared to be a low pass beyond.

Having made a noon halt, and grazed our mules for awhile on the excellent grama that grows abundantly upon these gravelly prairies, we repacked and continued the march. Pursuing an acclivity for five miles we reached "Marl spring," nineteen miles from the glen at which we rested yesterday. The camp-fires of the advanced party were still burning, showing that they had been but a short time absent. The spring was small, and there was not more than half enough water for the mules. But as it constantly though slowly flowed in, after awhile the animals were satisfied, and we obtained water for the uses of camp.

This country affords excellent grazing lands, similar to, but less extensive than those of New Mexico. The grass is highly nutritious. Cactaceæ are abundant. Tall and beautiful yuccas, the offensive larrea Mexicana, and obione, complete the list of vegetation. Wood is almost entirely wanting. For camp-fires we depend upon twigs of obione, (grease-wood), or the soft pulpy stalks of the yucca.

The day has been windy, cold, and disagreeable.

*March* 8—*Camp* 142.—Our spring, this morning, was filled to the high-water mark, but that afforded sufficient only for a moderate allowance to each mule. Had we the means of excavating to a greater depth, it is probable that an abundant supply might be procured. One of the herders found a second spring in a marly spot, where water trickled from the surface; but having no spade to clear out the dirt and rocks, only a few buckets full were obtained from it. While packing up, Lieutenant Jones, with a detachment of the escort, arrived, having travelled during the night. His mules looked fresh, and able to wait for water till the spring might be filled.

We ascended a granitic ridge to cut off a detour which led around through the open valley upon our left. From the hills we saw towards the north a row of volcanic peaks; beyond which appeared a deep and wide valley, probably that of the Mojave river. Still more distant was a snow-capped mountain, said to be near Rio Virgen, or Santa Clara. Northwest was seen the lofty range of the Sierra Madre, with several lesser ridges of mountains intervening.

Following the crest we soon came to a spur, along which we plunged down almost precipitously into the valley before mentioned, which sweeps around the southern base of the marl-spring mountains. Then, following the arroyo which threaded this valley, we passed a gap about a quarter of a mile wide, through metamorphic mountains; and, without any apparent change in the declivity, within a few miles entered a blank desert of drifted sand; but the surface was compact and hard, so that we passed easily and rapidly over it. In the midst of this barren plain were low isolated ridges of rocky hills, upon the northwest sides of which sand was piled nearly to the tops, showing the direction of the prevailing winds. Our trail passed between them, and a few miles beyond the sand disappeared. We then entered the dry bed of a lake covered with efflorescent salts, probably sulphate of soda. Having traversed this with a good road for about six miles, at ten o'clock in the evening we reached the camp of Lieutenant Ives, where water and grass were abundant. The latter was salt, and the former brackish; but, nevertheless, they sufficed to relieve present necessities.

By odometer the distance from Marl springs is thirty miles—the greatest jornada, without water, that has been encountered upon our route. But, although the mules were much worn down and wearied by the long-continued journey of many months, we have to-day lost not an animal, and neither man nor beast has suffered from thirst. For an emigrant-road it is probably the best route yet discovered across this western desert.

From Rio Colorado our marches have been forced, from there not being subsistence sufficient to afford time for explorations upon the right and left, as we desired. We were compelled to follow the guidance of the Indians over a high point of the mountain range in order to obtain water, and enable us to preserve and transport the collections and notes previously obtained; otherwise we would have tried to follow the bed of the Mojave river, provided this supposed channel actually exists, even though its course should have been found more circuitous towards the north; and we should have also explored farther south for a lower pass, which the conformation of the country we have seen appears to indicate. It is hoped that the party of Lieutenant Williamson, which is believed to have had orders to proceed in this direction from the city of San Francisco to the Colorado, has succeeded in obtaining all the information upon these points which the government may require.

Upon our arrival at the camp of Lieutenant Ives, we found that Lieutenant Tidball, with the escort and one of the guides, had gone on some twelve or fifteen miles farther to a point on the Mojave river, where he expected to find a flowing stream of pure water and better grass. Those who remained had seen Pai-Ute camp-fires near the mountains, and the Indian guide thought that there was danger of an attack; therefore the young gentlemen were themselves standing guard, and were glad of a reinforcement. As Lieutenant Ives had completed a set of astronomical observations, the labors for the day were ended, and all, except the watchful sentinels, threw their blankets upon the luxuriant grass to obtain the rest which they needed.

*March* 9—*Camp* 143.—Once more we have charming weather, like that experienced upon the

Colorado and Bill Williams' fork. There is the same transparency of atmosphere at sunrise so frequently noticed before.

Looking eastward, the mountains we have passed have a forbidding appearance, and even the gap by which we entered the basin seems nearly closed by a projecting spur. Towards the southeast is a great plain. The Mojave lake extends towards the north. Its height above the Colorado is by survey seven hundred and sixty-six feet, and the distance from that river by our trail is ninety-seven miles. This would seem to allow sufficient inclination for the channel of a stream.

At last night's camp, wherever we turned the sod, water was found; but it was highly alkaline, effervescing with acids like Rochelle powders. Some of the soldiers reported that, near by, they found a small quantity of fresh water. The lake for miles, as far as we could see, was covered to the depth of about half an inch with an efflorescent powder, white, or having a yellowish tinge, as if colored with oxide of iron. Mr. Marcou preserved specimens of it for future analyzation. It may prove a profitable article of commerce. The water found in the marshy pools was not palatable to men, but the mules drank it freely. At 10 a. m. we renewed our march. The route was nearly west, through a wide valley of drifted sand. The day was exceedingly warm, and the reflection of the sun's rays from the parched desert rendered the journey more oppressive than any before experienced. Our mules suffered greatly; six were wearied out and left behind. At length, having accomplished twelve miles, we were gladdened by the sight of Mojave river, a beautiful stream of fresh water, from ten to twenty feet wide, and a foot deep. It flows rapidly upon a hard, pebbly channel; and, a few hundred yards below, suddenly disappears beneath the sand. The Indian says it does not rise again until it reaches the Colorado. We encamped, and sent our mules to graze within ravines among the hills, where was found a small quantity of grass, and an aromatic shrub which they browsed upon very freely.

This evening our Indian guide repeated the object of the Mojaves and their chiefs in sending him with us. "The road," said he, "is good. Water is sufficient. Mules do not die of thirst. Mojaves have a good heart, and are friends to Americans. We want you to write these things to your great chief, that his people may come and buy our corn and flour, and vegetables. Let them, in return, give us clothing and knives. If they need assistance, Mojaves will afford it, and will guide them where water and grass may be found." It would seem as if these simple people were really pleased with the first dawning light of civilization. They feel the want of comfortable clothing, and perceive some of the advantages of trade. There is no doubt that, before many years pass away, a great change will take place in their country. The advancing tide of emigration will soon take possession of it, and, unless the strong arm of government protects them, the native population will be driven to the mountains or be exterminated. The Mormons made a great mistake in not occupying the valley of the Colorado. They could there produce articles for export, as well as for subsistence. Tobacco is indigenous to the soil, and might be cultivated, as it is by the Pima Indians, on the Gila. Cotton, also, is probably of native growth, as it was raised extensively in the same region when first visited by Spaniards, in 1539. Specimens of it cultivated by Pimas and Maricopas upon the Gila have been pronounced by southern planters nearly equal to the best Sea Island variety. For adaptation to the cultivation of all kinds of grain and vegetables, the Colorado valley can scarcely be surpassed. Upon the wide and rich bottom-lands below the junction of the Gila, sugar, and possibly rice, might be raised. In that fertile region, now densely covered with mezquite forests, about ten miles from the river, may yet be seen the acequias of a Spanish colony, which, some fifty or sixty years since, attempted to gain a foothold there. Indians, however, jealous of the encroachments of whites, exterminated the settlers, as they had previously done the missionaries at the junction. Since that time they were undisturbed until 1849, when we went among them to establish the boundary between the United States and Mexico.

With regard to the navigation of the Colorado river, the report of Capt. Sitgreaves will prob-

ably be explicit. It is well known that steamers of light draught already carry supplies for the troops as high as Fort Yuma. Mr. Leroux, who accompanied Capt. Sitgreaves, and who, years ago, trapped upon this river for beaver, says that, from Fort Yuma to the mouth of Rio Virgen, there seemed to be a deep channel without rapids. According to our observations, though the current is rapid, the inclination is less than one foot per mile: the depth appears to be sufficiently great to allow the passage of small steamboats.

The night being favorable, magnetic and astronomical observations have been obtained. The moon was observed with the transit, for the determination of the longitude of camp. .

*March* 10—*Camp* 144.—A breeze from the Sierra Nevada rendered the morning cool. Taking an early start, we ascended the stream to a gorge formed by the jutting of hills into the valley. The surveying party, with the spring-wagon, followed the banks, but the pack-train took an Indian trail over the hills, to avoid a bend. It proved an unwise experiment, as not much distance was saved, and the steep precipices ascended and descended strained the heavily-laden beasts. Upon one cliff, the trail, for about a hundred yards, threaded the verge of a precipice, and a mis-step, or a slide of a few inches, would have plunged them down a chasm several hundred feet deep. It was curious to witness how fearlessly the sure-footed animals would stop to look over, and then quietly move on. Re-entering the valley of the river, we found a broad trail, supposed to have been made by the party of Lieut. Williamson on its way to the Colorado. Near by were large masses of dried grass and rushes, which may have been collected by Indians for winter huts and beds. Here the river was quite wide, and in places knee-deep. Its banks were of a rich loamy soil, covered with grass, reeds, willows, and thickets of mezquite trees.

Keeping the trail, with the pack-train, we ascended an arroyo and crossed a spur of hills. The day had become warm, and the animals faint; therefore, finding good grass, we made a mid-day halt. Afterwards, proceeding to the river, we encamped, having plenty of mezquite wood, a stream of pure water, and good grazing for our animals in the valley. The survey followed the banks of the river, thirteen miles from last camp. For a portion of the distance the stream was lost beneath a sandy bed.

One weary mule was to-day left by the roadside, and will probably make a good meal for the hungry Pai-Utes who are watching our movements. Many tracks, a few hours' old, have been noticed proceeding from the hills to the valley.

The night is serene. The moon shines upon a few fleecy clouds, which form colored coronæ. There is not a breath of air to disturb the astronomical observations.

*March* 11—*Camp* 145.—Sunrise was unusually gorgeous, with various shades of crimson-tinted clouds, announcing the approach of a storm. The surveying party proceeded up the valley towards "Punta del Agua," on "the Spanish trail," supposed to be ten miles ahead. With the packs we proposed to follow; but, when prepared to start, it was reported, by the head packer for the escort, that one of his Mexicans herders had yesterday been left behind, alone and unarmed, in charge of two tired mules; and that he had not yet made his appearance. Defenceless, and with animals to tempt the cupidity of Indians, who in considerable numbers are evidently watching us, there could scarcely be a doubt of the fate of this poor man. However, Lieutenant Jones, Lieutenant Stanley, Dr. Bigelow, ten soldiers, four Mexican packers, and seven persons belonging to the surveying corps, returned to search for him; Lieutenant Ives, with the rest of the escort, guarding the camp. Feeling anxiety, also, regarding the small detachment that had advanced with the survey, the remaining portion of the party proceeded to join it.

Above camp, the valley of the river became more fertile, the rich loamy soil producing herbage and trees upon both banks of the stream. By an arroyo we ascended to a low mesa, cutting off a southern bend of the river, and traversed the edge of a level prairie of great extent, covered with an abundance of green bunch-grass. Travelling slowly for a while, our mules fed until they were satisfied. Then again we entered the bottom-lands which spread out to the width of several miles, and while ascending the well-wooded banks night overtook us. Accord-

ing to the prediction of the morning, there arose a storm of wind and thick clouds. In the darkness we lost the trail, and were apprehensive of passing the camp of the surveying party without seeing it. At length, however, after a weary march, we caught sight of bright fires, which led us to our friends. They had selected an excellent camp-ground. Mezquites, bearing tornillas, afforded forage for mules and fuel. Beneath meandered the quiet stream of limpid water. Upon each bank, grass grew luxuriantly. This pleasant spot would be favorable for a settlement. The soil is so fertile that irrigation might not be required. The river, however, would supply acequias to water a considerable portion of the valley.

The Indian who guided Lieutenant Tidball to the Mormon road, having performed his promise, met us this evening on his way home. Lieutenant Tidball with his escort has pushed on towards the settlements.

*March* 12—*Camp* 145.—We remained in camp to-day to await the arrival of the rear party, and learn the success of the expedition which went to find the missing Mexican, or chastise the mountain Pai-Utes. Meanwhile our Mojave guides prepared to take leave of us and return to the Colorado. They were loaded with presents of blankets and cast-off clothing, and were well content therewith.

We determined to make a final effort to free our minds from doubts with reference to the continuance of the Mojave river, or rather to ascertain whether there existed a bed or channel for it entirely to the Colorado. As the dry bed of Soda lake lies a short distance below the last point of the river where a flowing stream has been seen, and as it was found covered with efflorescent salts, giving it something of the character of the lakes farther north, in which streams of that country are lost, inference might lead to the conclusion that it should be classed in the same general system as the so-called Great Basin. Mr. Marcou and myself were inclined to entertain this idea. In opposition to it, is the popular belief, probably not without foundation, of the confluence of Mojave river with the Colorado.

In making inquiries of the Indians we were cautious not to incline their minds to any preconceived notions of our own by asking leading questions. But we traced in the sand a depression to denote the valley of the Colorado, and in the middle represented the meandering river, which they recognised. Heaps of sand piled on each side, and called "sierras," they understood to denote mountains. Our trail was then marked out, indicating the camps and the springs, and the mountains crossed, from the Mojave villages to the flowing water of Rio Mojave. Thence we represented the valley of that river by a channel scooped from the sand, indicating where there was water, and where there was none. Then we inquired of the Indians whether or not that channel was lost in the lake. The guide understood the question, and instantly with his hand cut a passage through the heaps of sand that had been piled upon the ground-map for mountains around the lake, representing a continuous valley to the arroyo by which we had left the Colorado. Pointing along the line traced, he said it was a smooth arroyo, containing no water upon the surface, nor obstructed by hills; but the valley was wide, level, and sandy throughout. When asked if the distance was great, he replied that it was; and counting with his fingers, he indicated ten as the number of days required to travel it with our wagons. His previous estimates for a day's march have averaged thirteen miles, making the length of the route by the river one hundred and thirty miles.

We had an unexpected view this evening of the wide bottom-lands upon the river. After dark, the herders carelessly allowed the fire upon the right bank to seize the tall and thick grass. It spread with fearful rapidity. We rushed into it with wet blankets, and after laborious exertions succeeded in breaking the immense circle of flame so as to give security to camp. Upon the other side it rolled on, like a vast wave, down the valley. Fortunately the stream was wide enough to prevent its passage to the left bank, or it might have caused a serious calamity to the rear party which was advancing. It proved rather of service, enabling them to follow our trail to camp, where they arrived at 9 p. m. Mournful tidings were brought of Torrivia, the lost Mexican herder. Our worst fears were realized. The first party that had

gone back in search of the man returned the same evening without having been successful in discovering any traces of him, though the body of the abandoned mule, with an arrow buried in its side, which was found near the spot where the Mexican had been last seen, gave unmistakeable evidence of the late presence of Pai-Utes. There was scarcely room for doubt as to the fate of the poor fellow; but it was determined that one more attempt should be made, at least, to find his body, and give it proper burial; and the next morning Lieut. Ives, with Lieut. Stanley, Dr. Kennerly, Mr. Campbell, Mr. Möllhausen, and four Mexicans, started to make a thorough search. Going back about six miles they entered a deep ravine through which the train had passed, and near whose mouth Torrivia, with the two tired mules, had been last seen. Many narrow gorges conducted back into a labyrinth of sand-hills that extended a long distance to the south. Carefully examining the entrance to each of these, the faint impress of a mule's foot was finally discovered. The nature of the ground rendered it difficult to perceive any tracks, but closer inspection showed at last that a party of Indians driving two mules had gone that way. As they ascended the gorge the trail became more distinct; and, though occasionally lost, it was always found again, and the pursuers followed it successfully several miles back, now passing over steep hills, and again threading deep and narrow chains that wound between high walls of sand and gravel. In one of these they came upon a cunning hiding-place which the Pai-Utes had occupied several hours previously. The remains of a mule were here seen, showing that they had had a feast upon part of their booty. From all appearances they must have eaten the flesh nearly if not quite raw. As there was every indication that they had been gone for some time, and as it was supposed that they were still a long distance ahead, the pursuing party were less careful to preserve silence in their movements, and one or two words were spoken in an unguarded tone, afterwards much regretted; for, following the trail onward, in a few minutes a sudden turn brought them into the very midst of the enemy's camp, from which it was evident the Indians had fled in the utmost haste, but a few moments before. A fire was burning, and upon it were large pieces of mule-meat that had only just been placed there to roast, for they were still bloody and raw. The surrounding hills entirely excluded the view, but there was an instant scattering in all directions to overtake the late occupants of the camp. The latter, however, were too fleet, and having the advantage of a perfect knowledge of the country, which was admirably adapted to furnish hiding-places, succeeded to a man in effecting their escape, and the pursuers came back, one by one, disappointed. The party of Pai-Utes apparently numbered fifteen or twenty. In their flight they had dropped most of their camp furniture and property. Baskets, cooking utensils, clothing, and even their bows and arrows, were found scattered upon the adjoining slopes. The clothes of the murdered Mexican were also found, literally riddled by arrows, and stiff with hardened blood. He had probably been killed by a party in ambush as he was driving his mules along the ravine. A long and laborious search for the body was ineffectual; and, after burning and destroying everything belonging to the Indians that could be found, Lieut. Ives and his party returned to the camp.

*March* 13—*Camp* 146.—In the cool air of the morning, our Mojave guides having taken leave of us, we proceeded onward towards the Pacific. Soon ascending a mesa to avoid a bend of the river, we overlooked a large extent of valley with prairie beyond. Southeast, towards the mouth of Bill Williams' fork, the plain extended to the horizon.

Having travelled about six miles, we struck the Mormon road. Upon it were fresh wagon tracks leading towards the Salt Lake City. At the crossing the stream was flowing, and the land fertile; but having been much used for a camp ground by emigrant parties, grass was scarce. The road was found excellent. The river as we ascended grew larger, and sunk less frequently beneath the surface. Cotton-wood and mezquite trees were more abundant. After a march of twenty miles on a general course west-southwest, we encamped. Near this point is said to be the trail which leaves the river and ascends the prairie slope towards Walker's Pass. There are a few isolated hills intervening, but none to interrupt a nearly uniform grade to an

apparent gap in the low ridge south of the great Sierra.* The prairie looks dry, and the distance from water to water is not known by any one attached to our party. Neither Savedra nor Leroux has traversed it.

* The literal meaning of *sierra* is "*saw;*" and hence, "*ridge of mountains.*" Any one who has seen the sharp serrated profiles of mountain chains in New Mexico and California, will understand the propriety of the term.

# CHAPTER XVI.

## *From the Mormon road to the Pacific.*

Mormon travellers.—Cajon Pass.—Timber.—Express from Jarupa.—Disbanding of party.—Cocomonga.—Cahuillas.—El Monte.—Mormons at San Bernardino.—Mission of San Gabriel.—Los Angeles.—Sale of property.—San Pedro.

*March* 14—*Camp* 147.—At sunrise we resumed the survey. The road was good; the air calm and clear. A short distance above our last camp the valley became contracted, and in the midst of it were rocky hills in pyramidal forms, dividing the river into two large brooks, which encompassed the bottom-lands, and united far below, forming a large island. At length, as we proceeded, in order to shorten the distance, the road again left the valley, and crossed a gravelly ridge, where we met a small party of Mormons *en route* for Salt Lake City. They informed us of the melancholy fate of the lamented Capt. Gunnison and a portion of his party, but professed to have no fears themselves of the Pah Utahs, because, they said, the Indians were at peace with Mormons. Although it may be in accordance with an old system of the Mexican government, it is a new feature in ours, for one State or Territory to be at peace with a band of Indians known to be hostile to, or at war with the rest. For many years it has been the practice of the Apaches, who reside upon the frontiers of Chihuahua and Sonora, when meditating an attack upon one, to make peace with the other. The mules and horses then taken are hastily driven to the neighboring State, and there disposed of at low prices. But the practice should not be permitted within our limits.

Having made a noon halt to graze the mules, we continued our journey until dark; and, in an inviting part of the valley, encamped, after a march of twenty-two miles.

*March* 15—*Camp* 148.—We were awakened this morning by a heavy shower of rain; but we packed up, and moved onward, passing a very pretty country, well adapted for settlement. It is said that the Mormons propose soon to take possession of it.

Having travelled upon the right bank of the river about fifteen miles, in a course nearly southwest, we arrived at a bend where the road to the Cajon separates from the valley. We crossed the stream; here about 150 feet wide, and in places 2½ feet deep; and, at the foot of the left bank, halted for rest and refreshment. Noticing several patches of verdure upon the steep slopes, we ascended, and found large springs of water gushing from the bank about fifty feet above the river, having a temperature of 66°.4 Fahrenheit, which we may, therefore, adopt as, approximately, the mean temperature at this place.

Having rested until 3.30 p. m., the survey was continued. From the top of the bank, some 100 feet high, we looked back upon the pretty valley, its meandering stream traceable to a great distance by a fringe of foliage. Doubtless ere long it will be covered with villages and farms. Our course, now directed towards an apparent break in the range near San Bernardino mountain, is nearly south 38° west by compass; the magnetic variation being about 14° east of north. We are ascending the prairie slope, which, extending to the base of the great Sierra, leads to every pass in the chain which might communicate with the Tulare valley. Our provisions are so nearly exhausted, as to place it out of our power to make an examination of those passes without first obtaining an additional supply. Lieut. Jones, with the escort, has been already obliged, on this account, to push ahead for the settlements. Therefore we propose to follow him and proceed by the shorter route through the Cajon, continuing to take notes and make sketches of the route we traverse.

The ascent from the river's bank has been quite gradual. Tall yucca trees soon made their appearance. Afterwards we entered thickets of cedars interspersed with artemisia and green bunch-grass; where, about fifteen miles from the point of leaving the river, we encamped. There is no water at this point. The Mojave river appears to be several miles distant upon the left. Leroux, who has previously travelled the old Spanish trail, which follows that stream to its head, says it is divided into three branches; the most eastern having its source near Cajon Pass. The evening is cool, with the thermometer at 38° Fahrenheit, but sufficiently calm and clear to afford an opportunity for making astronomical observations.

*March* 16—*Camp* 149.—The night had been rendered uncomfortable by a chilling blast from snow-covered peaks of a mountain some fifteen miles southwest, called by Leroux "San Gabriel." We packed up by moonlight, and at sunrise continued the survey. For the first four miles and a half we ascended at a nearly uniform rate of eighty-one feet per mile. Thence we rose more rapidly, making about 800 feet in 4.5 miles, which placed us upon the summit of Cajon Pass. The crest was a sharp and narrow "divide," formed by a ridge of hills, with gravel and sand upon the surface. Westwardly, and thence curving around towards the north, there seemed, from the base of the rugged mountains, an extension of the same smooth slope that we had traversed from the bend of the Mojave river. But towards the south was presented scenery quite different. Between lofty mountains there was a deep ravine, through which, in the distance, could be seen a great plain or valley lying thousands of feet below. To the foot of the gravelly ridge upon which we stood, the angle of inclination was about 45°. But the road followed a slight spur, and by that our descent in one mile was 820 feet. That brought us into an arroyo, or creek, which threads the ravine. At this place we were on nearly the same level as at a point measured on our trail, five and a half miles distant, upon the other side of the summit. A careful survey, tracing upon the ground a horizontal curve through either of the points mentioned, would probably discover a place where the width of the crest might be somewhat less. But it is evident that, for a railroad through this pass, there would be required a long and expensive tunnel. From the southern foot of the sharp crest referred to, keeping the dry channel of Cajon creek, we descended, in two miles, 250 feet, and there found water. Continuing our march, the ravine became rougher and steeper; the descent along the trickling stream being nearly 500 feet in 3.36 miles. Having now travelled about twenty-five miles from the Mojave river, we made a halt, to allow the animals to drink and graze. We then descended four miles farther down the rocky ravine, and encamped for the night. This last declivity was slightly less than 100 feet per mile.

The geological formation of this range of mountains is quite interesting; white marble and red porphyry being found, and indications also of gold and silver mines. The time of its upheaval proves to have been later than heretofore supposed, Mr. Marcou placing it somewhere in the tertiary period.* We are again in a woodland region. Scattering piñons, oaks, and sycamores,

* The following letter from Baron Humboldt, describing the chemical composition of some of the volcanic rocks collected by our geologist, will be read with great interest:

*à* Potsdam, au Chateau de la Ville, *à* 18 *Août*, 1855.

Monsieur: Si j'offre si tard l'hommage de ma vive et affectueuse reconnaissance à Monsieur le Pr. Lieutenant Whipple pour les interessantes communications qu'il a bien voulu me faire, ce retard n'a eu pour cause que l'absence d'un savant géologue, que j'ai voulu faire jouir de l'examen des roches volcaniques que nous devons à vos bontés Monsieur. C'est un monde nouveau pour le rapport de la géologie que votre important ouvrage nous fera connaitre. Mr. Möllhausen * * * * * * * vous dirait avec quel scrupuleux intérêt nous avons cherchés sur les cartes les localités des sites où M. Jules Marcou, savant et zélé géologue, a recueilli les roches, choisies avec cette intelligence qui en facilite l'étude du composition minéralogique. Cet aperçu géologique devient doublement interessant lorsqu' on le voit completé par l'examen des vues pittoresques tracées avec un vrai talent par votre topographe et habile dessinateur, Mr. Möllhausen. On posséde par là à la fois les contours des montagnes, les traits physionomiques des formations de roches et la possibilité d'en déterminer la composition minéralogique. Le "Resumé of a geological reconnaissance between the junction of the Arkansas and the Mississippi and the Pueblo de los Angeles, in California" (Chapter VI of Doc. 129) embrasse, d'une maniére très piquante; 1er, l'étendue des formations secondaires et tertiares que l'on ne connaissait pas à cette latitude dans ses frappantes analogies avec l'Europe; et 2eme; les cones volcaniques qui les ont percés et recouverts d'immenses "overflowings of lava." La collection de roches que nous devons à vos bontés par la généreuse permission de Monsieur le Secrétaire de la Guerre a été déposée à votre nom au cabinet

appear in the ravines, or upon the hill-sides. Towards the tops of the mountains are firs and pines, excellent for timber. A few miles east from this place is a saw-mill, where the Mormons of San Bernardino are said to manufacture good lumber.

Upon arriving at our camp ground, we found a Mormon from San Bernardino come out to meet us with a load of provisions for sale. He professed to be one of the Saints, but nevertheless charged most exorbitant prices for his sugar, flour, and coffee. He also smuggled in a keg of whiskey; but as none of the men have money, it is likely to return untouched.

The Cajon in which we are encamped is said to be a bad place with respect to Indian depredations. Marauding parties, supposed to be sometimes led by outlawed white men in disguise, lurk here until a favorable opportunity is presented, when they rush down into the valley and drive off the stock from a rancho, or from some emigrant camp. At the place of our noon halt we saw vestiges of Indian huts, broken pottery, and metates. One of the latter was fashioned with considerable skill. The exterior was hemispherical, with a conical cup in the centre capable of holding about two quarts of grain. The rock was of sienite, hard, polished, smooth,

minéralogique de l'université à Berlin. Les roches annoncent au Rio del Norte près d'Albuquerque et plus au sud-ouest une formation de granite blanc, abondant en mica à base de potasse (Kali-Glimmer.) À l'ouest de la haute crête des montagnes (Sierra Madre) il y a deux vastes régions volcaniques et trachytiques que je distinguerai sous les noms de *régions de Mount Taylor* et *des Cerros de San Francisco*.

I. *Région de Mount Taylor*. Le cime est un volcan étient entouré de courants de lave. Il y a des trachytes riches en petits cristeaux de feldspath-vitreux (glasiger, feldspath, saridin) et vrai semblablement aussi d'un peu d'oligoclase. Près de Cieneguilla, entre Santa Fé et Albuquerque, est une roche de trachyte dioritique composeé d'amphibole (hornblende) et de cristaux d'oligoclase très distincts. Ce trachyte parait recouvrir la partie occidentale des *Rocky mountains*. Il renferme aussi de l'olivine (peridot ) Des courants de lave noire se sont epanchés sur le calcaire blanc de la formation jurassique (Jura Talgstein.) Toute cette région volcanique est à l'est de Zuñi.

II. *Région de la Sierra de San Francisco*, à l'occident du vieux Zuñi. Les échantillons portés des rives de *Mojave river*, qui se reunit au Rio Colorado annoncent le même trachyte, composé de hornblende et d'oligoclase, des environs de *Mount Taylor*. A la haute cordillère de San Francisco, surtout au Picacho, il y a des basaltes avec olivine et de plus des courants de lave à base de Obsidienne. Des échantillons pris par la rive du Colorado sont une roche de Serpentine.

Comme dans ces derniers tems le composition des trachytes qui forment les volcans de la partie centrale du Mexique (sous les 19° de latitude) a été examiné avec beaucoup de soin, il n'est pas sans intérêt de remarquer ici que les trachytes des deux régions de *Mount Taylor* et de la *Sierra de San Francisco*, identiques entre elles, se trouvent repetés dans les trachytes des volcans de Toluca et du Pic d'Orizaba très différents de la roche du Popocatepet'l et du volcan de Colima, prèsque dans la latitude de la capitale du Mexique. Les deux derniers sont composés d'oligoclase et d'Augite (pyroxene) tandisque les volcans de Toluca et d'Orizabe, comme vos régions à l'est et à l'ouest de Zuñi, offrent de l'oligoclase avec de la hornblende, roche de la famille des diorites Le tout se fonde sur l'examen rigoureux du chimiste géologue, M. le Professeur Gustave Rose, mon compagnon dans l'expédition de Sibérie. J'ajoute encore que la formation de hornblende et d'oligoclase se retrouve aussi dans les volcans éteints de la Gréce (Ile d'Egine) dans l'Asie Mineur, et à l'ile de Tara, comme cela se trouvera exposé plus au long dans le 4me et dernier volume de mon Cosmos qui pourra être publié bientôt.

Je ne puis terminer ces lignes sans vous répéter, mon cher Monsieur, combien ont été instructifs pour moi le "complete set of the printed reports," et les cartes que vous avez bien voulus ajouter a votre envoi. Je compte écrire moi-même à M. William Blake, qui a suivi l'Expédition du Comm. Lieut. Williamson, et dont le *geological report* est plein d'intérêt scientifique. J'accepterai pour enrichir le cabinet de l'Université de Berlin, avec le plus vive reconnaissance, quelques échantillons des roches volcaniques ou plutoniques, que M. Blake nous fait espérer. Les plus petits fragmens, à fraiche cassure, sont précieux lorsqu'ils ont été recueillis par de savantes et intelligentes mains.

Nous avons été si contents de ce que nous devons à votre bienveillance que nous n'appelerons pas de nouveau à la générosité de S. E. Monsieur le Secretaire de la Guerre. Ce serait en abuser que d'accepter ses offres. Il est resté, parmi toutes les nations eclairées de l'Europe, un sentiment de vive reconnaissance au gouvernement des Etats Unis, pour les nobles sacrifices qu'il n'a cessé de faire pour rendre utile au progrés des connaissances humaines de grandes expéditions intimement lieés à l'avancement de la prospérité publique. Le principe libéral de la publicité ajoute à ce bienfait.

Agreéz, je vous prie, monsieur, l'assurance renouvellée de la haute et affectueuse considération avec laquelle j'ai l'honneur d'être,

Votre très-humble et très devoué serv.,

Alexandre v. Humboldt

Comme, à mon grand âge, j'écris d'une manière si illisible, j'ai prié M. Möllhausen de traduire en Anglais un extrait de cette lettre, pour le cas où vous voudriez vous en servir pour vos publications.

Mr. A. W. Whipple,

*1st Lieutenant Top. Eng. U. S. Army, Washington, D. C., U. S. of North America.*

and symmetrical within and without. The pottery was rough, unpainted, and unglazed. The huts covered circular depressions in the ground about ten feet in diameter, and two feet deep. The day has been clear, but with a cold wind from the snowy peaks of San Gabriel. They appear to be ten thousand feet above the level of the sea. Tall pines crown their summits.

*March* 17—*Camp* 149.—Finding the Cajon so difficult for a railroad passage to the Pacific, we greatly desired to examine Walker's Pass into Tulare valley. But on consultation, several obstacles were opposed to the undertaking; one of them being the fear of spring freshets, which usually make the mountain streams in that region impassable. As the question was under consideration, a messenger arrived from Capt. Lovell, bringing letters and papers. The latter gave accounts from Lieut. Williamson and Capt. Stoneman, making known the fact that all the passes, from Walker's to the Cajon inclusive, had been thoroughly explored by parties under their direction. It was therefore evident that, as the department had already obtained the desired information upon that question, further examinations would not be expected of us; and, our share of the appropriation being nearly exhausted, we determined to diminish the party at once, and then push rapidly on to Los Angeles.

It is with much satisfaction that we learn the success that attended the survey of Lieutenant Williamson; for we are assured, from the appearance of the country forming the western shed of the mountains, that every pass leading into the Tulare valley is accessible from the Mojave river; and that point being passed, our route will terminate at San Francisco.

We remained in camp during the day, and paid off and discharged all the laborers of the party excepting a few Mexican herders, who are needed to guard the mules.

Our field labors, therefore, may now be looked upon as completed. It remains to develop in detail the results that may be gathered from the material that has been collected. Until this be accomplished, no definite nor satisfactory evidence can be given to others of the success that has attended our operations; but, to ourselves, there is no doubt remaining that, for the construction of a railway, the route we have passed over is not only practicable, but, in many respects, eminently advantageous. The first six hundred and fifty miles, from the eastern border of the Choctaw territory to the river Pecos, possesses, in the valley of the Canadian, a natural highway that establishes, beyond question, the superior advantages of this belt of country over any other that can be selected, between the same degrees of longitude, within the limits of our territory. The Canadian seems formed by nature for the special object in view. Its general course, for the distance alluded to, is nearly east. Its mean inclination is but nine feet to the mile; thus enabling us almost imperceptibly to attain the summit of the lofty table-lands of New Mexico. Expensive excavations and embankments are entirely avoided; and, notwithstanding the numerous affluents that fertilize and enrich the adjacent country, few bridges are required, as most of the water-courses sink beneath the surface as they approach the great valley. Upon the eastern portion valuable coal mines exist, and vast forests of oak may furnish an unfailing supply of timber and fuel. The Cross Timbers extend to the meridian of 99° west from Greenwich, and the wooded branches of the False Washita afford abundance of the same material for fifty or sixty miles beyond. Sandstone, quick-lime, and gypsum, are found throughout the whole distance. If the fertile valleys were thrown open to settlers, and an outlet secured for the products of the soil, this region would form the nucleus of new States, and the roving tribes of Indians that now occupy it would give place to a flourishing population. It is believed that in climate, as well as soil, this country far surpasses that of Kansas.

Westward from the Rio Grande, the valley of the river Gila, though somewhat inferior to the Canadian as regards fertility of soil and its supplies of timber and fuel, presents similar advantages, in respect to the direction of its course, and the facilities it would afford for laying a railway. If the harbor of San Diego were selected as the terminus of the road, there would be no doubt that the road should follow the valleys of the two above-mentioned rivers; and a

suitable connection might be established between their sources, either by following down the valley of the Rio Grande, or, more directly, by exploring for a route from the headwaters of Pajarito creek to some point on the Rio Grande, near the Mesilla valley.* As San Francisco, however, must necessarily be the terminus of the main branch of the Pacific railroad, to follow the Gila would increase the distance several hundred miles. This divergence may be avoided by continuing upon the route we have now traversed.

Between Rio Grande and the Colorado, we passed through a region which, though to a great extent fertile in nutritious grasses, and abounding in woodlands, springs, and streams, possesses the disadvantage of being intersected by several mountain chains. But, through them, we have discovered passes that render the route practicable, if not easy; and the knowledge now possessed of the country is sufficient to point out for examination many short lines of intersection, where, doubtless, the length of the trail might be shortened, or the grades diminished. From the Colorado to the upper waters of Mojave river—thought he soil is more waterless and barren—there is no serious obstacle to the construction of a railway. Upon either side of our trail, a better line doubtless exists; and, to connect with a pass to Tulare valley and San Francisco, it is believed that our general route will be found highly favorable.

A constant succession of light showers has occurred during the day. Night brings no sign of approaching fair weather.

*March* 18—*Camp* 150.—At daybreak the camp equipage was nearly as wet as when it was gathered up from the water of Rio Colorado; and the once goodly tents, now shaved down to shreds to diminish the weight to be transported, afforded little protection from the incessant rain. The poor mules, with curved back, and four feet drawn into a bunch, looked the picture of discomfort, as with ill grace they submitted to the galling packs. Recommencing our operations, the descent, for a few miles, was along the steep and rocky bed of Cajon creek, which has received several tributaries, and is now a good-sized mountain rivulet. Six miles brought us to a spur which followed the right bank of the creek, and separated it from a smaller ravine called "El puerto de los Negros."

We now left the road which leads to San Bernardino, and to the military post at Jarupa, and turned westward along the base of the mountain chain towards Los Angeles. The cold

* NOTE.—About the time that this report was ready to be submitted to the department, a letter was received by the Chief of the Corps of Topographical Engineers, containing information in regard to this subject. By his kind permission it has been copied, and is herewith subjoined. The writer, for many years, has been stationed in New Mexico, and has bestowed much attention upon the character of the country, particularly with reference to the object in view. His opinions are therefore entitled to great consideration. The map referred to has not yet been received at the bureau.

HEADQUARTERS THIRD INFANTRY, FORT FILLMORE, N. M.,
*September* 7, 1855.

COLONEL: I have the honor to inform you that I have given a map of a reconnaissance made by me, over and through the Sacramento and White mountain ranges, to Lieut. Parke, of your corps, to deliver to you. Its chief value consists in exhibiting a pass, and the only one in the whole range of what may be called the Guadalupe, Sacramento, Capitan, and White mountains, in almost a plain, going east, by ascending the Tulirosa to its head, crossing a dividing ridge with easy slopes of a short distance, (the only elevation of the whole route,) and then descending the Cerrissa to its junction with the Ruidosa; thence to the junction of the Bonita—which forms the Honda, which empties into the Pecos—turns to the south of the Capitan mountain, opening into the extended plain of the Pecos, reaching as high as Anton Chico.

The Ruidosa, Cerrissa, and Tulirosa are densely covered with the largest and finest pine timber found within the limits of New Mexico.

This map may be useful to you at this particular time, by showing how the best survey, east and west of the Rio Grande, can be connected, with the least expense, in making the Pacific railway. I refer to Captain Whipple's survey up the Canadian, with Lieut. Parke's down the Gila.

The distance from the southeast point of the Capitan to Anton Chico is estimated at about one hundred miles; it has never been surveyed. The map contains the other distances, as taken by viameter, to the Bonita: from that crossing to the southeast point of Capitan is not over ten miles.

I have the honor, Colonel, to be, very respectfully, your obedient servant,

D. J. MILES,
*Lieutenant Colonel, Third Infantry.*

Colonel J. J. ABERT,
*Chief Topographical Bureau, Washington City, D. C.*

drizzling rain yet falling, covered and frequently concealed the top of the Sierra. But near the base were forests of trees uniting with smooth grassy slopes, and bright green patches of wild oats stretching far down into the valley. Issuing from ravines among the mountains were several turbid streams, whose existence depends upon the rainy season. Some of them were already difficult to cross. Leaving the immediate base of the mountains, we entered the great grassy plain which inclines gently towards the south, where, many miles distant, there seems to be the trace of a permanent stream flowing westward nearly parallel to our course. The intermediate plain contained numerous herds of horses and cattle grazing upon the immense sheet of tall and luxuriant grass. It was variegated with an abundance of bright flowers, and much of the shrubbery that lined the numerous streams coming down from the mountains was in full bloom.

At length, after a march of twenty miles, we arrived at the rancho of Cocomonga, and encamped upon a pretty stream that waters it. The house of Señor Prudhomme, the owner, stands upon a grassy knoll, and had been visible nearly the whole day. Below it are cultivated fields and vineyards. The rivulet is fed by permanent springs near the base of the mountain, and after fertilizing a considerable extent of the valley, passes among some low hills to join the Santa Ana.

We are told that the rainy season is now in full vigor, giving showers every day. Whenever the air proceeds from the mountains, it comes saturated with moisture. Coast breezes are followed by pleasant weather.

*March* 19—*Camp* 150.—Several mules strayed yesterday morning, and were not missed until night. We agreed to rest here for the day, in order to allow the herders to go back for them. They set out at daybreak, and at dark returned quite successful. The animals had been found where they were left, undisturbed by any of the mountain robbers. But we are told here that the settlers deem it necessary to watch their herds with as much vigilance as if they were upon the prairies, in the midst of wild Indians.

Our camp is near a rancheria of Cahuillas, who appear to be peons of Cocomonga. With them is an old Indian, dressed in an entirely new suit, in the style of a California ranchero, and he professes to have come from José Antonio, the general-in-chief of the tribe. His object is to learn from us, officially, whether the Californians have told them the truth in saying that Santa Ana was on his way hither to drive the Americans from the land. The old fellow said that he was not a Cahuilla, but a Christian, because, when a boy, a priest at San Luis Rey took and converted him. After the missions of California were broken up, he returned to his own people under the government of General José Antonio, but he declares that he has lost none of the doctrines taught by the padres. As he spoke Spanish, we were enabled to obtain a vocabulary of his native tongue. When questioned regarding the religion and traditions of his tribe, he became very cautious, seeming to think that we might have some sinister object in view. His people are a filthy and a miserable-looking set, and great beggars, presenting an unfavorable contrast to the Indians upon the Colorado.

During the day there has been a constant succession of April-like showers, with bright sunshine between. A rainbow at sunset promised fair weather for the morrow.

In the storehouse of Mr. Prudhomme we found many barrels of wine, manufactured from his vineyards; but it was new, and not pleasant to our taste. The hedges around the gardens were formed of huge cactuses, growing twelve to fifteen feet in height. The leaves, or, as they are more properly called, joints, are about a foot and a half in diameter. This variety of cactus is probably not native, but imported from Spain by the Jesuits. It bears a purple fruit, called tuna, much prized for food by the people of this country. It somewhat resembles a large plum.

*March* 20—*Camp* 151.—We prepared this morning for an early march, and found the promise of the rainbow fulfilled. The atmosphere was soft, serene, and fragrant. At sunrise a dense fog rose from the valley, and hung upon the side of the mountain of San Gabriel, seeming to encircle the peaks; leaving the tops visible, several thousand feet above the plain.

Our course was west-southwest upon the northern border of the elongated basin before mentioned. In size, importance, and direction, it conforms to the great mountain chain, by the upheaval of which this depression was probably produced. It is watered by many streams; some of them said to be permanent, others owing their origin to rains and melting snows upon the mountains. Over this wide extent of fertile valley are seen a few adobe houses, and occasional grazing herds of horses and cattle. Upon our left was pointed out the superb "Rancho de China," for which Colonel Frémont is said to have offered, in 1849 or 1850, two hundred thousand dollars. Beyond, having travelled twenty-four miles, we encamped upon the bank of the pretty stream of San Gabriel, opposite the town of El Monte.

On the way, two California gentlemen from San José met and accompanied us a short distance. They showed much interest in our operations, and expressed their opinion that the Tejon was the best pass known, and that through it the railway should be constructed to Tulare valley, and thence to San Francisco.

*March* 21—*Camp* 152.—Having crossed the little river of San Gabriel, we entered the precincts of the town of Monte. Each spot of 160 acres, for miles in all directions, appeared to be ditched around, hedged, and cultivated. Houses of canvass, brush, boards, or adobes, gave shelter each to a family of settlers. Improvements were rapidly progressing. There were the cheerful sounds of American voices, of the blacksmith's hammer, and the merry laugh of children trudging to school. The whole scene appeared very odd, as if a New England village had by some magic sprung up upon the Pacific. Possession of all the beautiful country we have traversed since leaving Cajon Pass is claimed under old grants from Spain or Mexico. A few months since, however, a party of emigrants conceived that there was a flaw in the old Californian's title to this spot, and consequently they "squatted." There are supposed to be five hundred families upon the location. Their estimate of the fertility of its soil and the excellence of its climate is clearly exhibited, by their leaving rich placers to cultivate and improve lands, with the risk of being finally driven from them by law.

Upon our course, south 60° west by compass, we passed to the left of the beautiful mission of San Gabriel, and were near enough to see that it was a fine old ruin, surrounded by gardens and vineyards, and with a rivulet flowing at the foot of a lawn. To save distance probably, for smooth prairies seemed continuous upon the right, our road entered a ravine among ridges of hills, passed over broken ground for a short distance, and then, from a slight eminence, we looked upon the valley and city of Los Angeles. Descending, we crossed the river which waters the valley, and entered the city. The stream, where we forded it, was about fifty yards wide, and from two to two and a half feet deep. Above and below were numerous acequias; irrigating vineyards, orange and olive groves, peach orchards, gardens, and cornfields. Along dismal-looking lanes were scattered piles of adobe houses, and the intervening spaces were lined with mud walls and cactus hedges. But as we proceeded towards the plaza, the sombre character of the place nearly disappeared before the march of American improvements. There were respectable indications of business and activity. We noticed hotels, cafés, barbers' signs, and a long array of flaunting shops. The buildings were formerly of one story, with a broad piazza in front. But houses are being erected in more modern style, and many white tents in the suburbs mark the spots where new comers design to build. The population is said to be 3,000, and is rapidly increasing.

Camp was pitched upon the point of a ridge of hills which comes down to the left bank of the river, overlooking the city. As we were now within the limits of the operations of the "Coast Survey," and an almost unbroken plain is said to lead from Los Angeles to San Pedro, we determined to disband the party, and proceed with all possible despatch to Washington; there to make known the results of our explorations. As there was no officer of the government in the place to whom the United States' property in our possession could be turned over, it appeared necessary to dispose of it, and immediate notice was given that a public sale would take place at the plaza, on the morrow. At night astronomical observations were taken for the determination of latitude and longitude.

*March* 22—*Camp* 152.—A dense fog hung over the valley at sunrise, but it soon disappeared, and we were favored with a bright and beautiful day, such as are said to render the climate of Los Angeles the most delightful of California. At ten a. m. the auction commenced, and continued during the day. The sale being forced, the prices were confessedly low, although some of our mules brought upwards of one hundred dollars each.

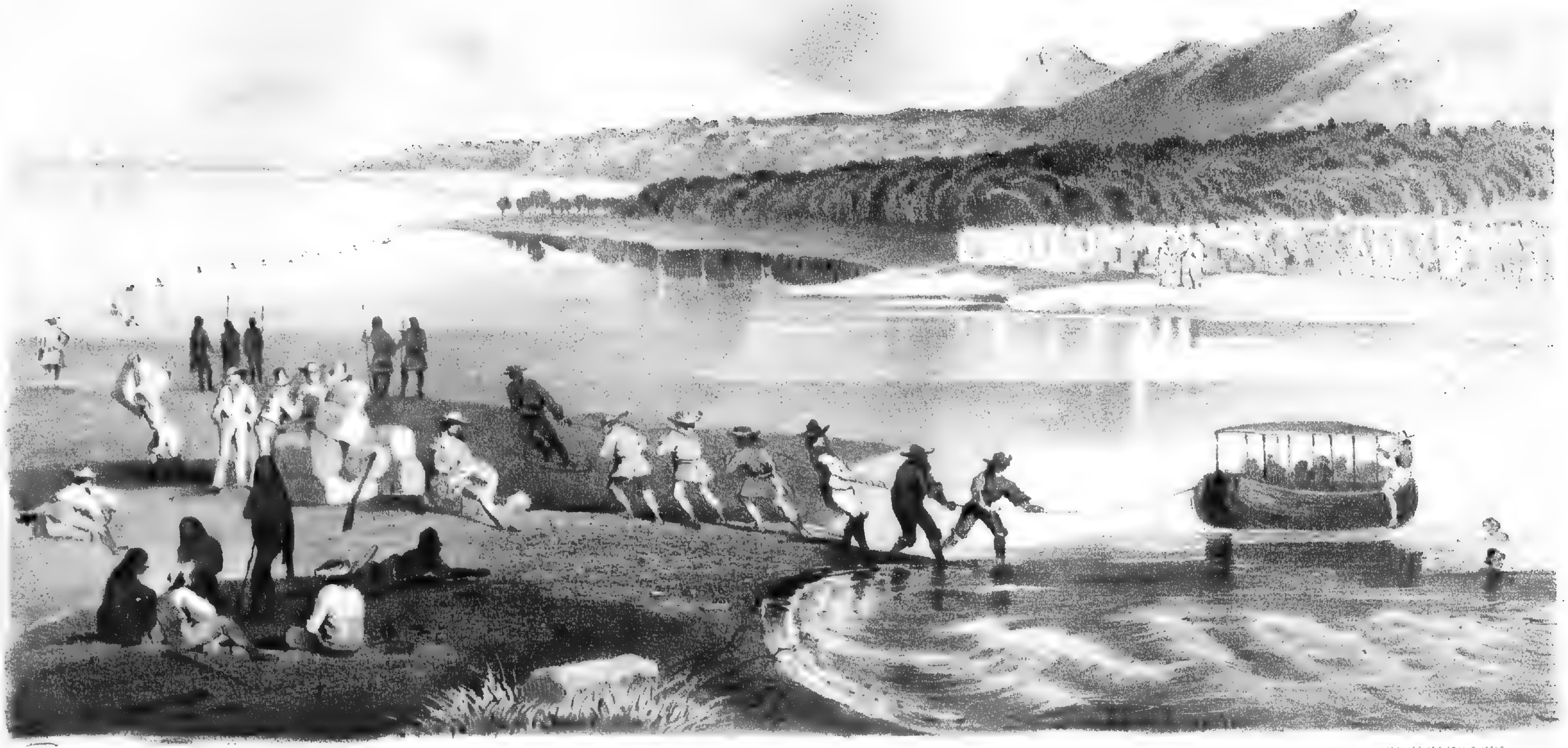
*March* 23—*Camp* 153.—The sale was continued, and brought to a conclusion with all possible despatch, for we learned that the steamer for San Francisco would arrive a day earlier than had been expected, and it was necessary to proceed to San Pedro in the evening, in order to meet it. At 4 p. m. we were told that the stage-coach could wait for us no longer; so, having placed the few things we had not time to attend to in charge of one of the assistants of the party, who proposed to remain, we started for San Pedro. The odometer was attached to a wheel, to measure the distance; and with a prismatic compass and sketch-book, we hoped to make a hasty reconnaissance of the country to be passed over. Rolling rapidly over the fine prairie upon the right of the well-cultivated valley of the river, Los Angeles soon became dim in the distance behind. A rain-storm, and, shortly after, darkness overtook us, and we splashed through ponds of water produced by rain or brought by high tides from the ocean. The storm drove furiously; the road was lost in darkness; the stage-coach went blindly along, now and then dropping into a hole, and compelling us to alight to avoid an upset. At length two lights gleamed from ranchos ahead, and the driver found out where he was. But the road was so muddy and full of holes, that he said we must walk, first to the light on our right, and thence to the other, where he would meet us. As we plunged half knee-deep into water and mud, the light of heaven seemed actually extinct, and terra firma had to be felt for unseen. The driver cautioned us, as we started, to look out for some deep pits that had been dug for wells in the neighborhood, and to beware of the savage dogs that were kept at the ranchos. As for "looking out," that was impossible, so we steered straight for the distant light, and, without serious accident, reached it. We represented our condition to the master of the mansion, and asked him to lend us a lantern. We then, after many narrow escapes from sloughs and ditches, waded to the other house, took the coach, and without accident arrived about midnight at San Pedro, where we met with most hospitable entertainment.

*March* 24.—The morning was bright and clear. At 8 a. m. the reading of the thermometer was 68°; barometer 30.030 inches. The custom-house, where these observations were made, stands upon the bluff bank, from twenty to thirty feet above high-water mark. Spring tides are said to rise nine or ten feet; neap tides from four to five. The port of San Pedro does not afford complete protection for large vessels; small ones, by crossing a bar with some twelve feet water at high tide, enter a basin at the mouth of San Gabriel river, where they are entirely sheltered. A city has there been laid out, and several houses built, in the expectation of rivalling the pueblo of Los Angeles. At the playa, or principal landing, there is an indentation of the coast by which shipping is said to be screened, except from southeast winds. These occur only in winter, and then very seldom. Last winter only one arose, and a ship in port rode it out at anchor. Captain Ord, who is conducting the coast survey at this point, informs me that a breakwater of about a mile in length would make a safe and commodious harbor even for a fleet, and wharves could easily be built out into deep water so as to furnish every advantage of a good port.

Our reconnaissance yesterday evening from Los Angeles was interrupted by the darkness. The distance measured by odometer was nearly twenty-five miles, and the course, approximately obtained, was a few degrees west of south, to San Pedro. The country was almost a plain, with a slight dip towards the coast. In the dark we seemed to cross a low ridge of hills; whether to avoid the overflowed grounds or to shorten the distance, we did not learn. Evidently it could have been avoided.

Early this morning the steamer from San Diego arrived, and, excepting Mr. White and Mr. Sherburne, who, delighted with the beauty of the country, preferred to remain in Los Angeles, all the officers of the party took passage for San Francisco, en route to Washington.

# PART II.



Drawn by J Young from a Sketch by H.R Möllhausen.

SARONY MAJOR & KNA

RIO COLORADO—NEAR THE MOJAVE VILLAGES

VIEW No 2.

from an Island looking north.

EXPLORATIONS AND SURVEYS FOR A RAILROAD ROUTE FROM THE MISSISSIPPI RIVER TO THE PACIFIC OCEAN.

WAR DEPARTMENT.

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ROUTE NEAR THE THIRTY-FIFTH PARALLEL, UNDER THE COMMAND OF LIEUT. A. W. WHIPPLE, TOPOGRAPHICAL ENGINEERS, IN 1853 AND 1854.

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# REPORT

ON

# THE TOPOGRAPHICAL FEATURES

AND

# CHARACTER OF THE COUNTRY.

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WASHINGTON, D. C.
1856.

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General map from Fort Smith to Rio del Norte, upon a scale of one inch to 15 miles.

General map from Rio del Norte to the Pacific ocean, upon a scale of one inch to 15 miles.

Profile of a route for the Pacific railroad, from Fort Smith to Martinez, near San Francisco.

## GENERAL SKETCH OF THE ROUTE.

Our operations have been confined to a belt of country bordering upon the parallel of 35° north latitude. The conformation of this region is such as to afford some peculiar advantages for the construction of a national railroad. There are many water-courses passing through it, and valleys extend in the desired direction over a great portion of the distance between the Mississippi river and the Pacific ocean. This route would accommodate the eastern trade which centres at Vicksburg, Memphis, and St. Louis; and the railroads which are contemplated westward from those cities, through the States of Louisiana, Arkansas, and Missouri, might well converge,and unite upon the Canadian.

From the eastern border of the Choctaw territory to the head of Pajarito creek, about seven hundred miles, our route is near the valley of the Canadian. Beyond, to Rio Pecos, (nearly forty miles,) it passes a ridge which extends northwardly from the Llano Estacado and divides the waters of the Mississippi from those of Rio del Norte. After crossing the Pecos, threading Cañon Blanco, and traversing the high mesa which breaks the continuity of the Rocky mountains, this line unites with the valley of Rio Galisteo, and strikes the Rio del Norte near San Felipe; or, by a shorter route, from the lagunas near the head of Cañon Blanco, proceeds by the way of San Antonio Pass to the narrows of Rio Grande, at the Pueblo of Isleta.

Having crossed the Rio del Norte, and also the Puerco, we ascend by Rio San José and the broad opening in which it takes its rise, to a low point upon the crest of the Sierra Madre; the range which divides the waters flowing towards the Gulf of Mexico from those emptying into the Pacific. From this summit, the valley of Rio Puerco of the west leads to Colorado Chiquito, (Flax river,) down which we proceed to the great bend towards the northwest. Then, by a pass south of the San Francisco mountains, we enter a well-wooded region where springs feed the head branches of Rio Verde. Continuing westward, we cross various small rivulets, and, edging along the banks of Pueblo creek, ascend to Aztec Pass. Thence to the Mojave villages two routes are noticed; one, following the valleys of Williams' river* and Rio Colorado; the other, a shorter line in nearly a direct course westward from Aztec Pass, via White Cliff creek and a gap which separates the Cerbat range from the Blue Ridge or Hamook-hăbî mountains, to the Colorado above the cañon of "The Needles," near Camp 132. Leaving Rio Colorado at the Mojave villages, we pass the Paiute mountain, with steep but regular slopes, to Soda lake, and a few miles beyond, upon the flowing waters of Mojave river, unite with the survey of Lieutenant Williamson. As that officer is now understood to have been successful in his explorations through one of the Tulare passes to San Francisco, we need but refer to his report for a description of the remainder of this route to the Pacific.

The line will now be divided into sections, and the topographical features of the country given somewhat in detail.

* Heretofore called "Bill Williams' Fork." The Mojave or Cuchan name of this stream is "Hăwîl-hamɔok," meaning *third river*.

## SECTION I.

### *From the Mississippi River to Fort Smith.*

The legislature of Arkansas having already taken the initiative with regard to the construction of a railway through the State, from the Mississippi river to Fort Smith, no special examinations were required of us within those limits. It may, however, be remarked that, from the general nature of the country and the vicinity of navigable rivers, the grades would necessarily be light, and materials for the construction of a road easily obtained.

The height of Little Rock was found by observations to be 351 feet above the level of the sea. Napoleon is 142 feet above tide-water, and Memphis, by estimate, 54 feet higher, making 196 feet. This would allow the difference of level between Memphis and Little Rock to be 155 feet; and the distance being about 155 miles, the mean ascent would be one foot per mile. From information that seems reliable, it appears that, from the point opposite Memphis to the river St. Francis, thirty-nine miles, there is an extensive marsh subject to overflow, rendering an embankment necessary for the road that crosses it. To avoid this, although probably not a very serious obstacle, Helena has been suggested as the terminus of the proposed railway from Fort Smith to the Mississippi. From the St. Francis to Little Rock, 116 miles, the country is said to be undulating, with woodlands and prairies favorable for the location of a railway.

Between Little Rock and Fort Smith there are two ranges of mountains, called the La Fourche and Petit Jean. They rise abruptly from the river, with peaks 1,000 feet high, and are said to extend southwest some thirty miles. It is believed that the country beyond is favorable for a railroad, which would thus avoid a large bend of the river valley.

The banks of the Arkansas are covered with excellent timber—ash, elm, black walnut, pecan, and various kinds of oaks. Above Little Rock the lower carboniferous formation commences, soon passing into coal measures. Coal outcrops at various points in the neighborhood of the river; it is bituminous, of good quality, and easily obtained. Considerable use is made of it for fuel, and as population increases, and the superabundance of wood is diminished, the value of this source of wealth will be more highly appreciated. The State abounds in mineral wealth. Its stores of iron are believed to be inexhaustible. Lead, copper, and silver are said to be found in considerable quantities. Quarries of roofing slate, near the river, furnish a large supply of that material for the markets of St. Louis and Cincinnati.

Fort Smith is situated upon the right bank of the Arkansas river, just below the junction of the Poteau. The military post is near the fork, and within the Choctaw territory. The town, or city, commences a few hundred yards below, and is within the limits of the State. The position is upon a ridge of dark micaceous sandstone, rising about sixty feet above the river. The back country is composed of wooded hills and high prairies. Some thirty or forty miles distant, south, are seen the summits of Sugar-Loaf and Poteau mountains, two thousand feet above the river.

Numerous barometric observations at Fort Smith made its altitude four hundred and sixty-eight feet above the sea. Supposing the distance from Little Rock to be one hundred and sixty miles by land, and the elevation, as observed, one hundred and seventeen feet, the mean grade would be less than a foot per mile.

## SECTION II.

*From Fort Smith to the head of Pajarito Creek, seven hundred and two miles.*

The Canadian river and the branch above mentioned may be considered as occupying the same general valley, the course of which is nearly west for the distance specified.

The mean inclination of the Canadian is nine feet per mile, from the junction of Tucumcari creek to its entrance to the Arkansas, affording light grades, without expensive excavations or embankments. Few large bridges would be required, because most of the tributaries sink as they approach the great valley. The trail upon which our profile was made, in order to avoid some of the principal bends of the river, is generally favorable for the location of a railway. Some of the valleys traversed, particularly those of Walnut creek, Deer creek, and the affluents to the False Washita, contain better timber than is found upon the banks of the Canadian, in the same meridians. There is, upon this section, plenty of sandstone, quicklime, and gypsum. Upon the eastern part, extensive beds of coal and large forests of trees afford fuel and timber in abundance. The Cross Timbers extend to the meridian of 99° 11′ west from Greenwich; and the wooded branches of the False Washita would afford materials for bridges and railroad-ties fifty or sixty miles beyond. Thence, to the end of the section, from three and a half to four degrees further west, good timber is scarce; yet large cotton-wood trees grow in the valleys, and the hill-slopes are covered with thick groves of cedars which afford excellent fuel. Lieutenant Abert reports the existence of "an abundance of timber" a short distance above the mouth of Tucumcari creek. Hence, the supply for the construction of a road in this vicinity might be obtained from that region, or from the Cross Timbers. Upon this section, the labor of graduation could not much exceed that required in the valley of the Ohio. The expense of bridging will be small. In cutting off the bends of streams, our trail crossed a few barren spots; but the valleys throughout this section may be cultivated. The eastern portion is remarkably fertile. Throughout the extent of the Canadian valley, the precipitation o moisture is evidently greater than occurs elsewhere, north or south, within the arid region that lies east of the Rocky mountains. Springs and streams are numerous, and common wells, or short aqueducts, would furnish sufficient water at those points where railroad stations would be required.

From a general view of this section, we will pass to the consideration of some of its topographical details, taken from the field-notes and journals of the expedition.

From station 1, near the flag-staff at Fort Smith, to the ferry of the Poteau, the distance southwest is nine hundred yards, and the descent fifty-two feet. The width of the stream at that point is two hundred and thirty-five feet. The water is somewhat turbid and apparently deep, being backed up from the Arkansas with which it unites a few hundred yards below. The right bank of the Poteau is formed by a nearly precipitous ledge of slaty rock, from twenty-five to thirty feet high. The left bank is generally about eight feet above the water's edge, but during freshets is overflown. Better points for bridging occur above the ferry. That considered the most favorable is at the ford, where the bottom is of rock, and bluff-banks at nearly equal heights line both sides. A span from thirty to fifty feet is believed to be sufficient; and building materials may be found in the vicinity.

From the ferry, before noticed, the road crosses a low bottom land, extending from the Arkansas on the right to the Poteau on the left. This is covered with forest trees of various kinds, and a thick undergrowth. Eight miles distant from Fort Smith there is a Choctaw set-

tlement with cultivated fields. A mile or two beyond, the road ascends to a ridge about sixty feet above the river. Here is a farm-house, near which was formed our Camp 1. It is nearly intermediate between the Poteau and the Arkansas. The slopes are covered with oak timber, suitable for railroad ties. The soil is good for tillage, and both the smooth prairies and the ravines afford pasture. There is no need for the railroad line to ascend this ridge. Either base of it could be followed, but that by the Poteau is preferred.

From Camp 1 to Scullyville, the road continues upon the high lands, crossing a prairie and several ravines with descents and ascents averaging about fifty feet. The country is well timbered with white-oak, post-oak, and blackjack. Several farm-houses and cultivated fields were passed. The route proposed for the railroad follows the course of the Poteau upon the left.

From Scullyville the general character of the country near the road is unchanged to Camp 7; consisting of isolated prairies and wooded hills, with small creeks and rills among the ravines. A few miles south of the road is found a more level country of prairie character, with a drainage to the Poteau. Upon this is the railroad line, proceeding from a point south of Scullyville to a densely timbered valley between Piney Ridge and the Sans Bois mountains. Near the western part of this valley we reach the head-waters of a branch of the Poteau, cross an almost inappreciable summit, and find other prairies leading to Sans Bois river. This river is seventy feet wide, and would require a bridge with a span of seventy-five feet. The distance from Fort Smith is fifty-four miles; the grades quite easy, the maximum being forty feet per mile, with little labor for excavation or embankment. There are few ravines which would require bridging. The route now follows the valley, ascending the right bank of the Sans Bois river for a distance of sixteen miles, then crossing the stream, which is seventy feet wide, and keeping near the left bank to its head-waters. From that point a low divide is passed, and we reach La Honda, which a short distance below empties into Gaines's creek.

In the vicinity of Sans Bois creek there are forests of great extent, abounding in oak, hickory, and pecan timber. Upon the hills, sandstone is found suitable for the purposes of construction. The wide bottom-lands, through which numerous tributaries of the South Fork of the Canadian have worn deep channels, possess a rich alluvium, covered with timber of remarkable size and beauty. In this vicinity there are Chickasaw settlements, with numerous cultivated fields.

Gaines's creek is a clear stream twenty feet wide, with banks in some places twenty feet in height. For a bridge, a span of fifty feet would be required. Thence, the country is undulating for fourteen miles to Coal creek. This stream, which is ninety-five feet wide at the crossing, is another of the tributaries of the South Fork. Its name is derived from the great quantity of coal found in the vicinity. In several places the coal-bearing strata crop out above the surface. They appear also upon Sans Bois creek and at other points between Fort Smith and this place. Ordinary wells in this region, from forty to fifty feet deep, frequently discover beds of coal two to three feet thick. Besides bituminous coal, sufficient for the uses of a railway and for exportation, this formation contains sandstones and limestones excellent for the construction of bridges and viaducts.

The valley of Coal creek, although intersected by several ravines and spurs of rocky hills, may be followed to the head of one of its branches near a low divide, south of the Shawnee hills, which separates it from Boggy river. This range of hills is rough and steep, even for the wagon road which crosses it; but as it trends westwardly, it may be turned by passing the dividing ridge between Coal creek and the Boggy, about eight miles south of Shawnee village. The ascent from Coal creek to the summit is by a broad prairie; thence to Camp 17 there is a forest, intersected by narrow ravines and intervening hills across which easy passages are found. The grades are from twenty to thirty feet per mile.

Upon entering the wide and nearly level basin, fertilized by numerous small tributaries of Boggy river, the woods become less dense, and soon give place to open prairies of considerable extent. Upon the north is a ridge of wooded hills, extending from the Canadian towards the southwest, so as to include Delaware Mount. There are several passes through this range, two

of which open to an extensive prairie, nearly level, leading to Beaverstown. A route is indicated also west-southwest, about eight miles, to the valley of Washita river; which, as laid down from Captain Marcy's survey, would afford a good location to its source near the Canadian. The line which is developed upon the profile keeps near the road, passing Beaverstown, and crossing the almost inappreciable crest of the divide at Camp 23. Beyond, it is easy to pass into the valley of the Washita, or follow in the vicinity of our trail, threading the fertile basins watered by Walnut and Deer creeks, edging the forest of Cross Timbers to Rock Mary, and thence crossing a bleak prairie to Gypsum creek, near its confluence with the Washita.

Delaware ridge is the boundary between the carboniferous group and the new red sandstone, or Trias; and the topographical features east and west are also different. Thence to Camp 20, the country is wooded and somewhat hilly, being intersected by Topofki creek and other affluents of the Canadian. The streams are small, with gravelly beds—the largest thirty feet in width. The hills passed are from fifty to seventy-five feet in height above their base; they gradually diminish and disappear in the direction towards the Canadian. From Camp 20 to Beaverstown, we crossed a portion of the woodless plain referred to. It is, however, intersected by several ravines, with a border of trees variegating the landscape. Beyond, the country acquires in a great degree the distinctive characters of the western prairie. The surface is nearly level, and trees scarce. Opposite Camp 22, the Canadian makes a large bend towards the north, and our trail, instead of following it, kept near the summit of the prairie slopes, which separates the waters of the Canadian from the tributaries of Red river. At Camp 23, near the eastern edge of the forest of Cross Timbers, there is an Indian trail leading southwest, along the borders of a small creek, to the Washita river. This is a favorable entrance to the valley of that stream, which would probably afford a favorable location for a railroad to its source. To avoid penetrating the dense growth of post-oak and blackjack, of which this forest consists, the wagon road skirted the northern edge of it, crossing numerous flowing streams tributary to Walnut creek. The soil of their valleys is a rich loam, producing rank grass, and large oak and hickory trees. At the head of Walnut creek, we again found ourselves upon a broad prairie, where gypsum appeared upon the surface. The Cross Timbers here recede several miles towards the south. The grassy plains, somewhat cut up by ravines, extend to the well-wooded valley of Deer creek. This is a clear and rapid stream, flowing to the Canadian. Where forded, it was two and a half feet deep and six feet wide. Its waters irrigate a considerable extent of country, admirably adapted to agriculture. Leaving Deer creek, we again crossed a series of plains intersected by small arroyos; the Cross Timbers being visible upon our left until we reached "Rock Mary," one of the so-called natural mounds, which are from seventy-five to one hundred feet in height. These are horizontally stratified, and appear to be isolated remnants of the mesa formation which once covered this region. Beyond, the surface is level, sandy, and covered with extensive beds of gypsum of the best quality. For about ten miles, no streams or springs were passed. The aspect of the country is barren and desolate. It could be avoided by descending from Camp 28 into the valley of the Canadian, or by following the Washita, as proposed, from Camp 23. Near Camp 30, we crossed Gypsum creek, an affluent to the Washita, flowing south through bluff banks cut from an alluvial valley. It would require a bridge about 150 feet in length. The stream is well wooded with oaks and elms, excellent for timber; the current is rapid; the water is slightly brackish, but deep, containing an abundance of fishes.

At short distances beyond, are Bear creek and Elm creek, both covered with timber, the latter twelve feet wide and three and a half feet deep. Then appears the main valley of the Washita, a beautiful stream, traceable for a long distance, from the west-northwest towards the east-southeast, by the belt of timber which borders it. The valley is wide and fertile. It receives numerous tributaries from the north, divided by banks of red clay and gravel. As far as visible, it affords a good location for a railway. Probably it might be followed to its junction with Red river, and thence, via Shreveport, communication would be established with all the southern commercial cities.

The ridge which divides the waters of the Canadian from those of the Washita, maintains a nearly uniform height throughout its whole extent; but it is much contracted in width near the head branches of the latter stream. The arroyos, therefore, which lead from it are washed into gullies, and have steep declivities. For a railroad, it might be preferable to ascend in a northwest course along the southern slope of this ridge, cross the elevated mesa south of the Antelope hills, and enter the Canadian valley at Grape creek. Our trail followed a northward course towards the Canadian, crossing various tributaries of the Washita. Comet creek flows in a cañon, with banks about thirty feet high, requiring, near its mouth, a heavy embankment and a bridge from fifty to one hundred feet in length. Thence to Camp 33, the appearance of the country remains nearly the same as has been described; a succession of spurs and intervening rivulets, which unite a short distance below, in the valley of the Washita. Marcou creek, Oak creek, Buffalo creek, and some others, are flowing rivulets, with banks covered with timber, which would suffice for the necessary bridges. The numerous valleys are adapted to agriculture, and the high lands to grazing. Buffalo-grass appears near the head-waters of the Washita. Other prairie grasses are abundant eastward.

The first of the engineering difficulties encountered upon this route is in crossing the narrow ridge which divides the head-waters of the Washita from the Canadian. From the summit, gullies have been washed from the red clay banks so as to render considerable excavation and embankment necessary for a side location upon the ridge. In order to avoid the gullies, two modes are proposed. The first—following the main valley of the Washita to its head, edging along the southern slopes of the mesa to its top, near the Antelope hills, and then crossing into Grape creek—has already been referred to; the other, is to ascend a branch of the Washita, and cut through the crest to a corresponding ravine which leads to the Canadian.* The distance is short, but the excavation would be considerable. According to the profile a maximum grade of 75.6 feet per mile would be required for a short distance.

The following brief extracts from the field-notes will give more in detail the character of this dividing ridge, and other difficult portions of the route immediately on the line of survey.

The creek at Camp 33 is well timbered with oak and some cotton-wood. From the camp back to where the road crosses the river is a valley, the general width of which is about half a mile. The stream is very crooked. There is a low range of hills to the left. From station 19† the ground appears more favorable upon the left of the trail, until, passing Camp 33, we reach station 3. Grade, from station 3 to station 12, not more than fifty feet per mile. Station 7 is upon the table-land, and the ascent to it, from Camp 33, is gradual. Two creeks, branches of Buffalo creek, pass through stations 11 and 12, and join below. Both are dry, but contain large alamos and oaks. Station 15 is on the top of a ridge. The hill is considerably cut up into gullies; the soil is composed of red clay and sand; good water is found at Alamo spring. Beyond, the surface is prairie; and to station 23 there are few obstructions. Between station 23 and Camp 34 is the dividing ridge which separates the waters of the Canadian from those of the Washita. It can be passed by running from station 22 or station 23, slightly to the right of station 27, which is upon the summit; and thence entering a ravine which leads to the Canadian, about two miles distant. To obtain a grade of sixty feet per mile, a cutting of fifty feet would be required.

Near station 26 there are a few dwarf oaks. Captain Marcy's trail, which, avoiding the valley of the Washita, kept the dividing ridge near the Canadian, passes through station 27 and to the

* From this point of the Canadian, it is believed that a railroad might easily be constructed, in nearly a direct line, to Springfield, Missouri, there to unite with the railroad from St. Louis. The gypsum formation extends for some distance north of the Canadian, and produces, probably, a country not unlike that traversed upon the south. Beyond this the route would cross the new red sandstone and carboniferous formations, developing mines in the coal basin. The most important items of expense on this location, would doubtless be for bridging the Arkansas and Canadian rivers; and, in that respect, the line under consideration from Fort Smith is more advantageous.

† The stations referred to are plotted on the detailed sheets, but the general maps are upon too small a scale to allow them to be represented.

left of station 29. Station 32 is in a wooded ravine tributary to the Canadian. Near by is Camp 34, upon Epsom spring, the water of which is brackish.

From Camp 34 to station 4, several ravines are crossed, with high banks, covered with cotton-wood trees. Station 5 is a quarter of a mile from the Canadian. Station 8, at the foot of the hills, is in the valley of the river. The stream here is shallow, flowing over a wide surface of deep-red sand and clay. The bottom-lands are about half a mile wide, and have the appearance of having been overflowed; containing bushes and weeds, but little grass or timber.

From Camp 34 the line should keep to the left of the trail, edging along the ridge to the valley at station 8. For six miles the broad valley of the Canadian follows a westerly course. The gravelly ridge, which bounds it, is then ascended to avoid a northerly bend produced by the Antelope hills that deflect the river from its direct course. Station 16 is upon the top of the table-land. Station 17 is on a stream covered with cotton-wood timber, and containing good water flowing to the Canadian. On account of its steep banks it is called Cañon creek. Camp 35 is upon the bordering prairie, which extends nearly to the river, a distance of about a mile and a half, where the valley is a quarter of a mile wide. The trail passing between the Antelope hills, to cut off a bend of the river valley, is intersected by several ravines with steep banks. Sandy creek, 150 feet wide, is the largest. Indian creek is near the Antelope hills. Grape creek is remarkable for the number of vines that grow upon its banks. Camp 36 is in the Canadian valley, at the mouth of a dry arroyo. The intermediate country is principally prairie, much elevated at the Antelope hills, and, in some places, sandy. By the trail, the surface of the ground, from Camp 35 to station 3, has a rapid ascending grade, being 284 feet in two and three quarter miles, or 103 feet to the mile. From station 3 to station 9 the grades are easy. From 9 to 10, one mile, the difference of elevation is 135 feet, in consequence of station 10 having been taken in a ravine which might be avoided by an embankment or bridge. Thence to station 16, the grade is light. From 16 to 17, a quarter of a mile, the difference of elevation is 63 feet. This could be avoided by keeping to the left of the ridge between stations 16 and 21. From station 17 to the Canadian the distance is one and a half miles; from station 21, one mile; and between Camps 35 and 36, the greatest estimated width of the table-land, which slopes down towards the river, is two and a half miles. The distance by the valley will not much exceed that by the trail, and the former would be adopted as the line of location, so as to avoid the heavy work and steep grades above referred to.

From Camp 36, to avoid the soft alluvial soil of the valley, the wagon-road ascends about 150 feet, to the gravelly prairie that bounds the Canadian river. The plain is considerably cut up by water-courses, many of them dry. The highest part crossed is about a mile beyond station 1; and from that point there is a slope to a ravine, 200 yards wide, containing good water. Opposite station 2, upon the left bank of the Canadian, there is a ridge of sand-hills, with trees at the foot. A rivulet of clear water crosses the trail near station 7. At station 9 there is a dry arroyo, with banks covered with cotton-wood. Beyond station 10 the valley of the Canadian is well wooded. The trail, after passing several sandy beds of streams, crosses a creek with running water, between stations 27 and 28. Camp 37 is on a rivulet emptying into the Canadian. It contains good water, with cotton-wood upon its banks. From Camp 36 to this place the trail is about a mile south of the Canadian river. For a railroad, the valley would be followed at small expense, and with a uniform grade.

Leaving Camp 37, the trail enters the Canadian valley near station 1, where the alluvium upon the right bank of the river is about one mile in width. It is covered with timber. Upon the opposite side the width is half a mile. Beyond, the valley increases in width. Groves of cotton-wood occur, sometimes upon the right bank of the river, sometimes upon the left. Mounds 15 feet in height, and numerous ravines, appear in the vicinity of station 8. Between stations 10 and 11 is Dry river, with a gravelly bed 200 yards wide one mile from its junction with the

Canadian. Beyond are sand-hills, thinly covered with grass. At station 12 the sand ends, and clay appears. From station 13 to station 20 the trail keeps the edge of the valley, from half a mile to a mile distant from the river. Upon the opposite bank are cotton-wood groves. Passing two dry arroyos with wide sandy beds we reach Camp 38, which is within the wide delta formed by the junction of Wine creek with the Canadian valley. Grape-vines grow in profusion at this place, covering many acres, and loaded with fruit.

Along the river, a short distance beyond Camp 38, are Chickasaw plum, hackberry, and willow trees. Opposite station 2 no timber exists upon either side of the river. Beyond station 3 there is a sparse growth of cotton-wood. From station 8 to station 9 are found ash, cotton-wood, and hackberry. Beyond station 11 the valley opens to the width of two and one-eighth miles. Small, isolated hills appear near station 12, with cotton-wood and willows in the valley. These hills seem to bear some relation to a long range of natural mounds which extend towards the south. There are sand-hills in the valley opposite station 19, and at station 20 is a cotton-wood grove, near the mouth of a rivulet. Between stations 21 and 22 is Valley river, a fine stream of water, with fertile banks about three-quarters of a mile wide. Camp 39 is situated near its junction with the Canadian, overlooking a pleasantly diversified region of woodland and meadow.

Above Camp 39 a range of small sand-hills intersects the south side of the valley. For the purpose of avoiding it the trail crossed the stream at the mouth of Valley river. The Canadian is there one-third of a mile wide, and three feet deep in the largest channels, which are separated by sand-bars. The northern bank is sandy, and the valley wide. At station 15 the stream was recrossed. Here the bed of red clay and sand measured 840 yards in width. The flowing stream was 150 yards wide, and from one to two and a half feet deep. Station 16 is on the southern bank of the river, and from Camp 39 to this point there is no visible obstruction to the formation of a road upon either side of the valley. The naked sand-hills referred to are small, and do not appear to be continuous to the river. To avoid a miry slue, a ridge of similar sand-hills was crossed beyond station 17. Thence to Camp 40 the valley continues wide and somewhat sandy, with few trees upon the banks of the stream.

About half a mile beyond Camp 40 is a rivulet called Spring creek, three feet wide, its banks lined with cotton-wood trees. The valley of the Canadian continues to average from a mile to a mile and a half in width, thinly covered with trees. Between stations 3 and 4 there is a valley, bordered with cotton-wood trees. Near station 5 the prairie that bounds the Canadian terminates in a bluff edge 150 feet high. Some detached fragments of it form isolated hills of sand and gravel. At the foot of the hill, near station 6, there is a spring. Another is found in the Canadian valley between stations 6 and 7. A stream of clear water called Bluff creek flows past station 11 to the Canadian. Its bed is 30 yards wide, and the banks sandy. Beyond, the width of the valley averages about half a mile upon either side of the Canadian. Near station 26 the bluffs of the right bank approach to within 800 or 900 feet of the river, while upon the opposite side the valley spreads out to the width of two miles. Between stations 27 and 30 the valley is bounded upon the south by a nearly perpendicular limestone bluff. Beyond, the slopes of the prairie become gentle. From station 30 to 32, upon the south side of the valley, there are gravelly knolls. From station 32 to 34 a spur of hills comes down to the river. It is of soft sandstone and gravel. The trail crosses by threading two ravines, which head near the summit. The width of the ridge is 400 yards, and the height of it 56 feet. This is the only point yet seen in the Canadian valley where deep cutting may be required. Camp 41 is in the bottom-land near the western side of the spur. The fall of the river from this place to Camp 34 is seven feet per mile.

Beyond Camp 41 the wide river valley is bounded by a bluff composed of rock, sand, and gravel. Opposite station 2 there is a ravine between the hills. It is clothed with trees and a rank growth of weeds, but shows no worn channel for the water which it drains from the prairie during wet weather. On the north side of the river the prairie slopes gradually down

to the valley, until opposite station 1. There it is edged by a perpendicular bluff, composed of red marl, limestone, and sandstone, approaching within 150 yards of the river. On the right bank the alluvial bottom-land continues a quarter of a mile wide. Between stations 5 and 6 flows Mole creek, a rivulet six feet wide and one foot deep. At the foot of the bluff near station 8, is found red sand strongly impregnated with common salt. There are pools of salt water in the vicinity. At station 10, to avoid a cañon at the Agate bluffs, the trail leaves the valley of the Canadian, enters a wide ravine with irregular banks, ascends near to its head, and at station 11 rises to the high, rolling prairie, which slopes gently from the Llano Estacado. Station 14 is upon the high table-land, which is covered with short grass. The soil is a mixture of sand, clay, and a little gravel. Between stations 19 and 20 is a water-course with gently sloping banks. Another is crossed between stations 25 and 26, near Camp 42. It is sixty yards wide, containing pools of water and bound by rugged banks.

Should it prove necessary for the railroad to emerge from the Canadian valley at station 10, and ascend, by the sides of the ravine, to the high prairie which the trail passed over, for the first five miles a grade varying from 92 to 70 feet per mile would be required. The general slope of the plain is about 18 feet per mile; but it is considerably cut up by ravines, some of them having steep banks which would render heavy cutting and filling necessary in order to produce moderate grades. According to the profile the maximum grade would be 60 feet per mile.

From Camp 42 the trail continues upon the same undulating prairie at a distance varying from three to six miles from the Canadian, which there flows in the cañon formed by the Agate Bluffs described by Lieutenant Abert. Having traversed the table-land for a distance of about 25 miles, we descend with a grade of 60 feet per mile to the border of a beautiful stream called Shady creek. The broad valley through which it flows to the Canadian is covered with a forest of timber, consisting of cotton-wood, white oak, and hickory. To the left of the camp there is a small hill composed of dolomite, and beyond is a bluff of red sandstone. The grade between Camps 42 and 43 would not exceed 60 feet per mile. At station 17 there is a bed of an arroyo 100 yards wide, with steep banks, across which a bridge or embankment would be necessary. Shady creek would require a bridge, materials for which, both of wood and stone, can be found in the vicinity. The proposed railroad line follows this stream to its mouth, and thence ascends the valley of the Canadian to the junction of Tucumcari creek. For a description of the portions of the Canadian river not fully explored by us, reference is made to the published reports of Major Long and Lieutenants Abert and Peck.

From Shady creek our own trail passed over a portion of the Llano Estacado, and crossed Tucumcari creek about 30 miles above its junction with the Canadian. The following notes relate to this line:

From Camp 43 to station 1, which is 75 yards distant from Shady creek, the ascent is steep. Station 2 is one mile south of the stream. There is but little timber opposite this place. Between stations 4 and 5 the valley is contracted to one-fourth of a mile in width. At station 5 the steep rocky hill-sides approach to within 60 yards of the trail. Beyond we pass into a ravine, which soon becomes a cañon, 200 yards wide, terminating at a ridge of sand and gravel, which separates it from Red Bank creek. This stream is crossed between stations 11 and 12. It is sparsely fringed with cotton-wood, and contains large pools of water. Crossing other prairie slopes we reach station 16, upon the bank of Amarillo creek, which contains plenty of water, but no wood. Its bed is 30 yards wide. The width of the valley is 400 yards. Beyond, the trail traverses the prairie and crosses two dry ravines. Camp 44 is upon the bank of a stream, where water is abundant.

Station 1, beyond Camp 44, is in a ravine 300 yards wide. Station 2 is near the commencement of a broad mesa. Two arroyos are crossed between stations 7 and 9; the latter having rocky sides covered with small cedar trees. Between stations 9 and 10 is a ravine, deep, broad, and rocky. To the right of station 11 is a rocky bluff. Between 13 and 14 there are large pools of water. The bluffs of the Llano, covered with cedars, are one-third of a mile to the left of

station 16. The country sloping from them is prairie. Station 17 is in a ravine with a few cotton-wood trees. At station 18, the slopes are covered with mezquite bushes. Beneath the Llano bluffs, near Camp 45, there is a pleasant valley abounding in grapes and sprinkled with cotton-wood trees. It is watered by several springs and a small stream called Rincon de la Crux.

The ravine in which Camp 45 is situated extends far back among the hills, breaking the continuity of the precipitous cliffs, and affording facilities for an ascent to the top of the Llano. Upon the edge of it there is a spur of uniform acclivity, which the trail ascends. Station 4 is upon the summit, which, towards the south, appears smooth, level, and of unlimited extent. It is covered with short buffalo-grass, but contains neither shrub nor tree to vary the landscape. Eight miles beyond, the plain is cut by a deep ravine, in which a small stream, called Encampment creek, flows towards the Canadian. It branches, where we crossed it to obtain water, and might have been headed by a slight detour towards the south. Rising to the plain, we continued upon the northerly tongue of the Llano, about eighteen miles, to its western edge, which affords an extensive view. At the foot lies Rocky Dell creek, a rapid brook flowing to the Canadian. From fifty to sixty miles distant, towards the west, are seen the Tucumcari hills. The intermediate country appears like a vast basin, bounded upon the south by escarped bluffs of the Llano Estacado. Near the base of the slopes are dense groves of cedar and piñon, and lines of small cotton-wood mark the courses of many little valleys and streams which traverse this region.

Rocky Dell creek heads in a re-entering angle of the Llano bluffs, near the trail, and affords a way for a descent along its banks to Camp 46. The maximum grade, according to the topographical sketches, need not exceed sixty feet per mile.

Beyond Camp 46, the country is prairie, with gentle slopes, traversed by small rivulets which take their rise in springs beneath the Llano cliffs. Between stations 4 and 5 the trail crosses a ravine containing water, but destitute of trees. The foot of the Llano is two miles distant, and there cedars and piñons are abundant. Emigrant creek is crossed between stations 9 and 10. Station 10 is upon the side of a dry ravine, which is lined with small cotton-wood trees. The remainder of this day's march was upon a plain, a large portion of which possesses a loose friable soil, which, with sufficient water, would doubtless be fertile. It is almost destitute of trees. Camp 47 is near a ravine, which contains large pools of water and excellent grass. Between stations 19 and 20, a grade of fifty-five feet per mile would be required ; elsewhere the grades would be easy.

The ground rises gently between Camp 47 and station 2. Between stations 2 and 3 is the crossing of Halt creek, eight feet wide and three deep. It has no trees upon its banks. Opposite stations 4 and 5, the bluffs of the Llano are four miles distant. Further westward, a salient point of it is within a mile and a half of station 12. There, as elsewhere, the foot of it is covered with cedars, excellent for fuel. The whole route to Camp 48 is but slightly undulating, and much of the soil appears favorable for tillage. Several arroyos, containing pools of water, were passed.

Between Camp 48 and station 1 there is a muddy creek. Its banks are destitute of trees. Station 2 is in the valley of Fossil creek, or a branch of it, which contains a sluggish stream of water, bordered by a few cotton-wood trees. Between stations 5 and 6 is a larger rivulet of flowing water, of a clay color ; its width is 150 yards. Upon the right of the trail, towards the Canadian, its valley is well supplied with cotton-wood timber. There are trees, also, a mile distant upon the left. Its valley is 300 yards wide. Station 6 is on the bank of this stream, four feet above the water. Station 11 is upon a branch of Tucumcari creek. Near this stream, the trail continues to Camp 49. There is much timber in its valley towards the Canadian. To the left of the trail there are few trees, except at the base of the Llano bluffs. From station 12, the slopes to the river are gentle. The average width of this branch of Tucumcari valley is about half a mile. From station 13 to station 17, the trail is within a few hundred yards of the water ; thence to Camp 49, it follows near the valley of Tucumcari creek. In the construc-

tion of a road over this day's march, light grades could be obtained. The main item of expense would be for bridges and culverts, in crossing the streams.

Leaving Camp 49, we ascend a branch of the valley of Tucumcari creek, and find detached portions of the Llano one-fourth of a mile to the north of station 2. The bluffs upon both sides approach the trail near station 4, leaving a valley between about two miles wide. A few hundred yards to the left of the road, between stations 4 and 5, is an isolated hill, nearly conical, called Pyramid mountain. Its horizontal stratification shows it to be a remnant of the Llano. A sketch of it was taken, and a description will be found in the geological report. Between stations 5 and 6, the width of the valley is increased to several miles. At station 6 there is a large pool of water. To the left, the hills are one and a half miles distant; and the width of the valley beyond, to Camp 50, on Laguna Colorada, varies from one to three and a half miles. Between stations 14 and 15, the ground is marshy and covered with bushes; below, there is a stream. A rugged hill, of the red sandstone formation, bounds Laguna Colorada upon the north.

Camp 50 lies in the basin of Laguna Colorada, near large pools of shallow water. Between stations 2 and 3 there is a thick grove of cedars; and the valley opens to four and a half miles in width. Near station 7, the trail crosses a rocky hill, which is sprinkled with pine trees. Station 10 is in a valley one-fourth of a mile wide—a branch of Pajarito creek. Opposite station 13, the hill-slopes contain timber of cedar and pine. There is a large pool of water at station 14. The range of bluffs continue upon the left of the trail, but recede from the right, making room for the tributaries of Pajarito creek. Between stations 17 and 18 is a ravine, containing pools of water. At station 18, the total width of valley is five miles. The slopes are gentle; the bottoms are covered with luxuriant grass. Camp 51 is upon one of the numerous branches of this creek. Water is plenty in springs and pools, but is slightly brackish. Large cedar trees are abundant upon the hills, about a mile distant.

From the notes of the survey, it is evident that, from Fort Smith to this place, little difficulty would be experienced in constructing a railroad in the immediate vicinity of our trail. The reconnoissances, however, covered a larger extent of country; and, taken in connexion with the reports of others, have led to some deviations from that line. The section delineated by the profile avoids the cañon of the Agate bluffs, by passing the table-land south; re-enters the Canadian valley at the mouth of Shady creek; ascends its banks to the Spanish road, near the mouth of Tucumcari creek; and thence threads the wide valleys that receive the waters of Laguna Colorada, Cuerbito, and Pajarito creeks. This route enables us to avoid the ascent to the Llano Estacado at Rincon de la Cruz, and to maintain more nearly the uniform grade of the valley. The trace marked out, near Lieutenant Abert's trail, crosses to the north side of the Canadian valley; it is quite probable, however, that the right bank of the river would afford an equally good location for a road, and thus enable us to avoid the construction of expensive bridges.

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## NOTE.

*Extracts from the report of Lieutenant James W. Abert, Corps of Topographical Engineers, commencing August 29th, about fifty-six miles northwest from the junction of Tucumcari creek with the Canadian.*

*August* 29.—We encamped in a beautiful valley which afforded an abundance of grass. In the afternoon Lieutenant Peck and I mounted our horses and started off to make an examination of the cañon. We were caught on a tongue of land which separates the forks of a tributary cañon, and at length found ourselves upon the brink of a stern precipice fron 150 to 200 feet perpendicular, and on either side was an impassable ravine. These, uniting at our feet, swept onwards to join the river. Through the bottom a small stream of water pursued its meandering

course, silent and slothful. The rocks on both sides were cut down vertically, so as to render it impossible to clamber down even a foot. * * The rocks were highly ferruginous sandstone, rusty and blackened by oxidation, and harmonized well with the dark green foliage of the cedar. Latitude 35° 50″ 43′; longitude 104° 10′ 19″.

*August* 30.—In our journey to-day we have been forced to bear strongly towards the east, in order to avoid the deep gullies which, in rainy weather, serve to drain the elevated plain upon which we now found ourselves; for, on looking to the south, we saw it suddenly break off, and the eye plunged into an ocean of mist floating over a prairie of indefinite extent far below, now and then pierced by the tops of seeming islands whose summits, on a level with our feet, had once formed an integral portion of this plain. Here the river escapes from the jaws of the cañon, where the rocks are piled up to the height of 600 feet. Being everywhere covered with a dense growth of timber, they present very much the appearance of rising mountains. * * * The valley of the Canadian, four or five hundred feet below, lay spread out to the breadth of twelve or fifteen miles, roughened by isolated ledges of rock and curiously shaped buttes, being bounded on the opposite side by cliffs scarcely discernible. * * * Continuing our journey, and constantly forced by the nature of the country still further from the river, we reached a passable camping ground in the bottom of a small ravine, * * having made a march of twenty-two miles. We found here plenty of grapes and plums, the latter not yet fully ripe. This country abounds with timber, and on an elevated ground to the east of us is a fine grove of timber. * *

*August* 31. (Valley of Utah creek.)—As we found ourselves getting still further from the route we wished to pursue, * * we resolved to attempt the descent. * * Having cleared the loose fragments of rock from an inclined slope of 150 feet in length, which terminated in a shelf, and from which we thought to find a winding path to the bottom, * * the wagons, by means of ropes, were let down. * * * The stream we first struck was the Arroyo de los Yutas, or * * Salt creek. That which we finally encamped on was a tributary to it. The Sandy plain over which we had just passed was strewn with numerous flowers, which indicated a change of soil. * * Latitude 35° 41′ 56″.6; longitude 103° 45′ 5″.

*September* 1. (Utah creek.)—Before we had proceeded far we found a rapid running stream. * * * The valley, though sandy, appeared fertile. * * A grove of large cotton-wood, surrounded by a natural meadow of fine tall grass, made our camp one of the best we had found. * * To the south the beautiful valley of the Canadian spread out, covered with scattering "buttes." * * A heavy line of timber marked the course of the river itself, and we judged that we were still twelve miles distant from it. * *

*September* 2. (Junction of Utah creek with the Canadian, five miles west of the mouth of Tucumcari creek.)—We are now in a shady grove of buttonwood, * * mingled with cotton-wood. Since we left the Canadian, at the "El Vado de Piedras," it has increased to seventy or eighty feet in width, with a deep and very rapid current, so that we could scarcely keep our feet whilst bathing. The bottom in which we encamped is everywhere covered with various species of cactus. * * * Among the sylva, the hackberry * * is quite common, and we observed for the first time an extensive grove of the Pride of India, * * a tree gifted with a beautiful form and dense foliage, not more than thirty feet in height. * * The trees were everywhere loaded with heavy masses of grape-vines, * * which afforded the whole camp a great abundance of fruit. * * * At this place is what is called the "Spanish Crossing," where the people of New Mexico pass with pack-mules on their way to and from the Comanche country. Latitude 35° 20′ 59″; longitude 103° 29′ 38″.

*September* 3. (About eight miles east of Tucumcari creek.)—We commenced following the Gooalpa, (Canadian,) meeting with scarcely any obstructions, although the road was strewed with the broken axletrees of the Spanish carts that had preceded us. On the way we found quantities of luscious plums. * * * We camped in the Canadian bottom again, near an old Spanish camp. * *

*September* 4.—The trail led us through four or five miles of high and rounded sand-hills,

wrought into regular form by the winds. * * The day was hot, and as we held our course over the barren waste, without sign of water, we languished, and feared we should not find that necessary article. Our sufferings were greatly alleviated by the refreshing fruit of the plum-tree, which everywhere grew in great abundance; and we found the fruit equal to any of the cultivated varieties that we recollected to have tasted in the United States. * * * We reached a beautiful valley, where we found a clear, cold spring. * * * Our camp was formed under a grove of unusually tall cotton-woods, the characteristic sylva of this region, and which heavily-timbered the course of the rill which flowed from the spring. A few yards north of our camp were a few low "buttes," covered with dwarf plum-trees, profusely laden with fruit. * *

*September* 5.—We continued on the same trail as yesterday until about 8 o'clock, when, finding that we were rapidly diverging from the river, we were forced to leave it, and to shape our course almost direct for the "Gooalpa." We passed through a sandy country, * * and, after a toilsome march of seventeen miles, reached the bank, cañoned by a bluff escarpment 100 feet high, and absolutely impossible of descent. We were obliged to make a retrograde movement, and camped in a deep, tortuous ravine, where we found a little stream of clear water. * * The valley appeared full of grape-vines. * * We saw to-day an abundance of mezquite, * * thought by some persons to be the same as the "acacia Arabica."

*September* 6.—After quite a pleasant march on the level prairie we attempted to reach the river, and, knowing that there were high banks which coasted it, we undertook to reach its valley by the way of a tributary ravine. * * * * We find the Canadian still increasing in width and velocity of its waters, which have now a deep tinge, and justly merit the name of Colorado. Latitude 35° 31′ 36″; longitude 102° 47′ 02″.

*September* 7.— * * * * The sandy bed of the river is here 100 yards wide; the water, dwindled to a small stream by the absorbing material through which it flows, is slowly meandering, and as we travel on is alternately rising and disappearing. After a march of 19 miles we again formed our "kraal" in the bottom. * * * * Our road to-day was everywhere beautified by a luxuriant profusion of plum-trees and grape-vines. * *

*September* 8.— * * * * About noon we found a stream of cool water which ran swiftly along the bottom of a deep ravine. * * * * We pitched our tents at night on a point lying between the river and the bluff. * *

*September* 9.—The rain still continuing at intervals, we remained in camp all day. * * * The river had been rising gradually during the day. On hearing a rush of water, and looking out, we saw a foaming torrent, bearing rapidly along with it trunks and branches of trees. * * * * The river immediately doubled in depth and velocity, and, for a moment, threatened to deluge our camp, and at once dissipated our hope of being able to cross it and pursue our journey on the opposite side. We were therefore forced to clear a way along the face of the bluff. * * * The bottom here is pretty wide, and bears marks of fertility, and is walled up by a bluff 100 feet high. * *

*September* 10.—At an early hour in the morning we were on our way, and soon leaving the bottom, entered a more desolate country than we had hitherto seen. The high and dry table-lands were covered with but a few scattered plants, and were altogether desert-like. The cacti and mezquite were most abundant. * * * Wherever we approached the river we found it swollen and muddy, with a very rapid current. * * * We again found an abundance of prickly pears, grape-vines, and plum-trees. * * * Our day's march was upwards of 27 miles, and the route sandy. * * * We encamped close to the river's banks, which were not more than five feet high, with the bottom extending back 300 feet to the base of the bluffs. Upon going into the river to bathe I found the depth to be two feet. * * * Latitude 35° 27′ 25″; longitude 102° 0′ 6″.

*September* 11.—At 7 o'clock we found ourselves on our journey, but experienced some trouble by meeting continually with cut rock and deep ravines. Passing into a valley, beautiful in the

freshness of its vegetation, we entered a bottom where the tall grass grew abundantly. As we wound along under a romantic cliff, our progress was suddenly stayed by a projecting bluff which rendered further advance impossible. To cross was impracticable; to recede would occupy too much time; it was therefore resolved to ascend the bluff, which was here very steep and high. * * * Passing onward, the road for a time promised to be smooth, when suddenly an immense ravine yawned before us, and we were on the brink of the river again at a point where it was joined by one of its tributaries. As we looked onward, nothing but red precipices met our view, and they were piled up 250 feet perpendicular, and perfectly impassable. * * * On looking down into the deep cañon, instead of the beautiful green strip at the bottom, which we had hitherto seen, we discovered that it was covered with sand-hills. * * * We now found ourselves obliged to turn back in order to head the ravine we had encountered, * * and encamped on a neck of land between two valleys. * *

*September* 12.—(No topographical remarks.)

*September* 13.— * * * Shortly before reaching camp we were obliged to cross the bottom of a creek several times. * *

*September* 14.—We now travelled down the sandy bottom of the creek for the distance of one-fourth of a mile, several times crossing the broad and shallow sheet of water. Just at the junction with the Canadian we flushed a large covey of quails. Our way now lay along the low lands on the river-side, where the grass grew tall and the sand was deep. * * * The bluffs on each side were filled with gypsum of snowy whiteness, crumbling easily. At one time the river swept down to the base of a projecting spur of the cliff. Our course being momentarily impeded and our embarrassments increasing, we resolved to hazard an attempt to cross the river. * * * The river is about half a mile wide, generally shallow, though in some places belly-deep to the mules. * * * A short distance below our ford we found a pretty good camping ground. * * * Latitude 35° 47′ 56″; longitude 101° 35′ 47″.

*September* 15.— * * * Continuing on down the Canadian, we found the country around us composed of gypsum. * * * The bottom lands were very well timbered with cotton-wood, which in some places formed extensive groves. * * * Plum-trees are in abundance, and grape-vines in wild luxuriance, completely enshrouding the shrubbery which upheld them.

Lieutenant Abert says that on the 27th of September, in longitude 99° 11′, on the north side of the Canadian, he passed through a country "completely covered with a dense growth of oak, commonly called blackjack oak," the trees not more than 30 feet in height. These forests stretched back from the river as far as the eye could reach, forming a portion of the celebrated Cross Timbers. In some of the bottoms, "where the trees were of a more luxuriant growth," he found "the bur-oak."

## SECTION III.

*From the head of Pajarito Creek to the crossing of Rio Pecos, forty-four miles.*

Thus far the line of location has threaded the principal valleys; leaving them, only from choice, whenever a decided advantage could be gained by it. In this section, upon the other hand, it will be necessary to cross a dividing ridge, and intersect several chasmed streams nearly at right angles to their course.

It is probable that the valley of Tucumcari creek extends far towards the southwest into the Llano, and forms a favorable passage to a branch of Rio Pecos; connecting our route up the Canadian with the line explored by Colonel D. S. Miles, and referred to in his letter to Colonel Abert, which is appended to the preceding *itinerary*. If so, this would unite the Canadian with Rio Gila; and make available, for one route, the two great valleys that, extending east and west, cover so large a portion of the distance between the Mississippi river and the Pacific ocean.

Pajarito creek has its source in a chain of hills that connect the flat-topped Llano on the south with lofty fragments of the same that exist towards the north, and form the great cañon of the Canadian. The ridge is considerably broken. Its slopes are broad, and, by winding around them, little difficulty would be experienced in obtaining moderate grades. From the top of this prairie to the banks of the Pecos the country continues high and undulating, with few spots fit for cultivation. Hurrah creek and two branches of Rio Gallinas cut through it, making it necessary to adopt heavier grades than were generally required upon the previous section; the maximum being 78.3 feet per mile. Upon this section there is plenty of fuel, but timber is wanting. For oak we must have recourse to the Cross Timbers. Forests of pine are found nearer at hand, upon the highlands bordering the Pecos. The streams crossed may be easily bridged; the materials for masonry being abundant upon the banks. Below Anton Chico there is a long, sloping bank leading gently down into the Pecos valley. The ascent to the high plains upon the western bank is rough and difficult. However, with a grade of 93.7 feet per mile, it is not impracticable; and the profile is constructed upon that route.

From the springs at Las Chupainas a westerly course would conduct to the crest of the bank overlooking the Pecos, and thence along the side of a spur which abuts upon the river a short distance above Anton Chico. On the opposite bank approaches a bluff of the cañon having nearly the same height. A viaduct thrown over the river there would save a descent of several hundred feet. Sandstone, limestone, and gypsum could be obtained in the vicinity for such a construction. Forests of Douglass' spruce are abundant upon the neighboring heights, affording good material for railroad ties. Upon the mountains, from twenty to thirty miles distant, there is a supply of pitch-pine timber of large size, well suited for the purpose of bridge-building. La Cuesta is fifteen miles west-northwest from Anton Chico; and the difference of level between the two places, as indicated by barometer, is five hundred feet. This would show a fall in the river of about 30 feet to the mile. The bluffs between which the Pecos flows, as observed at La Cuesta, are five hundred feet in height. Below, they are said to form a very narrow cañon; and it might be found advantageous to follow the left bank to this gorge, where, probably, a shorter viaduct would serve to unite them, and place the road on the general level of the country. The following notes from the field-books are more specific regarding the details of the topography on the trail.

Between camp 51 and station 2 there is a water-course. To the right of station 2 the bluff edge of the high mesa is five miles distant. It is rocky, and, as elsewhere, covered with fir trees. At station 4 the bluffs upon the left are but sixty yards distant. From stations 4 to 6 the prairie extends two miles to the right of the trail; and after passing the summit which separates the waters of the Canadian from those of Rio Pecos, it slopes gently towards the left two and a half miles. There is a large pool of water between stations 13 and 14. The prairie extends three miles upon the left and two and a half miles on the right of the trail. Camp 52 is upon the bank of Hurrah creek, four miles above its junction with the Gallinas. It is a clear and rapid stream, destitute of wood.

From Camp 52, on Hurrah creek, to Camp 53, at Las Chupainas, is a high broken prairie, intersected by many ravines. Near station 3 is a ravine the bed of which is 20 feet wide. From station 3 to 4 the ascent is steep; beyond there is a wide plain. Between stations 8 and 9 is a stream, with pools of water. Station 15 is in the water of Rio Gallinas, which contains neither wood nor soil fit for cultivation. There is a stream of water between stations 18 and 19, and another at Camp 53, the water of which proceeds from the springs of Las Chupainas, and is slightly brackish. There is fuel, but no good timber, upon the slopes of the mesas back of camp. Large forests exist some miles distant towards the Santa Fé mountains.

North of Camp 53 is Man-of-War mountain, a high, mesa-capped peak in a range of new-red sandstone hills that extends towards the northwest and bounds the Pecos valley. The sides are steep, rocky, and covered with cedars. A secondary spur, of nearly the same altitude as the general surface of the high prairies, extends from this place to the Pecos river above Anton Chico. From Camp 53 to station 1 the trail crosses the wide and fertile basin which is watered by springs from the bluffs. There are pools of water near station 2. Thence to station 8, in the Pecos valley, the descent is by a long and regular slope. The river is crossed between stations 8 and 9, its stream being about fifty feet wide and two and a half feet deep and the bed rocky. Station 9 is at Camp 54, upon the west side of the Pecos valley, a few hundred yards from the river. The village of Anton Chico is about three-fourths of a mile above, overlooking the river and a wide extent of cultivated valley.

## SECTION IV.

*From Rio Pecos to Rio del Norte, one hundred and four miles.*

Having reached the top of the bluffs which bound the western edge of the Pecos valley, our route, as far as the entrance to Cañon Blanco, lies upon an elevated table-land, the geological strata of which, by the upheaval of the Rocky mountains, have been tilted from 15° to 20° to the east. The surface is somewhat broken by wooded hills and broad valleys leading to the Pecos. The descent is easy into Cañon Blanco, which for several miles forms an excellent location for a railway. To issue from it, near the head of one of its branches, and cross a low ridge which separates its waters from those of Laguna, would require considerable labor. The summit may be reached by edging along the side of the cañon and throwing a high embankment across a branch ravine. The profile, however, follows to the head of one of the branches, and makes a deep cut through the crest of the ridge. This summit, the most elevated crossed by our trail between the Mississippi river and the Rio del Norte, is 6,943 feet above the level of the sea; and, although its elevation above the prairies, east and west, is but slight, it may be considered as the Pass of the Rocky mountain chain.

Laguna, which lies a short distance west of the ridge above referred to, is a depression in the prairie, which receives the drainage of a wide surface, and forms a natural reservoir, containing a large supply of water. From this point, looking west, are seen the Zandia mountains, about thirty miles distant. To the north lie the mountains of Santa Fé. Between these two masses of mountains there is an opening, through which Rio Galisteo flows to Rio del Norte. South of Zandia mountain is seen a depression in the chain separating the Zandia from Manzana mountain, and forming the Pass of San Antonio, which leads directly to Albuquerque, or to Isleta. Eastward of that range, and from the vicinity of Santa Fé on the north, to the Salinas on the south, lies a prairie, the general surface of which is somewhat undulating, and occasionally traversed by ravines. The crest, which bounds it upon the east, seems to possess about the same height at the head of Rio Galisteo as at the point already noticed near the Laguna. This appearance, connected with subsequent observations, led to the belief that a railway might ascend the east bank of the Pecos to some favorable crossing place, said to exist in the vicinity of San Miguel, and thence pass into the valley of Rio Galisteo, which leads to the Del Norte, near San Felipe. Our own explorations for a crossing of Rio Pecos were confined to the vicinity of Anton Chico and La Cuesta. This river, as has been stated, flows in a deep cañon, with a ribbon-like valley of excellent soil enclosed within bluff banks near the villages mentioned. Between those places the cañon is contracted to a narrow chasm, which may be surmounted by a viaduct. Its construction might involve greater expense than would be required by the route upon which the profile is traced; but it would cause a saving both in distance and in grade.

From Camp 54, near Anton Chico, to station 7, the ascent by the road is steep. There is a ravine further south, through which the profile is carried to obtain a practicable grade. Station 8 is at the summit of the acclivity; and beyond, the general surface is moderately undulating. In the vicinity of station 10 are hills covered with forests of pines and cedars. Near station 11 is a peak 200 feet high, and higher hills appear two miles distant upon the left. From station 11 to station 13, the surface is a prairie. From 13 to 15 are cedar trees, and at station 17 are

hills covered with the same. The slopes are gentle to station 23, where the width of the valley traversed is contracted to 100 yards. From station 25 to station 28, the trail passes through a thick forest of large pine trees. Upon each side of the road, from station 21, and a quarter of a mile distant, are high hills, steep and rocky; those upon the right are covered with cedars. Here, by a gentle descent, we enter Cañon Blanco, a wide chasm, whose rocky sides are covered with pines and cedars; and beside a pool of water is Camp 55.

Cañon Blanco extends from Camp 55 to station 16. Its width is variable, being at station 1 five hundred and forty yards; at station 3 one and a half miles; at station 4 one mile; and at station 6 half a mile. At the narrowest point, between stations 6 and 7, the width is one hundred and fifty yards. The sides of the cañon are rocky, steep, and covered with small cedar trees. It has many branches; the main one drains the waters from station 3 towards the southeast. At station 16 the trail issues from the cañon and, passing a crest to an undulating prairie, reaches Camp 56, near large ponds of water called Lagunas.

From the Lagunas, two routes, as before mentioned, lead to Rio Grande; one by way of San Antonio Pass, between Zandia and Manzana mountains, to Isleta, twelve miles south of Albuquerque; the other, more northerly, along a branch of Rio Galisteo, around the Gold mountains, to San Felipe. Both routes were found practicable, and each intersects the Del Norte at a point favorable for bridging. The slope by Galisteo commences directly, and is nearly uniform through its whole course. The grade would scarcely exceed thirty-five or forty feet per mile; while, by San Antonio, a maximum of 105.7 feet per mile would be required. There is much tillable land in the Galisteo valley, but no timber; that could be obtained among the Zandia mountains, from ten to twenty miles distant.

The more direct route from the Lagunas to the Rio del Norte, via the San Antonio Pass to Albuquerque or Isleta, was explored by A. H. Campbell, Esq., my principal assistant engineer. The following description of this part of the line is taken from his report, and the accompanying cut, representing the Pass of San Antonio, has been taken from his sketches:

"*From the Pecos to Albuquerque via Rio San Antonio, or Cañon Carnuel.*—The problem of leaving the Pecos is a more difficult one than we have yet had to solve. There are, however, two methods which are practicable in the vicinity of our exploration, and I doubt not that by following the river to one of its valleys heading with the Galisteo, a very easy mode of crossing the Rocky mountain range can be accomplished. To determine a suitable point for crossing near Anton Chico, and to even approximate to its cost, would require very careful surveys with the level and the compass. The approach from the east is not so difficult. The river can be crossed with a single span of 150 feet at Anton Chico, or about half a mile below with a less span.

"Proceeding, then, from either of those points, one route would lead up a small valley south of the town, which heads in the elevated plateaux through which the Pecos cañons, as at Cuesta; pusuing a westerly course thence, over a rolling region, to Cañon Blanco. The average ascent per mile to this point is but forty-three feet, but the maximum grade for the first ten miles will be at least eighty feet per mile. The other route from the Pecos would cross the river some four or five miles above the town by a viaduct, at an elevation of from 150 to 200 feet; thence to a point some ten or twelve miles from Anton Chico, connecting with the other route to the summit between Cañon Blanco and the Pecos. This route would be several miles the shorter, and the maximum grade probably not exceed seventy feet per mile. The great cost of a viaduct on this route, however, would render it a question as to which of these routes would be preferable. From the entrance to Cañon Blanco, the line explored pursues that cañon to near its western limit; thence, over the divide, into the basin between the Rocky mountains and the Pecos. For several miles the ground descends in the cañon to about half-way through; thence ascends to the divide above mentioned. The drainage of this cañon is southeasterly, probably to the Pecos, the main cleft opening and descending in that direction. The grades through Cañon Blanco will be light, not exceeding twenty feet per mile, except at the western

limits, where it will require at least sixty feet grade, and from thirty-five to forty feet cutting, to attain the summit. From this summit, a little south of Las Lagunas, to the main summit of the Rocky mountains, at the San Pedro mountain, the line traverses a rolling country, descending at an average rate per mile of about thirty-three feet to the lowest point of this basin, which drains, it is supposed, into or towards Las Salinas. From this point the San Pedro Pass can be approached with a grade of about thirty-five feet per mile.

San Antonio Pass.

"This pass divides the waters which flow into the Rio Tuerto from those that flow into, or towards, Las Salinas. About nine miles farther is another pass or summit, which divides the waters of the Tuerto from those of the Rio San Antonio, in the Cañon de Carnuel, with a forty-feet cut at the San Pedro summit, and a descending grade of about eight feet per mile for seven miles. We pass the second summit with only about forty feet cutting, and thence descend at the rate of about eighty-two feet per mile for thirteen miles; thence down the sloping mesa to the Rio Grande, opposite Isleta, at a rate of about from twelve to fifteen feet per mile. At Isleta the Rio Grande contracts through a comparatively narrow gorge, presenting a most favorable point for crossing. Three spans of from one hundred and fifty to two hundred feet will effect this object, there being a bluff on both sides favorable for landing without embankments."

## SECTION V.

*From Rio del Norte to Flax* River*, 237.5 *miles.*

Bridging the river at San Felipe or at Isleta would not be a difficult operation. Few of the principal railroads in the eastern States are without structures of equal magnitude. From the point selected, a gentle curve toward the south would enable the engineer to ascend the steep slope of the high table-land which divides the Del Norte from Rio Puerco. Thence, passing to the latter stream, he would reach its junction with the valley of Rio San José, which extends westwardly to Campbell's Pass of the Sierra Madre. To this point the grades would be light, the maximum being 53 feet per mile. Excellent spruce and pine timber is plentiful upon the slopes of Sierra Madre, and may be easily obtained. Material for masonry is also sufficiently abundant.

By the term "Sierra Madre" is meant—according to Mr. Gallatin†—"that ridge which separates the waters that fall into the Atlantic from the rivers which empty into the Pacific ocean, without any regard to its elevation." Near the sources of Rio Gila it is a lofty range. Below the parallel of 32° 30′ the chain is broken, and divided into a series of minor ridges, having crests, more or less prominent, extending in the same general north and south direction. Near latitude 32° this system is extended to about 3° in width, and the low swelling ridges form a succession of basins, without any surface outlet for their scanty supply of waters. Here rains are absorbed by the sandy soil, or are evaporated from the mineralized surface of some shallow lake. The most favorable passage of the Sierra Madre range that can be found north of the head-waters of Rio Gila, is probably at Campbell's Pass. This, although more elevated than those of the Mesilla country, possesses but one crest intervening between the waters of the Atlantic from those of the Pacific. It is a wide gap, separating the ridge known as the Zuñi mountain from the Sierra de San Juan; upon the east the waters of Agua Azul flow through the open valley of San José, and a rill from the spring of Ojo del Oso courses along the gentle declivity which forms the Rio Puerco of the west. The great advantages of this pass of the Sierra Madre consist in its single summit; in the easy grades by which it may be approached east and west; in the convenient positions of springs and streams; and in its close proximity to forests of good timber.

Westward from this point we have the valley of Rio Puerco of the west, extending in a general west-southwest course for 121 miles, to its junction with Flax river; the average grade being about thirteen feet per mile. After leaving the slopes of the Sierre Madre the sylva consist of cedars upon the prairies and a few cotton-woods upon the banks of the streams; the pine forests of the Zuñi mountains contain an ample supply of timber for this section.

The main survey crossed the Sierra Madre by the pass of the Camino del Obispo, and thence traversed the valley of Zuñi. The following notes relate more particularly to that line.

The valley of Rio Grande from Albuquerque to Isleta, fourteen miles, is wide and fertile. It contains several villages and large *haciendas*, surrounded with well-cultivated fields, which are irrigated by numerous *acequias* that traverse the bottom-lands. Upon the west it is bounded

* Flax river is the translation of "Rio del Lino," the first Spanish name given to the stream lately known as the Colorado Chiquito. As there are already within our territory many rivers named Colorado, it would seem desirable to withdraw this from the list.

† See letter of Hon. Albert Gallatin, in Major Emory's report, Ex. Doc. No. 41, 30th Congress, 1st session.

by the bluff edge of the mesa, 700 feet in height, that divides it from the valley of Rio Puerco. The best point for ascending it is below Isleta. Between Albuquerque and Atrisco the river is wide, shallow, and usually fordable—measuring 650 yards in width, from bank to bank, and two to three feet in depth, in two channels which enclose a shifting sand-bar. The banks are flooded during freshets. The crossing at Isleta is much more favorable for the construction of a bridge. Spurs, from twenty to twenty-five feet in height, from each side come down to the water's edge, and the width of the river between is about 800 feet. The bluff of the Puerco mesa here makes a salient point, but below forms a re-entering angle back of Las Lunas, where a wide and open ravine leads by a gentle ascent near to the top. The valley of Rio Grande, opposite the village, is wide, and upon both sides of the river are groves of timber.

The ascent from Isleta commences at station 1, and follows the edge of the mesa slope. Considerable lava and volcanic cones were found in the vicinity of the trail. The soil of the lower portion of the hill is sandy. The upper stratum of the mesa is a rocky cliff, nearly unbroken upon our right until we reach the water-course at F. Station 4 is upon the top of the mesa. Thence for several miles the surface is nearly level, and beyond, we gradually descend by a wide ravine to the Puerco valley, near the mouth of Rio San José.

From Isleta, with light cutting and filling across the gentle spurs, and by keeping higher upon the slope to the right of the trail, the maximum grade to station 3 would be 52.5 feet per mile. From station 3 to station 4, with a maximum filling of 30 feet, the grade is 76 feet. From 4 to 5, the location is on the top of the mesa nearly level. From station 5 to Camp 62, the grade is from 46 to 56 feet per mile.

At Camp 62, the bed of Rio Puerco is 18 feet below the alluvial soil of the valley. It can be bridged with a span of 100 feet. The tongue of land included between Rio San José and the Puerco is formed by a ridge of hills, with flat tops, covered with cedar trees. The trail crossed this ridge a few miles north of the valley of San José.

The ascent to the hills is quite steep. From station 1 to station A, the soil is composed of clay and sand. Twenty-five yards to the left of station A is a hill containing coal. Station 2 is between two hills, 20 yards distant and 20 feet in height, composed of sandstone. At station 3 commences an ascent of 200 feet in two-thirds of a mile, station 8 being upon the summit. Station 12 is in an arroyo 50 feet below the general surface. To the left of station 16, one mile from the trail, are hills covered with cedar trees. From station 15 to 16, the ground has a general slope towards the San José valley upon the left. To the right of the trail there is a range of hills with rocky sides. At station 16 they come within 20 yards of the trail, and are 85 feet high ; somewhat further on, they are composed of red and white sandstone. The valley extends to the left about a mile, and is bounded by a mountainous range covered with cedar-trees. About station 17 the soil is sandy, with but little grass. One mile to the right of the trail, from station 17 to 19, there is a range of hills 120 feet high. The base is formed of a stratum of red sandstone. Thence we follow the wide valley of Rio San José, in which is the deserted valley of Rito, to Camp 63, where steep, rocky banks approach the river, forming a cañon. On the right, the red sandstone bluff is 300 feet high. The stream here, usually called Rio Rito, is a good-sized brook ; the water is slightly impregnated with salts.

The route from Rio Puerco to Camp 63 should follow the valley of Rio San José, which affords a light grade, 17.5 feet per mile being the natural inclination of the stream. The trail is less favorable ; though in the vicinity of it, with considerable cutting and filling, a line may be traced whose maximum grade would be 70 feet per mile for a distance of two and a quarter miles.

Between Camp 63 and the Pueblo of Laguna, the San José river is deflected towards the north by a spur of hills, at the point of which a narrow cañon is formed. The wagon trail is across the hills ; though with some labor in rock cutting, the banks of the stream would doubtless afford a better location for a railroad. From Camp 63, the trail follows the edge of the stream to station 4, where it turns into a ravine upon the left, and ascends the high lands. From station 7 to 10, the rise is 79 feet in a third of a mile. Thence, passing the crest, the descent is

moderately gradual to station 11, in the valley of La Laguna. From station 11 to 12, the trail crosses the river. Above this point there is no obstruction in the wide valley of San José. The road, however, passes over the rocky eminence, about 70 feet in height, upon which stands the Pueblo of Laguna. Thence it follows near the edge of the bluffs, which upon the north bound the cultivated basin of La Laguna, to a branch of the valley leading to Covero.

The direct route from La Laguna to Camp 65 is through the valley of Rio San José, leaving Covero about two miles to the north. That by the trail, however, may be followed with nearly equal facility. It leads from Camp 64, through the town of Covero, to a broad plain which slopes gently from San Mateo to Rio San José. Station 7 is upon the edge of that stream, where the banks are steep, and the channel 20 feet in width. There are cedars upon the hill-slopes, but no timber in the valley. Thence the trail to Camp 65 follows the narrow belt of alluvial soil that borders the river; the bluff banks enclosing it increasing from 50 to 150 feet in height. About two miles north from station 10, is the foot of a bluff which bounds the mesa surrounding the volcanic peak of San Mateo. It is about 1,000 feet in height; and, at station 15, approaches to within 300 yards of the river. At station 17 the valley is one mile in width, and thence to Camp 65 it is covered with luxuriant grass. The hills upon both sides are covered with cedar and pine timber. The river flows beside, and sometimes beneath, a broken *coulé* of lava which threads the valley. The grades are easy from La Laguna to this point.

Near Camp 65 the trail crosses the river and ascends the valley with nearly a uniform grade, via Ojo del Gallo, Agua Azul, and other head springs of Rio San José, to the wide opening at Campbell's Pass, 6,952 feet above the level of the sea. Upon the left are the Zuñi mountains, covered with forests containing several varieties of excellent pine timber. From the summit westward for about three miles, to Ojo del Oso, the head springs of Rio Puerco of the west, the surface is somewhat broken, requiring a moderate amount of cutting to attain a uniform grade of 50 feet per mile. Thence the Rio Puerco of the west leads through a wide valley toward the west-southwest, crossing the trail from Fort Defiance about twenty-five miles north-northwest of Zuñi, and coursing onward to Flax river, with which it unites near the mouth of Lithodendron creek.

The wagon route through the Obispo Pass and along the Zuñi river struck the Puerco of the west near the Navajo springs, at Camp 74. The region traversed is fertile, but unfavorable for a railroad, on account of the high altitude at which the Sierra Madre was crossed, and the necessity of a tunnel at that place. The grades through Campbell's Pass and along Rio Puerco of the west are highly favorable; but the river, though at all times containing large pools of water, is not a constantly flowing stream, and its banks are destitute of timber. Cedar forests, however, cover the mesas in the vicinity. Near its mouth, the Puerco, like Lithodendron and other creeks in that region, cuts through the gravelly mesa, and forms deep ravines which would require bridging. Quarries of sandstone, fit for masonry, may be found in the vicinity of the valley of Flax river.

## SECTION VI.

*From Flax River to Rio Colorado*, 307.7 *miles.*

It is much to be regretted that a greater length of time could not have been devoted to the examination of the region embraced in this section. It is full of interest, and probably no other portion of our territory would so richly recompense the cost and labor of a minute exploration. The region referred to is mainly included between the Gila and Colorada rivers, and their principal tributaries, Rio Verde and Flax river. The latter, having its sources in the Mogoyon and Zuñi regions, flows west and northwest to the Colorado, with which it is supposed to unite near the head of the celebrated Great Cañon. Thence, the Colorado is said to course westward, through a fissure 1,500 feet below the surface of the vast plain that borders it, to the mouth of Rio Virgen; there it turns south, and moves onward to the junction of Rio Gila. Rio Verde takes its rise near the San Francisco mountains, and, flowing south through fetile valleys, joins the Salinas and unites with Rio Gila near the Coco Maricopa villages. The Gila forms the southern boundary of the area under consideration, which our line of survey intersects. It is traversed by several mountain chains of greater or less extent—of which the Hamook-häbî (Blue Ridge), Cerbat, Aquarius, Aztec, Black Forest, and Mogollon ranges are the principal—and dotted with many conical hills of volcanic origin. Between them are springs, streams, and valleys of considerable fertility.

The northern portion of this area is believed to be an elevated table-land of the new-red sandstone formation; with strata slightly dipping towards the north-northeast, forming a region nearly as barren and waterless, upon the surface, as the celebrated Llano Estacado. Captain Sitgreaves traversed it in 1852, and from Camp 21 to Camp 26, a distance of 75 or 80 miles, no water was found. Near the parallel of 35° 15′ the strata are broken; and south of that line the upper portions are swept away, exposing "magnesian limestone, sandstone of the coal measures, and the carboniferous limestone." Still farther south, "and especially at Pueblo creek, beds of old-red sandstone are seen below the lower carboniferous, and in contact with the gneiss and granite, similar to the old-red of the Catskill mountains."* Extending across this country, in a direction northeast and southwest, there is a series of volcanic cones indicating an axis of igneous eruptions. The San Francisco peaks, which are 5,000 feet above the base of the mountain, and 12,000 feet above the sea, appear to mark the point of greatest activity. Thence, the line of cones can be traced eastwardly across Flax river towards the Moqui country, and southwest so as to include Bill Williams' mountain, Mount Hope, in the Aztec range, and Mount Ives and Artillery Peak, upon Williams' river. Whatever may be the cause, the fact is evident that a large portion of the region south of the parallel of 35° 15′ is well watered and fertile; while that north of it is the reverse. Ruins of ancient pueblos and evidences of former cultivation are abundant throughout the valleys leading towards the Gila. The mountains and hills are covered with timber, the plains are variegated with patches of woodland and pasture, and the borders of the streams contain belts of arable soil. This country is capable of sustaining a considerable pastoral and agricultural population; and, probably, the mines of silver and gold reported by the Spaniards and Indians as existing in the San Francisco and other mountains in the vicinity, and of which we saw indications, will add inducements to its settlement.

West of the Aztec range the character of the country is considerably modified. The streams have generally a southwest course until they break through the beds of trap, lying upon the

* See the preliminary report of Jules Marcou, geologist to the expedition.

eastern slope of the Aquarius mountains, and join the main valley of Williams' river. North of White Cliff creek there are long, swelling slopes, peculiar to a granitic region, with two distinct ranges of mountains between Cactus Pass and Rio Colorado. These ranges extend nearly in a north and south direction, with broad depressions between them. The eastern terminates, or is broken, near the parallel of 35°, leaving between it and the northern point of the Cerbat range a wide opening. The western range, called Blue Ridge, or *Hamook-häbî*,* which borders the left bank of the Colorado, extends somewhat farther south; but gradually diminishes in height, and, near the latitude of the Mojave villages, is lost in an extensive prairie. Upon the east this prairie is bounded by the Cerbat range; and upon the south by numerous parallel chains of metamorphic mountains, through which Williams' river breaks in its course to the Colorado.

At the southeast point of the great bend of Williams' river is the junction of Rio Santa Maria, which appears to take its rise near a low depression in the Aztec range between Sierra Prieta and Mount Hope. It evidently drains a wide extent of country, the character of which is not known. Near its mouth it has a strip of valley with alluvial soil of apparent fertility. The sylva upon its banks are mezquites, mingled with cotton-wood trees.

From the Aztec range to the Aquarius mountains, the hills are covered with pine and cedar trees; and the plains, which are mainly formed by immense beds of trap, are clothed with a carpet of nutritious gramina. Most of the numerous rivulets which traverse this region, south of the latitude of Aztec Pass, form narrow cañons through the igneous rocks, and possess little soil capable of cultivation. Enclosed between the Aquarius and Cerbat ranges is the bed of Williams' river, which flows nearly south until it enters short cañons among metamorphic hills of the Cerbat range; it then turns westward, unites with the Santa Maria, and forces its way to the Colorado. The bottom-lands of the valley will average from half a mile to a mile in width, and the surface consists of alternate patches of sand and fertile soil. Groves of mezquite and cotton-wood, with dense thickets of willows, exist upon its banks, giving to this stream some of the characteristics belonging to the Gila. The hills that enclose it are generally barren of all useful vegetation, though diversified with numerous varieties of beautiful cactaceæ, rendering the scenery novel and picturesque.

From an examination of the observations made at numerous points of the survey, it now appears evident that gently sloping prairies extend continuously from the mouth of White Cliff creek around the northern extremity of the Cerbat range; and thence, sweeping slightly south for the purpose of avoiding the Blue Ridge, to the Mojave crossing of Rio Colorado. The distance for a railroad by that line would be about 70 miles. Grades of about 92 feet per mile could probably be obtained, with little expense for excavation or embankment. There is neither timber nor fuel in the vicinity; both would be brought from the Aztec and Aquarius mountains. Water is scarce; the Indians informed us of two springs only upon the route, which would make the distance from water to water about twenty-five miles. I do not know whether the substrata are such as to make it probable that water could be obtained at proper points by artesian borings; but a supply could doubtless be preserved by judiciously constructed tanks.

From our entrance to the valley of Rio Colorado Chiquito, or Flax river, its course is slightly north of west to Camp 82, a distance of about 35 miles; and the arable soil bordering it averages from one to two miles in width. The river is about 30 feet wide, flowing between alluvial banks eight to ten feet in height. The soil is generally light and porous, like that of Rio Gila.

* Mr. Blake has lately called my attention to the etymology of the word "Mojave." It appears to be formed of two Yuma words—hamook (three,) and häbî (mountains)—and designates the tribe of Indians which occupies a valley of the Colorado lying between three mountains. The ranges supposed to be referred to are: 1st, "The Needles," which terminates the valley upon the south, and is called Asientic-häbî, or first range; 2d, the heights that bound the right bank of the Colorado north of the Mojave villages, termed Havic-häbî, or second range; and, 3d, the Blue Ridge, extending along the left bank of the river, to which has been given the name of Hamook-häbî, or third range.

The banks of the main stream, as well as those of the numerous tributaries, are sprinkled with cotton-wood trees. Small groves of them occur at the junctions of these streams. Leroux's Fork is crossed near Camp 78. It is a rivulet of clear water about 20 feet wide, and densely wooded. Beyond, the valley is bordered with low, gravelly mesas, covered with a species of nutritious grass called grama, and has an elevation of about 50 feet above the river. The wagons frequently crossed spurs from them to avoid patches of soft earth in the bottoms. Between stations 3 and 4, a valley half a mile wide comes in from the northeast. At station 5, there is a branch from the north, with steep banks 10 feet in height. Between stations 5 and 6, sandstone bluffs, rising upon the right of the trail to the height of 150 feet, bound the valley, which is here one-third of a mile wide. Upon the opposite side of the river, near station 10, is the escarped edge of an elevated plain, extending south, apparently, to the Mogollon mountains. It is intersected by several tributaries. Between Camps 79 and 80, the river-bottom is in some places marshy, with willow thickets, and in others covered with a loose, pulverized soil. The south side of the valley appears to be in some places from two to two and a half miles wide. There is much marshy ground between Camps 80 and 81, which may be avoided by following the trail along the edge of the prairie slopes. Cottonwood Fork joins Flax river near station 2. The latter stream may be bridged at this place, or the line continued upon the north bank to the old Indian pueblo at Camp 82. Here the river is finely timbered with cotton-wood, and the south side of the wide valley contains traces of an ancient acequia.

At the point where the trail crosses the river, the stream is 50 feet wide, two and a half feet deep, and flows between clayey banks about 10 feet in height. A short distance below, it makes a bend and sweeps towards the north and northwest. To avoid this deflection, a reconnoissance was made in a direct line nearly west towards a low gap south of the San Francisco mountains.

Leaving the valley of Flax river a few miles below Camp 82, a low and narrow ridge was crossed, and a basin-like valley was entered, which, although containing no well defined stream, was said to be the outlet of Dry Fork. Having traversed this for about five miles, a gradual and almost imperceptible ascent led to a high prairie, somewhat cut up by gentle valleys, and dotted with isolated hills of sandstone, from 15 to 30 feet in height. Twenty-six miles from Camp 82 is the crossing of Cañon Diablo, which flows north in a chasm from 100 to 150 feet deep, and about 100 yards wide, cleft in a horizontal stratum of magnesian limestone. Thence to station 4, between Camps 89 and 90, the general surface of the intermediate country is a plain, sloping towards the east with an inclination of 40 feet per mile. It is, however, traversed by several ravines, occasionally forming small cañons; but they interpose no serious obstacle to the construction of a railway across this section. There is water in Cañon Diablo, and at the Conino caves, near this line; probably it could be found at other intermediate points. Cedar trees are scattered along the trail between Dry Fork and Cañon Diablo. Dense thickets commence a short distance further west; and, upon reaching the vicinity of the Conino caves, they give place to forests of magnificent pines.

From the base of the San Francisco peaks, many wide valleys, bounded by heavily timbered hills, extend towards the branches of Cañon Diablo and Flax river. Station 4 is upon the northern edge of one of the former, called Pine valley, which has a breadth of about five or six miles. The trail ascends its smooth, grassy slope. At station 6 the valley is several miles wide; at station 9, it unites with a broad, open prairie, bordered with pine forests, and extending towards the northwest to the foot of the steep mountain slopes. Continuing up this valley towards the southwest, at station D we reach the summit of a low ridge between the San Francisco mountains and a long spur from the Sierra Mogollon, which divides the waters of the Colorado Chiquito from Rio Verde. The ascent to this point is remarkably uniform; and the deep depression which here exists between the mountains is about a mile in width, and so gentle in its declivities as to render it difficult to define the exact position of the dividing crest. Superb forests cover the slopes of the mountains upon each side. The maximum grade through this

pass—according to the profile—is 85 feet per mile; and an excavation would be required at the summit. Thence to Camp 90, the descent would not be difficult with moderate grades.

From Camp 90 to station 5, the line continues upon the edge of the pine forest overlooking the immense valley of Rio Verde. This stream heads in various ravines formed by spurs from the San Francisco mountains. The southeastern terminus of this range, or rather mass of mountains, is a huge pile of granite, rising abruptly upon the right of the trail to the height of about 2,500 feet. To the northwest, several volcanic peaks appear, elevated 5,000 feet above the base. Crossing the low spur upon which station 7 is situated, we enter another branch of the valley, and at station 13 reach the springs of San Francisco. Water is abundant here, and it flows in a small stream southward to the Rio Verde. From these springs we pass a slight ascent, and enter a dry cañon, the narrowest part of which (about 100 feet) was plentifully strewed with boulders broken from the cliffs. From this point the trail ascended the bank, about 200 feet in height, and, having crossed an undulating surface, re-entered the valley at station 9. Thence to Camp 91 there is a broad valley the whole way, and at the head of it is Leroux's spring, where a stream of clear water gushes from the hill-side. Its temperature, December 29, at sunrise, was 48.4° Fahrenheit; that of the atmosphere at the same time being 37°.5. Large pine and spruce trees grow in the ravines and upon the sides of the mountains; and extensive forests of different varieties of good timber cover the vast plains and valleys that slope toward the south. With regard to the construction of a railroad from Camp 90 to Camp 91, no difficulties were presented to the eye, except for a short distance through the cañon referred to. The reduction of the notes of survey, however, leads to conclusions less satisfactory than had been anticipated; and, unless some error has crept into the work, the maximum grade will exceed 90 feet per mile, and the labor of graduation will be great. To avoid these objections a more southerly course across branches of Rio Verde has been recommended.

Leaving Leroux's spring, and the fertile basin which it irrigates, the trail crosses a slight ridge* north of Triangulation hill, traverses a forest of yellow pines and long, grassy plains to New Year's spring, at Camp 94. A secondary range extends towards the west, from the San Francisco peaks, and, two or three miles distant from the trail upon the right, contains several peaks from 2,000 to 2,500 feet above the plains at their southern bases.

Nearly south-southwest from New Year's spring is Bill Williams' mountain, about 10 miles distant, whose peaks are above 3,000 feet high. The intermediate country has a generally level surface, divided into woodland and prairie. The hill-slopes are covered with pine timber.

One mile east from New Year's spring there is a hill about 200 feet high, from the top of which is obtained an extensive view of the surrounding country. Towards the north and north-northwest appears an elevated plain, looking bleak, waterless and barren. It is dotted with conical hills of black volcanic rock. In a west-northwest direction, a broad open valley, dark with the foliage of cedar forests, extends to the mountains of La Laja, and for some distance is bounded upon the southwest by a low range of hills covered with trees excellent for timber. Towards the south-southwest lies the volcanic pile of mountains called "Bill Williams'," west of which is a succession of valleys and plains extending about 30 miles from New Year's spring to a conspicuous peak known as Picacho. This is the southern terminus of the range of La Laja; and at its base Partridge creek, which drains the intermediate country, empties into *Val de China*. The triangular space included between New Year's spring, Bill Williams' mountain, and Picacho, has the general appearance of a vast plain sloping gently to the southwest; examined more minutely, it is dotted with small hills and traversed by valleys, which in a few places are contracted, and enclosed by low walls forming cañons. There is good pine timber in

* A reduction of the reading of the barometer at noon upon the summit of this ridge makes its altitude 204 feet above Leroux's spring. Mr. Campbell agrees with me in the opinion that it is too great. This appears to be one of the errors which will be found referred to in the subsequent "Remarks upon the profile." It is consequent to the application of the formula for correction due to mid-day air temperatures. The effect is, as there stated, to give a roughness to the profile, and heavier grades than the surface of the country requires.

-E. Stout from a sketch by A. H. Campbell.

Lith. of SARONY, MAJOR & KNAPP, New York.

VIEW OF THE BLACK FOREST MOUNT HOPE AND SIERRA PRIETA.

Looking S.W. from Topographical Hill.

the vicinity of New Year's spring, and also in the region of Bill Williams' mountain. East of Val de China lies an extensive tract covered with large cedars and piñons, forming the so called Black Forest.

It may be seen from the profile, that, by the trail from the San Francisco springs to Picacho, the route is not impracticable for a railroad. The conformation of the country south of that line, however, is such as to lead to the belief that, by crossing the head branches of Rio Verde south of Bill Williams' mountain, traversing the Black Forest, and entering Val de China near the mouth of Pueblo creek, we would avoid the ascent above the San Francisco springs, entirely dispense with the most elevated summit upon the route, and shorten the distance to Aztec Pass without increasing the grades or expense per mile for graduation. Many questions regarding similar deviations from the line are to be determined by more elaborate surveys.

A semi-circular range of hills extends from the San Francisco peaks to Bill Williams' mountain, forming the northern and eastern boundary of the flat prairie and forest basin, which has been described. Near New Year's spring there is a wide gap in it, where the ridge is almost inappreciable. From this point a low spur extends west and west-northwest to the mountains of La Laja; dividing the water courses which drain northwest, through Park valley, from those that flow, by various branches of Partridge creek, into Val de China. From the examinations made, it was found easy to pass down the southern slope of this ridge into the valley of an eastern branch of Partridge creek. By some mistake, however, attributed to the intricacies of the numerous ravines, and the thickets of trees that cover much of this region, the train and the main survey followed, for a considerable distance, the northern base of the ridge, and beyond Camp 95 crossed over to Partridge creek. The more minute topography is, therefore, upon this line.

New Year's spring, at Camp 94, is at the head of one of the branches of Park valley. It is surrounded by a grove of pine trees, from 125 to 150 feet in height. Leaving the spring, we ascend the low prairie ridge and take a westerly course over a surface that, at a distance, appears level; but is found to be considerably broken by ravines, some of them from 30 to 50 feet in depth. The first contained pools of water. Station 1 is in Park valley, which, covered with cedar trees, extends like a broad plain towards the northwest, with the view uninterrupted almost to the horizon. Savedra made an exploration across this valley, and was absent three days without finding water. Again rising to the prairie at station B, we were about half a mile from the most northerly peak of Bill Williams' mountain, which is about 500 feet in height. To our right, between stations 3 and 4, there is a valley; and from 4 to 7 the trail is parallel to it. Between stations 8 and 9 we crossed a cañon, and at station 10 entered another; both of which incline to the right. Passing onward to Lava creek, we found a magnificent pool of water, and encamped. The soil of the prairies, though covered with excellent grama, is somewhat sandy, and overlies beds of lava or trap. The rock is exposed upon the sides of the cañons. Even the valleys have little depth of soil, and are uncultivable. Pine trees cover the hills and extend along the valleys. The grade for a road need not exceed 55 feet per mile. The ravines would be difficult to cross, but by keeping more to the left, most of them could be headed.

From Camp 95 to station 4, the trail descends to a broad cañon, about one-fourth of a mile wide at top, and the banks 75 feet in height. Near stations 7 and 8 are large piles of naked lava. The pines have now given place to cedars, which cover the slopes in every direction. Passing a slight elevation, we entered another valley, which, as we advanced, grew narrow, and between stations 8 and 9 formed a rocky ravine. We ascended the side slopes 135 feet to station B, which is upon the crest of a high ridge covered with cedar and piñon trees. It is composed of sandstone and carboniferous limestone, and extends far towards the right with a regular slope. About three or four miles beyond, there is a similar and parallel range of hills; and, between, lies a wide valley, densely wooded, and called—perhaps improperly, for we found no water in it—Cedar creek. From station B the descent for about 200 feet was at an inclination of nearly 45°; thence to station 18, two miles, 280 feet; and from that point, one mile and

a third, to Camp 96, in the bottom of the valley, 160 feet. This ridge would be impracticable for a railroad, except for the smoothness, regularity, and extent of its western slope. From an examination of the ground, it would appear practicable to cut through the crest at the gorge referred to, and construct a road upon the side slope, with a grade of about 75 feet per mile. This would enable us to strike the trail at station 14, between Camps 96 and 97.

From Camp 96 we followed the valley, which between stations 1 and 2 is contracted to the width of 150 yards, with banks from 20 to 30 feet in height. Beyond, the slopes upon the left are gentle; and at station 5 a wide branch of the valley comes in from the south. Three miles to the right of station A is the continuation of the bluffs, crossed at station B, between Camps 95 and 96; and they continue far towards the west-northwest. The valley between is dotted with knolls and sprinkled with cedar thickets. The surface is smooth and covered with grass. A quarter of a mile to the right of station 13 there is a hill 200 feet high. The slopes to the right are very gentle; the surface is prairie, with few trees. Upon the hill-sides, to the right of stations 14 and 15, much red sandstone appears. Here we passed a low dividing ridge, and entered the valley of Partridge creek—high hills continuing upon the right of the trail. Beyond, the valley becomes narrow, and at length enters a cañon of Partridge creek, with high bluff banks, which are covered with cedar trees. The trail followed the undulating slopes upon its borders to Camp 97, situated within a rocky glen, where the creek contained large pools of water. The geological outcrops are of the lower carboniferous formation. The country passed over is rough, but the general slopes are favorable for a roadway. From station 14 to Camp 97 the maximum grade may amount to 80 or 90 feet per mile.

From Camp 97 to Camp 98 the route lies near the cañon of Partridge creek. Its steep banks are from 50 to 80 feet in height, varying from one to three hundred yards in width. The top of the bluffs, though broken and rough, are upon a level with the general surface of the country, and, for a road, the labor of graduation would be less at some distance from the creek. The stream is not flowing, but it contains numerous pools of water. Grass and trees are abundant upon the trail. There is but little arable soil in the vicinity.

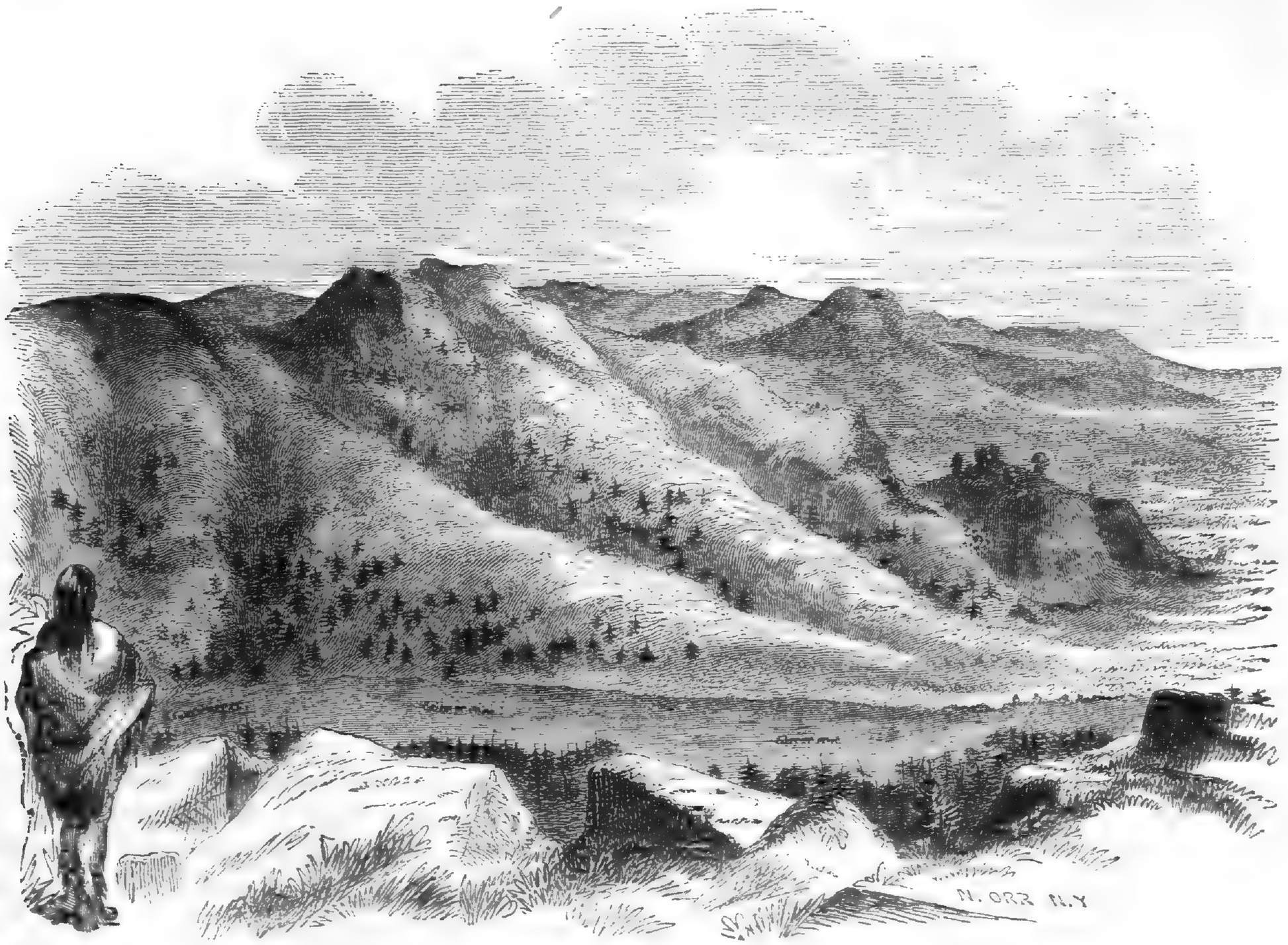
From Camp 98 to station 5, the trail follows the bed of the cañon. At that point the banks recede, leaving a good-sized valley between. The stream, however, makes a large bend toward the southeast; and, to avoid it, the line of survey took a direct course southwest across the nearly level prairie toward Picacho. Between stations 9 and 10 is a dry arroyo leading to Partridge creek. The ridge of Black Forest appears about fifteen miles to the left. Another chain of hills lies upon the right, about ten miles distant. From station 10 to 14 the country is level, producing a few scattered cedar trees; thence to Camp 99, the trail crossed a rolling prairie, intersected by a number of deep ravines, in which water was found. About three miles to the northwest is Picacho, with a gravelly spur extending to the vicinity of camp, and forming the southern terminus of the range of La Laja; the Black Forest range, from the south-southeast, ends about two miles southeast from the same point, leaving between the two ranges an opening through which Partridge creek flows into the great Val de China. The bed of this valley is about 200 feet below the general surface of the prairie, which borders Partridge creek, and ends in a bluff below Camp 99. Camp 100 is situated at the foot of it, about one mile distant from, and 188 feet below, Camp 99. By following Partridge creek from Camp 98 to its entrance to Val de China, the grades would be light. It would, probably, be equally practicable to construct a road along the trail, from station 5 to station 15—between Camps 98 and 99—and there entering a ravine, follow it to the confluence with Val de China, near Camp 100. The gradients would be favorable, except upon the latter portion, where they might amount to eighty feet per mile. The direct route from New Year's spring, referred to in the general description of this region, would take the northeast branch of Partridge creek, and unite with the survey near Camp 100.

Between Camps 100 and 101, a distance of seven and a half miles, the trail passes across the rich bottom-lands of Val de China, in a southwest course, nearly perpendicular to the general direction of the valley at this point. The country is smooth enough for the laying of tracks

for a road upon the surface. There are a few water-worn channels, which would be crossed by culverts or short bridges.

From Camp 101 the course of the trail is south-southwest, toward Mount Hope. Upon the right is the northern part of the Aztec range of mountains, and from the base of its steep sides low spurs of hills extend westwardly, gradually sloping to the edge of Val de China. Through these hills, which are covered with cedar trees, the trail ascends the gentle slope of a small ravine to its head near station 5. Thence it passes a low ridge and enters a small valley, with rich alluvial soil, through which flows a pretty rivulet called Turkey creek. Amidst a grove of oak and walnut timber is Camp 102. From Camp 102 to Camp 103 another spur of hills is crossed, which separates Turkey creek from Pueblo creek. The latter stream heads at Aztec Pass and flows easterly through a wide and deep ravine, dividing this range of mountains into two portions; the northern being horizontally stratified, the southern disturbed and changed by subterranean heat. From the foot of the cliffs upon the north to the bed of the rivulet, the slopes are regular, affording a side location for a railway, with favorable grades around the southeastern and southern declivities, from the ridge near Turkey creek to Aztec Pass; thus avoiding the descent to Camp 103 upon Pueblo creek. There is considerable arable soil upon this stream, and in the vicinity a variety of sylva. The mountains are covered with pine timber; the living streams are bordered with oak, cotton-wood, walnut, or ash, and the hills yield a dense growth of cedars.

Aztec Pass is between Camps 104 and 105. It is upon the top of a low granitic spur, which




View of Aztec Pass from the Indian ruins, looking south.

seems to connect the northern with the southern portion of the Aztec range. At its junction with the steep slopes of the southern peaks, two water-courses are formed. The eastern falls down a steep ravine, half a mile to the foot of the hill, and then, joined by a ravine from the

north, forms the head of Pueblo creek. The second follows the gentle slope of a wide and smooth valley towards the west-northwest, and becomes tributary to Williams' river.

The accompanying sketch, taken from the ancient ruins that crown a height upon the north, overlooking the pass, represents the summit of the dividing ridge and the prolongation of the Aztec range towards the south. In the distance, upon the left, is seen the top of Mount Hope, and the Gemini mountain is shown upon the right. From the latter extends a sloping plain to the wide valley in which Williams' river takes its rise.

The difficulty in constructing a railroad through this pass consists in the high embankment that would be required to cross the northerly ravine above referred to. With a cut, about 40 feet deep at the summit, the excavation and embankment would be nearly equal, and the gradients probably would not exceed 50 feet per mile. Having accomplished the passage of the summit, the descent would be easy down the wide valley through which the trail follows, to Camp 105. Below, upon the banks of the same rivulet, Camp 106 is situated. A small stream threads the valley and is occasionally lost beneath the surface. But few trees line its banks, though pines abound in ravines among the mountains, and cedars are plenty upon the hill-slopes and upon the plains adjoining.

From Camp 106, the trail follows the valley, in which there are a few small cañons cut through beds of lava. The soil is a sandy loam, producing good grass. Two miles distant upon the left, there is a ridge of hills bordering the valley. Station 3 is in the bed of a ravine containing water. From station 3 to station 4, the valley is several miles wide. The slopes of the hills upon the right are regular; while, upon the left, the country is rocky and broken. A low ridge, which, extending from the Gemini mountains, turns the valley towards the north, was crossed at station 7. Thence, passing a gently undulating prairie, sprinkled with occasional thickets of cedars, we struck the stream again at Camp 107, where it has high bluff banks. A short distance below, a chasm is formed; width about 80 feet, and height of rocky sides from 60 to 100 feet. There is water in the bed of the stream, and cedar trees upon the banks. The railroad line from Camp 106 would follow the valley of the stream, making a bend towards the north, and thus avoid crossing the cañon.

From Camp 107 to station A, the ascent is not difficult. Thence, attempting to descend along the bank of the stream, a deep ravine was crossed. One mile to the right of the trail, there extends a ridge of hills belonging to the Aquarius mountains. The general surface of the country is an undulating prairie; the soil containing much clay and loam. The prevailing rocks are granite and trap, which are so much cut up into chasms as to make the passage with wagons difficult. Hence the train returned; and Camp 108 was formed at station A, in the immediate vicinity of Camp 107. A reconnoitring party, however, pursued the course of the stream some miles further, and then passed northerly over the slopes of the Aquarius range, to White Cliff creek, which was followed to its junction with Big Sandy.

From Camp 108 to station A, the surface is somewhat broken. A small stream crosses the trail between stations 1 and 2, and another between stations 5 and 6; both evidently branches of White Cliff creek. From station 3 to station 7, the surface continues undulating; although the general slope is quite uniform, and from a slight eminence appears level. From station 7 to E, between stations 10 and 11, the trail passes over low ridges which divide ravines that have a southerly direction. Upon the right, three miles distant, there is a range of hills 400 feet high. To the left of station 9 there is a large valley, supposed to contain the main branch of White Cliff creek; and from station E to Camp 109 the ground is furrowed by various ravines, apparently tributaries to that stream. North of camp are rocky hills, covered with cedars. There is a chain of highlands also upon the left. The profile, from Camp 108, is projected south of the trail, along the valley noticed above.

The rivulet is rocky in the vicinity of Camp 109. The trail toward the west-northwest crosses several small valleys which extend southwest among small ridges, peaks, and mesas. From station 2 to station 3 the surface is level. Near station 4 the dry bed of a stream

is crossed. From camp to station A, between stations 6 and 7, the ascent is nearly continuous. There is a steep descent into a cañon from station 8 to station 9; and the trail from stations 9 to 15 is in the dry bed of a tributary to White Cliff creek. Passing into another branch at station 16, the trail then ascends its valley to Camp 110, near Cactus Pass. There is water in this branch of the creek, and cedar trees are still abundant upon all the hill-slopes in the vicinity. Cactus Pass is not practicable for the location of a railway; and it is proposed to make the profile for that line, as before stated, from Camp 108 down the valley of White Cliff creek. Measurements for that purpose were made upon a reconnoissance, and will be referred to hereafter.

Cactus Pass is formed by a deep gorge in a high range of granitic mountains. From the summit, about 300 feet above the pass, an extensive panoramic view is obtained. The Hamookhäbî, or Blue Ridge, is seen bordering the Colorado, and a lesser range intermediate. The latter terminates nearly in the latitude of this place, and, after an intervening gap, the Cerbat range is prolonged in the same southerly direction. Toward the northwest there is a vast plain, leading apparently to Yampa creek, and bounded upon the east by broken ranges of low mountains. East of the Cactus mountains may be seen the extensive broken plains already traversed—Cross mountain, 800 feet high, and the Aquarius range, 1,000 feet high, being the principal of the peaks and ranges that break the general level of its surface.

The ascent from Camp 110 to station 1, at the summit of Cactus Pass, is about 100 feet in little more than half a mile. Thence, down the first portion of the ravine, the declivity is nearly precipitous, and in one mile and three-quarters, to station 3, the descent is 830 feet. Here the valley becomes wide and sandy, and the trail keeps to the left of it, crossing a gently swelling slope that comes down from a southerly spur of the Cactus mountains. Near station 5 there are springs, in the vicinity of which the reconnoitring party bivouacked, January 28.

Station 6 is 560 feet below station 3. Thence to Camp 111, near the mouth of White Cliff creek, the descent is 350 feet more; making a total, from Cactus Pass, of 1,640 feet in a distance of eight miles. White Cliff creek is a clear and rapid stream, with a strip of fertile soil upon its banks for eight or nine miles up the valley, to the bivouac of the exploring party, January 27. Its principal tributary is about four miles below that point, and both streams are bordered by a dense growth of cotton-wood. The altitude of the bivouac, from the readings of the barometers, is 4,480 feet, or 950 feet above Camp 111; giving the descent of the stream above 100 feet per mile. But, as it contained no steep rapids, to the eye the declivity seemed much less, and possibly an error may have been made in the record of the observations. The distance from the bivouac to Camp 108, near the head of this stream, is about 8.5 miles; and the altitude of that camp being 4,814 feet, the fall of the rivulet between those points would be nearly forty feet per mile. Its valley, with the deflection indicated upon the profile from Camp 108 to Camp 111, may be considered practicable for the location of the railroad line. White Cliff creek is bounded upon the north by high gravelly slopes and mesas, which terminate the mountain spur south of Cactus Pass. It is therefore believed feasible to locate the line upon this ridge, so as to turn the southwest point of the high mountains, and avoid the descent to the bed of the lower portion of the creek. This line would strike the trail, from Camp 110 to 111, at station 9; which, being about 200 feet above the latter camp, would cause an improvement in the grade. Station 9 is in a valley leading, by a gentle ascent, to the wide prairie which has been described as seen from Cactus Pass. It is apparently nearly level to the gap north of the Cerbat range, and thence inclines, by broad slopes, to the Colorado river. From an examination of our topographical sketches and views, and a comparison with the heights of relative points, both upon our own exploration and upon that of Captain Stitgreaves, the elevation of the gap is estimated at 3,900 feet above the sea; giving for the ascent, from Camp 111, 374 feet, and an ascending grade of 11.5 feet per mile. From this summit a broad plain slopes the Colorado river, and a spur of it impinges upon that stream between the mountain ridge, called "The Needles," and the Mojave villages. The elevation of the bluff is 450 feet above

the sea, and the descent from the pass is 3,450 feet. The distance in nearly a straight line is 37.4 miles, and the grade, if uniform, as the appearance of the country seems to indicate, would be 92.4 feet per mile. The sketch No. 3, taken from the right bank of Rio Colorado, looking east, gives a view of the country here described.

The region which includes the Cactus and Aquarius mountains is well supplied with cedar trees. Westward the sharp-crested ridges appear naked, and the plains nearly destitute of foliage. Wood is scarce, even for fuel. The two Indian springs, already referred to as existing upon this route, probably indicate points where, by digging, a sufficiency of water would be found.

From White Cliff creek to the Mojave crossing of Rio Colorado, our wagon trail followed Big Sandy creek, Williams' river, and the valley of the Colorado. For a description of the topography upon this part of the route I would refer to the Itinerary. Although meagre in its details, it may suffice to give a general idea of the character of those streams.

## SECTION VII.

### *From Rio Colorado to the Pacific.*

The lofty crest of the Sierra Nevada, which forms the distinguishing topographical feature of California, extends uninterruptedly through five degrees of latitude, from Madeline Pass on the north, to Walker's Pass on the south, the latter being in latitude 35° 40′. Between these points, it appears to be conceded that there is no break in the chain available for a railroad route. A secondary range of mountains, called the Coast range, dividing the waters of the Salinas from those of the San Joaquin, extends southeast from Monte Diablo to a point southwest from Walker's Pass; where, in latitude 34° 30′ about, it intersects with a third great range. The latter commences at Point Conception, and extends* east-southeast to San Bernardino; and thence, according to recent explorations, is prolonged to the Colorado, near the junction of Rio Gila, and forms the northeast boundary of the California desert. South of San Bernardino commences another system of mountains, which traverses the whole length of Lower California. These various ranges are all united by low hills and ridges that are confined to a belt, about a degree and a half in width, bounded on the north by the parallel of 35° 15′, and upon the south by latitude 33° 45′; and among these connecting links are to be found the few available passes leading from the Colorado river to Los Angeles or San Francisco.

The vapors that rise from the coast are generally precipitated upon the western slopes of the mountain ranges referred to; and therefore, south of the parallel of 36°, there is no stream, worthy of note, flowing from their bases eastward, save the Mojave river. This stream was formerly supposed to empty into the Colorado, near the Mojave villages; and, when our survey was projected, we believed it would lead by a favorable course the whole distance from that place to the eastern base of the Sierra Nevada. It now appears, however, from the examinations of Lieutenant Williamson—and subsequently those of Lieutenant Parke—that the Mojave river is lost at Soda lake. Hence, the region it traverses forms a basin belonging to the same system as those that are so celebrated further north. It is separated from the valley of Rio Colorado by a wide granitic mass, called the Painte mountain, which seems to be a prolongation of the Wasatch range. The slopes upon the east are so regular and smooth as to appear like a nearly level plain. Upon the summit there are but a few crested ridges, and the topographical sketches show passes, north and south of our line, lower than that upon which the levels were taken. It is believed that a more extensive exploration would discover a route across this ridge, by which the grades to Soda lake would not exceed 80 feet per mile.

The region in the vicinity of the junction of the great mountain ranges that bound the Pacific slopes of California, within the belt above referred to, was explored by Lieutenant Williamson; and the passes which he surveyed are described in his report. I beg leave briefly to refer to a few of them, as they have an important bearing upon the termination of the route under consideration.

The best of the passes examined by Mr. Williamson are the San Gorgonio, at the junction of the Lower California range of mountains with the San Bernardino range; New Pass, through the latter range; and Taheechaypah Pass, through the ridge dividing the so-called Great Basin from the head of Tulare valley. San Gorgonio Pass is available only to connect the Gila route with Los Angeles or San Diego. In the prolongation of this line to San Francisco, it is neces-

* This general sketch does not refer to the geological divisions, or strike of the mountain ranges, but simply, the direction of the masses.

sary to thread both of the other passes mentioned. The latter—the Taheechaypah—is in latitude 35° 7′, and from its summit, slopes of gentle inclination lead eastwardly across the Great Basin to the northwest bend of the Mojave river. In this consists one of the advantages of the route by the 35th parallel, viz: that by a single pass—the most available known—the Cordilleras of California are surmounted, and San Francisco reached with the least practicable deviation from a straight line. Therefore, we are enabled to adopt San Francisco as the termination of this route, and to disregard the difficulties which would have been encountered at Cajon Pass in obtaining an entrance to the valley of Los Angeles.

The central portion of the region embraced in this section of our route is noted for barrenness. Some of the soil possesses the elements of fertility, but vegetable growth is prevented by the want of moisture. As before stated, the vapor rising from the Pacific is generally precipitated upon the western slopes of the mountain chains that traverse the State of California, nearly parallel to the coast. At their eastern bases are found a few springs, and small streams flowing towards the desert; but, excepting the Mojave, they disappear at a short distance from their sources. Between the mountains and the Colorado the climate is dry; the winds parch the earth, and the soil is arid. No part of our country has a wider celebrity for barrenness than that known as the Californian desert, between Cariso creek and Rio Colorado. Until the autumn of 1849, it was found to be a sandy and dreary jornada, without water or grass for about 80 miles, causing great suffering to the overland emigrants who attempted to cross it. Then, suddenly, water appeared in various lagunas and channels; and in a few weeks the central portion of this desert was covered with large fields of luxuriant grass. The water was probably backed up by a strong south wind upon the Gulf, and a simultaneous rise of the Colorado river had the effect of irrigating the soil of the desert basin. At length, by evaporation and absorption, the water disappeared; and a spot that had given evidence of remarkable fertility became naked as before, without the faintest trace of vegetation.

There are peculiarities in the conformation of the country, near the parallel of 35°, requiring some modification of the general characteristics above described. The sudden breaking down of the Sierra Nevada, near that latitude, probably allows a passage for a portion of the moist air from the coast, sufficient to nourish nutritious grasses upon the prairie slopes, and, by precipitation upon the San Bernardino range, to feed the Mojave river. Upon the elevated ridge between Soda lake and the Colorado, there is also a deposition of moisture sufficient to sustain a few small springs, and give sustenance to grama grass upon its broad slopes. The Mojave river, from its source to the entrance into the basin of Soda lake, irrigates a valley which contains a belt of arable soil. From that point to the western slope of the Paiute mountains, with the exception of a narrow space in the vicinity of the lake, the country is sandy and barren, possessing all the characteristics of a desert.

The valley of Rio Colorado affords a large extent of fertile bottom-land which may be irrigated and cultivated. The soil is believed to be superior to that of the Rio Grande. Large patches of it are cultivated by Indians, producing crops of maize, wheat, beans, melons, and squashes.

As artificial irrigation seems to have been but little resorted to by the natives in their system of agriculture, it may be inferred that there is much moisture in the atmosphere, or that summer rains are more frequent here than in New Mexico. With a suitable system of acequias, or drains from the river, to water the soil, this valley would doubtless be as well adapted for the production of tobacco and cotton as the bottom-lands of Rio Gila, near the Pimo villages. The southern portion seems favorable for the production of rice and sugar.

The amount of arable land upon the Colorado, between the parallel of 35° and the junction of Rio Gila, is roughly estimated at 700 square miles. This estimate is based, partly upon our own observations, but mainly upon the results of Captain Sitgreaves' survey, with measurements taken from his map, and is made up as follows, viz: the Mojave valley, forty miles in length, averaging four miles in width, equal to 160 square miles; the Chemehuevis valley, eight miles in length, averaging four miles in width, equal to thirty-two square miles; the

valley at the mouth of Williams' river, eight miles in length, averaging three miles in width, equal to twenty-four square miles; the Yuma valley, forty miles in length, averaging eight miles in width, equal to 320 miles; the Cuchan valley, eighteen miles in length, averaging three and a half miles in width, equal to sixty-three square miles; the valley of Caballo en Pelo, above the junction of the Rio Gila, ten miles in length, averaging eight miles in width, equal to eighty square miles; other portions of the stream being bordered by narrow belts of good soil, sufficient, probably, to make up the amount stated above. Below the mouth of Rio Gila the bottom-lands that may be irrigated are very extensive.

The Colorado river, at the crossing near the Mojave villages, was divided by an island into two channels; one about seven feet, the other ten feet in depth. From that place to the mouth of Williams' river—a distance of fifty-two miles—the inclination of the stream is 1.6 foot per mile; and there is no appearance of shallows, rapids, or other obstructions to navigation. Between the mouth of Williams' river—the computed elevation of which is 356.4 feet above the sea—and Fort Yuma, 150 miles, the slope of the valley is believed to remain nearly the same, giving to the Colorado similar characteristics to those above described. Assuming the fall of the river to be 1.6 foot per mile, the altitude of the river at Fort Yuma would become 116.4 feet above the sea; and thence to tide-water of the Gulf, 80 miles, the descent would be nearly 1.5 foot per mile. Steamboats from the Pacific have long navigated the Gulf of California and the Colorado river to Fort Yuma, for the purpose of conveying supplies to that military post. From all that is known of this river, there seems to be sufficient reason for believing that the same vessels of light draught might navigate the channel for the remaining 200 miles to the Mojave villages. The whole distance, from shore to shore, at the ferry above referred to, is about 1,800 feet—more than twice the width of the river at the upper or lower end of the Mojave valley. Near the middle of the river, separating the stream into two channels, there is an island of sand 200 yards wide, and about a quarter of a mile in length. For the location of a bridge, however, a more favorable point is found near Camp 132, where gentle slopes of the prairie form low bluffs impinging upon the river. From the east, this point may be approached by the route around the northern base of the Cerbat range; and upon the west the line would edge along prairie slopes to the Sacramento springs. Our trail, from Camp 134, was across the fertile bottom lands upon the right bank of the Colorado, and thence along the base of the gravelly spur which borders it. Camp 135 was formed upon an arm of the river, which encloses a wide marsh covered with rushes. Upon the eastern side of the valley, parallel to our trail, there exists a broad ridge of mountains, limiting the width of the arable soil between its base and the river to about ten miles. The trees upon the stream are principally mezquite and cotton-wood.

A short distance above Camp 135, a valley, from the W.N.W., unites with the Colorado. It contains the sandy bed of a stream which heretofore has been supposed to be Mojave river. Our trail, leaving the Colorado valley near the last mentioned Camp, crossed a gravelly spur 80 feet in height, and entered the arroyo at station 2. A short range of high hills upon the north terminates near station 3, and the valley sweeps around its western and southern bases. There is a similar highland range upon the south about eight miles distant. Toward the west appears a broad ascending plain, without any visible crest surmounting it, but traversed by a ravine, which the trail ascends to station 4. Here it is bordered by a few small hills whose bases are composed of beds of marl containing several springs of water. They are about ten miles, in a straight line, from the Colorado, and nearly 800 feet above it.

A view of this region was sketched from the left bank of the Colorado, looking W.N.W. It is represented in plate No. 1, and prefixed to the Itinerary. Plate No. 2, taken from the island in the Colorado, and giving the view looking north, precedes the topographical report. Plate No. 3, representing the right bank of the Colorado, looking east, or E.S.E., will accompany the Indian report. The three landscapes differ with respect to their foregrounds, but the spaces between the points of view are so small that the distant scenery is scarcely affected thereby. They may therefore be united, for the purpose of showing the character of the moun-

tain ranges, and thus a panoramic view will be obtained, covering an angle of 180°, from the W.N.W., by the north, to the E.S.E. No. 3 shows the plain by which it is proposed to descend to the Colorado valley from the east. No. 1 gives a view of the pass through which the Mojave river was previously supposed to flow, and by which the profile crosses the mountain ridge, separating the Colorado valley from Soda lake.

From the Sacramento springs the trail takes a northerly course, following prairie slopes upon the western edge of the valley, which is from five to ten miles in width. Upon the left there is a slight ridge, with several openings for sandy arroyos, perpendicular to the trail, showing channels for the drainage of the waters of the plains beyond. Upon one of these ravines is Camp 136, about twenty-one miles from the river, and 1,700 feet above it; the grades being nearly uniform. The whole country traversed since leaving the Colorado valley—except at the springs above noticed, where are patches of grass—is nearly destitute of vegetation. Chamiza upon the plains, and a few yuccas near the arroyos, furnish a scanty pittance of food for the animals and fuel for camp-fires.

From Camp 136 the route continues nearly north to station 2. Upon the left is a range of hills, 800 feet above the trail and 1,500 feet above the valley, at the foot of the wide slopes upon the right. At station 2 this range is broken, leaving an opening towards the west two and a half miles in width. Thence we approach the base of a cluster of sharp crested hills, from 800 to 900 feet in height, at the rocky base of which flows a rivulet called Paiute creek. Upon its borders, near Camp 137, are patches of fertile soil, which have been cultivated by Indians, producing corn and melons. There are cedar trees and grass upon the hill sides. The stream flows S.E., and is probably lost in the valley before mentioned, which, sweeping around the northeastern base of the mountain, continues south and east to the Colorado. The ascent from Camp 136—about 600 feet in nine miles—has been gradual, except near the entrance to the creek, where several rough ravines were crossed.

From Camp 137 the trail ascended a tortuous ravine to the head of one of the branches of Paiute creek, and then mounted to the crest of the ridge at station 2, about 830 feet above the cultivated fields in the valley. From this point sketches were taken, showing a wide gap between the hills upon the left, and upon the right a low valley, three-quarters of a mile wide, appearing to drain the waters of the plain, which lay extended towards the west, into the same great valley that receives Paiute creek. Station B is at the western base of the ridge. From that point the course of the trail is nearly magnetic west across a vast plain extending about twenty miles to Camp 39, at Rock Spring. The ascent is uniform, at an inclination of about eighty feet per mile. Grama grass abounds throughout its whole extent, and upon the sandy arroyos, which traverse it, there are fringes of cedar trees furnishing fuel. Rock Spring issues from a deep ravine, the sides of which are composed of ledges of sienite. A few hundred yards below, it flows into a large valley that proceeds from the N.W. to the S.E. toward the Sacramento springs. Toward the south, 15 to 30 miles distant, are noted two short ranges of mountains; and between them and the trail the sketches indicate a broad valley, judged to be one thousand feet lower than the region passed over. Near the camp are several rocky hills, covered with cedar trees, and containing good grass upon their slopes.

Leaving Rock Spring we pass around the northern base of the sienitic hill, and make a gradual ascent of 300 feet in 3 miles, which brings us to station 5, upon the summit of the Paiute ridge. Before us appears a gap between two elevated crests—one upon the north, the other upon the south—and a ravine with a well-defined water-course westward. The rise to this summit from the east is nearly uniform for 25 miles. Little grading, therefore, would be required to construct a road of a grade from 80 to 100 feet per mile upon the natural inclination of the surface. It would be difficult to diminish the grades, except by winding in a serpentine course across the wide plains, so as to increase the distance. The mountains upon each side of the pass are from one to two miles distant, 600 or 700 feet in height, and are covered with cedar trees and a few pines. The arroyo bends between stations 5 and 6, inclining gently toward the

west. At station 6, about 2 miles west of and 40 feet below station 5, the width between bluff banks is a quarter of a mile. From this point the ravine becomes abrupt, descending the western slope of the mountain-ridge with a rapid declivity to a broad valley which sweeps from the north, and turning the S.E. base of Marl hill, leads between sandy slopes to Soda lake. From station 6 to station A, where the trail intersects the Sand-hill valley, the distance is seven and a half miles, and the descent 1,538 feet. The crest of the mountain, however being passed, gravelly slopes proceed from between stations 6 and 7; and by edging along the foot of the crest, above stations 7 and 8, and bending to the north, this valley may be reached several miles above station A, where the increased altitude and the natural declivity of the prairie would enable the engineer to locate a track for a road with a grade not much exceeding 100 feet per mile. The distance thence, by the course of the valley, to Camp 42, at Soda lake, s about 45 miles, with a descent of 2,618 feet, averaging nearly 60 feet per mile. The first portion of this distance, however, would be steeper than that near the lake, and the maximum would be from 90 to 100 feet per mile.

From the crossing of Sand-hill valley the trail led over an ascending prairie to Marl Springs. These issue from the foot of a granitic ridge, furnishing a small quantity of water at the surface. There is grass upon the hill-sides and at a few spots upon the plains, but the region is generally characterized by barrenness. Yucca trees and chamisa shrubs relieve its nakedness. From the springs a valley several miles in width leads in a southerly course to Sand-hill valley. Westward of Marl Springs there are high broken prairies, over which the trail passed. These are rocky and nearly destitute of vegetation. Upon the north of station 8 there is a large black mountain, beyond which appears a broad valley, parallel to the trail until opposite station 10. Beyond this station the trail turns toward the southwest, and descends a steep ravine to Camp 141, which is in a dry gorge between two mountains, where grass was found upon the slopes.

For three miles from Camp 141 the trail descends a gradually sloping prairie, with a declivity of about 200 feet per mile, to the border of a broad basin of white sand. This is a perfect desert, extending six miles to station 2. The surface is generally hard enough to bear the weight of horses. Opposite station D, upon the left, is a ridge of hills, with drifted sand piled upon the northwestern sides. Upon the right, seven miles distant, appears a high mountain range. Between stations 1 and 2 is a rocky ridge upon the north, with bluff sides from 200 to 300 feet in height. Beyond, the hills recede, leaving a wide vista north and south, apparently level for a great distance. At station 2 there are a few small sand-hills which lie upon the border of a dry lake, its surface indurated with ferruginous exhalations, or encrusted with white efflorescent salt. It extends toward the north, and is about four miles and a half in width between station 2 and Camp 142.

Camp 142 is upon the western border of the lake, 1,000 feet above the level of the sea. An abundance of rank, coarse grass grows in the vicinity, and large pools of brackish water were obtained by turning aside the marshy sod. Upon the north-northwest, about one mile and a half distant, there is a range of hills, upon the eastern slopes of which were Indian camp fires, and hence, probably, springs of water. Six miles south of camp there is another range of hills, and at a greater distance a high mountain is visible above it.

Leaving Soda lake we again entered a field of sand. It was loose, yielding to the pressure of feet, and occasionally drifted into hillocks. Upon the north and south, many miles distant, are ranges of high hills, seeming to enclose this desert space, which extends westward from Soda lake to Camp 143, twelve miles, with a uniform acclivity of 18 feet per mile. Here we first meet the flowing waters of Mojave river. At Camp 143 it is a clear and rapid rivulet. A short distance below, upon the north of the trail, it is lost in a bed of sand.

We now ascend the banks of Mojave river and enter a cañon, formed by the near approach of two ranges of hills about 300 feet in height. Near station 1 the cañon is contracted to 200 yards in width. At another narrow point, between stations 2 and 3, it is 300 yards wide.

Above, to Camp 144, the valley opens, the hills assume the character of a broken mesa formation, and the bottom-lands vary from a few hundred feet to nearly a mile in width. Wherever the stream appears flowing upon the surface, its banks are clothed with luxuriant vegetation, consisting principally of mezquite thickets, willows, and rank grass. Between stations 4 and 6 the water sinks, and the valley is sandy and barren. There is grama grass upon some of the hill slopes and in the ravines.

At Camp 144 there is running water, with grass and mezquite trees upon the banks. The width of the alluvial bottoms is 700 yards. Ascending the valley, we find it bounded by low grassy mesas from 25 to 80 feet above the stream. At station 1 the surface is dry and sandy. Station 2 is on a spur of the table-land which impinges upon the right bank of the stream. From station 2 to station 3 the trail crosses the river, ascends a prairie covered with luxuriant grass, and descends to the valley again at station 4. From this point to Camp 145, three miles and a half, the mesas recede, leaving a basin of arable soil several miles in width. A pretty stream flows through it, bordered with cotton-wood and tornillas, and the surface is covered with an exuberant growth of meadow grass. From this place the trail leads along the edge of a broad mesa; and at station 1, five miles from Camp 145, it enters the valley of Mojave river, at its intersection with the Mormon road from Great Salt Lake. The slopes are broad, and the valley, in many places, dry and sandy, until we reach station 5. From that point to Camp 146, the bottom-lands enclosed by hills become narrow. The stream bears a larger flow of water, and the banks are fertile.

Above Camp 146 the valley is from one to two miles in width, containing good soil and large groves of cotton-wood trees. The river is a continuously flowing stream, containing water sufficient to irrigate the wide bottom-lands below. At station 5 the trail turns from the valley to cut off a large bend of the river towards the northwest; and opposite station 6 is a break in the mesa, indicating the entrance of a ravine, or an arroyo, from the east. This is the point where it is proposed to leave the Mojave river, and proceed, by the route examined by Lieutenant Williamson, to Tah-ee-chay-pah Pass, and thence to San Francisco. For full descriptions of the surveys upon that line, reference will be made to Lieutenant Williamson's report, from which may be obtained a knowledge of the character of the country from the Mojave river across the Great Basin, and through the Tah-ee-chay-pah Pass into Tulare valley. The height of the Mojave river at the point between Camps 146 and 147, where we propose to leave it, is 2,313 feet above the sea. The latitude of this place is 34° 53′.5. Mr. Williamson's Dry lake is nearly west, about thirty miles distant, at an altitude of 2,388 feet above the sea, or seventy-five feet above the Majove river. The country between is an undulating prairie, deemed favorable for the location of a railroad. The width of the lake appears to be about 9.5 miles. From the western edge of it to the stream at the entrance to Tah-ee-chay-pah Pass, which has an elevation of 3,300 feet above the sea, the distance would be 23.5 miles, in a course slightly north of west, with an average grade of about 39 feet per mile. Thence ascending the stream 16½ miles to the summit of the pass, the maximum natural grade is 88 feet per mile.

The following extract from Captain Humphries's report will suffice to give an idea of the remainder of this route to the Pacific:

"The most direct route to San Francisco from the Tah-ee-chay-pah Pass will be found through one of the passes known to exist in the mountain range separating the San Joaquin valley from those of the Salinas river and San José river. The distance through them is about ten miles; the elevation of their summits about 600 feet. They may be reached from the Tah-ee-chay-pah Pass by passing around the head of the Tulares valley to its western side, or by keeping on the eastern side of the Tulares valley 15 or 20 miles after crossing Kern river, then crossing the valley; in doing which, it will be necessary to use piling for the distance of ten miles to make a sufficiently firm road-bed over the soft, miry, alluvial soil. The distance to the port of San Francisco, by this route, from the Tah-ee-chay-pah Pass, is about 288 miles. The average grades, except through the short pa..s, will be two or three feet per mile.

"The soil of the Tulares and San Joaquin valleys is well constituted for fertility, and needs merely the proper amount of water to be highly productive. There are settlements along the eastern side of these valleys under the mountains. The San José valley is one of the best cultivated and most populous districts of California.

"Sufficient water and fuel for working parties can be found at convenient distances on this section, and lumber and good building stone at various points along the line in the mountains, 15 or 20 miles from the foot of their western slopes."

Subsequent to the examinations previously referred to, a reconnoissance has been made in California by Lieutenant Parke, of the topographical engineers, and it is understood that he has found a highly favorable route, leading from Tah-ee-chay-pah Pass across the Coast Range to a branch of the Salinas river, and thence directly to San Francisco. His report will, probably, give specific information upon this subject.

It would be desirable to construct a branch railroad from the Mojave river to the port of Los Angeles. The country is well adapted to the purpose, excepting the portion embraced by the Cajon Pass. There, a long tunnel would be required through the crest of the summit, and grades from 100 to 150 feet per mile along the ravine in which the Cajon creek flows, or expensive cutting and filling across spurs of the mountain slopes. For a road of secondary importance, however, it might be deemed advisable to adopt the surface grades along the creek, and, perhaps, use stationary power to ascend the summit from the Pacific side. Upon those conditions the expense for constructing the road would be brought within very moderate limits.

# GENERAL REMARKS UPON SPECIAL SUBJECTS.

## TIMBER AND FUEL.

These necessary requisites for a railroad are found in great abundance upon several portions of our route. The State of Arkansas and the Choctaw Territory, as far as Shawneetown, abound in superb forests, and contain extensive beds of coal. Westward from Shawneetown, we have live-oak and black-jack in the Cross Timbers, and, in the valleys of the streams, as far as to the head-waters of the Washita, there is a growth of larger timber. Thence to the Pecos but few well wooded valleys occur, and the prairies which bound them are generally destitute of trees. Valley river and Shady creek contain groves of timber, and the Canadian is generally bordered by cotton-wood trees. Upon the slopes along the base of the Llano bluffs, near the head-waters of Tucumcari creek, and thence westwardly to Hurrah creek, there are extensive tracts covered with cedars affording a large supply of fuel. As we approach Anton Chico, cedars again appear, and upon the mountains, a short distance north, there are pine trees, such as are used throughout New Mexico for lumber. Between Rio Pecos and Rio Grande we pass through forests which afford, at convenient distances, both timber and fuel. A vein of coal crops out in the San Antonio cañon, but it is doubtful whether it can be obtained there in sufficient quantities to enable us to depend upon it for a supply of fuel. The Douglas' spruce and other firs, which cover the slopes of the Zandia mountains, would suffice for the requirements at this place.

Wood is scarce in the valley of Rio Grande. Fuel for the inhabitants is usually obtained from the Rio Puerco, where cedar thickets again appear. Near the latter stream good coal has been found, and there are indications of it further west, but the specimens obtained are said to be of inferior quality. The geologist supposes that the quantity which exists there is small.

Forests of stately pines cover the slopes of the Sierra Madre, furnishing an unfailing supply of timber and fuel.

Beyond Zuñi, a region of country, some thirty or forty miles in extent, is covered with a thick growth of cedars. Thence, fuel is scarce, for nearly an equal space, to Flax river. That stream rises in the well-wooded region of the Mogoyon mountains; and, by rafts during spring freshets, a supply of timber and fuel might doubtless be obtained. The banks of the river are skirted with cotton-wood trees. Leaving the valley, we immediately enter among small cedars, which increase in size and numbers, until reaching the base of the San Francisco mountains, they intermingle with, and finally give place to, immense forests of stately pines and Douglas' spruce. No finer timber grows in the interior of our continent. For 130 miles there is a constant succession of these forests. They disappear upon the head-waters of Williams' river. In the valley of that stream, as well as upon Rio Colorado, there are trees of cotton-wood and mezquite, which frequently form large and beautiful groves. They might prove useful in affording material for a primary supply of railroad ties. Among the ravines are a few cedars. Leaving Rio Colorado, we traverse a region for 110 miles almost destitute of fuel. Thence, the valley of Mojave river, sparsely fringed with mezquites and small cotton-woods, leads to the well-wooded region of the California mountains. By the direct route from the bend of the Mojave river across the basin to Tah-ee-chay-pah Pass, there is a space of above sixty-three miles of prairie, which would receive its supply of fuel and timber from the nearest points of the Sierra Nevada.

WATER.

The valley of the Canadian river is believed to contain springs and streams sufficient for railroad uses; common wells only at certain points being necessary to secure a permanent supply of water. From the head of Pajarito creek to Rio Pecos, springs and rivulets occur at convenient distances. From Rio Pecos to Rio Grande, artificial means would be required to preserve a perpetual supply of water in Cañon Blanco, and possibly at the Laguna. This object could be accomplished by an artesian well, or by a large tank at Camp 55, and an artificial reservoir at the Laguna. Thence to Isleta, the water stations that could be placed upon Rio San Antonio would probably be sufficient.

From Rio Grande to Rio Pecos, a distance of about 23 miles, the route crosses a waterless mesa. The latter stream contains running water for a portion of the year, and then sinks below the surface. A reservoir, or artesian well, would be required in its vicinity. Thence, up the valley of Rio San José to Campbell's Pass, in the Sierra Madre, there is sufficient water at moderate distances. From the fine spring of Agua Azul to Carrizo—a laguna which forms one of the head branches of Rio Puerco of the west—the distance is 25 miles. Thence, 10 miles lead to Ojo del Oso, another tributary of the same stream, which waters a fertile basin in the pass; and at the same distance beyond is found Salt Spring with brackish water. These springs flow down the Rio Puerco of the west, which is dry for a part of the year. It would be necessary to construct tanks in its valley, or common wells, to obtain a permanent supply of water at proper points. Near the lower portion of it, there are springs and tributary rivulets. Flax river is a permanent stream. Leaving it at Camp 82, we then find water at Cañon Diablo, Cosnino Caves, San Francisco Springs, and Leroux's Spring, the greatest distance between being about 20 miles. Other permanent springs can probably be found at intermediate points. From Leroux's Spring to New Year's Spring, the distance is about 23 miles. To obtain water between, tanks would be required. The route further south, previously suggested for examination, down the valley of Rio Verde, and across branches to Val de China, would doubtless prove better in every respect, and afford abundance of water. Partridge creek contains large pools of water, and is probably never dry. Pueblo creek is a flowing stream, from springs at its source in Aztec Pass. From near the same point commences a branch of Williams' river, which flows to the Colorado. No difficulty would be found in obtaining sufficient water at suitable points along its valley. The route now proposed, however, leaves that stream, and descends a branch called White Cliff creek, which also contains running water, to its junction with Big Sandy. Leaving the valley at Camp 111 to the left, and passing westward, the line crosses wide sloping prairies for 80 miles to the Colorado, near the Mojave villages. The Indians told us of two or three springs upon the way, and it is possible that water could be otained at other points, upon the mountain slopes, by artesian wells. A sufficient supply of water could undoubtedly be obtained by the construction of tanks. Ten miles west of the Colorado are the Little Springs. Painte creek is 21 miles beyond. Thence to Rock Spring is 20 miles; and Marl Spring is 20 miles beyond. The greatest jornada encountered is from Marl Springs to Soda lake, a distance of about 30 miles. It could, doubtless, be much diminished, by digging a well of moderate depth upon the eastern border of the lake. Many of the springs referred to are believed to be permanent. Several points of the crest of this mountain chain are above 5,000 feet in height, and it is evident that considerable precipitation of moisture takes place upon them. By the construction of reservoirs, sufficient water might be obtained for railway purposes. From Soda lake, it is a distance of 12 miles to the point where we found the flowing water of Mojave river. This stream now furnishes an abundance of water, until we reach its northwest bend, where the line leaves it to join the survey of Lieutenant Williamson, passing across the basin, through Tah-ee-chay-pah Pass, and to San Francisco. From Mr. Williamson's examinations, it seems probable that springs may be found at several points within the basin. It is the opinion of Mr.

Blake, the geologist, that, within this region, artesian borings may be resorted to with success. Within Tah-ee-chay-pah Pass there is water, and the remainder of the route to San Francisco is reported favorable in this respect.

### SNOW.

Upon the parallel of 35° snow cannot prove an obstruction to a railway. From Memphis to Rio Pecos, snow-storms rarely occur. At Fort Smith, as has been shown, but one was noted in the winter of 1852, and that covered the ground to the depth of only two inches. From thence to the Pecos, three or four inches may occasionally fall, but must rapidly be absorbed by the warm porous soil. It is not likely that the surface would remain whitened for many days during the year. Passing the ranges of the Rocky mountains east, and the Sierra Madre west, of the Rio Grande, storms are said to be more frequent, snow sometimes covering the ground to the depth of one or two feet; but here, too, it quickly melts, and forms no obstruction to travellers. The latter range, which we passed late in November, was entirely bare. The first snow seen was in December, glistening upon the distant peaks of Sierra Mogoyon. During the latter part of December and the first of January we were at the base of the San Francisco mountains, where more was found than upon any other portion of the route. It scarcely ever exceeded eight inches in depth, was nowhere drifted, and formed little obstruction to our march. We learned, nevertheless, that the season was unusually severe, and the amount of snow greater than had been seen at that place during several previous winters. On the 18th of January, when upon a reconnaissance in the Aztec range, there was a fall of snow several inches in depth. Four days after, we were again at the same spot, and it had nearly disappeared—from the southern slopes entirely. Leaving this range, we saw no more indications of snow, except near a few mountain summits. Without doubt, between Aztec Pass and California, it may sometimes fall to the depth of half a foot, but in so mild a climate it soon melts away. At Tah-ee-chay-pah Pass, for a limited season, there may be a greater abundance of snow; but probably not enough to make a serious inconvenience to the use of a railroad passing through it.

### CLIMATE.

One of the most important of the advantages claimed for this route is the pleasant and salubrious climate of the region through which it passes. There is no long series of parched plains, rendering the summer heat intolerable, nor do those dreaded winds termed "northers" reach this latitude. The mountain ranges that are crossed are not blocked up in winter by ice and snow sufficient to interrupt travel. From July to January, and for the whole year, this line may be traversed in safety.

The different portions of our survey were performed at such seasons as to enable us to make observations upon the most unfavorable characteristics of the climate. In August we were upon the comparatively low and arid plains upon the head-waters of the Canadian, and near the Llano Estacado. During the winter months we passed over the elevated region and through the mountain passes between Rio Grande and Rio Colorado. These observations may be found in Appendix H. They will be briefly alluded to in this place, although worthy of careful examination.

Judging from the material gathered upon the survey, the climate of the valley of Rio Grande is remarkably mild. One hundred and sixty-nine thermometric observations, taken there during the month of October, give 62°.2 for the mean temperature of that month. The highest temperature recorded is 100°.6; the lowest 25°.

In November we passed from Rio Grande to Zuñi, crossing the Sierra Madre. The mean temperature for that month is 52°.5; the maximum 82°.4, the minimum 23°.

During the month of December we were between Zuñi and the pass of the San Francisco

mountains; and, from one hundred and fifty-five observations, had a mean temperature of 41°.4, with a maximum of 73°.3, and a minimum of 15°.*

Upon the first of January we were at the highest point of our route, and during the month travelled to White Cliff creek. One hundred and twenty-six observations give for the mean temperature of January, in this region, 40°; the maximum being 73°.9, and the minimum 21°.

During the month of February observations were taken between White Cliff creek and the Mojave villages, in the valley of Rio Colorado. The mean temperature, from one hundred and seven observations, is 57°.4; the maximum is 80°, and the minimum 31°.

Although, as may be perceived, a few of the early morning observations indicated a considerable degree of cold, the sun was always warm, creating a visible effect upon the snow whenever it appeared.

In relation to this subject, I would refer to the hygrometrical tables of Appendix H, and also to the accompanying climatological map, with remarks prepared by L. Blodget, esq., from observations collected by the Smithsonian Institute, in connexion with those made during the survey. It will be perceived that the parallel of 35° is particularly favored by rain. The valley of the Canadian, the Zuñi region, the vicinity of the San Francisco mountains, and the Aquarius range have evidently a large supply of precipitated moisture. The arid regions between the Mississippi and the Pacific are here contracted to their narrowest limit.

*Rough estimate of the amount of woodland,† prairie, arable soil, &c., upon the belt of country* 15 *miles in width upon each side of the line from Fort Smith to Rio Mojave.*

| Section. | Distance in miles. | No. of sq. miles in belt 30 miles wide. | Character. | | |
|---|---|---|---|---|---|
| From Fort Smith to Shawneetown..... | 125 | 3,750 | Woodland, $\frac{4}{5}$..... | = 3,000 | sq. miles. |
| | | | Cultivable soil, $\frac{6}{10}$..... | = 2,250 | do. |
| | | | Prairie and pasture land, $\frac{1}{4}$.. | = 937 | do. |
| | | | Rocky hills, $\frac{1}{10}$..... | = 375 | do. |
| From Shawneetown to head of Washita river. | 185 | 5,550 | Woodland, $\frac{2}{5}$..... | = 2,220 | do. |
| | | | Cultivable soil, $\frac{2}{5}$..... | = 2,220 | do. |
| | | | Rocky hills, $\frac{1}{40}$..... | = 138 | do. |
| | | | Barren, $\frac{1}{40}$..... | = 138 | do. |
| | | | Prairie and pasture land, $\frac{23}{40}$ | = 3,052 | do. |
| From head of Washita river to mouth of Tucumcari creek. | 210 | 6,300 | Woodland, $\frac{1}{90}$..... | = 70 | do. |
| | | | Cultivable soil, $\frac{1}{15}$..... | = 420 | do. |
| | | | Rocky hills, $\frac{1}{30}$..... | = 210 | do. |
| | | | Barren, $\frac{1}{30}$..... | = 210 | do. |
| | | | Prairie and pasture land, $\frac{83}{90}$ | = 5,460 | do. |
| From mouth of Tucumcari to head of Pajarito creek. | 70 | 2,100 | Woodland, $\frac{1}{5}$..... | = 420 | do. |
| | | | Cultivable soil, $\frac{1}{5}$..... | = 420 | do. |
| | | | Rocky hills, $\frac{1}{10}$..... | = 210 | do. |
| | | | Prairie and pasture land, $\frac{7}{10}$ | = 1,470 | do. |
| From head of Pajarito creek to Anton Chico. | 35 | 1,050 | Woodland, $\frac{1}{10}$..... | = 105 | do. |
| | | | Cultivable soil, $\frac{1}{30}$..... | = 35 | do. |
| | | | Rocky hills, $\frac{1}{5}$..... | = 210 | do. |
| | | | Prairie and pasture land, $\frac{7}{10}$ | = 735 | do. |

* Upon one of the reconnoissances a lower temperature was noted. I have not the observations before me, but I think near the San Francisco mountains the thermometer read as low as 8° Fahrenheit.

† In the term "woodland" are included all those portions of the country covered with trees useful for timber or fuel. "Prairie and pasture land" refers to plains, and slopes, and valleys, which are generally covered with grass.

## ROUGH ESTIMATE—Continued.

| Section. | Distance in miles. | No. of sq. miles in belt 30 miles wide. | Character. |
|---|---|---|---|
| From Anton Chico to Rio Grande | 85 | 2,550 | Woodland, $\frac{1}{5}$ = 510 sq. miles.<br>Cultivable soil, $\frac{1}{15}$ = 170 do.<br>Rocky hills, $\frac{1}{5}$ = 510 do.<br>Prairie and pasture land, $\frac{3}{5}$ = 1,530 do. |
| From Rio Grande to Campbell's Pass of the Sierra Madre. | 95 | 2,850 | Woodland, $\frac{1}{10}$ = 285 do.<br>Cultivable soil, $\frac{1}{15}$ = 190 do.<br>Rocky hills, $\frac{1}{10}$ = 285 do.<br>Prairie and pasture, $\frac{8}{10}$ = 2,280 do. |
| From Campbell's Pass to Flax river | 110 | 3,300 | Woodland, $\frac{1}{10}$ = 330 do.<br>Cultivable soil, $\frac{1}{30}$ = 110 do.<br>Rocky hills, $\frac{1}{10}$ = 330 do.<br>Prairie and pasture, $\frac{8}{10}$ = 2,640 do. |
| From Flax river to San Francisco Pass | 100 | 3,000 | Woodland, $\frac{1}{5}$ = 600 do.<br>Cultivable soil, $\frac{1}{15}$ = 200 do.<br>Rocky hills, $\frac{1}{10}$ = 300 do.<br>Prairie and pasture land, $\frac{7}{10}$ = 2,100 do. |
| From San Francisco Pass to Aztec Pass | 73 | 2,190 | Woodland, $\frac{2}{5}$ = 876 do.<br>Cultivable soil, $\frac{1}{10}$ = 219 do.<br>Rocky hills, $\frac{1}{20}$ = 109 do.<br>Prairie and pasture land, $\frac{11}{20}$ = 1,204 do. |
| From Aztec Pass to mouth of White Cliff creek. | 42 | 1,260 | Woodland, $\frac{1}{15}$ = 84 do.<br>Cultivable soil, $\frac{1}{15}$ = 84 do.<br>Rocky hills, $\frac{1}{15}$ = 84 do.<br>Prairie and pasture land, $\frac{13}{15}$ = 1,092 do. |
| From mouth of White Cliff creek to Rio Colorado. | 60 | 1,800 | Woodland, $\frac{1}{100}$ = 18 do.<br>Cultivable soil, $\frac{1}{12}$ = 150 do.<br>Rocky hills, $\frac{1}{20}$ = 90 do.<br>Prairie and pasture land, $\frac{94}{100}$ = 1,692 do. |
| From Rio Colorado to Soda lake | 84 | 2,520 | Woodland, $\frac{2}{500}$ = 10 do.<br>Cultivable soil, $\frac{2}{500}$ = 10 do.<br>Rocky hills, $\frac{1}{50}$ = 50 do.<br>Sandy desert, $\frac{1}{20}$ = 126 do.<br>Prairie and pasture land, $\frac{467}{500}$ = 2,335 do. |
| From Soda lake to northwest bend of Rio Mojave. | 61 | 1,830 | Woodland, $\frac{2}{500}$ = 7 do.<br>Cultivable soil, $\frac{1}{30}$ = 61 do.<br>Rocky hills, $\frac{1}{50}$ = 36 do.<br>Sandy desert, $\frac{1}{30}$ = 61 do.<br>Prairie and pasture land, $\frac{477}{500}$ = 1,726 do. |

### MINERALOGICAL RESOURCES.

For full and specific information upon this subject, I beg leave to refer to the geological reports. The following brief remarks are intended to convey a few general ideas regarding the value of the mineralogical outcrops of the country in relation to the construction and support of a railway. Many of the details here submitted were compiled from the Resumé of Mr. Marcou, geologist and mining engineer to the expedition. In some cases its concise language has been retained. Generally, the remarks have been condensed, and facts derived from other sources have been added.

The alluvium of the great valley of the Mississippi extends along the banks of the river Arkansas as far west as Little Rock. This place is situated upon a slaty hill, at the commencement of a metamorphic ridge of mountains. Upon the river's banks, a short distance above

the city, are found sandstones and limestones of the carboniferous period. "Here begins the fine coal-basin of Arkansas which" * * * "our survey traversed from the vicinity of Little Rock to Delaware Mount, a distance of several hundred miles; coal being found almost everywhere from Petit Jean mountain to Coal creek and the Shawnee mountains. It forms a vast reservoir for the sustenance of industry and commerce along the whole line of the Pacific railroad. This carboniferous basin contains, in addition to the coal, an abundance of excellent sandstone for building bridges and embankments, good beds of limestone for the manufacture of lime, and also iron. Artesian wells will give an immense supply of water for agricultural and other uses, and it may be predicted that this region will be one of the richest portions in the southern States of the Union."

From the Shawnee village to Little river there is excellent sandstone. Delaware Mount is formed of upheaved beds of carboniferous limestone, affording building material and quick-lime. After passing this ridge, we leave the carboniferous group and enter upon the new red sandstone or trias. This formation is four or five thousand feet in thickness, and its various strata are traversed upon our route westward, except among the mountains where we rise above it, for more than one thousand miles. Mr. Marcou establishes, provisionally, "three principal divisions in these rocks." The lower group is composed of red and blue clay at the base, and red sandstone above. It is some two or three thousand feet in thickness, and forms the surface of the country from Topofki creek to Rock Mary. In consequence of the prevalence of clayey soil, nearly the whole of this region is well watered by numerous rivulets, producing a bountiful fertility of forest and meadow. The sandstone upon this section is frequently coarse and friable. Quarries of good building stone may occasionally be found, though it is probable that bricks formed of the argillaceous clays would afford an economical and more durable material for masonry.

"The second group, or middle division" of the trias, "is formed of beds of red clay, containing very often immense masses of white gypsum, amorphous, furrowed with veins of crystallized gypsum, with interposition of strata of magnesian or dolomitic limestone, and frequently beds of rock-salt or saliferous clay are found superposed upon the gypsum. The height of the beds in this middle group is about fifteen hundred feet. We met with it on our route from Rock Mary to the Arroyo Bonito or Shady creek, with the exception of two points, where the direction taken by our expedition, near Camp No. 31, crossed strata of neocomien, and at Antelope Hills whitish-gray sandstone, which belongs to the upper division of the trias." The mineralogical characteristics of the group are of considerable importance. The sandstones upon this section occasionally exist in isolated masses, and appear like lofty colonades of some ruined city, and in many places have sufficient hardness and durability for embankments and bridges; the dolomite produces an excellent hydraulic lime; the gypsum exists in vast quantities, and may become valuable for exportation, and the salt will be useful for the inhabitants of this region. With the exception of the well-watered and wooded valleys leading to the Washita, the soil of this region is deficient in clay. Hence, the numerous arroyos leading to the Canadian, and the Canadian valley itself, are sandy; and many of the little rivulets, started into existence by occasional heavy rains, soon become dry from the percolation of the water to the substrata of clay some feet below the surface. By common wells this reservoir of water could easily be reached, and made available for the purposes of a railroad, or for settlements. Nature has planted upon the sandy borders of the streams of this region the plum and the grape. The soil seems admirably adapted to their growth.

"The third division, or upper group" of the trias, "is subdivided again into two parts. The lower is formed of thick beds of whitish-gray sandstone, often rose-colored, and even red; and the upper consists of beds of sandy calcareous clay of very brilliant colors—violet, red, yellow, and white—in a word, of variegated marls," like "the *marnes irisées* of France, or the variegated marls of England." "These rocks having very little consistency, have been carried away almost everywhere by denudations. It is only where they are capped by the jurassic strata that

they can be observed. The sandstone of this third division is very much developed, with rather an indistinct and very massive stratification. Its thickness is one thousand feet, while the variegated marls are only four or five hundred feet thick; making a whole of fifteen hundred feet for the upper group of trias. Upon our route this sandstone forms the summits of the table-lands or mesas, which extend on each bank of the Canadian river from Antelope Hills to the Llano Estacado; then it forms the bottom of the valleys from Rocky Dell creek and the Plaza Larga to Anton Chico and the Cañon Blanco.'' The fertility of the great basin lying between the bluffs of the Llano Estacado and the Canadian, and extending nearly from Rocky Dell creek across Plaza Larga, and thence to the head of Pajarito and Cuerbito creeks, may be ascribed to the prevalence of a sandy calcareous clay, belonging to the strata of the variegated marls, and to the streamlets that issue from the base of the Llano bluffs. Other portions of this region, except upon the borders of rivulets or springs, are comparatively barren.

The Llano Estacado is composed principally of a more recent formation which, by Mr. Marcou, is called jurassic. The summit of the first steppe of it, which we crossed, consists of a compact white limestone, resting upon white sandstone. The former will furnish lime, the latter may be used for masonry. Near Tucumcari mount the mesas are capped by superior strata of the same formation, consisting of blue clay, yellowish sandstone, and, at the summit, a compact, white, silicious limestone. "This formation is not limited to the Llano, but it forms the summits of all the plateaux that are seen to the north, in the direction of the Canadian river, and between the Canadian and the Raton mountains, as well as the majority of the mesas which extend from the Rio Pecos to the foot of the Sierra de Sandia. Our survey has also met with it on the other side of the Rio Puerco, forming, with volcanic lava, almost the whole road between Covero and the Sierra Madre, and finally, between Inscription Rock and the Pueblo of Zuñi, where it again forms mesas, which extend in the direction of Fort Defiance and the Cañon de Chelly.'' Near several of the points above mentioned "there are beds of bituminous coal in the clay, but only three or four inches thick, so that probably they would not be rich enough to be successfully worked.''

In the cañon of San Antonio "the trias is met with again.'' It is here "upheaved and dislocated, the strata dipping to the east,'' and in the descent of the creek "gypsum, dolomite, sandstone, and red clay,'' are successively exposed. Near Tijeras, upon both sides of the gorge that has been cut through the Rocky mountains, "black schistose clay is seen, belonging to the coal measures; then grayish-blue limestone,'' containing fossils characteristic of the mountain limestone or lower carboniferous. Mr. Marcou remarks that "the presence of the black slate between the mountain limestone and the red clay of the trias indicates the existence of beds of coal on several points of the Rocky mountains;'' and the inhabitants of New Mexico, he says, pointed out to him "beds of bituminous coal belonging, without any doubt, to the rocks of the coal measures.'' Similar indications of coal are found at various points of the Zandia and Santa Fé mountains, and at the village of Pecos. Several intelligent citizens of the Territory state that coal has been discovered in considerable quantities near Rio Puerco and in the vicinity of Cibolleta, and the quality was such as to cause it to be used in blacksmiths' shops. Some very fine specimens sent to us by Captain Ewell, of the dragoons, have been noticed in a preceding portion of this report. There can be no doubt of its good quality, and it is believed to be sufficiently abundant to afford a limited supply of light and economical fuel for railway engines, or for the uses of the inhabitants.

The other mineralogical resources of this Territory have, perhaps, been sufficiently referred to in the Itinerary. When it is admitted that the mountains extending from the Sierra de Oro, near Tuerto, to the Sierra de los Organos, near Las Cruces, contain mines of gold and silver that have been successfully worked for centuries by rude and unskilful processes, no one can doubt that a railroad to the Atlantic would cause the mining resources of this region to be developed, and that the advantages afforded would be reciprocal. Placers and mines are known to cover regions extending from the mountains of Taos to El Paso; and, judging from the

character of the country, the specimens collected, the reports of early Spanish explorers, and from Mexican traditions, it seems probable that large amounts of treasure exist at Gran Quivira, among the San Francisco mountains, in the Aztec range, and upon Williams' river. The salineras or salt-pits upon the plains between Rio Pecos and the Del Norte will become another important source of mineral wealth to the settlers of New Mexico.

Leaving the coal-bearing strata that crop out upon the eastern slope of the Zandia range, we find the centre of the line of dislocation of the Rocky mountains, where exist the rich auriferous veins already referred to, composed of serpentine and granitic rocks, affording a good building material. We then enter the valley of the Rio Grande where the granite is covered by drift and alluvium. From the Del Norte to the volcanic peak of San Mateo there exist white, friable sandstones of the trias or jurassic formation. Some portions of the cliffs which bound the edges of the mesas have considerable hardness, and, by quarrying, a good material for embankments, bridges, and other constructions, could be obtained in the vicinity of the route. As we approach San Mateo, streams of disintegrating lava are frequently found in the valleys. "Near the culminating point of the Sierra Madre the trias is replaced by the carboniferous limestone; then for a distance of twelve miles the rocks are eruptive granite, gneiss, and mica schist. Beyond, on the western declivity of the Sierra, comes the carboniferous again, the beds of the trias, and finally the white and yellow sandstones of the jurassic, with streams of volcanic lava in the valleys. Inscription Rock, and the whole mesa that extends nearly to Zuñi, are formed of the jurassic rocks." The vertical faces of these cliffs are covered with ancient Indian or early Spanish inscriptions. From the dates of the latter, it appears that more than two centuries have elapsed since they were executed, and the crumbling of the rock from atmospheric influences has not caused them to be effaced. This fact affords a proof of the value of the jurassic sandstones for a building material. They may be easily cut into blocks of the required dimensions, and in this climate, where the exfoliation by frosts is exceedingly slight, it would prove a durable material for railroad constructions. In many localities upon the line, we have, as before stated, rocks of the primitive or metamorphic formations; but so much of the route is bordered by sandstones that the above record of their durability becomes highly important with regard to their fitness for railway purposes.

The triassic rocks extend from Zuñi to the volcanic peaks near the head-waters of Rio Verde; containing sandstone and red clay, with dolomite and gypsum. Thence across the Aztec range to White Cliff creek, the sedimentary and granitic rocks have in many places been covered by lava and basalt; but among the former, we find "magnesian limestone, the sandstone of the coal measures, and the carboniferous limestone." In the vicinity of Partridge creek, there are indications of coal. This region is believed to be rich in precious metals; but, being traversed by us in mid-winter, when a thin sheet of snow covered a great portion of the surface, our examinations with regard to this subject were imperfect.

Williams' river cuts through low mountain chains of eruptive or metamorphic rocks, in which Mr. Marcou found "several veins of argentiferous lead." The region more directly west, from White Cliff creek to the Mojave villages, is mostly covered with diluvial drift, forming a smooth surface, and plains of gentle inclination. Granitic rocks are exposed upon the mountain ranges that lie upon the north. West of the Colorado, the Paiute mountains are crossed, where sienitic granite is found alternating with sandstones and limestones. The little cañon on the Mojave river will probably afford good quarries of stone.

"In the Cajon Pass," were discovered "sienite, trap, and serpentine, exactly similar to those found between Rough and Ready, Grass Valley, and Nevada City, and which contain the veins of auriferous quartz." As specimens were obtained at Los Angeles "very rich in gold, coming from the Cajon Pass, it is more than probable that this point will one day be one of the richest places in California."

"In an economical point of view," continues Mr. Marcou, "the eruptive rocks, which form almost the whole country between Cactus Pass and the Cajon Pass, will furnish excellent mate-

rials for the construction of bridges, roads, and houses; there are also very beautiful marbles, red porphyry, and especially, I think, will be found there, mines rich in silver and gold."

Having reached the foot of the Pacific slope of the mountains, the route to Los Angeles and San Pedro passes over an alluvial soil. Quarries of stone may be obtained upon the mountain slopes, not far distant from the trail.

Between Los Angeles and San Diego—but near the latter place—there are veins of coal. They were first discovered, I believe, by Captain Warner, of the topographical engineers, while making examinations of this country, in 1848. When I visited the place in 1850, several veins were found upon the surface, from an inch to an inch and a half in thickness, which afforded specimens of coal believed to be moderately good. Shafts had been dug, but abandoned on account of the small quantity of mineral obtained. Lately, it has been stated* that "a bed of good coal, sufficiently thick for working purposes, has been opened. A shaft has also been run down, piercing several small strata from 16 to 20 inches thick." Bitumen also is found in considerable quantities upon the coast. Near Los Angeles, there are large pits of petroleum, which will doubtless prove to be of some value as an article of commerce.

## THE PROFILE.

After it has been determined that the natural resources of a country are of such a character as to afford facilities for the construction of a railway; that an adequate portion of the adjacent territory is susceptible of cultivation, and suitable for settlement; that materials for construction can be procured within the requisite distances, and permanent supplies of fuel and water insured at necessary points,—there remains the question of grade: 1st, as regards practicability; and 2d, economy. An examination of the country with the usual reconnoitring instruments—ascertaining the positions and heights of various points at considerable distances from each other—will, generally, be sufficient to determine the former. For the latter would be required a careful and minute survey of the whole line. Hence, in order to form an idea of the comparative advantages of different routes, general profiles are insufficient. The stations where altitudes are taken being at long intervals apart, the differences of altitude of these stations may be small; and, supposing that they can be connected by a uniform grade, a route represented may appear favorable; yet the intermediate minor ascents and descents may be so numerous and difficult, and the amount of cutting and filling required so great, that, where the line is of great length, the cost of the construction of a railroad would exceed practicable limits. The general profile of another route may present greater ascents and descents, and heavier grades; while the surface of the ground between the barometric stations is smooth, and the slopes are continuous and uniform, so that the cost of grading would be vastly less in the latter case than in the former. To form, therefore, a satisfactory conclusion in regard to the advantages of any proposed line, there is required more detailed information in regard to its topography than can be gathered from a profile showing only the grand general slopes, and the aggregate of their ascents and descents.

The country to be explored was of such extent, and the time so limited, that the field operations were necessarily hurried, and devoid of that accuracy which would have been desirable. In order, however, to give to our operations as nearly as possible the character of a survey, very numerous and frequent observations were made to determine the elevations and depressions along the line, and two complete sets of field sketches taken: the one exhibiting the general features of the country, and the other the special topography in the vicinity of the route traversed. From these have been constructed a series of topographical maps, on a scale of $\frac{1}{60000}$, delineating in detail a considerable portion of the profile trace. As the value of these maps depends upon the correctness of the altitudes given, it will be necessary to allude more fully to the method by which they were obtained.

* See Railroad Record, page 274.

The altitude of each camp is determined from a series of observations with mercurial barometers. The profile of each day's march is deduced from single observations, made with mercurial or aneroid barometers, at points where decided changes of elevation or depression occurred. The aneroid, when in use, was compared with the mercurial at every third hour during the day; from which comparison its error was determined.

The formula for the reduction of the observations have been strictly applied in accordance with the established rules. These are believed to have produced satisfactory results, excepting upon certain points, which will be stated in the course of these remarks. The first relates to a constant difference between the normal condition of the atmosphere upon the sea-coast and in the interior of the continent, with regard to the force of vapor. By a reference to the psychrometric tables it will be perceived, that at Beaverstown, in the Choctaw country, where our hygrometric observations were commenced, the mean elastic force of the vapor contained in the atmosphere was, by measurement, 17.1 millimetres, equal to 0.674 of an inch. This force was undoubtedly exerted upon the barometer at that place, in addition to the weight of the atmospheric column of dry air. Upon the Rocky mountains, east, and Sierra Madre, west of the Rio Grande—at Camps 56 and 67—the force of vapor measured from three to three and a half millimetres; or, at a mean, 0.126 of an inch. Therefore, to obtain the true differences between the weights of the atmospheric columns at the points referred to, it would be necessary to correct each barometer reading by the force of vapor known to be exerted upon it. The effect of such a correction, applied to our barometric observations, would be to diminish the computed altitudes, upon the most elevated parts of our survey, by nearly 600 feet;* which would greatly improve

* Upon the acknowledged principle that the vapor of water follows the same law as gases—viz: that one acts as a vacuum to another—it seems evident that the tension of vapor in the atmosphere must be a force exerted in addition to the gaseous pressure; and as the barometer measures the sum of the two forces, if either be known, it should be deducted from the barometric pressure to obtain the other. A distinguished meteorologist has suggested that a portion of the atmospheric column may be removed laterally, and replaced by the vapor of water, which, being a lighter fluid, may tend to neutralize, by diminished weight, the effect of increased elastic force. For example: when there exist surface currents of wind, highly charged with moisture, the heavy stratum of dry air is then replaced by a moist and light one; and, consequently, although the elastic force of vapor may have increased, the diminished pressure of the atmosphere effects a compensation, and the barometer does not rise. An occurrence of this kind would, I believe, form an exception to the general rule. At all events, it could not be applicable to a case like that in question, where a comparison is made between places far distant from each other, at which the normal conditions of the atmosphere are essentially different. The more I have examined the subject, the stronger has become my conviction that the barometric pressure at each point should have been divested of the force of vapor, and the weight of dry air alone used in the determination of differences of altitudes. However, in deference to the high authority of doubts that have been expressed regarding its propriety, I have refrained from making those corrections which would have so greatly modified and improved the profile of our route.

The following extract from a report of Lieutenant Colonel Sabine, R. A., "on some points in the meteorology of Bombay," discovered by me as this paper was about to be submitted to the department, has a direct bearing upon the subject under consideration:

"In concluding this communication, I beg respectfully to submit to the consideration of the eminent meteorologists here present, that it is very important towards the progress of this science that the propriety (in such discussions as the present) of separating the effect of the two elastic forces which are considered to unite in forming the barometric pressure, be speedily admitted or disproved. The very remarkable fact recently brought to our notice by Sir James Ross, as one of the results of his memorable voyage, that the mean height of the barometer is full an inch less in the latitude of 75° S. than in the tropics, and that it diminishes progressively from the tropics to the high latitudes, presses the consideration of this point upon our notice; for it is either explained wholly or in greater part by the diminution of the vapor constituent in the higher latitudes, which diminution appears nearly to correspond throughout to the decrease of barometric pressure observed by Sir James Ross; or it is a fact unexplained, and I believe hitherto unattempted to be explained, on any other hypothesis, and of so startling a character as to call for immediate attention.

"If, by deducting the tension of the vapor from the barometric pressure, we do indeed obtain a true measure of the pressure of the gaseous portion of the atmosphere, the variations of the mean annual gaseous pressure, which will thus be obtained in different parts of the globe, and the differences of pressure in different seasons at individual stations, may be expected to throw a much clearer light than we have hitherto possessed on those great ærial currents which owe their origin to variations of temperature proceeding partly from the different angles of inclination at which the sun's rays are received, and partly from the nature and configuration of the material bodies at the surface of the earth; and a field of research appears to be thus opened, by which our knowledge of both the persistent and the periodical disturbances of the equilibrium of the atmosphere may be greatly extended."

the appearance of the profile of the line. In conformity, however, with the practice of meteorologists, this element of variable pressure has not been taken into account. All the data upon which it depends are submitted; and when scientific investigations, that are now in progress, have sufficiently tested the subject, the error due to the variations in tension of vapor may be determined, and the altitude of each station properly reduced.

The corrections applied to the original record of the barometric observations are as follows:

1st. For relative expansion of column of mercury and scale due to variations of heat, in order to reduce the observations to an equivalent, at a temperature of 32° Fahrenheit. For this purpose, Professor Guiot's excellent tables were used.

2d. For constant error of barometer, or the difference between the zero point of its scale and that of the standard with which it was compared. The errors of the various barometers used are shown in the Appendix.

3d. For oscillations of the barometric column, due to diurnal variations of atmospheric pressure, and determined by hourly observations, taken for several consecutive days, at various points upon the route. The results obtained for this correction are also shown in the appendix.

All barometric oscillations seem to be due primarily to variations of temperature. Let the atmosphere be placed in equilibrio, and everywhere, at equal elevations, the columns of mercury supported would be the same. But as soon as one portion of the ærial fluid is warmed by the sun it expands, rises, and overflows the regions contiguous, producing currents of air more or less violent. The heated column becomes lighter, and the colder heavier, in consequence of the superincumbent mass. The effect upon the barometer is, however, greatly modified by the vapor of water which is at the same time generated by heat, and by its elastic force tends to increase the pressure. By the daily revolution of the earth, consecutive portions of its atmosphere are warmed, causing horary oscillations, which amount to about 2.5 millimetres within the tropics, and become almost inappreciable as we approach the frigid zone. Two points of maximum and two of minimum pressure occur during the twenty-four hours,* and their periods are determined by the relative value of the influences produced by heat upon dry air and upon moisture.

4th. For abnormal changes of atmospheric pressure, sometimes termed barometric waves. Contact of the air with an extensive surface of land heated by the sun's rays, and currents of wind charged with a greater or less amount of moisture, create another system of atmospheric dilatations, the effects of which may, in some respects, be compared to tides upon the ocean. Within large areas they produce simultaneous oscillations of the barometric column, called *abnormal.*† They recur at irregular periods, and are variable in their character. Their magnitude is less within the tropics than in the temperate zones. Within the limits of our western

* The remarks submitted above were entirely suggested by the reduction of the observations made upon the Pacific railroad explorations, and were informally communicated to the department some time since. Lately, through the kindness of Professor Henry, the distinguished secretary of the Smithsonian Institution, I have received a copy of a lecture on meteorology, delivered before that institution by Robert Russell, Esq., with an appendix by the secretary, giving much information upon this subject. The whole pamphlet is highly interesting. With regard to the horary oscillations of the barometer, Professor Henry remarks as follows:

"The fact that the barometer exhibits two maxima and two minima in the course of twenty-four hours has given rise to much speculation as to its cause. The most common explanation is, that it is due to the joint action of the variation of the temperature and moisture. In the morning, the moisture rising into the atmosphere increases the weight of the air more than the heat diminishes it by expansion; while at about ten o'clock a. m. the effect of heat overbalances that of vapor, and again as the sun begins to decline the weight of the latter predominates. Mr. Espy attributes the daily oscillations of the barometer to the upward and downward motion of the particles of air and moisture as they are separated or approximated by the change of temperature. The particles weigh more while the rate of separation is increasing, and less while it is diminishing. This is a true cause, but we are not certain that it is a sufficient one. Whatever may be the cause of the daily oscillations of the barometer, we know the effect is nearly the same in parts of the earth most widely separated."

According to the analysis of Mr. Dove, (see Kaemtz's Meteorology,) the pressure of dry air, when freed from the tension of vapor, exhibited but one diurnal *maximum and minimum.* Instances have occurred where the readings of the barometer, uncorrected for the force of vapor, have given a similar result.

† Abnormal oscillations include the residual errors of the barometric results, when corrected for all the atmospheric changes that may be measured.

territory, the maximum amplitude of these tides, as measured by the barometer, is about one inch—corresponding to 1,000 feet of elevation; though in latitude 35° it is somewhat less. Hence the necessity for simultaneous observations at those points whose differences of altitude are to be determined by the barometer; or, what is equivalent to it, corresponding observations at some fixed station, within the same barometric region, in order to mark the period and measure the amplitude of the oscillations for the determination of the correction due to them.

The latter plan has been adopted in our reconnoissance. For its execution, we have been furnished by the Surgeon General's Department with unpublished records kept by officers of the medical corps at various military posts in the vicinity of our route, and use has been made also of corresponding observations upon Governor Stevens' and Captain Beckwith's lines of survey.

On account of the slight knowledge heretofore existing with regard to the climatological character of the region between the Mississippi valley and the Pacific ocean, it could not be determined, in advance, between what limits the ærial tides could be considered sufficiently coincident to render barometric observations, taken at different points, comparable. This question was elucidated by the construction of diagrams, which exhibit the curves of unequal pressure, observed upon our line, and the corresponding oscillations obtained from the various records previously referred to. The diagrams are appended to this report, and probably will be examined with considerable interest. In noticing some of the ideas which they have suggested, it is not proposed to enter into a general discussion of the problem of variable atmospheric pressure: the data before us are too meagre. Until governments, or individuals, interested in scientific researches, choose to unite in an extensive system of atmospheric observations, we must continue to be dependent upon theories, more or less vague and unsatisfactory. Were America and Europe to combine in the undertaking, it would not be difficult nor expensive to arrange and carry out a plan of operations, whereby light-houses upon the coasts, and military posts in the interior, might be provided with instruments and observers; and a comparison of the records thus obtained would lead to a solution of most of the laws of the so-called meteorological phenomena. This is one of the great desiderata of science at the present day. Our own government, by the co-operation of its officers of the army and navy, and by the voluntary contributions of its citizens at home and abroad, might well take the initiative in the determination of the causes of winds, clouds, and rain; of variations of heat and atmospheric pressure; and thus add to the sum of human knowledge that which would be of incalculable value to man in every branch of practical industry.

From a comparison of the observations appended to this report, it appears that in the Mississippi valley currents of moist heated air from the Gulf of Mexico create a disturbance of the atmosphere, and produce local storms. To what distance westward their effects are communicated to the barometer can scarcely be deduced from the limited data examined. Our observations, however, at Napoleon, June 24, 1853, and those taken simultaneously at Memphis, marked a period of great atmospheric pressure. This same phenomenon was noted at all the barometric stations of the Mississippi valley, and at Fort Gibson in the Creek territory.

The Llano Estacado and great western prairies, being heated by the sun's rays, rarify the superincumbent atmosphere, modifying the climate, and doubtless also the series of barometric waves of the Mississippi valley; yet, from the diagram it appears that all the oscillations noticed at Fort Gibson, between July and September, inclusive, were felt almost simultaneously upon our line from Fort Smith to New Mexico. In October, the curves of variable pressure at Albuquerque still correspond to those observed at Fort Gibson, except as regards some of the periods of maxima and minima; and in December, even as far westward as the Colorado Chiquito—Flax river—a striking similarity continues for a considerable period.

The few observations collected for the month of December illustrate one important fact—the widely-spread influence of a single barometric wave. Between the 4th and 10th, a remarkably uniform rise and fall of the barometer is indicated at Fort Benton, near the eastern base of the Rocky mountains; opposite, at St. Mary's, on the head-waters of Clark's Fork of the Colum-

bia; at Fort Gibson, on the Arkansas; at Great Salt Lake City; at camps upon the Colorado Chiquito; and, though in a less degree, at San Diego, California. Hence, it appears that the same tide of low atmospheric pressure covered at once a large portion of the western part of this continent. It would be of interest to compare other observations made at the same period, and determine whether, upon distant points of the globe, correspondingly high pressures were produced. The phenomena commenced at Fort Benton and St. Mary's one day earlier than at Great Salt Lake, and at other places further south. This fact is particularly noticeable in the secondary oscillation of the 11th and 12th.

The meteorological record at Great Salt Lake conforms closely with the observations at Flax river. At both places the weather continued "clear and pleasant" during the first rise and part of the gradual fall of the barometer. Clouds were then formed. On the 10th, light showers occurred. This disturbance of the atmosphere having restored the equilibrium of pressure, the mercury rose, although heavy masses of threatening clouds were still visible. On the 12th, the tide of pressure turned, and the mercury fell rapidly until the night of the 13th, when occurred a light snow-storm. From this period the barometer remained almost stationary for a day and a half, and then commenced a gradual and uniform rise, notwithstanding the continuance of a series of violent storms of wind, rain, sleet and snow that swept from the San Francisco mountains.

This comparison leads to the following opinions regarding the abnormal movements of the barometer:*

1st. They are of great magnitude, and, if not taken into account, may produce an error in the deduced altitude of several hundreds of feet.

2d. They are but slightly affected by local storms.

3d. They *may* occur almost simultaneously over the whole interior portion of the continent.

4th. They are actually identical within certain areas of great extent.

Our line, from the Mississippi valley to the Pacific, crosses three distinct barometric regions. The first covers the extensive prairies east of the Rocky mountains; the second lies within the great basin and the valley of Rio Colorado; and the last occurs upon the Pacific slope of the Sierra Nevada. These different countries may be equally affected by heat and vapor, and produce similar changes of the barometric column. Usually, however, their waves are non-conformable, except when they meet and mingle near the immediate ranges of mountains.

The idea of applying to our barometric observations a correction, to be obtained by the plan alluded to above, was first entertained in the field; otherwise, it would have been necessary to have divided our party into two barometric divisions—one to be stationary, while the other was *en route*—a system which would have considerably retarded the operations. But upon our return to Washington, while hastily preparing the material for a profile, I was informed that no records of observations could be obtained suitable for a comparison. Hence, under the direction of L. Blodget, esq., then meteorologist of the Smithsonian Institute, our notes were computed in the manner described by him in a preface to the tables. Afterward, when called upon to review the work, I found that, notwithstanding the careful manner in which the observations had been reduced, there might be errors, due to the abnormal atmospheric changes, remaining uncorrected.

In the effort to determine these errors, and whether some practical method might be found for eliminating them, the idea of making a diagram of the observations was suggested. Those

* From observations made, for ten days together, by F. Laval, upon the top of St. Pilen, a mountain near Marseilles, which is 960 yards high, [see Russell's lectures, previously alluded to,] John Dalton remarks that "it may be inferred that the fluctuations of the barometer are occasioned chiefly by a variation in the density of the lower regions of the air, and not by an alternate elevation and depression of the whole superincumbent atmosphere." This theory, if true, would diminish the value of the barometer as an instrument for determining altitudes. However, the barometric waves in the elevated regions of the Rocky mountains are not appreciably less than at Fort Gibson, with a difference in altitude of 5,000 feet. Hence, while the observations are confined to the stratum near the general surface of the earth, it seems to be evident that the amount of the barometric oscillations is independent of the height above the sea.

No. 1.

*Diagram representing the abnormal oscillations of the barometric column*

JULY 1853.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

*Fort Gibson*

*Upon the Line*

AUGUST 1853.

*Fort Gibson*

*Upon the Line*

Note. *The stars mark points platted from observations. The abscissæ denote times of observations as indicated at the heads of the columns. The ordinates show the true rise or fall of the barometric column between these times. for example, a difference of one tenth of an inch between any two ordinates shows that the two readings of the barometric column at the corresponding times differed one tenth of an inch.*

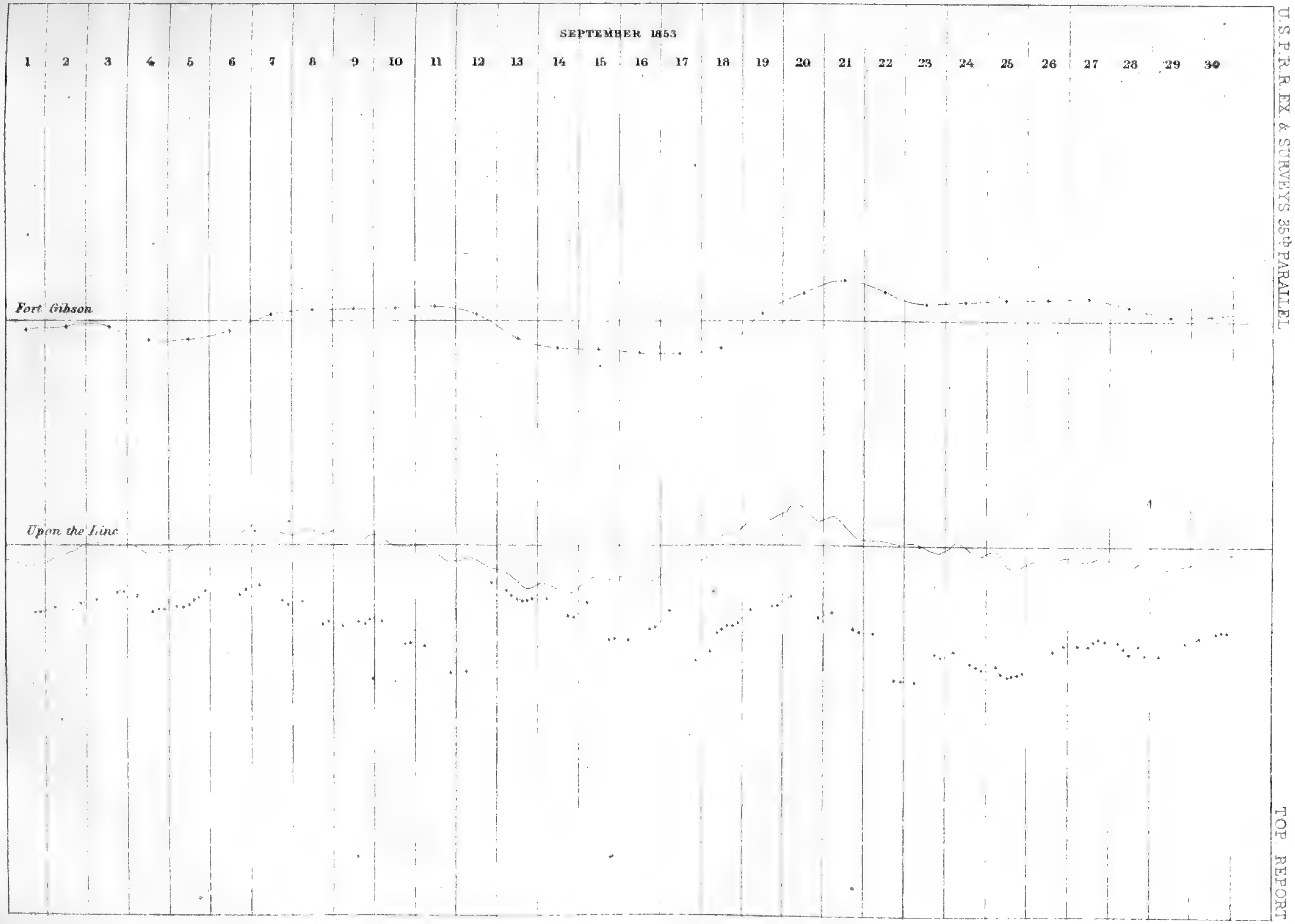
H. Lawrence Lith. 86 John St. New York

U. S. P. R. R. IX. & SURVEYS 35th PARALLEL

TOPOGRAPHICAL REPORT

No. 2

*Diagram representing the abnormal oscillations of the barometric column*



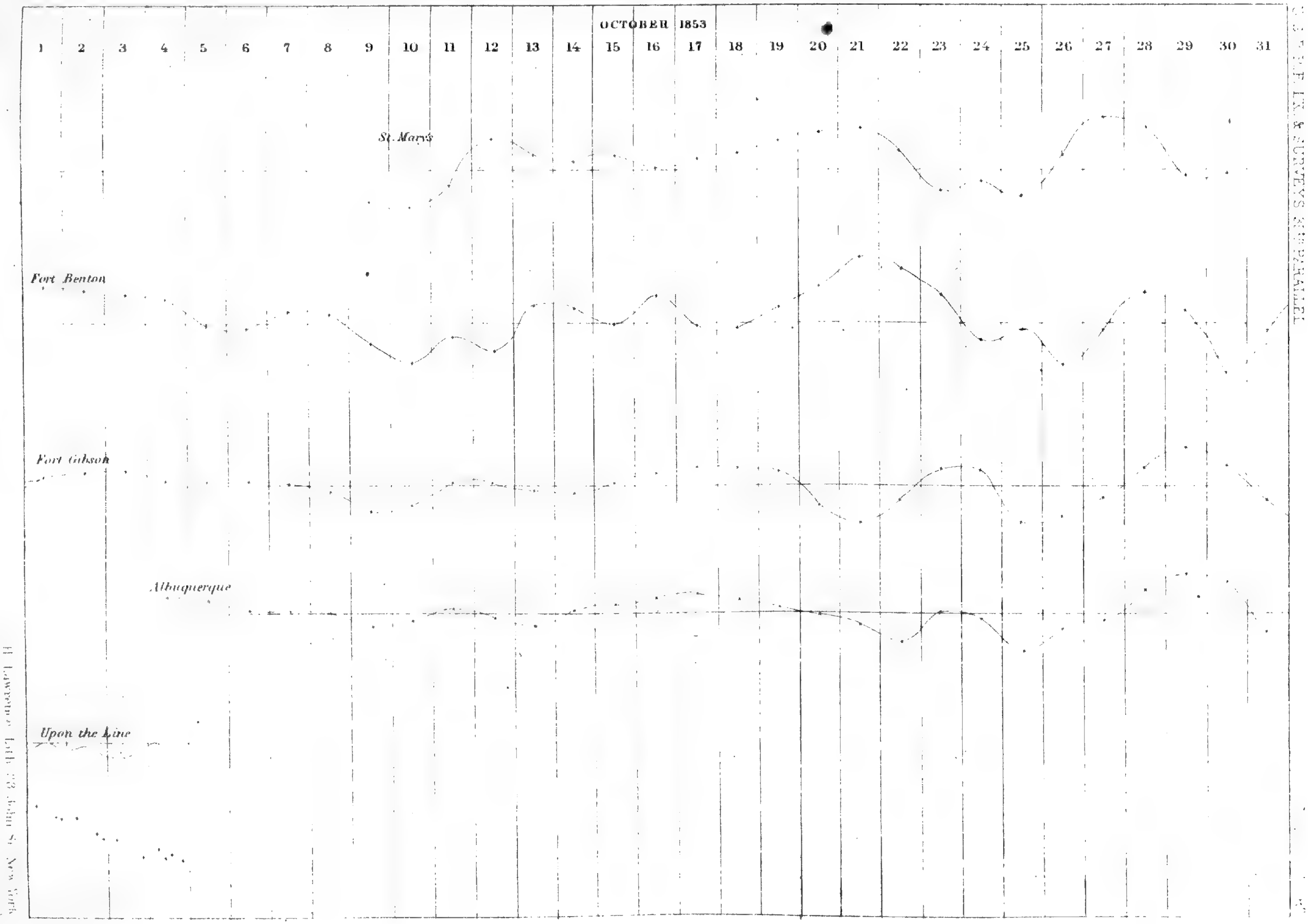

H Lawrence Lith 68 John St. New York.

U.S.P.R.R.EX. & SURVEYS 35th PARALLEL

TOP. REPORT

No. 3

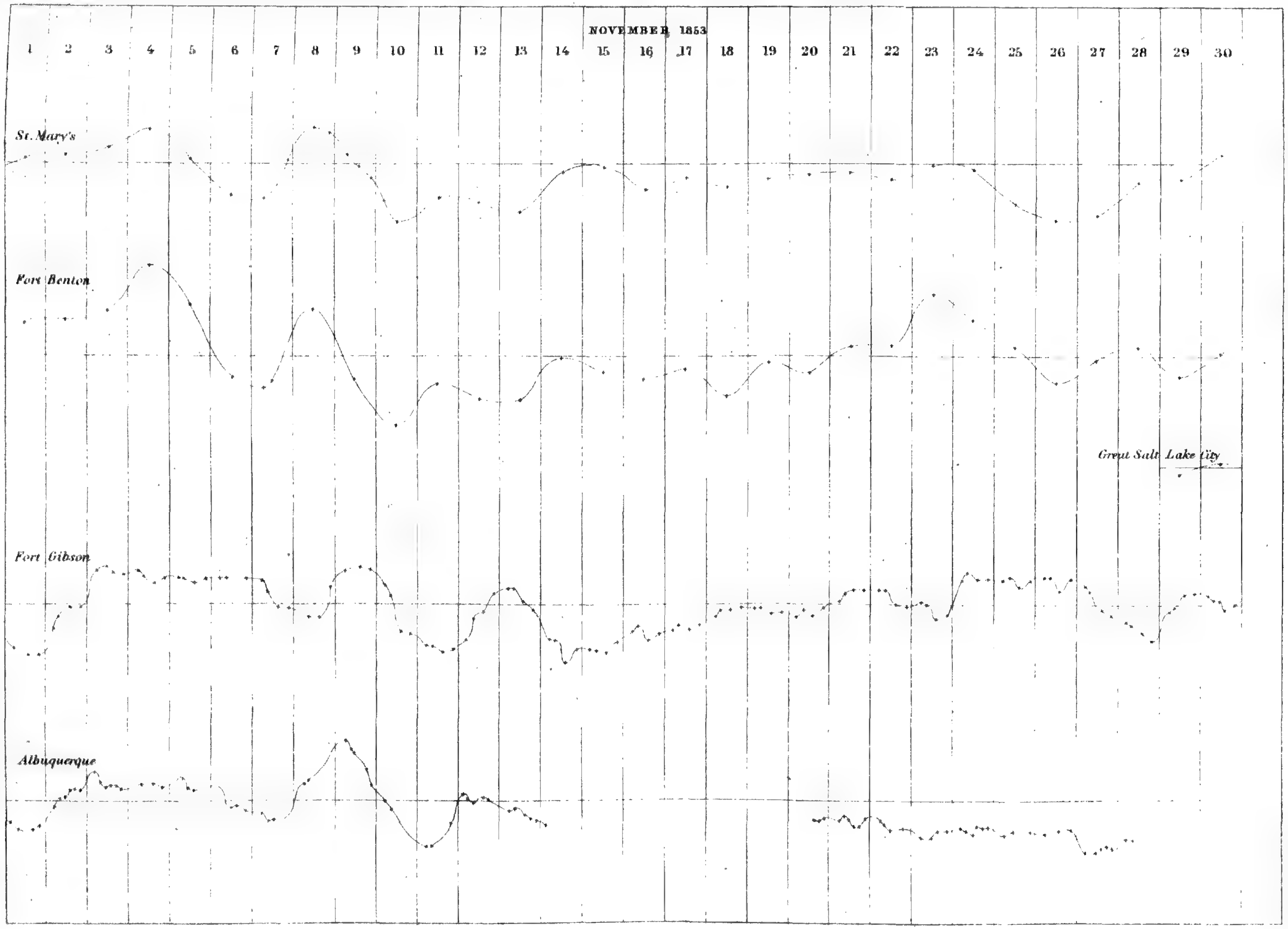
*Diagram representing the abnormal oscillations of the barometric column*




H. Lawrence Lith. 73 John St. New York

No. 4

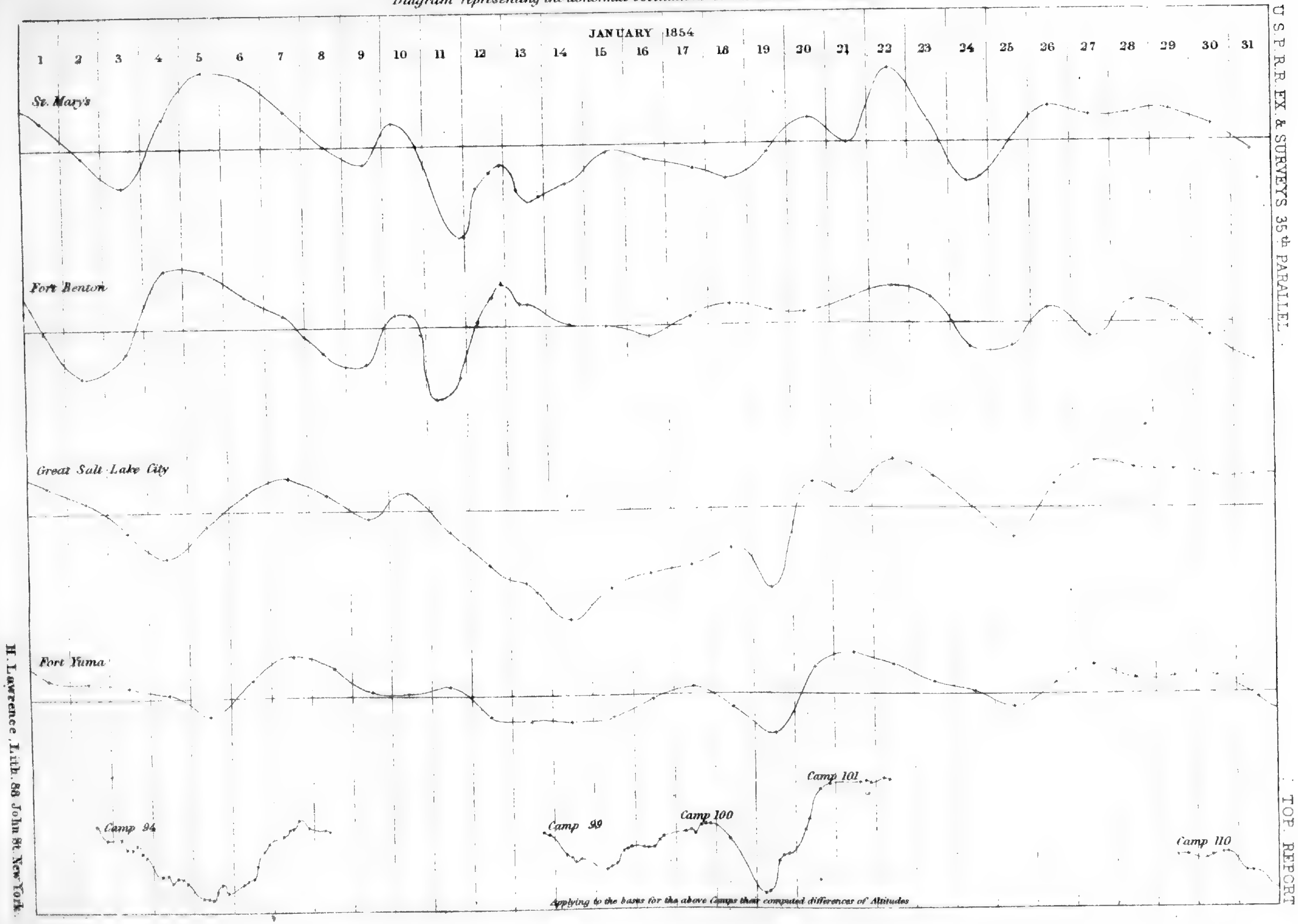
*Diagram representing the abnormal oscillations of the barometric column*




H. Lawrence Lith. 88 John St. New York

No. 6

*Diagram representing the abnormal oscillations of the barometric column*



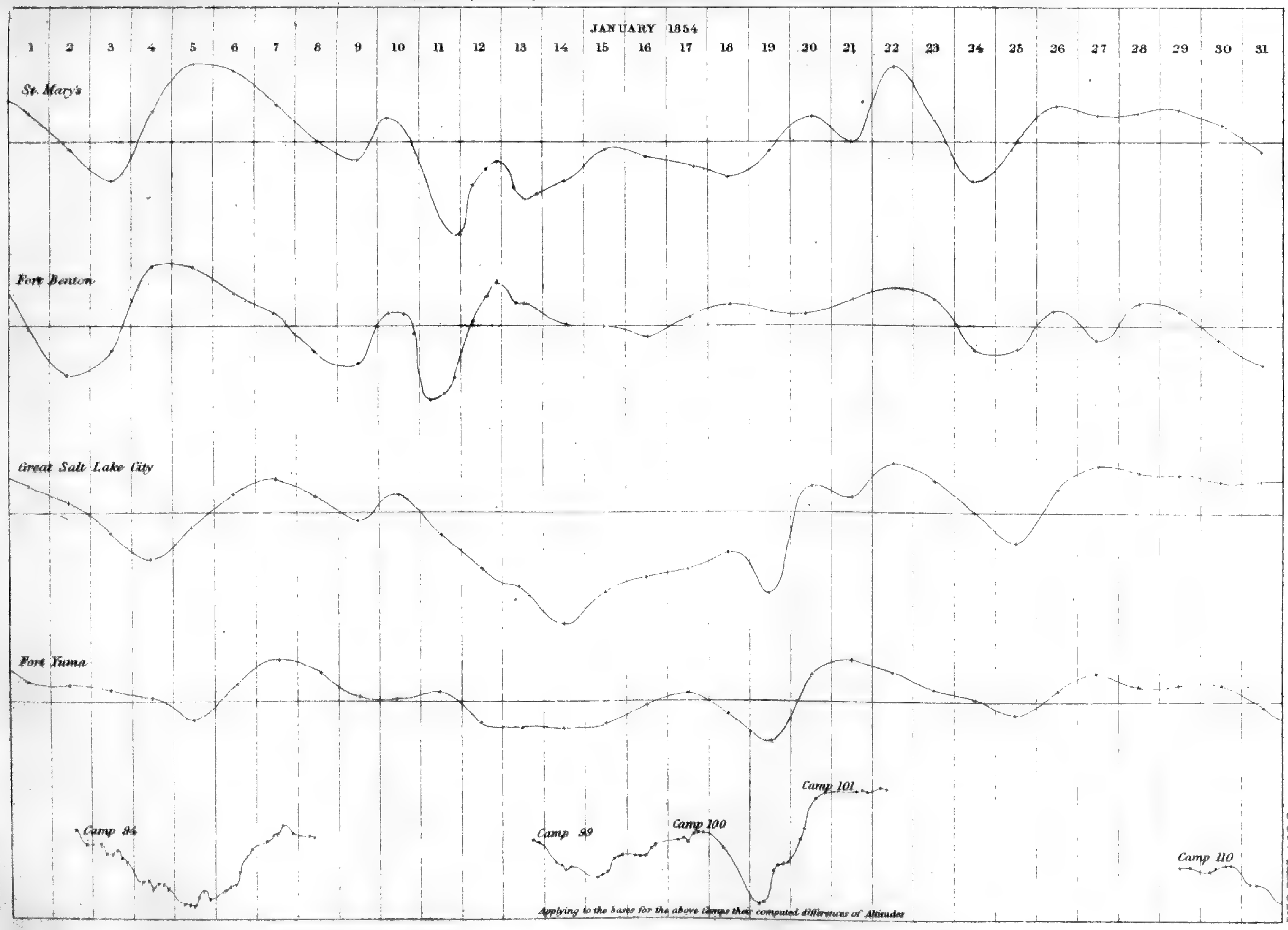

H. Lawrence Lith. 88 John St. New York.

U.S.P.R.R. EX. & SURVEYS 35th PARALLEL

TOP. REPORT

No. 6

*Diagram representing the abnormal oscillations of the barometric column*



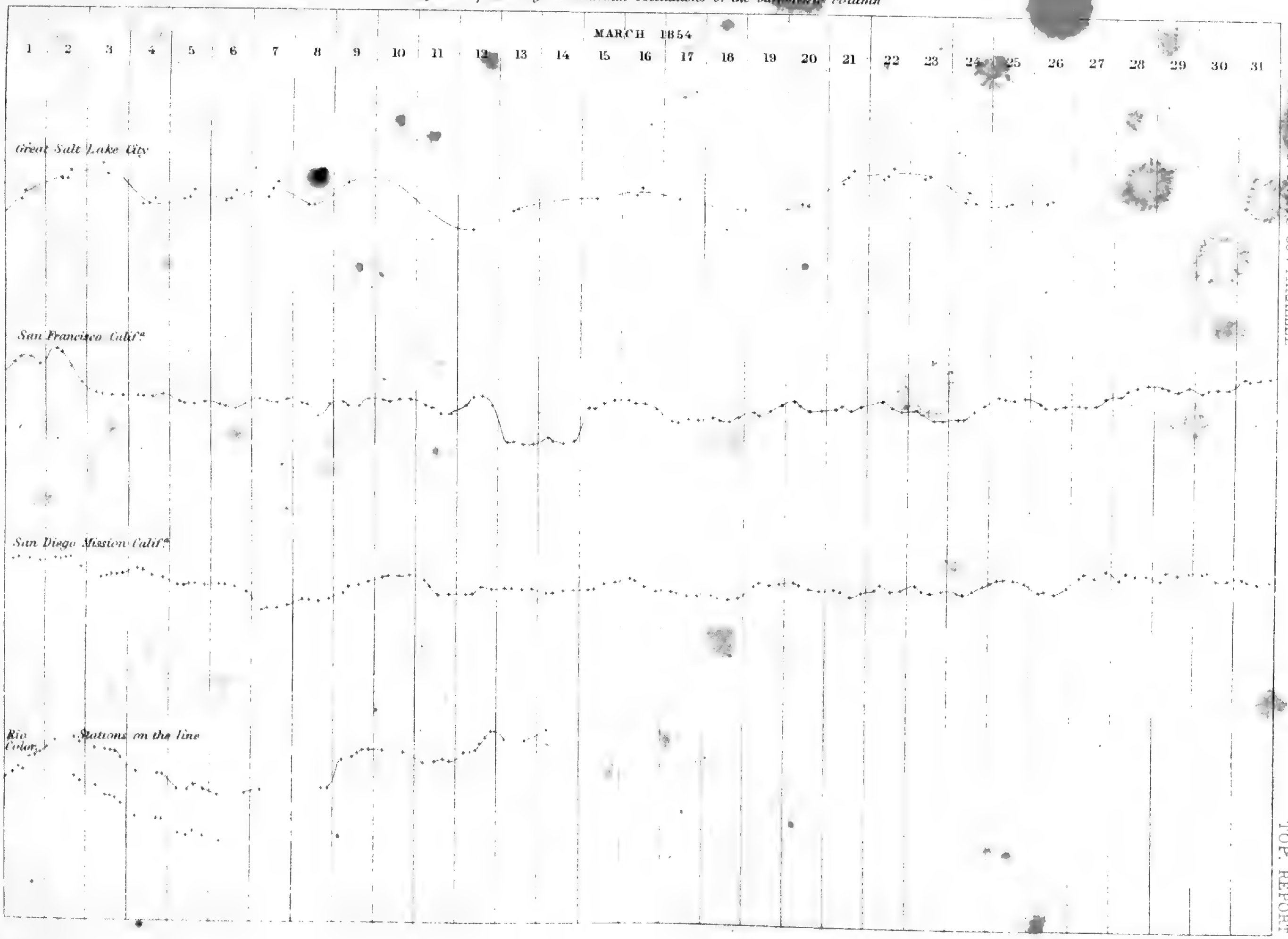

H. Lawrence Lith. 86 John St. New York.

U.S.P.R.R. EX. & SURVEYS 35th PARALLEL

TOP REPORT

No. 8

*Diagram representing the abnormal oscillations of the barometric column*




U.S. PACIFIC R.R. SURVEYS 35th PARALLEL

TOP. REPORT

E. Dawson, Lith. 26 John St. New York

made upon our line were developed into a curve; the abscissæ representing the times of observation, and the ordinates, corresponding readings, or rather fluctuations, of the barometer; the measured difference between the altitudes of any two ordinates being the true elevation or depression of the mercurial column after all the known corrections had been applied. This curve was found to be remarkably regular, so long as the observations from which it was plotted were made at the same station. But upon a change of place, the base being altered, the continuity of the line was broken; and observations made at the second station could not be compared with those taken a few hours before at the first, until the barometric movement for the intermediate time should be made known. This could be satisfactorily determined only by observations upon a barometer at rest during that period. Upon inquiry, it was ascertained that, subsequent to our first computations, barometric records had been received at the Surgeon General's office from various military posts in the vicinity of our route. To decide which of them would serve to connect the broken links of our series between consecutive stations, similar developments were made upon the diagram of other records covering the same periods of time. A comparison of them all showed which corresponded most nearly with our own. If day after day the oscillations at some fixed station were identical with those shown by the records made by us in two or more camps, it is fair to assume that, during our progress between those camps, the atmospheric dilatations were correctly represented in the same series.

This principle being established, its application was easy. By a construction, more elaborate than has been attempted in the diagram, a complete curve of the variable pressure upon our whole route might be represented. Then, having drawn a horizontal line to denote the mean pressure, the abnormal error at any hour, during the required period, could be measured off above or below, and applied, with its proper sign, to the observation; but, for the reduction of our profile, a simpler plan was adopted. Having, by the diagram, decided with which of the fixed barometric stations it was desirable to compare, the observations at that place were examined, and tables of the dilatations were made out, to be used as corrections. In deducing these lists of corrections, I am greatly indebted to Dr. R. H. Coolidge, United States army, and to Lorin Blodget, esq., for extending every facility and assistance that the Surgeon General's department could afford.

For the determination of the profile of different portions of our line, corresponding observations were compared, as follows, viz:

From Fort Smith to Rio del Norte, with Fort Gibson. From Rio del Norte to Camp 73, (less satisfactorily,) with Fort Gibson. From Camp 73 to Camp 91, (Leroux's Spring,) with Great Salt Lake. From Leroux's Spring to Camp 113, on Williams' river, with Fort Yuma. From Camp 113 to Camp 134, (last on Rio Colorado,) with mean between Great Salt Lake and San Diego. From Camp 134 to the Pacific, with San Diego.

Beside the comparisons above mentioned, the relative heights of many of the principal points were obtained by simultaneous observations at different stations along our route. This was done whenever the party was divided for the purpose of making explorations in advance of the main survey; and the duplicate sets of observations then taken have proved valuable tests to the results.

The readings of the barometer being thus corrected for expansion, horary oscillations, and abnormal variations, the altitudes of the points of observation were deduced by the hypsometrical tables calculated by Professor Loomis after the formula of Laplace. These tables were convenient and highly satisfactory, except with reference to a single term of the corrections, viz: that relating to the air temperatures. For the want of corresponding observations, made at appropriate fixed stations, the mean height of the mercurial column and mean temperature at the sea level in latitude 35° were assumed as the bases for comparison. It is evident that the observations obtained at the various points upon the survey should also be reduced to mean values, in order to be comparable with the assumed data. With regard to the barometer, this was accomplished with some pretensions to accuracy. The air temperatures, however, in consequence of

an oversight, due to the hasty manner in which the reductions were made, were not brought to that standard; but, in the first computations, the corrections for that element were based upon the observed reading, without regard to the hour of observation. Mr. Blodget soon saw that the effect was to introduce an error into the results, and therefore he assumed a table of modifications, by which each of the high temperatures was reduced, and the low temperatures were increased, by a quantity depending upon the observed reading. This was a wise precaution, serving to diminish the inaccuracies that were introduced into the first results, and leaving but small residual errors. The necessity of reducing the temperatures to their mean determinations was not understood until too late to apply the rule to the computations. It is believed, however, that the errors resulting from this neglect will not be found of much magnitude, and they are probably all upon the safe side, viz: they have increased the elevations of those points where observations were made during the middle portion of the day; rendering the grades too abrupt and the profile too broken to represent the natural slope of the ground.

In concluding the remarks with regard to this subject, it may not be deemed improper to mention that our operations have excited a spirit of inquiry after facts, and an investigation of the laws that govern the fluctuations of the barometric column. Parties that have succeeded ours in the field have thus been enabled to profit by our experience, and obtain results which prove that the general method of determining differences of altitude by measurements of atmospheric pressure is susceptible of a closer degree of accuracy than its advocates have heretofore claimed. The importance of such a determination will be appreciated by those who reflect upon the vast expense and labor which would be required to obtain profiles of the interior portion of our territory by any other process. Excepting the small errors that have been referred to, this portion of our work is believed to possess a satisfactory degree of accuracy. Each camp having been referred directly to the sea-level, the minor discrepancies, which in such a reconnoissance cannot easily be avoided, have not been suffered to accumulate. The camps, therefore, may be considered as the standard points of reference for the profile line. The contour of the ground between them was determined by an independent system; aneroid or mercurial barometers having been observed at the most important stations upon each day's march, and topographical sketches made of the whole belt of country within the field of view. The data thus gathered forms material for a series of maps upon a scale of $\frac{1}{60000}$ with curved lines, fine and coarse, to represent the sections of horizontal planes, ten and fifty feet apart. Although founded upon rapid examinations—strict accuracy not being claimed for all of the details—a delineation upon this scale was necessary, in order to exhibit the character of the country in accordance with our field-notes. Upon the topography of these maps we may trace the line most favorable for a railroad, and measure the curves and grades which the contour would require. A profile of this route has also been made upon the same large scale, showing approximately the cutting and filling necessary to produce the grades which are given. This differs materially, both as regards length and elevation, from the one previously submitted to the department, the latter exhibiting merely the wagon trail with the altitudes uncorrected for abnormal error.

In order to avoid the great expense of publishing the detailed maps and profiles previously alluded to, the greater part of the results which they have enabled us to arrive at, relating to distances and grades, as well as excavation and embankment, is condensed; and the former is presented in the accompanying table, marked Appendix N. In that may be found one of the most serious objections to which this route is liable, viz: a long succession of heavy grades through the mountainous regions of the interior. Future examinations over sections already referred to in the preceding pages, or through passes not yet discovered, will undoubtedly enable the engineer to modify and greatly improve the location of the line. The steep declivity and expensive rock-cutting in the San Antonio cañon, may be rendered unnecessary by following the Galisteo river. The elevated and somewhat broken region, between San Francisco Springs and Aztec Pass, may probably be avoided by pursuing a more southerly course, as indicated by

the dotted line upon the map. Should it be desirable to terminate the road at San Diego or Los Angeles, it might be found preferable even to descend the Rio Verde and the Salinas to Rio Gila, and there unite with the southern route. Such a connexion would join, by a cultivable valley, the most favorable parts of the two routes; and present a line bordered with arable soil adapted for settlement throughout a great portion of the distance between the Mississippi and the Pacific.

Other lines, dotted upon the map, are respectfully recommended for examination. One is from Rio Gallinas, via Ojo de Vernal, to Rio Pecos at San Miguel; and thence across the mesa to a branch of Rio Galisteo, which leads to Rio del Norte, at San Felipe. Crossing the river at that point, the line keeps a south-southwesterly course, to ascend the bluffs which bound it, then enters the valley of Rio Puerco, and joins the line of survey in the valley of Rio San José. Another route is indicated from the Val de China, through a break in the Aztec range near Sierra Prieta, and thence down Rio Santa Maria and Williams' river to the Colorado. From the latter point a practicable route is believed to lead in nearly a direct course to Soda lake.

By some of the methods suggested, it is believed that the greater part of the steep grades shown upon the profile, and given in the table, may be avoided. The length of the line might thereby be somewhat increased, but the expense of construction would probably be diminished.

By a reference to the general maps it will be perceived that, in two instances, the trace for the profile departs widely from the positon of the wagon and reconnoitring trails. The first is from Big Sandy creek to the Colorado; the second, from the Sacramento Springs to Soda lake. The country, however, in those regions is so open, that the several parts of it were plainly visible from various points upon our trail; and the plotting of the triangulation notes, connected by the topographical sketches, left no doubt upon our minds that its character is such as is represented. By the former, the great bend of Williams' river is avoided, making the distance to the Mojave village considerably less, and producing also a saving in expense for rock-cutting and bridging. The grades, on the other hand, are greatly increased. The latter deflection effects a saving both in distance and in grade. Upon both, tanks would probably be required at some of the necessary watering stations.

With reference to the elevation of the interior portion of the continent, as determined by comparative barometric measurements, it has already been stated that, from the non-application of a correction believed to be due to the diminution of the force of vapor in that region, the altitudes upon the central part of our line are probably several hundred feet too great. In the consideration of this subject, another idea has been suggested, viz: that a column of air upon the seacoast, the weight of which is taken as the standard of comparison, may contain, not only a large amount of vapor of water, but salts and other impurities in suspension, such as the air of the interior of the continent would be free from. In consequence of such unequal conditions of the air, differences of altitude would be too great, when deduced from the measured weights of the atmospheric columns. The amount of error due to this cause is probably small, yet it seems to be a subject worthy of investigation. However we may regret to throw doubt upon the final accuracy of the profile, it is gratifying to believe that the errors it contains have constantly the effect of exaggerating the difficulties to be overcome, and that future examinations will lead to more favorable results.

In the table of grades, which has been carefully deduced from the field-notes of the survey, the maximum inclination is believed to have been noted upon every portion of the line, except from the point of leaving the Mojave river to Tah-ee-chay-pah Pass. There, but few points are given in altitude, and, between them, mean inclinations are represented. The intermediate elevations and depressions would increase the grades; but, from the general appearance of the country, I should have estimated the amount somewhat less than Lieutenant Williamson has stated in his report. In order to exhibit the proposed termination of this line upon the Pacific, by the consent of the department, the profile of Lieutenant Williamson is adopted from Tah-ee-chay-pah Pass to San Francisco.

The sum of ascents and descents upon the whole line amounts to 47,539 feet; which, with the full working power of the road developed, would be equivalent (according to the formula of Messrs. Latrobe and Knight) to 900 miles of level grade. With the amount of work, however, estimated for the Pacific railway, the equated length, corresponding to the sum of ascents and descents, is supposed to be of little practical value.

## COST OF CONSTRUCTION.

The various explorations that have been made under orders from the War Department, make it sufficiently evident that the country between the Mississippi river and the Pacific ocean may be traversed by several lines, which are not so unfavorable for the location of a railway as heretofore supposed. The closer the subject is examined, the less serious appear the obstacles to be encountered, so far as they relate to the local conditions of the grade, curvature, and the characteristics of the soil; but the hasty manner in which the explorations were necessarily made, precludes the possibility of forming a satisfactory computation of the cost of constructing a railroad upon either of the lines. With the preliminary reports of the field-work before them, practical engineers differ widely in the conclusions to which they arrive upon this point. It is natural, perhaps, that one, desirous of impressing the public with a conviction of the practicability of the route which seems to him worthy to be adopted—particularly if guided, in a considerable degree, by conjecture rather than computation—should base his estimates upon the most favorable terms, and undervalue the difficulties incident to the country to be traversed. On the other hand, looking only at the magnitude of the undertaking, and anxious to convey a just appreciation of it, it would be equally easy to err upon the side of exaggeration. Besides, engineers differ in their ideas regarding the character of the road to be constructed: some estimating for a single track, with light rails, and a narrow gauge; others for a double track, and more expensive characteristics. Hence, when such varied estimates apply to different routes, a comparison of them affords no criterion for determining the relative merits of the lines proposed.

It would be a source of regret to me if, through any neglect or error of judgment upon my part, a false impression should be conveyed to the department upon this highly important question. To avoid it as far as practicable, the data upon which the following estimate is based will be submitted, that others, with practical experience in railroad engineering, in which I am deficient, may re-examine the details, and correct the errors which may be made.

The principal streams for the transportation of supplies, in the construction of a road, are the Arkansas and Canadian rivers upon the eastern division, and Rio Colorado and San Joaquin upon the western. The Colorado would doubtless be navigable to the Mojave village, for steamboats of light draught, for the greater portion of the year. The Canadian could be navigated in like manner, certainly, to Beaverstown, about 200 miles west from Fort Smith, and possibly, during the wet season, a considerable distance beyond. The main depots, therefore, for supplies, would be at Fort Smith and Beaverstown upon the east, and San Francisco and Mojave village on the west. For the distance within the two interior points—1,200 miles—it would be necessary to rely mainly upon land transportation.

For the preparation of the road-bed, parties might, with advantage, commence operations at each of the four points above mentioned, and proceed also east and west from Rio Grande. In distributing the iron, and laying the tracks, it would be economical to work from the main depots only, that the road itself may bear the chief burden of the land transportation. Progressing simultaneously from Beaverstown and Rio Colorado toward the interior, and laying tracks at an average of half a mile upon each side daily, it would require about three and a half years to effect a junction.

In the following estimate of the *cost of construction*, less expensive characteristics are assumed than those upon which the estimate in my preliminary report was based. The weight of rail is reduced to 75 pounds per yard. A single track, with sidings, is substituted for a double

track; and the full equipment is diminished to a proportion which is esteemed sufficient for the required service of the road. Another element of this reduction is founded upon the idea, that, the line having been decided upon, the country will be opened to settlers, who, occupying a great portion of the arable valleys upon the route, will be able to furnish much of the subsistence necessary for the laborers, and, in various ways, may aid in the construction of the road.

The various items of the estimate are, however, founded upon actual computation, as far as the details of the survey would admit; and where explicit data were wanting, all the known circumstances of the case have been weighed, and every doubtful point taken into consideration, in order that the amounts stated may not fall short of the necessary expense. Over the most difficult parts of the line, elaborated profiles, upon the horizontal scale of $\frac{1}{60000}$—the vertical being exaggerated 50 times—have given facilities for an approximate computation of the cutting and filling that would be required; and in the determination of the earthwork, masonry, &c., for a considerable portion of the work, I would acknowledge the valuable assistance received from Albert H. Campbell, esq., civil engineer.

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## ESTIMATE.

*Section* 1.—*From Fort Smith to the head of Pajarito creek,* 706 *miles.*

GRADUATION, MASONRY, ETC.

| | | |
|---|---|---|
| Earthwork, 13,012,124 cubic yards, at 15 cents | $1,951,819 | |
| Rock-cutting, 305,793 cubic yards, at $1 | 305,793 | |
| Masonry, 175,809 cubic yards, at $4 | 703,236 | |
| Bridging, 4,960 feet, at $30 | 148,800 | |
| Grubbing and clearing, 350 miles, at $200 | 70,000 | |
| Ballasting, 350 miles, at $1,000 | 350,000 | |
| | 3,529,648 | |
| Add 50 per cent. for increase over eastern prices | 1,764,824 | |
| Amount for graduation, masonry, &c. | | $5,294,472 |

SUPERSTRUCTURE.

| | | |
|---|---|---|
| Cross-ties for 706 miles, averaging $1,200 per mile | 847,200 | |
| Railroad iron—75 pounds per yard—delivered at Fort Smith, for single track and sidings for 706 miles, 102,511.2 tons, at $80 per ton | 8,200,896 | |
| Transportation of same 353 miles, at 3 cents per ton per mile | 1,085,594 | |
| Wrought iron chairs and spikes for 706 miles, at $500 per mile | 353,000 | |
| Distributing and placing iron and cross-ties, 706 miles, at $1,000 per mile | 706,000 | |
| Amount for superstructure | | 11,192,690 |

EQUIPMENT.

| | | |
|---|---|---|
| Locomotives, 80, at $10,000 | 800,000 | |
| Passenger cars, 70, at $3,000 | 210,000 | |
| Baggage cars, 25, at $1,500 | 37,500 | |
| Freight cars, 1,200, at $1,000 | 1,200,000 | |

| | | |
|---|---|---|
| Engine-houses and passenger depots | $250,000 | |
| Way stations for water and wood | 250,000 | |
| Amount for equipment | | $2,747,500 |
| For engineering and contingencies, add 10 per cent | | 1,923,466 |
| Amount | | 21,158,128 |
| Average cost per mile | | 29,969 |

*Section 2.—From the head of Pajarito creek to Isleta, 144 miles.*

GRADUATION, MASONRY, ETC.

| | | |
|---|---|---|
| Earthwork, 4,520,000 cubic yards, at 15 cents | 678,000 | |
| Rock-cutting, 2,880,000 cubic yards, at $1 | 2,880,000 | |
| Masonry, 43,200 cubic yards, at $4 | 172,800 | |
| Bridging, 5,660 feet, at $40 | 226,400 | |
| Grubbing and clearing, 100 miles, at $200 | 20,000 | |
| Ballasting, 20 miles, at $1,000 | 20,000 | |
| | 3,997,200 | |
| Add 50 per cent. for increase over eastern prices | 1,998,600 | |
| Amount for graduation, masonry, &c | | 5,995,800 |

SUPERSTRUCTURE.

| | | |
|---|---|---|
| Cross-ties for 144 miles, averaging $1,500 per mile | 216,000 | |
| Railroad iron—75 pounds per yard—delivered at Fort Smith, for single track and sidings for 144 miles, 20,908.8 tons, at $80 per ton | 1,672,684 | |
| Transportation of same 778 miles, at 4 cents per ton per mile | 650,680 | |
| Wrought iron chairs and spikes for 144 miles, at $600 per mile | 86,400 | |
| Distributing and placing iron and cross-ties, 144 miles, at $1,000 per mile | 144,000 | |
| Amount for superstructure | | 2,769,764 |

EQUIPMENT.

| | | |
|---|---|---|
| Locomotives, 16, at $10,000 | 160,000 | |
| Passenger cars, 15, at 3,000 | 45,000 | |
| Baggage cars, 4, at $1,500 | 6,000 | |
| Freight cars, 245, at 1,000 | 245,000 | |
| Engine-houses and passenger depots | 100,000 | |
| Way stations for water and wood | 150,000 | |
| Amount for equipment | | 706,000 |
| | | 9,471,564 |
| For engineering and contingencies, add 10 per cent | | 947,156 |
| Amount | | 10,418,720 |
| Average cost per mile | | 72,352 |

*Section* 3.—*From Isleta to Campbell's Pass*, 116.7 *miles.*

GRADUATION, MASONRY, ETC.

| | | |
|---|---|---|
| Earthwork, 2,015,000 cubic yards, at 15 cents | $302,250 | |
| Rock-cutting, 215,000 cubic yards, at $1 | 215,000 | |
| Masonry, 37,000 cubic yards, at $4 | 148,000 | |
| Bridging, 1,800 feet, at $30 | 54,000 | |
| Grubbing and clearing, 115 miles, at $200 | 23,000 | |
| Ballasting, 40 miles, at $1,000 | 40,000 | |
| | 782,250 | |
| Add 100 per cent. for increase over eastern prices | 782,250 | |
| Amount for graduation, masonry, &c. | | $1,564,500 |

SUPERSTRUCTURE.

| | | |
|---|---|---|
| Cross-ties, for 116.7 miles, at $1,500 per mile | 175,050 | |
| Railroad iron—75 pounds per yard—delivered at Fort Smith, for single track and sidings, for 116.7 miles, 16,945 tons, at $80 per ton | 1,355,600 | |
| Transportation of same, for 909 miles, at 5 cents per ton per mile | 770,150 | |
| Wrought-iron chairs and spikes, for 116.7 miles, at $700 per mile | 81,690 | |
| Distributing and placing iron and cross-ties, for 116.7 miles, at $1,500 per mile | 175,050 | |
| Amount for superstructure | | 2,558,540 |

EQUIPMENT.

| | | |
|---|---|---|
| Locomotives, 13, at $10,000 | 130,000 | |
| Passenger cars, 12, at $3,000 | 36,000 | |
| Baggage cars, 3, at $1,500 | 4,500 | |
| Freight cars, 200, at $1,000 | 200,000 | |
| Engine-houses and passenger depots | 100,000 | |
| Way stations for water and wood | 100,000 | |
| Amount for equipment | | 570,500 |
| | 4,693,540 | |
| For engineering and contingencies, add 10 per cent | 469,354 | |
| Amount | | 5,162,894 |
| Average cost per mile | | 44,240 |

*Section 4.—From Campbell's Pass to the mouth of Rio Puerco of the west*, 121 *miles.*

GRADUATION, MASONRY, ETC.

| | | |
|---|---|---|
| Earthwork, 3,405,230 cubic yards, at 15 cents | $510,735 | |
| Rock-cutting, 242,000 cubic yards, at $1 | 242,000 | |
| Masonry, 24,200 cubic yards, at $4 | 96,800 | |
| Bridging, 1,210 feet, at $30 | 36,300 | |
| Grubbing and clearing, 121 miles, at $200 | 24,200 | |
| Ballasting, 10 miles, at $1,000 | 10,000 | |
| | 920,035 | |
| Add 100 per cent. for increase over eastern prices | 920,035 | |
| Amount for graduation, masonry, &c | | $1,840,070 |

SUPERSTRUCTURE.

| | | |
|---|---|---|
| Cross-ties, for 121 miles, at $1,800 per mile | 217,800 | |
| Railroad iron—75 pounds per yard—delivered at Fort Smith, for single track and sidings, for 121 miles, 17,659.2 tons, at $80 per ton | 1,405,536 | |
| Transportation of same, 1,027 miles, at 5 cents per ton per mile | 902,178 | |
| Wrought-iron chairs and spikes, for 121 miles, at $800 per mile | 96,800 | |
| Distributing and placing cross-ties and rails, for 121 miles, at $1,500 per mile | 181,500 | |
| Amount for superstructure | | 2,803,814 |

EQUIPMENT.

| | | |
|---|---|---|
| Locomotives, 13, at $10,000 | 130,000 | |
| Passenger cars, 12, at $3,000 | 36,000 | |
| Baggage cars, 3, $1,500 | 4,500 | |
| Freight cars, 200, at $1,000 | 200,000 | |
| Engine-houses and passenger depots | 100,000 | |
| Way stations for water and wood | 200,000 | |
| Amount for equipment | | 670,500 |
| | 5,314,384 | |
| For engineering and contingencies, add 10 per cent | 531,438 | |
| Amount | 5,845,822 | |
| Average cost per mile | 48,313 | |

*Section 5.—Valley of Flax river, from mouth of Rio Puerco of the west to crossing of Flax river, 35 miles.*

GRADUATION, MASONRY, ETC.

| | | |
|---|---|---|
| Earthwork, 700,000 cubic yards, at 15 cents | $105,000 | |
| Masonry, 8,750 cubic yards, at $4 | 35,000 | |
| Bridging, 350 feet, at $30 | 10,500 | |
| Ballasting, 35 miles, at $1,000 | 35,000 | |
| | 185,500 | |
| Add 100 per cent. for increase over eastern prices | 185,500 | |
| Amount for graduation, masonary, &c | | $371,000 |

SUPERSTRUCTURE.

| | | |
|---|---|---|
| Cross-ties, for 35 miles, at $1,500 per mile | 52,500 | |
| Railroad iron—75 pounds per yard—delivered at the Mojave village, on Rio Colorado, for single track and sidings, for 35 miles, 5,082 tons, at $110 per ton | 559,020 | |
| Transportation of same, 326 miles, at 5 cents per ton per mile | 82,836 | |
| Wrought-iron chairs and spikes, for 35 miles, at $800 per mile | 28,000 | |
| Distributing and placing cross-ties and rails, 35 miles, at $1,500 per mile | 52,500 | |
| Amount for superstructure | | 774,856 |

EQUIPMENT.

| | | |
|---|---|---|
| Locomotives, 4, at $10,500 | 42,000 | |
| Passenger cars, 3, at $3,100 | 9,300 | |
| Baggage cars, 1, at $1,600 | 1,600 | |
| Freight cars, 45, at 1,100 | 49,500 | |
| Engine-houses and passenger depots | 30,000 | |
| Way stations for water and wood | 10,000 | |
| Amount for equipment | | 142,400 |
| | 1,288,256 | |
| For engineering and contingencies, add 10 per cent | 128,826 | |
| Amount | 1,417,082 | |
| Average cost per mile | 40,488 | |

*Section* 6.—*From crossing of Flax river to summit near Leroux's Spring*, 81 *miles.*

GRADUATION, MASONRY, ETC.

| | | |
|---|---|---|
| Earthwork, 2,430,000 cubic yards, at 15 cents | $364,500 | |
| Rock-cutting, 1,690,000 cubic yards, at $1 | 1,690,000 | |
| Masonry, 20,500 cubic yards, at $4 | 82,000 | |
| Bridging, 1,600 feet, at $30 | 48,000 | |
| Grubbing and clearing, 81 miles, at $200 | 16,200 | |
| | 2,200,700 | |
| Add 100 per cent. for increase over eastern prices | 2,200,700 | |
| Amount for graduation, masonry, &c | | $4,401,400 |

SUPERSTRUCTURE.

| | | |
|---|---|---|
| Cross-ties, for 81 miles, at $1,200 per mile | 97,200 | |
| Railroad iron—75 pounds per yard—delivered at the Mojave village, on Rio Colorado, for single track and sidings, for 81 miles, 11,761.2 tons, at $110 per ton | 1,293,732 | |
| Transportation of same, 232 miles, at 5 cents per ton per mile | 136,430 | |
| Wrought-iron chairs and spikes, for 81 miles, at $800 per mile | 64,800 | |
| Distributing and placing cross-ties and rails, 81 miles, at $1,500 | 121,500 | |
| Amount for superstructure | | 1,713,662 |

EQUIPMENT.

| | | |
|---|---|---|
| Locomotives, 9, at $10,500 | 94,500 | |
| Passenger cars, 8, at $3,100 | 24,800 | |
| Baggage cars, 2, at $1,600 | 3,200 | |
| Freight cars, 138, at $1,100 | 151,800 | |
| Engine-houses and passenger depots | 80,000 | |
| Way stations for water and wood | 80,000 | |
| Amount for equipment | | 434,300 |
| | | 6,549,362 |
| For engineering and contingencies, add 10 per cent | | 654,936 |
| Amount | | 7,204,298 |
| Average cost per mile | | 88,942 |

*Section 7.—From summit near Leroux's Spring to Aztec Pass, 87 miles.*

GRADUATION, MASONRY, ETC.

| | | |
|---|---|---|
| Earthwork, 4,105,851 cubic yards, at 15 cents | $615,878 | |
| Rock-cutting, 1,878,709 cubic yards, at $1 | 1,878,709 | |
| Masonry, 24,000 cubic yards, at $4 | 96,000 | |
| Bridging, 900 feet, at $30 | 27,000 | |
| Grubbing and clearing, 80 miles, at $200 | 16,000 | |
| Ballasting, 7 miles, at $1,000 | 7,000 | |
| | 2,640,587 | |
| Add 100 per cent. for increase over eastern prices | 2,640,587 | |
| Amount for graduation, masonry &c | | $5,281,174 |

SUPERSTRUCTURE.

| | | |
|---|---|---|
| Cross-ties, for 87 miles, at $1,200 per mile | 104,400 | |
| Railroad iron—75 pounds per yard—delivered at Mojave village, on Rio Colorado, for single track and sidings, for 87 miles, 12,632.4 tons, at $110 per ton | 1,389,564 | |
| Transportation of same, 148 miles, at 5 cents per ton per mile | 93,480 | |
| Wrought-iron chairs and spikes, for 87 miles, at $800 per mile | 69,600 | |
| Distributing and placing cross-ties and rails, 87 miles, at $1,500 per mile | 130,500 | |
| Amount for superstructure | | 1,787,544 |

EQUIPMENT.

| | | |
|---|---|---|
| Locomotives, 10, at $10,500 | 105,000 | |
| Passenger cars, 9, at $3,100 | 27,900 | |
| Baggage cars, 2, at $1,600 | 3,200 | |
| Freight cars, 148, at 1,100 | 162,800 | |
| Engine-houses and passenger depots | 90,000 | |
| Way stations for water and wood | 90,000 | |
| Amount for equipment | | 478,900 |
| | | 7,547,618 |
| For engineering and contingencies, add 10 per cent | | 754,762 |
| Amount | | 8,302,380 |
| Average cost per mile | | 95,200 |

*Section* 8.—*From Aztec Pass to Cross mountain*, 23.3 *miles.*

GRADUATION, MASONRY, ETC.

| | | |
|---|---|---|
| Earthwork, 582,000 cubic yards, at 15 cents | $87,300 | |
| Rock-cutting, 46,200 cubic yards, at $1 | 46,200 | |
| Masonry, 5,825 cubic yards, at $4 | 23,300 | |
| Bridging, 233 feet, at $30 | 6,990 | |
| Grubbing and clearing, 10 miles, at $200 | 2,000 | |
| Ballasting, 10 miles, at $1,000 | 10,000 | |
| | 175,790 | |
| Add 100 per cent. for increase over eastern prices | 175,790 | |
| Amount for graduation, masonry, &c | | $351,580 |

SUPERSTRUCTURE.

| | | |
|---|---|---|
| Cross-ties, for 23.3 miles, at $1,500 per mile | 34,950 | |
| Railroad iron—75 pounds per yard—delivered at Mojave village, on Rio Colorado, for single track and sidings, for 23.3 miles, 3,383.2 tons, at $110 per ton | 372,152 | |
| Transportation of same, 93 miles, at 5 cents per ton per mile | 15,732 | |
| Wrought-iron chairs and spikes, for 23.3 miles, at $800 per mile | 18,640 | |
| Distributing and placing cross-ties and iron, 23.3 miles, at $1,500 per mile | 34,950 | |
| Amount for superstructure | | 476,424 |

EQUIPMENT.

| | | |
|---|---|---|
| Locomotives, 3, at $10,500 | 31,500 | |
| Passenger cars, 2, at $3,100 | 6,200 | |
| Baggage cars, 1, at $1,600 | 1,600 | |
| Freight cars, 40, at 1,100 | 44,000 | |
| Engine-houses and passenger depots | 20,000 | |
| Way stations for water and wood | 10,000 | |
| Amount for equipment | | 113,300 |
| | | 941,304 |
| For engineering and contingencies, add 10 per cent | | 94,130 |
| Amount | | 1,035,434 |
| Average cost per mile | | 44,435 |

*Section 9.—From Cross mountain to the crossing of Big Sandy, 27.5 miles.*

GRADUATION, MASONRY, ETC.

| | | |
|---|---|---|
| Earthwork, 760,000 cubic yards, at 15 cents | $114,000 | |
| Rock-cutting, 425,000 cubic yards, at $1 | 425,000 | |
| Masonry, 8,250 cubic yards, at $4 | 33,000 | |
| Bridging, 550 feet, at $30 | 16,500 | |
| Grubbing and clearing, 25 miles, at $200 | 5,000 | |
| Ballasting, 10 miles, at $1,000 | 10,000 | |
| | 603,500 | |
| Add 100 per cent. for increase over eastern prices | 603,500 | |
| Amount for graduation, masonry, &c | | $1,207,000 |

SUPERSTRUCTURE.

| | | |
|---|---|---|
| Cross-ties, for 27.5 miles, at $1,800 | 47,500 | |
| Railroad iron—75 pounds per yard—delivered at Mojave village, on Rio Colorado, for single track and sidings, for 27.5 miles, 3,993 tons, at $110 | 439,230 | |
| Transportation of same, 68 miles, at 5 cents per ton per mile | 13,576 | |
| Wrought-iron chairs and spikes, for 27.5 miles, at $800 per mile | 22,000 | |
| Distributing and placing cross-ties and rails, 27.5 miles, at $1,500 | 41,250 | |
| Amount for superstructure | | 563,556 |

EQUIPMENT.

| | | |
|---|---|---|
| Locomotives, 3, at $10,500 | 31,500 | |
| Passenger cars, 3, at $3,100 | 9,300 | |
| Baggage cars, 1, at $1,600 | 1,600 | |
| Freight cars, 47, at $1,100 | 51,700 | |
| Engine-houses and passenger depots | 25,000 | |
| Way stations for water and wood | 50,000 | |
| Amount for equipment | | 169,100 |
| | | 1,939,656 |
| For engineering and contingencies, add 10 per cent | | 193,966 |
| Amount | | 2,133,622 |
| Average cost per mile | | 77,583 |

*Section* 10.—*From crossing of Big Sandy to crossing of Rio Colorado,* 53.7 *miles.*

GRADUATION, MASONRY, ETC.

| | | |
|---|---|---|
| Earthwork, 1,350,000 cubic yards, at 15 cents | $202,500 | |
| Rock-cutting, 27,000 cubic yards, at $1 | 27,000 | |
| Masonry, 10,800 cubic yards, at $4 | 43,200 | |
| Bridges, 537 feet, at $30 | 16,110 | |
| Grubbing and clearing, 53.7 miles, at $200 | 10,740 | |
| | 299,550 | |
| Add 100 per cent. for increase over eastern prices | 299,550 | |
| Amount for graduation, masonry, &c | | $599,100 |

SUPERSTRUCTURE.

| | | |
|---|---|---|
| Cross-ties, for 53.7 miles, at $2,000 per mile | 107,400 | |
| Railroad iron—75 pounds per yard—delivered at Mojave village, on Rio Colorado, for single track and sidings, for 53.7 miles, 7,797.2 tons, at $110 per ton | 857,696 | |
| Transportation of same, 27 miles, at 5 cents per ton per mile | 10,526 | |
| Wrought-iron chairs and spikes, for 53.7 miles, at $800 per mile | 42,960 | |
| Distributing and placing cross-ties and rails, 53.7 miles, at $1,500 | 80,550 | |
| Amount for superstructure | | 1,099,132 |

EQUIPMENT.

| | | |
|---|---|---|
| Locomotives, 6, at $10,500 | 63,000 | |
| Passenger cars, 5, at $3,100 | 15,500 | |
| Baggage cars, 2, at $1,600 | 3,200 | |
| Freight cars, 91, at $1,100 | 100,100 | |
| Engine-houses and passenger depots | 50,000 | |
| Way stations for water and wood | 200,000 | |
| Amount for equipment | | 431,800 |
| | | 2,130,032 |
| For engineering and contingencies, add 20 per cent | | 426,006 |
| Amount | | 2,556,038 |
| Average cost per mile | | 47,600 |

*Section* 11.—*From the crossing of Rio Colorado to Soda Lake*, 96.8 *miles.*

GRADUATION, MASONRY, ETC.

| | | |
|---|---|---|
| Earthwork, (grading,) 1,716,000 cubic yards, at 15 cents | $257,400 | |
| Earthwork, (embankment through sandy soil,) 700,000 cubic yards, at 25 cents | 175,000 | |
| Rock-cutting, 60,000 cubic yards, at $1 | 60,000 | |
| Masonry, 37,000 cubic yards, at $4 | 148,000 | |
| Bridges, 800 feet, at $40 | 32,000 | |
| Bridges, 600 feet, at $30 | 18,000 | |
| | 690,400 | |
| Add 100 per cent. for increase over eastern prices | 690,400 | |
| Amount for graduation, masonry, &c | | 1,380,800 |

SUPERSTRUCTURE.

| | | |
|---|---|---|
| Cross-ties, for 96.8 miles, at $2,000 per mile | 193,600 | |
| Railroad iron—75 lbs. per yard—delivered at Mojave village, on Rio Colorado, for single track and sidings, for 96.8 miles, 14,055 tons, at $110 per ton | 1,556,090 | |
| Transportation of same, 48 miles, at 5 cents per ton per mile | 33,732 | |
| Wrought-iron chairs and spikes, for 96.8 miles, at $800 per mile | 77,440 | |
| Distributing and placing cross-ties and rails, for 96.8 miles, at $1,500 per mile | 145,200 | |
| Amount for superstructure | | 2,006,062 |

EQUIPMENT.

| | | |
|---|---|---|
| Locomotives, 11, at $10,500 | 115,500 | |
| Passenger cars, 10, at 3,100 | 31,000 | |
| Baggage cars, 3, at 1,600 | 4,800 | |
| Freight cars, 164, at 1,100 | 180,400 | |
| Engine-houses and passenger depots | 100,000 | |
| Way stations for water and wood | 300,000 | |
| Amount for equipment | | 731,700 |
| | 4,118,562 | |
| For engineering and contingencies, add 20 per cent | 823,712 | |
| Amount | | 4,941,274 |
| Average cost per mile | | 51,057 |

*Section* 12.—*From Soda Lake to the point of leaving Mojave river*, 70.5 *miles.*

GRADUATION, MASONRY, ETC.

| | | |
|---|---|---|
| Earthwork, 1,410,000 cubic yards, at 15 cents | | $211,500 |
| Rock-cutting, 30,000 cubic yards, at $1 | | 30,000 |
| Masonry, 21,150 cubic yards, at $4 | | 84,600 |
| Bridges, 700 feet, at $30 | | 21,000 |
| Grubbing and clearing, 70.5 miles, at $200 per mile | | 14,100 |
| Ballasting, 50 miles, at $1,000 | | 50,000 |
| | 411,200 | |
| Add 100 per cent. for increase over eastern prices | 411,200 | |
| Amount for graduation, masonry, &c | | $822,400 |

SUPERSTRUCTURE.

| | | |
|---|---|---|
| Cross-ties, for 70.5 miles, at $1,800 per mile | | 126,900 |
| Railroad iron—75 lbs. per yard—delivered at San Francisco, for single track and sidings, for 70.5 miles, 10,236.6 tons, at $92 per ton | | 941,767 |
| Transportation of same, 425 miles, at 5 cents per ton per mile | | 217,528 |
| Wrought-iron chairs and spikes, for 70.5 miles, at $800 per mile | | 56,400 |
| Distributing and placing cross-ties and rails, for 70.5 miles, at $1,500 per mile | | 105,750 |
| Amount for superstructure | | 1,448,345 |

EQUIPMENT.

| | | |
|---|---|---|
| Locomotives, 8, at $10,500 | 84,000 | |
| Passenger cars, 7, at $3,100 | 21,700 | |
| Baggage cars, 2, at $1,600 | 3,200 | |
| Freight cars, 120, at $1,100 | 132,000 | |
| Engine-houses and passenger depots | 70,000 | |
| Way stations for water and wood | 70,000 | |
| Amount for equipment | | 380,900 |
| | | 2,651,645 |
| For engineering and contingencies, add 10 per cent | | 265,165 |
| Amount | | 2,916,810 |
| Average cost per mile | | 41,373 |

*Section* 13.—*From the point of leaving Mojave river to entrance of Tah-ee-chay-pah Pass,* 63 *miles.*

GRADUATION, MASONRY, ETC.

| | | |
|---|---|---|
| Earthwork, 1,890,000 cubic yards, at 15 cents | $283,500 | |
| Rock-cutting, 15,000 cubic yards, at $1 | 15,000 | |
| Masonry, 18,900 cubic yards, at $4 | 75,600 | |
| Bridging, 600 feet, at $30 | 18,000 | |
| Grubbing and clearing, 50 miles, at $200 | 10,000 | |
| Ballasting or piling, 13 miles, at $2,000 | 26,000 | |
| | 428,100 | |
| Add 100 per cent. for increase above eastern prices | 428,100 | |
| Amount for graduation, masonry, &c | | $856,200 |

SUPERSTRUCTURE.

| | | |
|---|---|---|
| Cross-ties, for 63 miles, at $1,800 per mile | 113,400 | |
| Railroad iron—75 pounds per yard—delivered at San Francisco, for single track and sidings, for 63 miles, 9,147.6 tons, at $92 per ton | 841,579 | |
| Transportation of same, 358 miles, at 5 cents per ton per mile | 163,742 | |
| Wrought iron chairs and spikes, for 63 miles, at $800 per mile | 50,400 | |
| Distributing and placing cross-ties and rails, for 63 miles, at $1,500 per mile | 94,500 | |
| Amount for superstructure | | 1,263,621 |

EQUIPMENT.

| | | |
|---|---|---|
| Locomotives, 7, at $10,500 | 73,500 | |
| Passenger cars, 6, at $3,100 | 18,600 | |
| Baggage cars, 2, at $1,600 | 3,200 | |
| Freight cars, 107, at $1,100 | 117,700 | |
| Engine-houses and passenger depots | 50,000 | |
| Way stations for water and fuel | 250,000 | |
| Amount for equipment | | 513,000 |
| | | 2,632,821 |
| For engineering and contingencies, add 10 per cent | 263,282 | |
| Amount | | 2,896,103 |
| Average cost per mile | | 45,970 |

RECAPITULATION OF ESTIMATE.

| Sections. | Distance. | Preparation of road-bed. | Superstructure. | Equipment. | Engineering & contingencies. | Amount. |
|---|---|---|---|---|---|---|
| Fort Smith to head of Pajarito creek | 706 | $5,294,472 | $11,192,690 | $2,747,500 | $1,923,466 | $21,158,128 |
| Head of Pajarito creek to Isleta | 144 | 5,995,800 | 2,769,764 | 706,000 | 947,156 | 10,418,720 |
| Isleta to Campbell's Pass | 116.7 | 1,564,500 | 2,558,540 | 570,500 | 469,354 | 5,162,894 |
| Campbell's Pass to mouth of Rio Puerco of the west. | 121 | 1,840,070 | 2,803,814 | 670,500 | 531,438 | 5,845,822 |
| Valley of Flax river | 35 | 371,000 | 774,856 | 142,400 | 128,826 | 1,417,082 |
| Flax river to Leroux's Spring | 81 | 4,401,400 | 1,713,662 | 434,300 | 654,936 | 7,204,298 |
| Leroux's Spring to Aztec Pass | 87 | 5,281,174 | 1,787,544 | 478,900 | 754,762 | 8,302,380 |
| Aztec Pass to Cross mountain | 23.3 | 351,580 | 476,424 | 113,300 | 94,130 | 1,035,434 |
| Cross mountain to Big Sandy | 27.5 | 1,207,000 | 563,556 | 169,100 | 193,966 | 2,133,622 |
| Big Sandy to Rio Colorado | 53.7 | 599,100 | 1,099,132 | 431,800 | 426,006 | 2,556,038 |
| Rio Colorado to Soda lake | 96.8 | 1,380,800 | 2,006,062 | 731,700 | 823,712 | 4,941,274 |
| Soda lake to point of leaving Mojave river. | 70.5 | 822,400 | 1,448,345 | 380,900 | 265,165 | 2,916,810 |
| Point of leaving Mojave river to Tah-ee-chay-pah Pass. | 63 | 856,200 | 1,263,621 | 513,000 | 263,282 | 2,896,103 |
| Through Tah-ee-chay-pah Pass | *38.5 | | | | | 3,465,000 |
| Tah-ee-chay-pah Pass to San Francisco | †288 | | | | | 14,400,000 |
| From Fort Smith to San Francisco | 1,952 | | | | | 93,853,605 |
| Average | | | | | | 48,081 |

* At $90,000 per mile, according to Capt. Humphrey's estimate.

† At $50,000 per mile, (see Capt. Humphrey's estimate.)

RECAPITULATION.

From a glance at the preceding estimates and remarks, founded upon examinations of the data obtained by the survey, it seems evident that the route near the parallel of 35° north latitude possesses some important advantages. Among them may be mentioned the general directness of its course from the principal commercial cities of the east to the harbor of San Francisco; its temperate and salubrious climate; its freedom from heavy snows; the large amount of timber and fuel upon its extremities and interior portions; the convenient distribution of stone for construction; the generally plentiful supply of water; the comparatively great extent of arable valleys along the route, and frequency of spots adapted to settlements. The objections that may be made to it, both with regard to grade and the barren character of the soil upon the western portion of the line, have already been noticed. The latter, to a greater or less degree, seems to be common to all the routes. There are portions of this desert region, however, that, by the labor of man, may undoubtedly be renovated, and made productive. This, and other changes, which the construction of a railroad from the Mississippi river to the Pacific would produce upon the country traversed, can scarcely be appreciated by one accustomed to view its present desolation. Many who visited California in 1849 and 1850 pronounced the country to be almost destitute of agricultural resources. The same mistake, in a less degree, has doubtless been made regarding a considerable portion of the uncultivated region under consideration.

In reference to the first objection above noticed, it may be remarked that, in the progress of the science of railroad engineering, considerable changes have taken place within the last few years in the practice of the art. Grades that were formerly deemed impracticable without stationary engines, are now readily overcome by the ordinary locomotives of the train; ridges that

would have been tunnelled, are now surmounted by a surface grade; thereby promoting economy, safety, and speed.*

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## CONCLUSION.

The operations of the survey have been narrated in the preceding pages considerably in detail. I am aware that greater brevity would have been desirable, but it seemed necessary to lay before the department not only the results obtained, but also the material upon which they were founded. It was less important to present my own opinions than to furnish the facts collected, and thus enable this route to be compared with others, so as to determine, from the character of the various countries described, the location of that line between the Mississippi river and the Pacific ocean which may be the most favorable for a railroad. Having seen much of the noble State of California, I am deeply impressed with the importance of uniting her more closely with the Atlantic portion of the Union; and believing that several routes proposed by the department are possessed of advantages and difficulties peculiar to each, it seems proper that they should be considered with sound judgment and discretion, that the final location of the road may be best adapted to the great interests of the nation. Therefore, disclaiming all personal preference for the line entrusted to me for examination, it has been my effort to make equally prominent the facilities and the obstructions which the survey has been able to detect, leaving the judgment to be rendered by the department and the nation in favor of, or adverse to, this line of location.

The geological, the botanical, and the zoölogical reports which follow, will greatly aid in the formation of an enlightened opinion upon this question. Each of them contains specific information, interesting to the scientific world, and particularly illustrative of the character of the country with reference to its adaptation to the purpose in view. The succeeding report upon the Indian tribes that have been known to inhabit the belt of country under consideration, will be found to contain some facts regarding the character of its soil and its capacity to support an agricultural or pastoral population.

* In a recent number of the "Railroad Record," there is an interesting article, copied from the London Civ. Eng. and Arch. Jour., on steep gradients of railways, and the locomotives employed. The following is an extract:

"Though it could not be denied that English railway engineers were formerly prejudiced against any steeper inclination than 1 in 100"—52.8 feet per mile—"and had believed that gradients of 1 in 50"—105.6 feet per mile—"could only be worked by means of ropes, yet it must be remembered that 15 years ago Halifax was approached by a gradient of 1 in 44, and that 22 passenger trains per day, besides goods trains, were, without difficulty, conveyed over that incline by locomotives. There was, therefore, nothing new in these steep inclines, nor in the manner of working them. It should also be mentioned, that the results of the later experience went to prove that it was more advantageous to rely on the locomotive than on any system of ropes. Not only had the latter system been abandoned on the Euston incline, (London,) and at Miles Platting incline, (Manchester,) but even at Oldham, where there was a gradient of 1 in 27 (195.5 feet per mile) for one and three-fourth mile; the rope was taken away two years ago, and the traffic was now entirely dependent on locomotives."

# PART III.

Drawn. by J.J Young from a Sketch by A.H. Campbell

Lith. of SARONY. MAJOR & KNAPP New York.

RIO COLORADO NEAR THE MOJAVE VILLAGES

VIEW No III.

from the right bank, looking East.

EXPLORATIONS AND SURVEYS FOR A RAILROAD ROUTE FROM THE MISSISSIPPI RIVER TO THE PACIFIC OCEAN.

WAR DEPARTMENT.

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ROUTE NEAR THE THIRTY-FIFTH PARALLEL, UNDER THE COMMAND OF LIEUT. A. W. WHIPPLE, TOPOGRAPHICAL ENGINEERS, IN 1853 AND 1854.

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# REPORT

UPON

# THE INDIAN TRIBES,

BY

LIEUT. A. W. WHIPPLE, THOMAS EWBANK, ESQ., AND PROF. WM. W. TURNER.

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WASHINGTON, D. C.,
1855.

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NOTE.—The above named views, portraits, and inscriptions, are careful representations of the originals. They were drawn by H. B. Möllhausen, artist to the expedition.

# CHAPTER I.

## *Remarks regarding the localities, numbers, modes of subsistence, &c., of various tribes upon the route.*

Of all the collateral branches to which our attention was directed by instructions from the department, the one now under consideration seems the most remotely connected with the main object of the exploration. Nevertheless, a knowledge of the inhabitants of the various districts traversed, and their usual mode of subsistence, whether by agriculture, by hunting, by gathering wild fruits and roots, or by plunder of neighboring countries, will tend to elucidate many facts regarding the characteristics and resources of that region, which our hasty reconnaissance could not determine more directly. Besides, a comparison of the various tribes within our borders, showing the effect produced upon each by the policy heretofore adopted by the government, may be useful in determining the course to be pursued towards them in future. In our dealings with this race, it is necessary to understand the peculiarities of their character, and the motives that govern their actions. If it be found that they construe gifts received from agents of the government as tribute paid from fear of their depredations upon emigrants and settlers, that mode of dispensing favors will have to be discontinued. If pride appear to be one of their characteristic traits, care must be taken not to trample upon it. If they possess manliness of spirit, are sensitive to expressions of contempt, and are grateful for considerate kindness bestowed, our mode of intercourse should be regulated accordingly. If it should be proved that those tribes, whom we have fostered for years with uniform consideration and substantial benefits, have considerably progressed in civilization, we shall be encouraged, for the sake of humanity, to extend the system which has produced such gratifying results; and, if this can be done at less cost to the national treasury than is required to chastise their aggressions, or to govern them by the fear of a military force, another inducement will urge on the benevolent work of enlightening this remnant of a numerous race. Many thousands of benighted beings now exist under our government without realizing its benefits. When this fact can be faithfully presented to the American people, much of the sympathy now bestowed upon negroes will be turned toward the Indians, who have none of the religious privileges, nor experience the careful protection, that the African enjoys. The aborigines are, upon every side, hemmed in by descendants of a foreign race. Year by year their fertile valleys are appropriated by others, their hunting-grounds invaded, and they themselves driven to narrower and more barren districts. The time is now arrived when we must decide whether they are to be exterminated: if not, the powerful arm of the law must be extended over them, to secure their right to the soil they occupy; to protect them from aggression; to afford facilities and aid in acquiring the arts of civilization, and the knowledge and humanizing influences of Christianity.

The material collected, and briefly presented in the following pages, is not as full and precise as could be desired. We passed through the territory of the Kaiowas and Comanches when

the greater portion of them were north of our trail, pursuing the buffalo. The San Francisco region was traversed in mid-winter, when its inhabitants had sought for more comfortable quarters in the lower country, upon the waters of Rio Verde. Hence, with many tribes we had less opportunity for personal observations than had been anticipated. But the notes which could be taken without interfering with the main operations of the survey, are submitted, in the hope that they may add something to the stock of information already before the department.

The territory ceded by the government to the Choctaw Nation extends from the State of Arkansas on the east, and the Canadian river upon the north, to the boundary of Texas upon the south and west; but only the eastern portion of it is actually occupied by this tribe. Several Chickasaw villages are scattered through the central parts; bands of Shawnees, Quapaws, and Delawares are located midway upon the Canadian, and the western division is occupied by various remnants of wilder tribes, such as Topofkees, Kichais, Kickapoos, Caddos, Huecos, and Witchitas. Upon the northern side of the Canadian are Creeks, Quapaws, and Cherokees. All of the above-mentioned have fixed habitations, and, to a greater or less extent, are engaged in agriculture. Those that have been planted here under the care of the government, have already made some progress in civilization; supporting schools for the young, and cultivating the arts. The remainder seem equally docile, and would doubtless adopt any well-digested system that our government might choose to direct for their improvement.

Upon the western borders of the Choctaw country commences the vast range of the wild Kaiowas and Comanches; extending uninterruptedly along the Canadian to Tucumcari creek and thence, occasionally, to Rio Pecos. From this line they pursue the buffalo northward as far as the Sioux country, and on the south are scarcely limited by the frontier settlements of Mexico, upon which their depredations are committed. The Comanches and Kaiowas are friends and allies. A tribe of Lipans ranges over a portion of the same region, with indiscriminate hostility both to Comanches and whites. They belong to the Apache nation, though in habits and in appearance greatly resembling the Kaiowas.

The tribes above mentioned may be divided into three classes: the semi-civilized, the rude, and the barbarous.

The first, according to the best evidence we have, consists of—

| | |
|---|---|
| Choctaws | 15,767 * |
| Chickasaws | 4,260 * |
| Cherokees | 17,367 * |
| Creeks and Seminoles | 24,000 * |
| Quapaws | 200 |
| Shawnees | 325 |
| Delawares | 200 |

making an aggregate of about 62,000 persons, peaceful in their dispositions, and depending for subsistence upon agriculture alone. They are characterized by docility, and have a desire to learn and practise the manners, habits, and language of the whites. The labors of missionaries among them have been crowned with success, and there appears to be no obstacle in the way to prevent their complete civilization. The Shawnees and Delawares of this region do not participate in the favors bestowed upon more northerly bands of their tribes, and therefore complain that government overlooks their interests, as it bestows upon them neither annuities, as to Choctaws, nor presents, such as are distributed among the hostile tribes of the prairies. They evidently have an idea that the latter are given to the wild Indians as a kind of tribute, from fear of their depredations; and naturally murmur that they, who are always friendly to the whites, should receive no assistance from them. It is believed that if government could

* Schoolcraft.

evince a greater regard for the prosperity of those portions of the peaceful tribes who live on the borders, the effect would be beneficial upon the roving bands.

Among those contiguous to our route, residing in the Choctaw or Creek territory, and characterized as rude, the following are enumerated:

| | |
|---|---|
| Topofkees | 200 |
| Kichais | 500 |
| Kickapoos | 400 |
| Caddoes | 100 |
| Huecos | 400 |
| Witchitas | 500 |
| Total | 2,100 |

These remnants of tribes have much intercourse with, and are supposed to be considerably influenced by, the semi-civilized class above alluded to. Probably they might easily be induced to conform to their mode of life. Already they cultivate the soil to some extent, but, retaining many of their old habits, are fond of hunting and a roving life, and commit occasional depredations upon their neighbors.

The third class, denominated barbarous, are the Arabs of the plains and the scourge of emigrants. According to the best information I could obtain, their numbers are as follows:*

| | |
|---|---|
| Comanches | 20,000 |
| Kaiowas | 3,500 |
| Lipans | 6,500 |

amounting to 30,000 persons, one-fifth of whom are supposed to be warriors. They are perfect types of the American savage, and to us appear more barbarous than the Spaniards considered them at the end of the preceding century.† Hunting and war are their favorite pursuits. Agriculture is esteemed a degradation, from which their proud natures revolt; their dependence for subsistence being upon game, and depredations upon frontier settlements. So haughty is their spirit, and so great their contempt for white men, that it is somewhat doubtful whether they will ever be induced to accept civilization and a local habitation, instead of the unrestrained freedom of their wild and lawless life.

Between the Comanche range and the Rio Grande are several fragments of roving bands of Apaches, whose condition in 1799 is described in chapter VI. As they were not seen upon our trail, and are not supposed to be numerous, they are passed over without further remark.

The Pueblo Indians of New Mexico present a strong contrast to those previously noticed. They remain living in towns, irrigating and cultivating the soil, nearly in the same manner as was their custom previous to the period of the Spanish conquest. We first met bands of them upon the Canadian river, where they were in search of Comanches for the purposes of trade. They said their tribe was called "Tiguex" by Spaniards, but, in their own language, the appellation was Ki'-o-wummi. They traced upon the ground a sketch of their country, with the names and locations of the pueblos occupied in New Mexico—a copy of which (somewhat

* These estimates differ from those given in Mr. Schoolcraft's History. The latter are as follows: Comanches 27,000, Kaiowas 3,500, Lipans 500—amounting to 31,000. Mr. Burnet, in an interesting article upon this subject, ranks the Lipans next to the Comanches. His estimates of numbers would, however, reduce the above by nearly one-half.

† See the description of Comanches in chapter vi.

improved) is annexed. It is more particularly referred to in chapter III. With regard to their numbers, it is difficult to form a satisfactory estimate.

PLATE I.

Indian map showing the positions of the Pueblos in New Mexico.

In the report of Lieutenant Abert is found an extract from an official statement of the population of New Mexico, in which the Pueblo Indians are included. The following is a copy of it:

*Extracts from the records in the State Department at Santa Fé.*

[Translation.]

"Mariano Martinez de Lejanza, brevet brigadier general and constitutional governor of the department of New Mexico, to its inhabitants sends greeting: That the assembly of the department has agreed to decree the following:

"The assembly of the department of New Mexico, in discharging the powers which are conceded by the 134th article of the organic law of the republic, decrees the following:

"DIVISION OF THE DEPARTMENT.

"*Article* 1. The department of New Mexico, conformably to the 4th article of the constitution, is hereby divided into three districts, which shall be called the Central, the North, and the Southeast. The whole shall be divided into seven counties, and these into three municipalities. The population, according to the statistics which are presented for this purpose, is 100,064. The capital of this department is Santa Fé.

"CENTRAL DISTRICT.

"*Art.* 2. This district is hereby divided into three counties, which shall be called Santa Fé, Santa Ana, and San Miguel del Bado. The capital of these three counties shall be the city of Santa Fé.

"*Art.* 3. The first county shall comprise all the inhabitants of Santa Fé, San Ildefonso, Pojuaque, Nambé, Cuyamanque, Tezuque, Rio Tezuque, Sienega, Sieneguilla, Agua Fria, Galisteo, El Real del Oro, and Tuerto. The county-seat is Santa Fé. The number of inhabitants is 12,500.

"*Art.* 4. The second county shall comprise the inhabitants of Rayada, Cochité, Peña Blanca, Chilili, Santo Domingo, Cobero, San Felipe, Jemez, Silla, Santa Ana, Angostura, and Algodones. The number of inhabitants is 10,500. The county-seat is fixed at Algodones.

"*Art.* 5. The third county shall comprise the inhabitants of Pecos, Gusano, Rio de la Vaca, Mula, Estramosa, San José, San Miguel del Bado, Pueblo, Puerticito, Cuesto, Cerrito, Anton Chico, Tecaloté, Vegas, and Sepillo. Inhabitants 18,800. The county-seat shall be San Miguel.

"NORTHERN DISTRICT.

"*Art.* 6. This district is divided into two counties, called Rio Arriba and Taos. The capital is Los Luceros.

"*Art.* 7. The county of Rio Arriba comprises the inhabitants of Santa Cruz de la Cañada, Chimayo, Cañada, Truchas, Santa Clara, Vegas, Chama, Cuchillo, Abiquiu, Rito Colorado, Ojo Caliente, Ranchitos, Chamita, San Juan, Rio Arriba, Joya, and Embuda. The county-seat is Los Luceros. The number of inhabitants is 15,000.

"*Art.* 8. The county of Taos comprises the inhabitants of Don Fernandez, San Francisco, Arroyo Hondo, Arroyo Seco, Desmontes, Sineguilla, Pecuriés, Santa Barbara, Zampas, Chamizal, Llano, Peñasco, Moro, Huerfano, and Cemmaron. The county-seat is Don Fernandez. The number of inhabitants amounts to 14,200.

"SOUTHEASTERN DISTRICT.

"*Art.* 9. This district is divided into two counties, called Valencia and Bernalillo. The capital is Valencia.

"*Art.* 10. The county of Valencia comprises Valencia, San Fernando, Tomé, Socoro, Limetar, Polvaderas, Sabinal, Elames, Casa Colorada, Cebolleta, Sabino, Parida, Luis Lopez, Belen, Lunes, Lentes, Zuñi, Acoma, and Rito. County-seat Valencia. Number of inhabitants 20,000.

"*Art.* 11. The county of Bernalillo comprises Isleta, Padilla, Pajarito, Ranchos de Atrisco, Atrisco, Placeres, Albuquerque, Alemeda, Corrales, Sandia, and Bernalillo. County-seat, Bernalillo. Number of inhabitants 8,204. The whole number of inhabitants of the district, 28,204.

" This decree shall be made known to the governor, that he may carry it into execution.

" JÉSUS MARIA GALLEGOS, *President.*

" JUAN BAPTISTA VIGIL Y MURIS, *Secretary.*

" By virtue of the premises, I command that this act be published, circulated, and made known, to all whom it may concern, for its most active observance and fulfilment.

" Palace of the government, Santa Fé.

" MARIANO MARTINEZ.

" JOSE FELIX JUBIA, *Secretary.*

" *June* 17, 1844."

It is probable that, since 1844, very little change has occurred in the number of Pueblo Indians. Therefore, by dividing the aggregate, so as to give each town its proportion, we may obtain an approximate estimate of the Indian population. In the following table this has been attempted.

TABLE.

| | | |
|---|---|---|
| Santa Fé | 4,500 | |
| San Ildefonso | 500 | |
| Pojuaque | 500 | |
| Nambé | 500 | |
| Cuyamanque | 400 | |
| Tezuque | 700 | |
| Rio Tezuque | 900 | |
| Sienega | 500 | |
| Sienaguilla | 300 | |
| Agua Fria | 500 | |
| Galisteo | 1,200 | |
| El Real | 1,000 | |
| Tuerto | 1,000 | |
| | | 12,500 |
| Rayada | 1,100 | |
| Cochité | 900 | |
| Peña Blanca | 1,200 | |
| Chilili | 800 | |
| San Domingo | 800 | |
| Cobero | 1,000 | |
| San Felipe | 800 | |
| Jemez | 450 | |
| Silla | 450 | |
| Santa Ana | 500 | |
| Angostura | 1,000 | |
| Algodones | 1,500 | |
| | | 10,500 |
| Pecos, (at present deserted) | | |
| Gusano | 1,400 | |
| Rio de la Vaca | 1,500 | |
| Mula | 1,000 | |
| Estramosa | 1,500 | |
| San José | 1,500 | |
| San Miguel del Bado | 1,800 | |
| Pueblo | 1,500 | |
| Puerticito | 800 | |
| Cuesto | 1,200 | |
| Cerrito | 800 | |
| Anton Chico | 1,500 | |
| Tecaloté | 1,000 | |
| Vegas | 1,800 | |
| Sepillo | 1,500 | |
| | | 18,800 |
| Santa Cruz de la Cañada | 900 | |
| Chemayo | 900 | |
| Cañada | 650 | |
| Truchas | 900 | |
| Santa Clara | 600 | |
| Vegas | 1,500 | |
| Chama | 900 | |
| Cuchillo | 900 | |
| Abiquiu | 1,800 | |
| Rito Colorado | 500 | |
| Ojo Caliente | 500 | |
| Ranchitos | 900 | |
| Chamita | 900 | |
| San Juan | 500 | |
| Rio Arriba | 900 | |
| Joya | 900 | |
| Embuda | 850 | |
| | | 15,000 |
| Don Fernandez | 2,000 | |
| San Francisco | 1,000 | |
| Arroyo Hondo | 700 | |
| Arroyo Seco | 700 | |
| Desmontes | 800 | |
| Sineguilla | 700 | |
| Picuriés | 800 | |
| Santa Barbara | 1,000 | |
| Zampas | 900 | |
| Chamizal | 900 | |
| Llano | 900 | |
| Peñasco | 900 | |
| Moro | 900 | |
| Huerfano | 900 | |
| Cemmaron | 900 | |
| | | 14,200 |
| Valencia | 1,500 | |
| San Fernando de Taos | 800 | |
| Tomé | 1,000 | |
| Socoro | 1,500 | |
| Limitar | 1,000 | |
| Polvaderas | 800 | |
| Sabinal | 1,000 | |
| Elames | 800 | |
| Casa Colorada | 900 | |
| Cebolleta | 1,000 | |
| Sabino | 800 | |
| Parida | 800 | |
| Luis Lopez | 800 | |
| Belen | 800 | |
| Lunes | 800 | |
| Lentes | 800 | |
| Zuñi | 2,000 | |
| Acoma | 1,200 | |
| Rito | 500 | |
| | | 20,000 |
| Isleta | 800 | |
| Padilla | 500 | |
| Pajarita | 500 | |
| Ranchos de Atrisco | 100 | |
| Atrisco | 800 | |
| Placeres | 500 | |
| Albuquerque | 3,000 | |
| Alemeda | 800 | |
| Corrales | 200 | |
| Sandia | 500 | |
| Bernalillo | 504 | |
| | | 8,204 |

From the preceding results, we derive the following table of the probable numbers of Tiguex and other Indians of New Mexico, occupying the twenty-one towns represented upon the sketch:

| | |
|---|---|
| Pueblo de Taos, | 800 |
| " de Picuriés, | 800 |
| " San Ildefonso, | 500 |
| " Pojuaque, | 500 |
| " San Juan, | 500 |
| Nambé, | 500 |
| Cuyamanque, | 400 |
| Tezuque, | 700 |
| Santa Clara, | 600 |
| Cochité, | 800 |
| San Domingo, | 800* |
| San Felipe, | 800† |
| Sandia, | 500† |
| Isleta, | 800† |
| Jemez, | 450* |
| Santa Ana, | 500 |
| Silla, | 450 |
| Pecos, | none |
| Chilili, | 900 |
| La Laguna, | 800‡ |
| Acoma, | 1,200§ |
| Zuñi, | 2,000‖ |
| | 15,300 |

According to the above statement, twenty-one pueblos, at present occupied, contain 15,300

* Estimate by Captain Simpson. † Estimate. ‡ Estimate by Simpson and others.
§ Estimate founded on Abert's description. ‖ Gregg, Simpson, Leroux, and others.

persons;* equal to about one-sixth of the whole population of the Territory. For the greater part of two centuries they have been characterized by peaceful dispositions, and noted for honesty and sobriety. They regularly till the soil, and have sufficient foresight to make seasonable provision for all their necessities. Although most friendly in their intercourse with their white neighbors, they live exclusively by themselves, and neither intermarry with, nor adopt the habits of, any other race. They appear to rejoice in the change from Mexican to American rule, and anticipate a return to them of the prosperity which their traditions commemorate as belonging to the Saturnalian or Montezuma era.

West of Rio Grande, we enter the country of the Navajos. They extend northward from our route to Rio San Juan, valley of Tuñe Cha, and Cañon de Chelle; occupying a region some 15,000 square miles in extent. Within the fertile valleys they cultivate wheat, corn, and vegetables; and upon the grassy plains graze numerous flocks and herds. Their hunting-grounds extend upon the south as far as the headwaters of Rio Gila. For weaving blankets, this band of the Apache tribe is famous; but they are not known to be expert in any other branch of arts. The number of the Navajos is variously stated—10,000 being the estimate of Gregg, which is probably nearly correct. Formerly, they were troublesome neighbors to the inhabitants of New Mexico; but since the establishment of a military post at Fort Defiance, under the command of an officer who understands Indian character, and is able at once to command their esteem and respect, few depredations have been committed. They appear to be making advancement in peaceful pursuits, and bid fair to become willing recipients of civilization.

West from the Navajos, and in the fork between the Little and the Big Colorados, lies the country of the Moquinos—a people famous in Spanish history as well for their devotion to liberty and successful valor in resisting foreign aggression, as for their hospitality, integrity of character, and attention to agriculture. In many respects, they assimilate to the people of Zuñi, with whom they ever maintain friendly relations. The situation of Moqui seems to be within wide and fertile valleys, lying near the base of mountains where are found the sources of various tributaries to the Colorado Chiquito. A few isolated portions of a high table-land remain in the vicinity of their fields, and upon the tops are the ancient pueblos, which, for centuries, have been considered remarkable monuments of Indian art.

The following are the names of the seven pueblos of Moqui. The estimate of the population is by Mr. Leroux, who has been among them:

| Names. | In Zuñi language. | Number of warriors. | Total population. |
|---|---|---|---|
| Ò-rái-bè | Ú-lè-ò-wà | 400 | 2,400 |
| Shú-mŭth-pà | Shú-mŭth-pài-ò-wà | 150 | 900 |
| Mú-shài-ì-nà | Mú-shài-è-nòw-à | 150 | 900 |
| Áh-lé-là | Áh-lè-là | 150 | 900 |
| Guál-pí | Wathl-pì-è | 150 | 900 |
| Shí-wĭn-nà | Shí-wĭn-è-wà | 20 | 120 |
| Té-quà† | Té-é-wŭn-nà | 100 | 600 |
| Whole number | | 1,120 | 6,720‡ |

Remarks.—In the spelling of Indian words, the vowels have the Spanish sounds; *a* like *ah*—*e* as a in *fate*; *o* like o in *note*; *u* like oo in *food*; but where a letter is marked thus, ˘ the sound is short.

* Since writing the above, I have noticed, in Mr. Schoolcraft's History, an estimate of the population of the pueblos of New Mexico, by which the aggregate is between 11,000 and 12,000.

† Probably should be Tiguex, one of the ancient tribes of Rio del Norte.

‡ I perceive in Mr. Schoolcraft's history (volume 1) different names for most of these pueblos, and a larger estimate of the population.

Between the Colorado Chiquito and Rio Gila roam two bands of Apaches, called Coyoteros and Pinal Leñas, consisting probably of 300 warriors, or 1,500 persons each. They live among the mountains, and occasionally cultivate patches of soil, producing wheat, corn, and squashes. In one instance a field of cotton was discovered near their rancherias. However, not being fond of quiet pursuits, they subsist partly upon roasted mescal and piñon nuts, which they find in their wanderings, and place their main dependence for support upon forays into Sonora, proving a great scourge to the Mexican frontier. They are not wanting in native shrewdness, and, though generally hostile to parties of white men whom they may meet, they have been known to receive Americans into their country with kindness and hospitality. There are some fine valleys and many fertile spots within their limits, and, if they were willing to work, they well know how to subsist without plunder.

We now reach the San Francisco mountains, and enter the hunting-grounds of the Cosninos. They are said to roam northward to the big bend of the Colorado. The vast region toward the south, lying between Rio Verde and the Aztec range of mountains, is occupied by Tontos; while west and northwest of that range, to the mouth of Rio Virgen, are found a tribe calling themselves Yabipais, or, as sometimes written, Yampais. Their numbers are estimated at 2,000 each. Leroux and Savedra believe these three to be allied tribes; but there exists some doubt upon the subject. The language of the latter proves that they have an affinity with the Mojaves and Cuchans of Rio Colorado; while, according to Don José Cortez, the Tontos belong to the Apache nation. I have myself found Tonto villages intermingled with those of Pinal Leñas, north of Rio Gila, with whom they lived on friendly terms, with like customs and habits; except that they subsisted almost exclusively upon mescal and piñones,* and possessed none of the fruits of agriculture. Yet the country they now occupy shows traces of ancient acequias, and has extensive valleys of great fertility, which might again be cultivated.

Mr. Leroux, on his return from California to New Mexico in May 1854, followed the river Gila from its mouth to the Pima village; and thence crossing over to the junction of the Salinas with Rio Verde, ascended the latter stream for some distance, and crossed from it to our trail upon Flax river.† He represents Rio Verde‡ as a fine large stream; in some cases rapid and deep, in others spreading out into wide lagoons. The ascent was by gradual steppes, which, stretching into plains, abounded in timber—pine, oak, ash, and walnut. The river banks were covered with ruins of stone houses and regular fortifications; which, he says, appeared to have been the work of civilized men, but had not been occupied for centuries. They were built upon the most fertile tracts of the valley, where were signs of acequias and of cultivation. The walls were of solid masonry, of rectangular form, some twenty to thirty paces in length, and yet remaining ten or fifteen feet in height. The buildings were of two stories, with small apertures or loopholes for defence when besieged. From his description, the style of building seems to be simi-

* Piñones are edible nuts, from a species of pine tree which grows abundantly in this region.

† Rio Colorado Chiquito.

‡ This river is called by Mr. Antoine Leroux, Rio San Francisco. He passed along it with a small party in the summer of 1854. The following description of the country and the rivers referred to has been kindly furnished to accompany this report:

*Extract from Leroux's Journal, on his last trip from Pueblo de los Angeles, California, to New Mexico.*

"*May* 16, 1854.—This morning left Rio Gila, and camped on Rio Salado.

"*May* 17.—Camp on Rio San Francisco. From last camp here, road hilly and stony; wood, grass, and water plenty. During the day we saw and examined the ruins of some abandoned Indian villages.

"*May* 18.—Camp on San Francisco. To-day, tolerably good road, wood plenty, splendid water, and grass rich. Woods are the walnut, cotton, locust, sycamore and willow trees.

"*May* 19.—Camp on San Francisco. Road pretty good, but we were obliged to ford the river about ten times. Wood, water, and grass in abundance.

"*May* 20.—Camp on San Francisco. Road hilly and stony, but still easy enough to travel. Water splendid; grass plenty; cotton-wood, ash, sycamore, &c., in quantities.

"*May* 21.—Camp on San Francisco. While nooning in the morning, we were struck by the beauty of some ruins, very likely those of some Indian town, and being in the centre of an open valley. The walls of the principal building, forming

lar to the chichiticale, or red house, above the Pimas, rather than like the Indian towns of New Mexico. In other respects, however, Leroux says that they reminded him of the great pueblos of the Moquinos. The large stones of which those structures were built, were often transported from a great distance. At another place he saw a well-built town and fortification about eight or ten miles from the nearest water. He believes that, since they were built, the conformation of the country has been changed, so as to convert springs and a fertile soil into a dry and barren waste. The idea is not a new one; Capt. Simpson advances something like it. This conforms to the Indian traditions of the Montezuma era, attributing to the high mesas an arable soil; and also partially accounts for the desertion of some of the more recent pueblos of New Mexico.

Upon the Colorado Chiquito (Flax river) were extensive traces of ancient ruins, some of which have been well represented in a report by Captain Sitgreaves. The Cosnino caves had been plastered with mortar, showing more artistic skill than is practised by the present occupants of the country. At Pueblo creek were found remains of towns and of fortifications crowning the surrounding heights, and overlooking Aztec Pass there are similar ruins. Westward, down Williams river to Rio Colorado and thence to the Pacific, no vestige of such ruins was seen. Yet means of subsistence are not wanting. There are fertile spots and permanent water in the valleys.

In the vicinity of Williams river, game is abundant; the rocky cliffs and barren-looking hills produce maguey plants; multitudes of the fruit-bearing *cereus giganteus* and mezquites grow in the valley; affording a sufficient supply of the usual Indian food. The inference, therefore, seems to be, that the belt of country previously crossed was indeed the track of the ancient pueblo builders; and that, according to tradition, they proceeded from the northwest to the upper waters of Rio Colorado. There they divided; portions ascended by the San Juan, Cañon de Chelle, or the more easterly branches of that stream, toward the centre of New Mexico; others, passing over to the waters of "Rio Verde," descended its valley to Rio Gila, and thence continued, perhaps, to the present city of Mexico. This theory of migration is considered nearly obselete, and ought not to be revived, provided another, more probable, may be suggested for the desertion of the ruins in the regions referred to. Upon the lower part of Rio Colorado no traces of permanent dwellings have been discovered. The same remark is applicable to Rio Gila below the junction of the Salinas, although upon the rocks there are many inscriptions similar to those found near Zuñi and at Rocky Dell creek.

The tribe that now occupies the region from Pueblo creek to the junction of Rio Verde with the Salinas is called Tonto. The word in Spanish signifies *stupid*, but Mexicans do not apply that signification to these Indians; on the contrary, they consider them rather sharp, particularly at stealing. Therefore, as it is not a term of reproach, we may reasonably suppose that, as is frequently the case, it is the Indian name corrupted, perhaps, by Spanish spelling. It is

a long square, are in some places twenty feet high and three feet thick, and have in many places loop-holes like those of a fortress. The walls were as regularly built as those of any building erected by civilized nations; to judge by the decay of the stones, these ruins might be several centuries old, (maybe those of some Montezuma town.) Heaps of broken and petrified vessels are strewn in all directions. Near camp are the ruins of another Indian village. Those ruins show that this country was once under cultivation; who were its inhabitants, and what became of them, is hard to tell. Road hilly, but of easy access everywhere. Grass and water in abundance.

"*May* 22.—Camp on San Francisco. Road very hilly, but practicable; plenty of wood and water. To-day we ascended and descended two high mountains (*à pied*) which looked just like the crossing of the Alps. Our camp is on a ridge of a most delightful valley, having the river to our left, gigantic rocky mountains on both sides, and under centenary trees.

"*May* 22 *and* 23.—Camp on San Francisco. Road good, grass plenty, and wood in abundance as well as water. On the night of the 22d we had an attack from some Indians, called the Tontos of the Yampais nation. Although a quantity of arrows were shot into camp, still neither men nor animals were wounded.

"*May* 24.—Camp on a small creek. Left Rio San Francisco this morning. The creek we are camped on runs between two chains of very steep and rocky mountains. In the afternoon we crossed a mountain about 1,500 feet high; the crossing was performed in two hours.

"The creek we are camped on is a tributary of the Rio San Francisco, and runs into it from the east. Road tolerably good, grass plenty, and water and wood in abundance. The district passed over is mostly covered with old ruins."

a coincidence worth noting, that when Father Marco de Niça, in 1539, was in search of the kingdom of Cevola, (now Zuñi,) he met an Indian from that place, who gave him information of several great nations and pueblos. After having described Cevola, the friar adds: "Likewise he saith that the kingdom of Totonteac lieth towards the west; a very mighty province, replenished with infinite store of people and riches." The position indicated, *west from Zuñi,* would apply to Pueblo creek, and it would be an easy corruption for the name Totonteac to pass into Tonto. Don José Cortez, as may be seen in chapter vi, calls them Apaches; but Sevedra, who is a well-informed Mexican, and, having been much among wild tribes of Indians, is generally considered authority in whatever relates to them, says that Tontos are Indians of Montezuma, like those of the pueblos of New Mexico. Pimas, Maricopas, Cuchans, and Mojaves, also, he adds, belong to the same great nation. In proof of this, he asserts that they all have one custom—that of cropping the front hair to meet their eyebrows,* suffering the rest, back of their ears, to grow and hang down its full length.

PLATE 2.

Yuma map of Rio Colorado, with the names and location of tribes within its valley.

The existence of several of these tribes appears to be known to Indians only. The same names were given to me in 1849, by the chief of the Yumas, at the mouth of the Rio Gila. Their population could not be ascertained from him.

The sketch which follows was traced by the chief of the Chemehuevis, who makes no mention of a mingling of other tribes with the Cuchans and Mojaves:

PLATE 3.

Pai-ute Map of Rio Colorado.

* There is not an exception to this rule among the Gila and Colorado Indians.

A Mojave guide, who accompanied us from his village to the Mormon road, was skillful in communicating ideas of numbers, and proved accurate in statements that we had means of testing. We therefore endeavored to obtain from him certain statistics regarding his tribe. There are five principal chiefs of the Mojave nation, each of whom we had seen at the head of a band of warriors. Our guide informed us that Joaquin commanded 60 fighting men; José Maria, 50; Oré, 80; Manuel, 80; Mezcal, 100. He said there were lesser captains like himself, each having the command of smaller numbers; his own band consisting of five only. The warriors above enumerated amount to 381. The whole number is somewhat greater. But, according to our observations when among them, many of the able-bodied young men choose to remain at home for the cultivation of their fields or the protection of the women, and, therefore, are not included among the warriors.

In order to get some idea of the rate of increase in the tribe, we asked concerning the wives and children of various chiefs whom we knew. The result is exhibited in the following table:

| Names of men. | Number of wives. | Number of children. | |
|---|---|---|---|
| | | Boys. | Girls. |
| Iratéba | 1 | 0 | 1 |
| Cai-ruk | 4 | 0 | 1 |
| José Maria | 2 | 1 | 2 |
| Joaquin | 2 | 1 | 0 |
| Oré | 2 | 1 | 1 |
| Manuel | 3 | 1 | 2 |
| Mezcal | 1 | 0 | 1 |

If it were safe to draw inferences from such limited data, females would appear to be more numerous than males. Children seem to be less in number than adults; giving evidence of a gradual decay of the tribe. If this conclusion be correct, it is difficult to assign a reason for it. The region they occupy is fertile, and its climate salubrious. They are vigorous and healthy, and have plenty of food. Diseases are rare among them, and evidently they live to extreme old age. They are more powerful than their neighbors, and have few enemies, except the Coco-Maricopas, who are incapable of doing them much harm.

The following estimate of the number of Indians now residing in the Colorado valley, from the Mojave villages down to the mouth of Rio Gila, is given by Mr. Leroux, based upon personal observations during various passages through the country:

| Name of tribe. | Number of warriors. | Whole number. |
|---|---|---|
| Mojaves | 600 | 4,000 |
| Chemehuèvis | 300 | 1,500 |
| Yumas, (Cuchans?) | 500 | 3,000 |
| | 1,400 | 8,500 |

This estimate does not include the Cocopas, (3,000,) who live near the mouth of the Colorado, nor the Yampais, (2,000,) now residing, as the Mojaves tell us, a short distance below the junction of Williams river. Those added, would make the population of the Colorado valley, below the Mojave villages, 13,500.

According to the manuscript report of Don José Cortes in 1799—a portion of which will be found in chapter vi—the population of this valley was then as follows, viz:

| | |
|---|---|
| Talliguamayque | 3,000 |
| Cajuenches (Cuchans?) | 2,000 |
| Yumas | 3,000 |
| Ta-ma-jābs (Mojaves?) | 3,000 |
| Talchedums | 3,000* |
| Cucapa (Cocopas?) | 3,000 |
| Making in all | 17,000 |

Therefore, supposing the above estimates both approximately correct, the number of Indians in the Colorado valley has considerably diminished since the beginning of the present century.

To what has been related in the Itinerary, illustrative of the character of the Indians of this valley, little will be added here. By all who have seen them, they are considered superior, both in mental capacity and in physical development, to others of their race in this section of the continent. Of their bravery our troops have had experience in a contest with the Yumas, who are a branch from the same stock as the Mojaves; but it is believed that they prefer peace to war, and fight only upon their own soil for the preservation of their independence and the protection of their homes. It is true, they are extremely jealous of the presence of strangers among them. The missions of San Pablo and San Pedro, established at the mouth of Rio Gila about a century since, were tolerated for a short time only. The Indians, doubtless, suspected that their liberties were menaced, and, therefore, put an end to those establishments, by killing the priests and destroying their dwellings. About fifty or sixty years ago, some Spanish adventurers established a colony upon a portion of the wide and fertile bottom lands of the Colorado, and, after a brief residence, experienced the same fate as the missionaries. From ten to fifteen miles from the river, the ruins of their acequias, now overgrown with large mezquite trees, are still visible. In 1849, numerous emigrants to California passed through this country, and gave many accounts of the hostility of the Yumas. But, in investigating the causes of the troubles, it appeared that the Americans, by appropriating the maize belonging to the Indians, had been the first aggressors; and that, too, after having received from the natives great assistance in crossing the river. At this time government troops were sent to the Colorado, and, by kind treatment of the Indians during a stay of two months, restored friendly relations between them and the emigrants. Afterwards, a band of outlaws, from the frontiers of the United States and Mexico, established a ferry below the mouth of Rio Gila, and imposed many restraints and indignities upon the natives. The latter took advantage of their first opportunity, and exterminated the party. This led to a contest with our troops, who, after several sanguinary engagements, succeeded in restoring peace.

The rude, untutored savage, without doubt, believes that he has a right to the spot where his wigwam stands—to the fields where his maize and melons grow—to the land which has been cultivated by his forefathers since time immemorial. He can see no reason why he should yield up his home and the graves of his ancestors to the first grasping white man who covets the spot. If the privileges, which nature has led this people to expect, are not secured to them, or some satisfactory compensation substituted, another Indian war may be the result, and the tribes upon the Colorado annihilated. It is hoped that they may be saved from such a melancholy fate by the prompt and generous interference of the government.

West of Rio Colorado we enter the range of the widely extended Utah nation. Those that roam over the region traversed by us, call themselves Paiutes,† and are closely allied to those that massacred the party of the lamented Captain Gunnison. This band probably does not number above 300 persons. Though supposed to maintain a scanty and precarious subsistence,

* No number is specified in the original manuscript; but this tribe is represented as being about equal with the rest.

† José Cortez, in chapter vi, writes the name Payuches.

principally upon roots, they are probably distinct from the Diggers of California. We passed through one little valley of theirs, at Paiute creek, where wheat and melons had been cultivated. Afterward we had another proof of their desire for substantial food. Though shy at our approach, they hovered about us at Soda lake, and finally committed the only act of hostility experienced by our party on the route. A herder having lagged behind the train with two tired mules, they killed him, and took the animals for food. We were unable to overtake and punish them as they deserved. They will scarcely be civil again to small parties of emigrants until our troops shall have taught them a salutary lesson.

From the Mormon road to the base of Sierra Nevada are scattered the wilder portion of the Cahuillas, who frequently make depredations upon the frontier ranchos of California. They do not appear to be numerous, and probably do not exceed 500 in number. Formerly all of this tribe belonged to the California missions. Since the decadence of those institutions, they have been peons upon the ranchos, where many yet remain. It is not surprising that some prefer to return to their primitive mode of life among the mountains, rather than submit to unmitigated degradation amidst a civilized race.

*General summary of the Indian population in the region contiguous to the route.*

| | |
|---|---|
| Semi-civilized, bordering the Canadian river | 62,000 |
| Rude " " " | 2,100 |
| Barbarous " " " | 30,000 |
| Pueblo Indians of New Mexico | 15,300 |
| Navajos | 10,000 |
| Moquinos | 6,720 |
| Pinal Leñas and Coyoteros | 3,000 |
| Tontos, Cosninos, and Yampais | 6,000 |
| Mojaves, Chemehuevis, and Cuchans | 8,500 |
| Pai-utes, near Soda lake | 300 |
| Cahuillas of the mountains | 500 |
| Total | 144,420 |

## CHAPTER II.

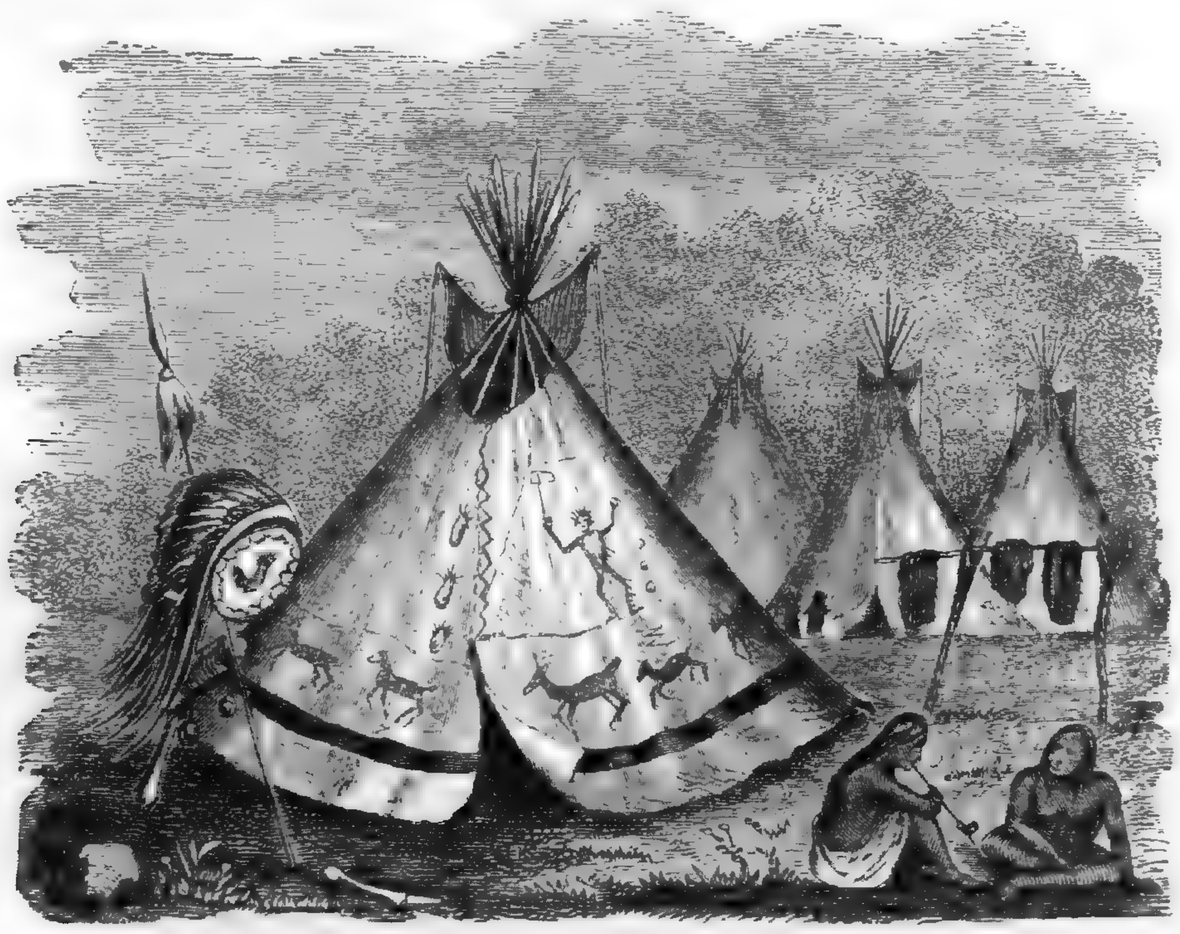
*Indian Residences.—Portraits and Dress.*

The semi-civilized Indians of the Choctaw territory occupy frame houses or log-cabins, such as white men would erect under similar circumstances; wanting only in that air of neatness and refinement which indicates the presence of an Anglo-American woman. As a type of these dwellings can be found everywhere within our new settlements upon the frontier, no drawing is deemed necessary to give an idea of their appearance. In the Itinerary may be found a description of some that were visited.

Beaverstown consists of a range of log houses, built by troops, at old Camp Arbuckle, for temporary quarters. When deserted by the soldiers, a band of Delawares took possession; although the structures are inferior to those erected by the Choctaws and Shawnees in their respective villages.

*Plate* 4 represents a Kaiowa camp in the valley of the Canadian. The tents are formed with light poles twelve feet in length, interlaced and tied near the top, and thence spreading so as to intersect the ground in a circle. Over these are spread coverings made of nicely dressed buffalo hides, the hair side being turned inward, and the exterior fancifully painted. The top may be opened to give egress to smoke, or closed to exclude rain.

Plate 4.

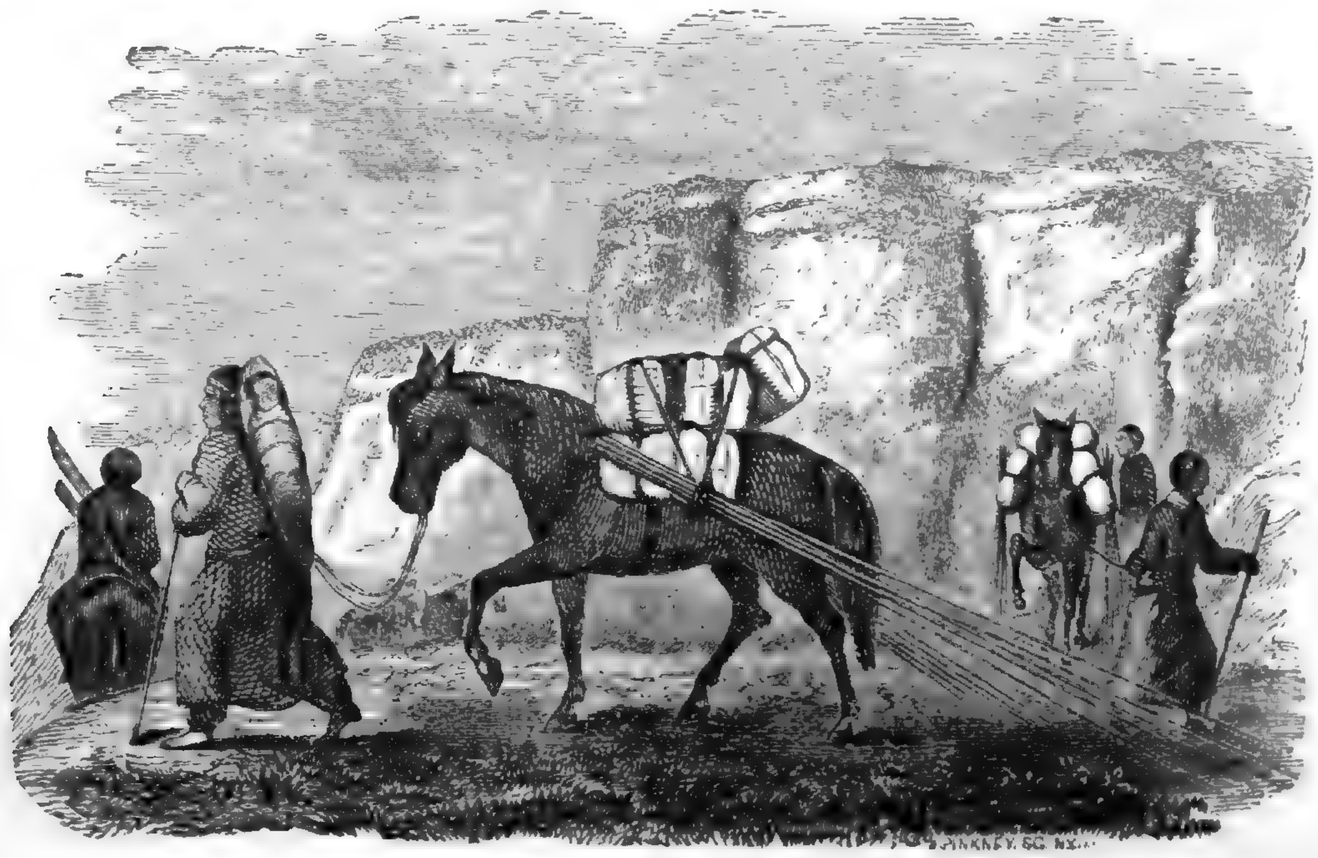


Kaiowa camp.

*Plate* 5 shows their method of packing the tents in changing the position of camp. The poles are fastened to the sides of a horse, and allowed to drag upon the ground. Comanches are said to make use of similar tents, except when hunting or at war. The camp which we

saw upon Shady creek was composed of artificial bowers, formed with bent saplings and leafy twigs. There were hundreds of them of the same construction, evidently intended for merely temporary use.

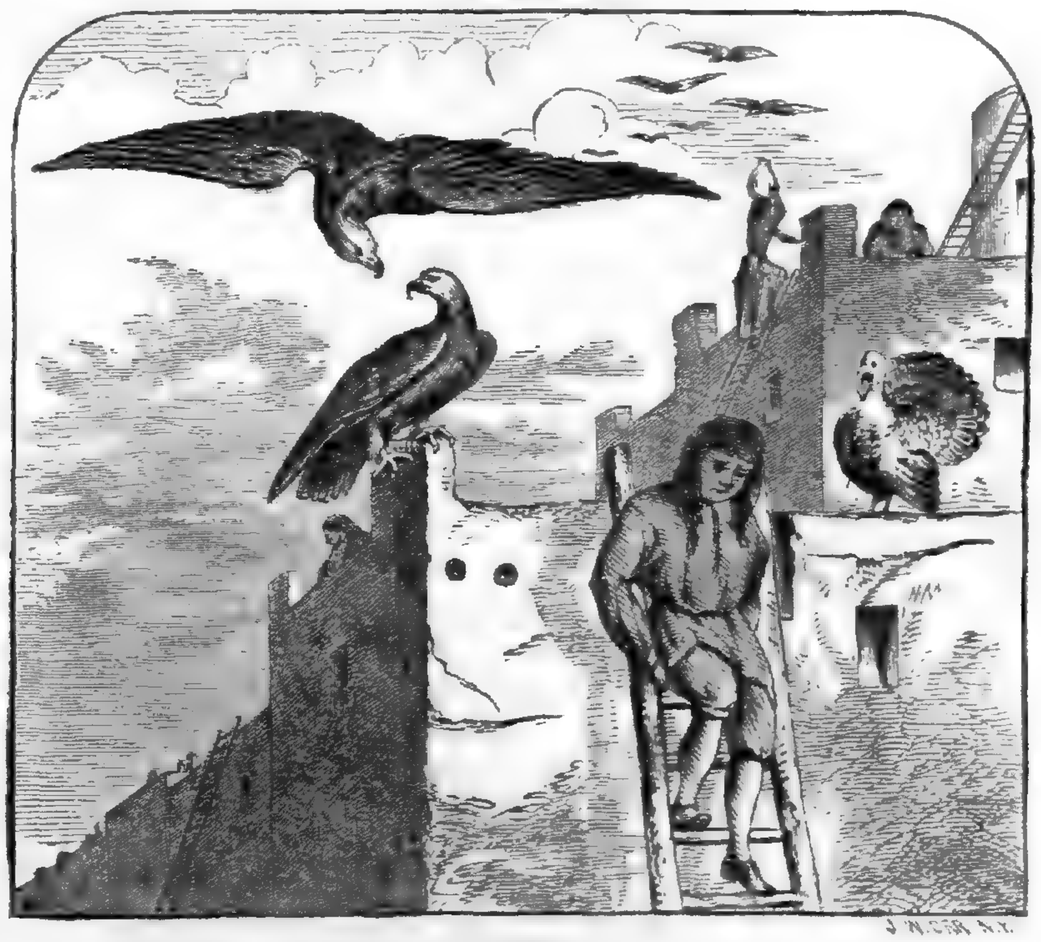
PLATE 5.



Kaiowa Indians removing camp.

*Plate* 6 shows the construction of a range of houses in Zuñi. It will answer also for a type of such pueblo buildings as are at present occupied in New Mexico. By a reference to Coronado's description of this place and people in 1540, it will appear that during three centuries no appreciable change has taken place. Had the pueblo been buried like Pompeii, and at length exhumed and its population resuscitated, there could not be a closer resemblance to the description of pioneer Spaniards than is now found between Zuñi and the ancient Cibola. This,

PLATE 6.

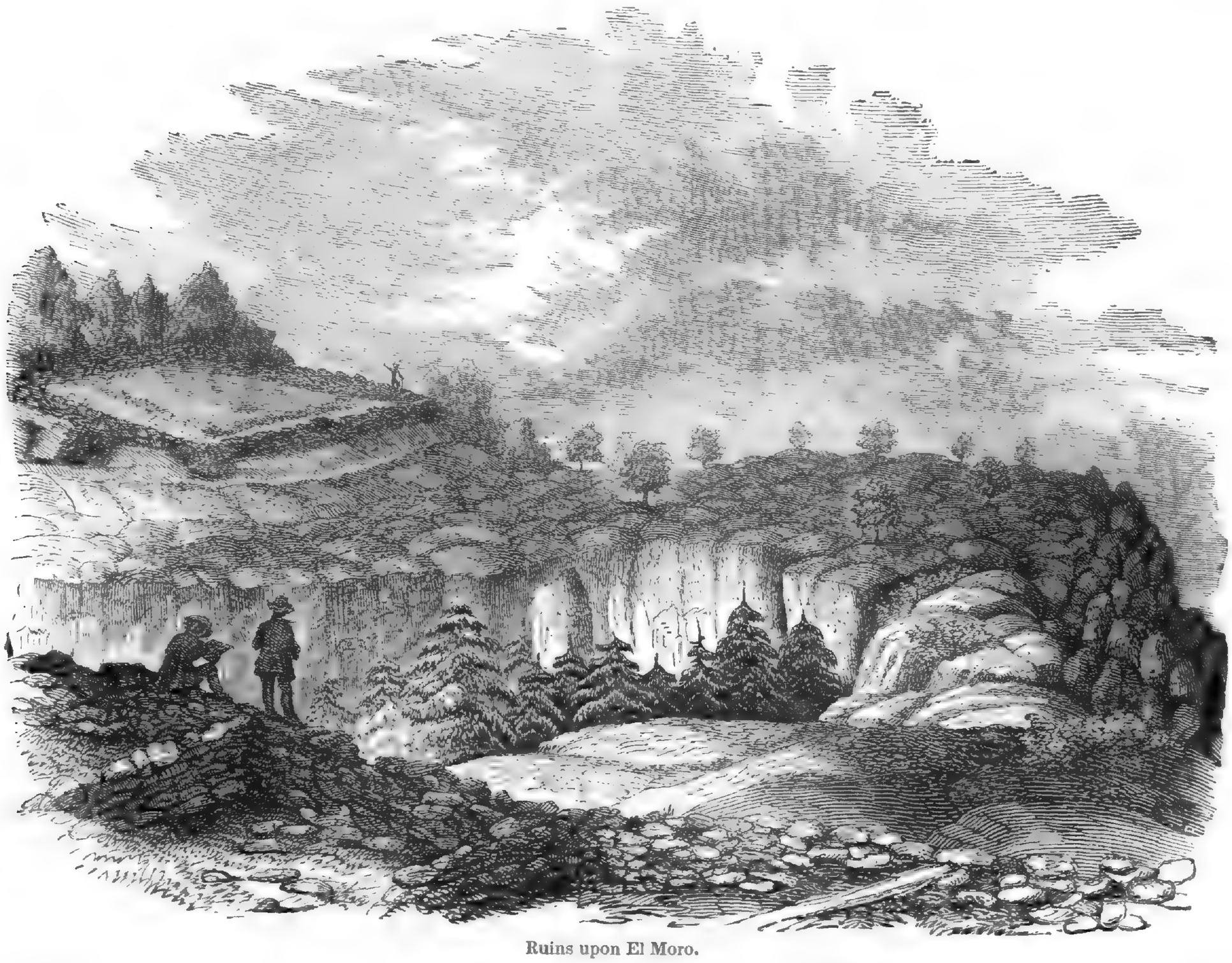


Zuñi.

however, is but one of the seven towns of Cibola; the others are in ruins, some of which are at El Moro, at Ojo Pescado, and at Arch spring. El Moro, under the name of Inscription Rock, may be found minutely portrayed in Captain Simpson's report of the Navajo expedition. The accompanying *plate* 7 gives a view from the top of the rock. For a full description of Acoma, San Domingo, and other existing pueblos, it is sufficient to refer to Lieutenant Abert's report

of his examination in New Mexico. Our object is merely to call attention to the fact of their great antiquity and entire dissimilarity to the abodes of other Indian tribes upon our route.

PLATE 7.



Ruins upon El Moro.

*Plate* 8 represents an Apache wigwam, as rude, it is believed, as any race of human beings have been known to construct for abodes. These huts are usually isolated in some mountain

PLATE 8.

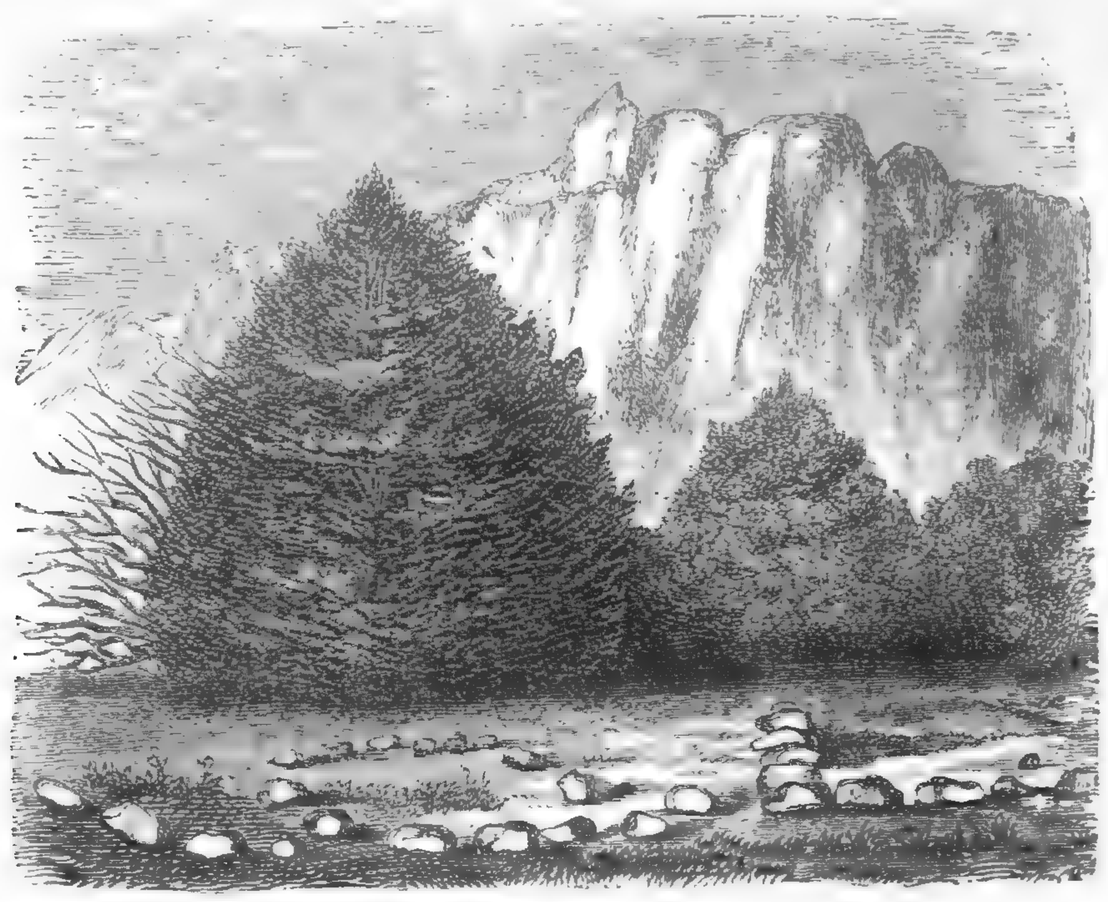
Apache wigwam.

gorge, near a rivulet or spring, and are composed of broken branches of trees. They are covered with weeds, grass, or earth, such as may be obtained most readily. A large flat or

concave stone, upon which they grind corn or grass seed to flour, is the only utensil or article of furniture that they do not remove in their wanderings. Visits to the houses of Mexicans, or their more enterprising Indian neighbors, excite no desire to improve their condition by the erection of more comfortable habitations. Tents they do not use, even when robbed from Mexicans or some poor party of emigrants surprised and murdered. The Tontos, Yampais, and most of the Apache Indians within New Mexico and California are equally barbarous and rude in the construction of their habitations.

*Plate* 9 is intended to give some idea of the faint traces of ancient adobe dwellings, as they now frequently appear in the Zuñi country, upon Rio Gila, upon Pueblo creek, upon the Colorado Chiquito (Flax river) and at other places in the vast region between longitudes 108 and 113, and between 32° and 35½° north latitude. Large fields in the valley of Rio Gila, and many spots among the Pinal Leña mountains, are thus marked with the foundations of decayed adobe houses. In Cañon de Chelly, near the San Francisco mountains, and upon Rio Verde, there are ruins of more permanent structures of stone, which in their day must have excelled the famed pueblos of New Mexico. Those found near the cascades of the Colorado Chiquito are represented in Captain Sitgreaves's report. Others have already been referred to in the Itinerary.

PLATE 9.

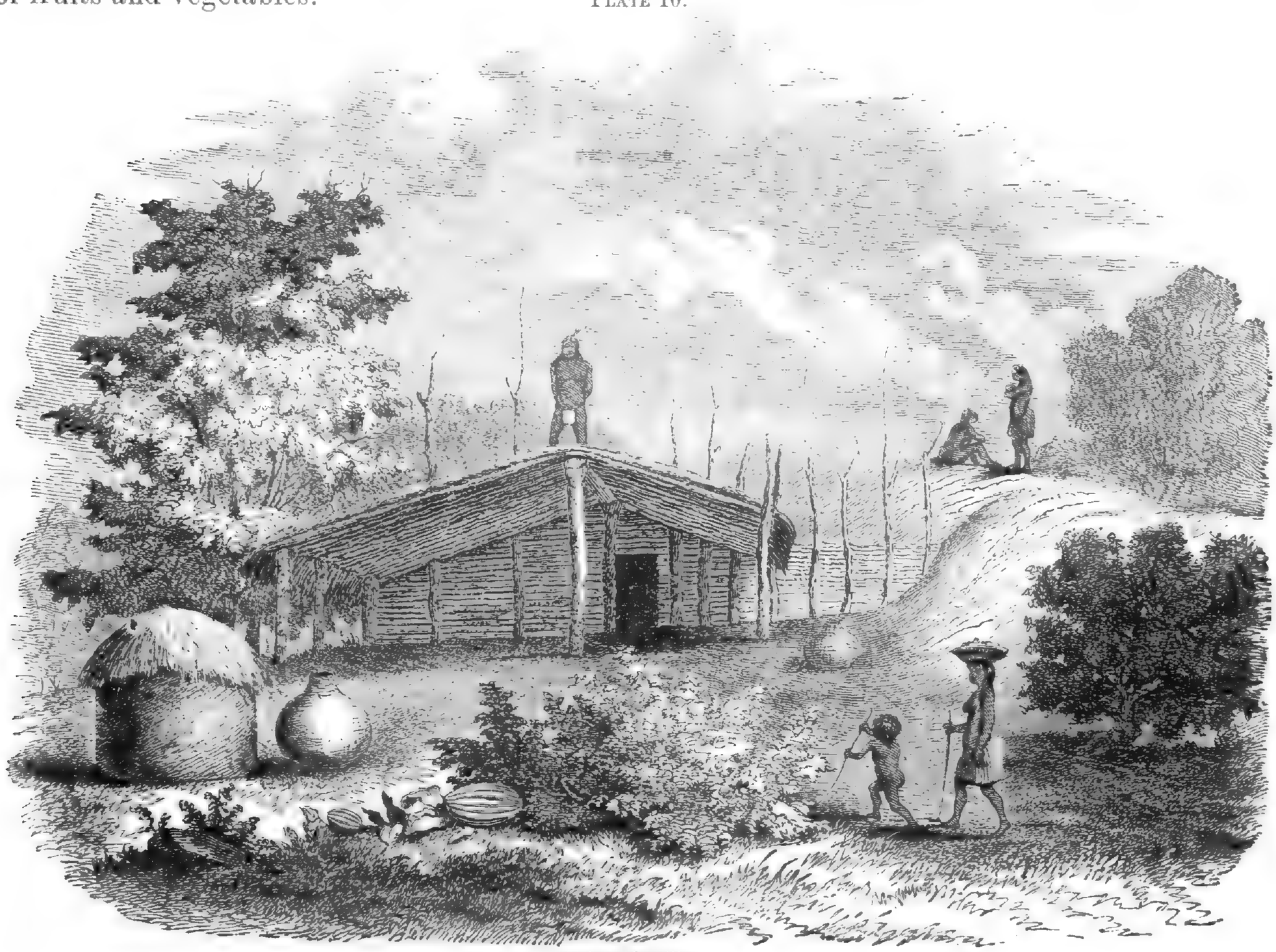


Vestiges of ancient dwellings.

*Plate* 10 represents one of the dwellings of the Mojaves. The large cottonwood posts, and the substantial roof of the wide shed in front, are characteristic of the architecture of this people. This particular house appears to run into a sand-bank, and is peculiar. Others are formed in the valley, with all their walls supported by posts; and the longitudinal beams have their interstices filled up with straw or mud mortar. The cylindrical structure in front is tastefully made of osier twigs, and thatched so as to be impervious to rain. It is used as a storehouse for grain and fruit of the mezquite. The large earthen jar, figured by the side of the granary, is also a receptacle for corn. The interior of the houses consists of a single room with thatched roof, sandy floor, and walls so closely cemented by mud as to be nearly air-tight. It has no window, and receives no light except by the door which leads to the shed, and by a small hole at the top which gives egress to the smoke of fires. Structures similar to this are common throughout the lower portion of the Colorado valley, and may be found also among the Coco-Maricopas and Pimas of Rio Gila. With the latter, however, the circular hut, described by Mr. Bartlett, is much in vogue. In such gloomy abodes the Indians seek shelter from cold.

Arranged around the walls, are large earthen jars, in which they preserve their main supply of fruits and vegetables.

PLATE 10.



Mojave dwelling.

*Plates* 11 *and* 12 represent Choctaws. Their dress is fanciful, showing a fondness for bright

PLATE 11.

Choctaws.

colors and silver ornaments. Pendants of beads or shells are frequently attached to the ears, nose, or neck. The hair is sometimes cropped in front, to reach to the eyebrows; and red or blue paint is generally used to beautify their faces. A favorite style of wearing it is in half circles beneath the eyes. The moustache is not worn, nor is there the appearance of a beard.

PLATE 12.

Choctaws.

PLATE 13.

Shawnees

The features are rounded, and the cheek-bones have not the prominence which characterizes western prairie Indians. The eyes are large, oval, and brilliant; and, though not blue, have the mild expression that belongs to that color.

*Plates* 13 *and* 14 are portraits of Shawnees who live upon the right bank of the Canadian,

PLATE 14.

Shawnees.

opposite the mouth of Little river. Although further from the white settlements, they seem not less advanced in civilization than the Choctaws. They dress less gaudily, and care little for other ornaments than silver ear-rings, finger-rings, and brooches of their own manufacture,

PLATE 15.

Black Beaver.

PLATE 16.

Delaware device.

some of which are executed with taste and skill. The hair is parted in front, or cut so as to fall loosely upon the neck. Moustaches are usually worn by the men. The women are neater and better looking than the Choctaws.

*Plate* 15 is a portrait of Black Beaver, the chief of a band of Delawares living between the Shawnees and Kichais. Black Beaver is an invalid, and hardly a fair type of his people. They are much like the Shawnees, although the latter are better looking. In both bands there are many who wear a moustache. The accompanying figure, represented in *plate* 16, is a facsimile of an image tattooed upon Black Beaver's arm. Whether it was merely a fanciful device of the artist, or some sacred emblem of Indian superstition, could not be learned.

*Plate* 17 represents two savages of the Huéco tribe whom we met upon the prairie south of the

PLATE 17.

Hueco Indians.

Canadian. They have high cheek-bones, and a wild look, (which the artist has failed to represent,) totally different from the quiet features of those representing the preceding tribes. Their loose hair is uncropped. Feathers, tied to a lock at the crown of the head, float with the breeze.

They are armed with bow and quiver of arrows; wear blankets wrapped around their loins, and buckskin sandals upon their feet. Kichai Indians afterward visited us, but we saw about them no characteristics differing from Huécos.

*Plate* 18 represents a couple of Comanches, wrapped in blankets, girdled with cords, and on horseback. One is figured in the act of speaking by signs. They are armed with bows and arrows, and are without moccasins. They are expert horsemen, ride gracefully and rapidly, with no other equipments than the simple raw-hide noose represented. However, they are not averse to using both saddle and bridle, whenever in their marauding expeditions they can obtain possession of them. Their features are sharp; nose long; eyes small, black, and sparkling. Their furtive glances express cunning, if not treachery.

PLATE 18.

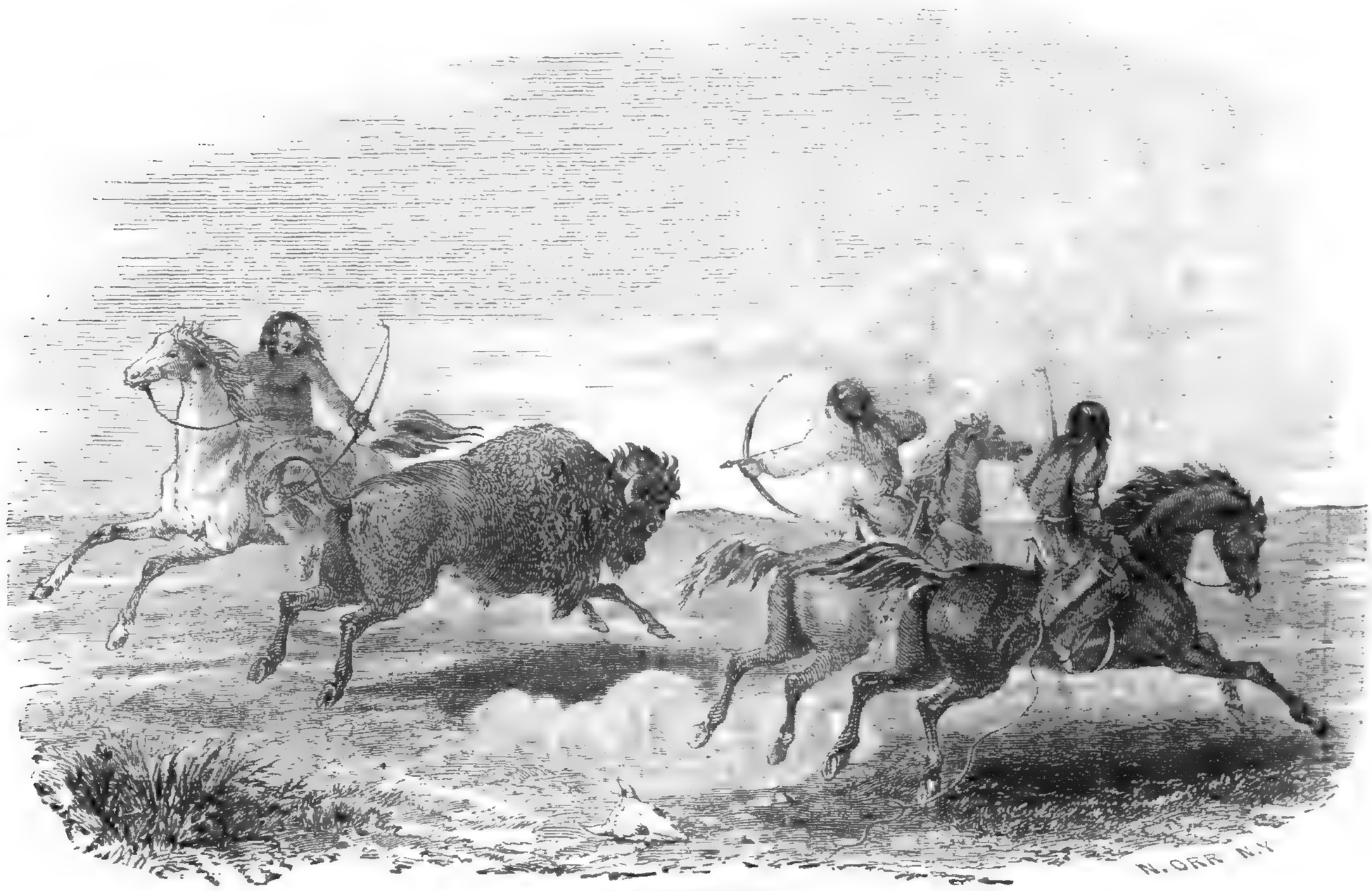
Comanches.

*Plate* 19 is intended to represent Kaiowas upon a hunt. We gave them a cow, and they said they would show us how they killed buffalo. Therefore, mounting horses, they first goaded the poor cow to madness, and then pursued her. The scene is sufficiently indicated, except that the artist has transformed the game into that which we were desired to imagine. There appears to be no characteristic difference between the Kaiowas and Comanches. It is probable that they are both branches of the "Snake" tribe. Our vocabularies of their languages, which Professor Turner is examining, will determine the fact. The Kaiowas* wear blankets wrapped around their bodies, in the toga style. They are excessively fond of ornaments of iridescent shells, of silver, and of brass, such as are represented in the chapter upon Indian arts. They wear enormous head-dresses made of feathers, with long trails behind, ornamented with circular plates of silver. Yellow ochre is the favorite tint for besmearing their faces, and vermillion is used to color the head where the hair is parted. Like the Comanches, they suffer

* The Indians and Mexicans sometimes pronounce the name as if written Kayaguas. I have seen it so spelled.

the hair to fall loosely behind, and sometimes clip a lock or two in front, that it may not cover their eyes. As a class they are lank, lean, and bony, with small eyes, piercingly black and fiendish. Their shoulders are broad and limbs muscular. They seem to me of lighter complexion than most of the tribes west of the Del Norte.

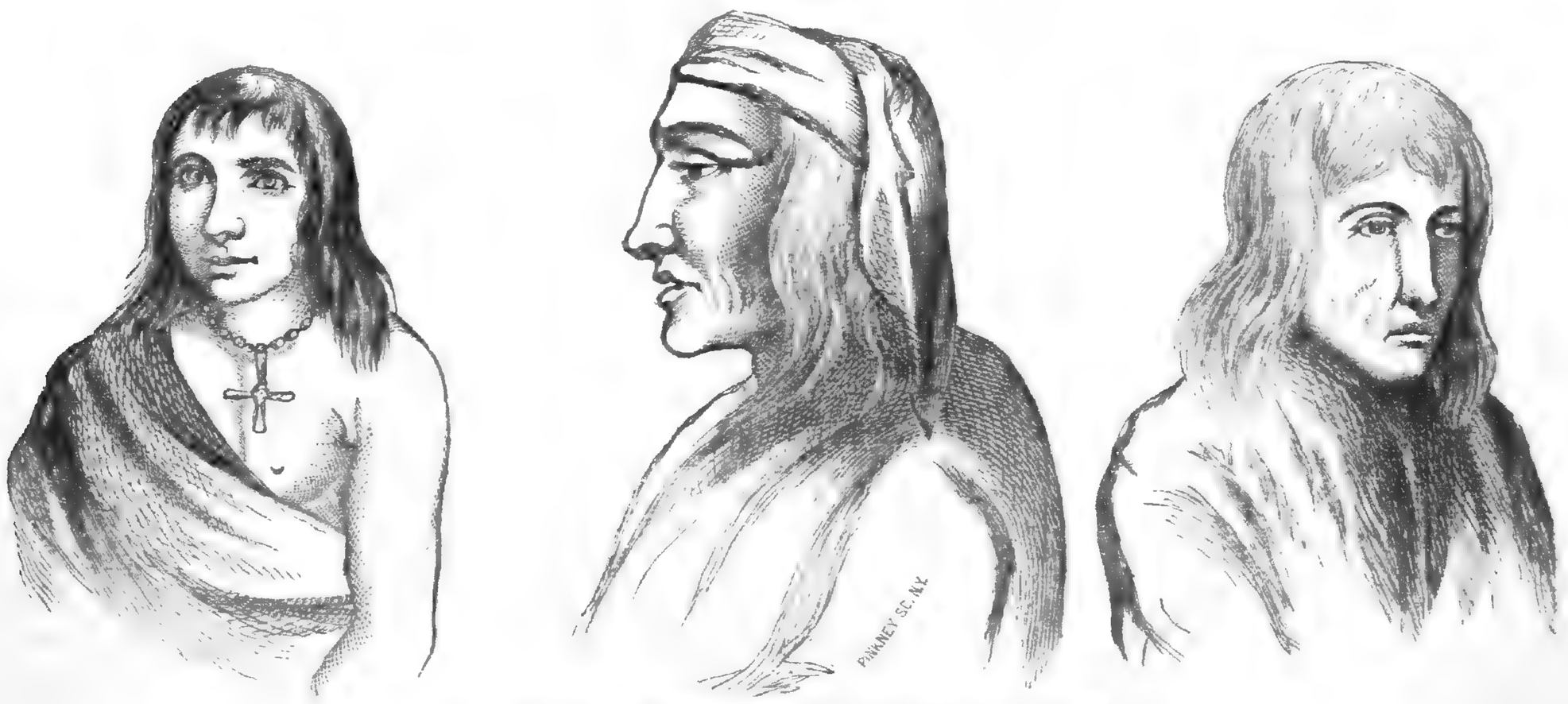
PLATE 19.




Kaiowa buffalo chase.

*Plate* 20 gives sketches of Pueblo Indians of San Domingo. Their features express mildness and a considerable share of intelligence. A blanket, loosely wrapped around the body, is a

PLATE 20.




Governor and other Indians of the pueblo of San Domingo, N. M.

favorite article of dress. The hair is rudely clipped or parted upon the forehead, and falls behind upon the shoulders. Sometimes it is braided and bound into a queue. A tiara or band is frequently worn around the head. This people do not appear to have an excessive regard for ornaments; the women are content with a string of beads and a cross.

*Plate* 21 represents a chief and a warrior of the pueblo of Zuñi. The chief holds in his hands a spear and a chimal. The latter, however, is in truth a trophy won from the Navajos, and not of Zuñi manufacture. It is made of bull-hide, curiously painted in colors, and nearly surrounded

PLATE 21.

Zuñi Indians.

by a strip of red cloth trimmed with feathers. These shields are impervious to arrows, and frequently hard enough to turn aside a ball. The gay colors and waving trails of cloth and feathers are supposed to be useful as well as ornamental. In battle the Indians are not quiet for a moment, but, with constantly bended knees, leap rapidly from side to side, waving their shield and its long streamers, for the purpose of dazzling the eyes of their adversaries. Apaches are said to oil their joints before going to battle, in order to make them supple.

NAVAJOS.

The Zuñians have eyes darker and more piercing than Choctaws. Their dress consists usually of buckskin hunting-shirts and fringed moccasins. Their mode of cropping and dressing the hair is nearly the same as that practised by other Pueblo Indians; sometimes it is parted upon the forehead and confined by a band. It is to be regretted that we obtained no portrait of the white Indians of Zuñi; but the small-pox being prevalent among them, it was deemed imprudent to visit their houses. Some of them, however, were seen; having light or auburn hair, fair complexions, and blue eyes. It is remarkable that the first Indian from Zuñi seen by Father de Niça in 1539, is described as a "white man of fair complexion." A few of that type have existed there ever since.

*Plate* 22 is intended to represent Navajos. The sketch is given as furnished by the artist; though, excepting the striped blanket of Navajo manufacture, the portraits differ little from those of the Pueblo Indians. One is represented with hair cut squarely in front to the eyebrows—a custom not heretofore attributed to any of the Apache race. The Navajos are distin-

PLATE 23.

Tontos.

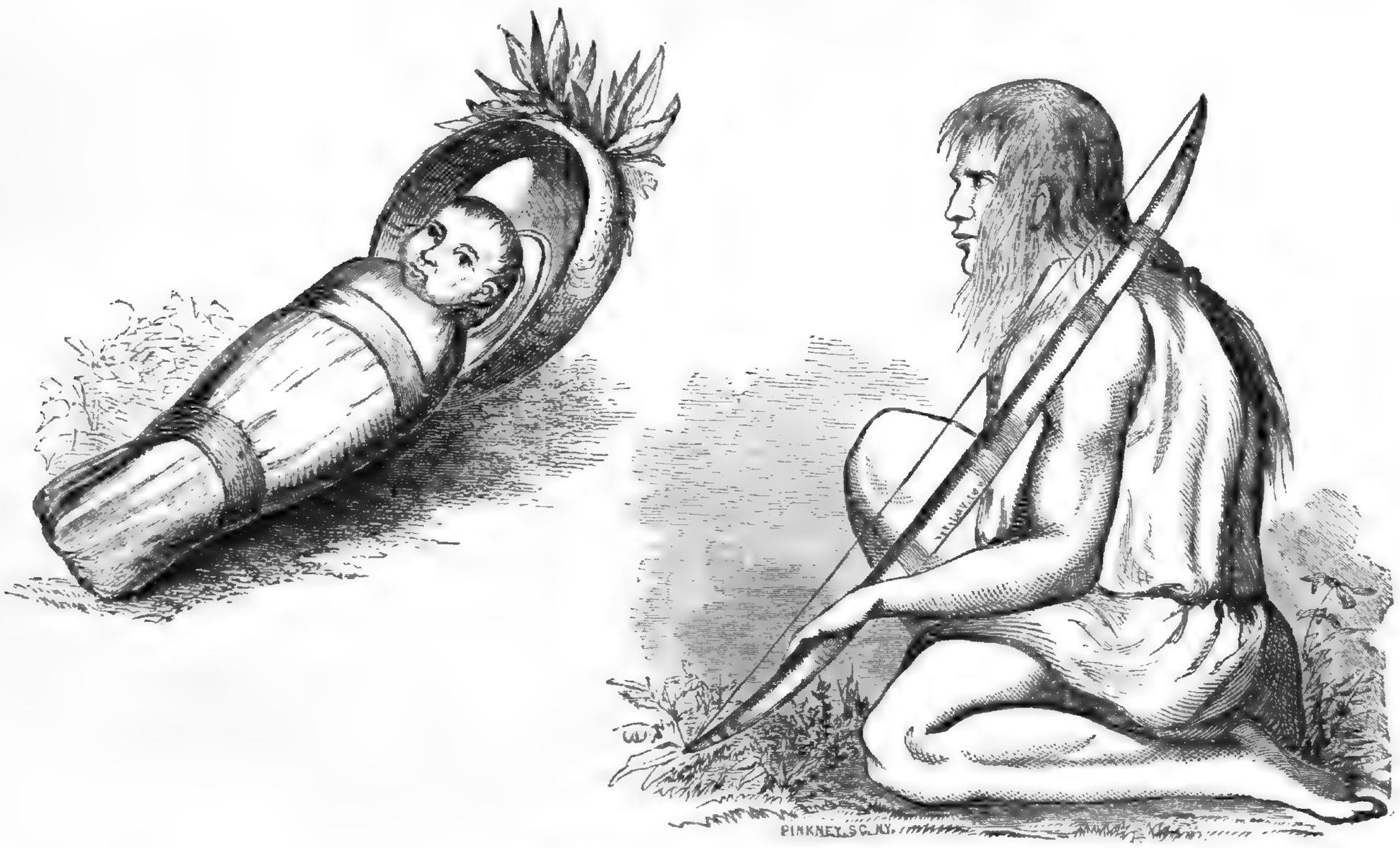
guished from all other tribes of Indians, and even from the more southern bands of Apaches, by the fullness and roundness of their eyes. There is something of a "wide-awake" expression about them, which is peculiarly characteristic. In the manufacture of blankets, and in cultivation of the soil, they are far superior to other bands of their tribe, and compare favorably even with the famed Pimas of Rio Gila. There is a considerable personal resemblance between these tribes, though the latter are taller and finer looking. It is believed that, in color, Navajos and Pimas are a shade less dark than other bands of New Mexican Indians. Specimens of the Navajo blanket were obtained for the Indian Bureau. In closeness of texture, they are scarcely excelled even by the labored and costly serapes of Mexico and South America.

*Plate* 23 exhibits portraits of Tonto Indians. Their appearance, according to the sketch, certainly indicates stupidity sufficient to render their name appropriate. But our guide, who had been among them, and known their reputation for thieving, said that they were neither stupid nor foolish, but, on the contrary, remarkably shrewd. Some allowance ought, perhaps, to be made for their situation; being prisoners, and supposing themselves under sentence of death, while their portraits were being taken. One is represented with naked limbs and bare feet, the picture of poverty. A torn shred of Navajo blanket and a fine bow with arrows are all that he possesses. His hair is rudely clipped in front. The other is dressed in ragged buckskin, with a band around his head.

The Yampais that we saw in the same region had the appearance of more intelligence than those before us. We neglected to sketch them, expecting to see others; but none came near us again.

*Plate* 24 contains sketches of Paiutes or Chemehuévis Indians of Rio Colorado. They are a

PLATE 24.




Chemehuevis Indians. (Pah-Utahs.)

portion of the great Pah-Utah nation, and have a language entirely distinct from the tribes by which they are surrounded. In other respects, however, they assimilate to their neighbors, with whom they live in amity. Agriculture is their main pursuit; hunting an occasional pastime. Their bow is characteristic of the tribe to which they belong, being of *bois-d'arc*, elegantly curved, bound with sinews, and frequently ornamented at one end by the skin or rattle

H.B. Möllhausen.

MOJAVE INDIANS.

of a snake. They are less majestic in figure than are the Mojaves and Yumas ; their eyes are small ; their hair is clipped in front, and usually gathered behind by a narrow band, from which it hangs loosely down the back. Their native dress consists simply of a bark petticoat for women, and a breech-cloth for men, each girded upon the loins by a cord. Infants are bound to a board, and have over their heads a cradle-like cover made of osier twigs. The hands are not confined, however,, and the constraint does not seem irksome to the child. Partly to this practice may be ascribed the erect and faultless form for which the Colorado Indians are distinguished.

*Plate* 25 represents Mojaves and the style in which they paint themselves. Their pigments are ochre, clay, and probably charcoal, mingled with oil. Blue marks tattooed upon a woman's chin denote that she is married. The skirt consists of two distinct articles ; the back part being composed simply of a mass of strips of the inner bark of cottonwood, united to a string which passes around the hips, while the apron is of twisted cords made of vegetable fibres, in various colors, hanging loosely from the girdle, to which they are bound. A belt, like those of Pima manufacture, is also wound around the body. Both men and women delight in wearing upon their necks coils of wampum composed of shells cut into circular discs, with holes drilled through the centre, by which they are strung. Married women also frequently wear a single bivalve shell curiously wrought. Eagles' feathers, tied to a lock of hair, are worn only by men. Nose-

PLATE 25.

Mojaves.

jewels designate a man of wealth and rank. The principal chiefs have elaborate feather head-dresses. The artist has hardly done justice to the precision with which this people trim and dress their hair. Mojaves, like Pimas, Maricopas, and Yumas, pay special attention to this part of their toilet, all cutting squarely to the eyebrows in front, and the men taking great pride in the length and smoothness of the plaits that fall down upon the back. Vermin are destroyed by matting the hair with clay, which is worn for two or three days. The head is then sub-

jected to a thorough washing in the river, and again appears in the superb covering which nature has afforded. This people never become bald, and grey hair is seen only upon persons feeble in old age. The men are remarkably tall and gracefully proportioned. The women, on the contrary, are short and thick; their features, however, are regular, with an oval contour of face, and large, merry-looking black eyes.

*Plate* 26 is a sketch of Cahuillas of California, as seen at Coco Mongo rancho. They are squalid, miserable, and degraded. From children of the forest, as they had been before the Spanish conquest, they were by Jesuits led to an observance of the rites of the Christian church,

PLATE 26.

Cahuillas: Peons, or domestic Indians of California.

and became obedient to their teachers. Although instructed in labor, their duties were light, and they were sufficiently clothed and fed. Those, probably, were the palmiest days of this people. When the priests were divested of authority, their converts became peons or slaves of the rancheros. At length the system of peonage is nominally abolished in California, but the Cahuillas are sunk in ignorance and sloth, and no provision has yet been made to lift them from their destitute condition.

## CHAPTER III.

### *Indian Traditions, Superstitions, and Pictographs.*

At the Delaware settlement, called Beaversville, we were visited by Jesse Chisholm, a Cherokee. He is well known throughout the Cherokee, Creek, and Choctaw countries, and, as a trader, has been much among the wild tribes of the prairies. He speaks English and Spanish, and is so well versed in Indian languages, that at a late council of Comanches, Kaiowas, Huécos, Kichais, Cadoes, and Witchitas, with the various semi-civilized tribes inhabiting the regions referred to, he was chosen interpreter for all. His opportunities, therefore, for acquiring information upon the subject under consideration are evident. He states that all the above-mentioned tribes have a firm conviction of the existence of one Great Spirit. The wilder the Indian, the less he has seen of white men, the more implicit is his trust in the invisible Deity. From this unity of faith and similarity in the modes of worship, Chisholm infers that the different tribes have all the same origin.

The civilized Indians are beginning to put less confidence in the "Creek fire," though it is still kept burning. The Cherokees also are becoming remiss in the performance of their ancestral rites. However, they maintain their ancient custom of having one family of the tribe set apart for the priesthood. Upon the birth of a son, he is subjected to a fast, which continues seven days. On the third day he is consecrated to his office; on the ninth other ceremonies are performed. The boy is afterwards trained to his profession, and becomes a priest or "medicine man," to win celebrity and power in proportion to his talents and ambition. When any undertaking of magnitude is contemplated, the priest is consulted for an augury. Not long since Chisholm attended one of these ceremonies. The people, apprehending an attack from their enemies, had consulted the priest. He arose with dignity and addressed the assembly. He told them that the Great Spirit equally loved all people; but that those who prayed to him, and believed most implicitly in his power, he condescended to favor with knowledge denied to others. Having concluded an eloquent and imposing invocation, he produced a small black stone, or piece of metal, and said that, in very ancient times, the Great Spirit had been pleased to give it to his chosen people to indicate his will. Then taking a curiously wrought bowl, alleged to be of great antiquity, he filled it with water, and placed the black substance within, causing it to move from one side to the other, and from bottom to top, by a word. Alluding, then, to danger and foes, the enchanted mineral fled from the point of his knife; but as he began to speak of peace and security, it turned toward and clung to it, till lifted entirely from the water. The priest finally interpreted the omen, by informing the people that peace was in the ascendant, no enemy being near.

Cherokees, from time immemorial, have been accustomed to baptise their infants with water when three days old. They believe that, without this rite, the child cannot live. They have a custom of sacrifices and burnt-offerings. The victim is generally a deer; sometimes the whole animal, at others the heart and selected portions of the entrails are burned.

They believe in future rewards, but not in future punishments; in the Good Spirit, and in a happy spirit-land; but know nothing of the Evil One and his domains, excepting what they have learned from white men. Misdeeds, they think, are punished in this world; hence sickness, poverty, war, and death.

His intercourse with Comanches has impressed him with a high opinion of their intellect. Their language is copious, but difficult to learn; there being often many words to represent the

same idea. They have an unwavering confidence in the Good Spirit, and believe that, however great may be the disproportion in numbers or strength, if He be on their side, they are sure to be successful.* If defeated, they say "He was angry with us, and this is a punishment for some offence." They have yearly gatherings to light the sacred fires. They build a large collection of huts, and sit crowded about them, taking medicine for purification, and fasting for seven days. Those who can endure to keep the fast unbroken, are rendered sacred in the eyes of the rest. While the ceremony lasts, a perfect silence reigns. No word is spoken. When the "spirit moves," they rise and dance until exhausted, then again sit quietly upon the ground to commune with their own thoughts.

The custom of fasting is practised by all the tribes of this region. With Cherokees it is the prevailing mode of purification, and an abstinence of seven days renders the devotee famous. Seven is a magic number. The tribe is divided into seven clans. The seventh son is necessarily a prophet, and has the gift of healing by touch. A deserted Comanche camp on Shady creek, (rudely represented in *plate* 27,) gave evidence of superstitious rites and Indian offerings, in corroboration of many of the customs above mentioned.

At camp 42, upon the Canadian, near the Llano Estacado, were seen Pueblo Indians from San Domingo. After an introductory smoke, they became quite communicative, furnishing a vocabulary of their language, and much curious information as to their traditions and peculiar faith. They are Tiguex; or, according to their own language, "Ki-o-wum-mi," which, by referring to the vocabulary, is found to denote *two*. When questioned regarding the number and positions of the pueblos in New Mexico, they rudely traced upon the ground a sketch, which is represented in chapter i.

According to tradition, this tribe first appeared at Shipap, the northwest source of Rio del Norte. Whence they came is not known. They were wandering without fixed abodes, and sought shelter among cañons of the river, in caves which yet remain. They sojourned awhile at Acoti, the birth-place of Montezuma, who became leader and guide of the subsequent migration. He taught them to build pueblos, with lofty houses and estufas, and to kindle sacred fires, to be guarded by priests. Taos was the first pueblo he established; and from thence he proceeded southward, forming settlements in the order of succession named upon the map. Acoma was strongly built, and fortified by him. Pecos was one of the principal towns; and, while here, Montezuma took a tall tree, and planted it in an inverted position, saying that when he should disappear, a foreign race would rule over his people, and there would be no rain. But he commanded them to watch the sacred fire till that tree should fall, at which time white men would pour into the land from the east, to overthrow their oppressors, and he himself would return to build up his kingdom. The earth would again be fertilized by rain, and the mountains yield treasures of silver and gold. From Pecos, which—seeming to have fulfilled its destiny—is now desolate, Montezuma continued southward, spreading pueblos far and wide, till he reached the city of Mexico. There, they say, he lived till the arrival of the Spaniards, when he disappeared. "Since then," said the narrator, becoming quite excited by his story, "the prediction has been verified, and the tree at Pecos fell as the American army was entering Santa Fé." For some time previous the Indians of that pueblo had been dwindling away; and soon after, an old priest, the last of his tribe, died at his post, and the sacred fire was extinguished. They are now anxiously expecting the arrival of Montezuma; and it is related that in San Domingo, every morning at sunrise, a sentinel climbs to his house-top, and looks eastward, to watch for his coming.

The Tiguex say that Comanches, Navajos, and all tribes of Indians, are of the same race, descended from Montezuma. All smoke to the sun, that he may send them antelope to kill, Indians to trade with,* and save them from enemies.

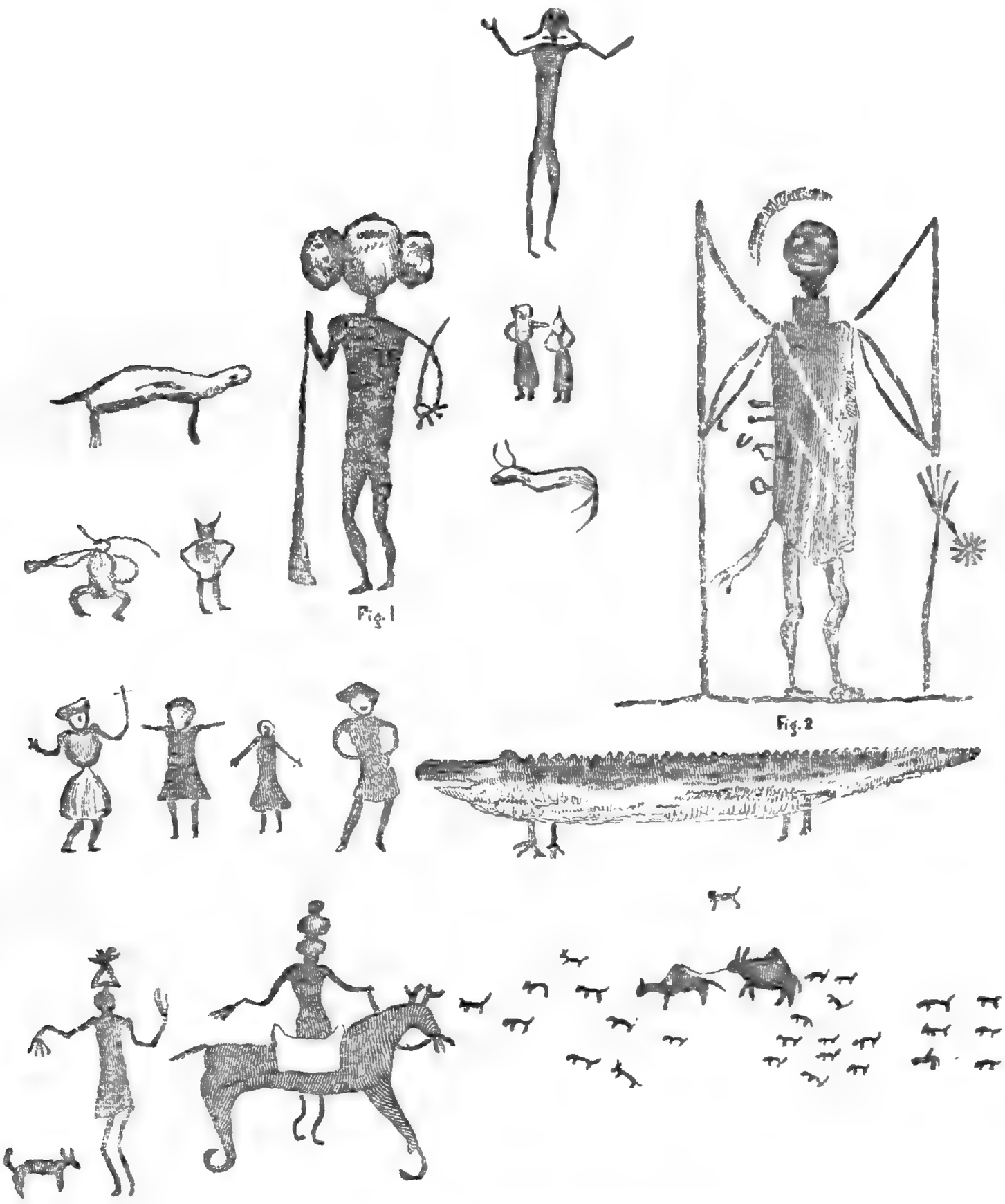
The first of the Indian hieroglyphics discovered upon our route were at Rocky Dell creek,

* Our informers were on a trading expedition through the land of the Comanches, whom they could not find; therefore, the prayers are applicable to their condition.

COMANCHE CAMP ON SHADY CREEK

between the edge of the Llano Estacado and the Canadian. The stream flows through a gorge, upon one side of which a shelving sandstone rock forms a sort of cave. The roof is covered with paintings, some evidently ancient, and beneath are innumerable carvings of footprints, animals, and symmetrical lines. Fac-similes of a portion of them may be found in *plates* 28, 29, and 30.

PLATE 28.




Pictographs at Rocky Dell creek.

Fig. 1 is much defaced, and appears to be very old. It occupies a conspicuous part of the rock. The figure is naked, and to the head are appended circles, as if to represent enormous ears. In one hand is a huge club, and in the other a sword. The colors used are red, black, and white.

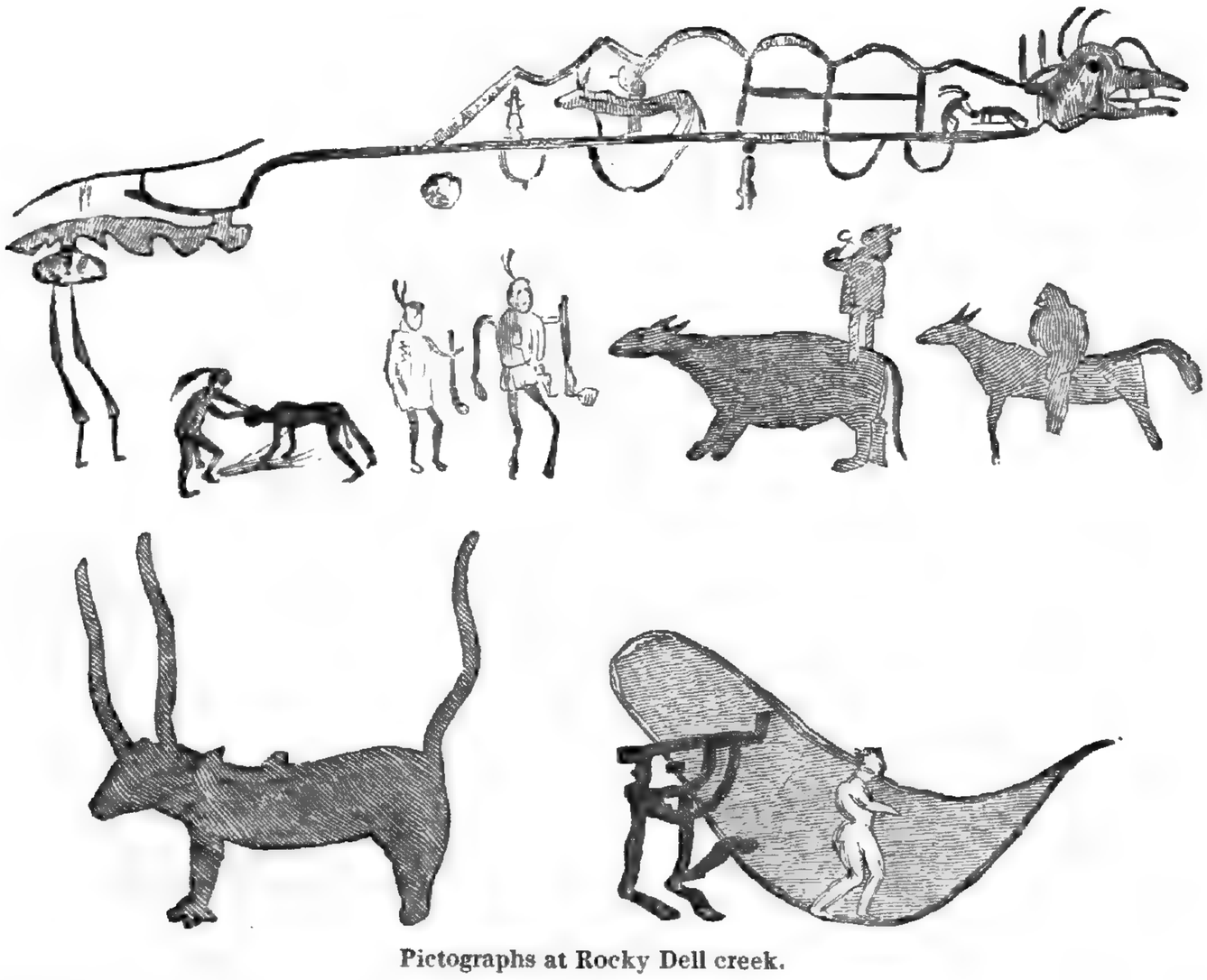
Fig. 2 is of the same period; a representation of some superior being, with wings, perhaps to denote spirituality, and a hand, signifying that he is the creator of the sun, which appears issuing from it. He stands upon the back of an alligator, but the latter appears to be of later origin.

The colors of No. 3* are dim, and many of the details obliterated, giving room for Imagination to fill up the details to her own satisfaction. This series, more than the others, seems to represent a chain of historical events, being embraced by serpentine lines. First is a rude

* The sketches here referred to have been lost. The relative positions of others are slightly changed.

sketch resembling a ship, with sails; then comes a horse, with gay trappings, a man with a long speaking-trumpet being mounted upon him, while a little bare-legged Indian stands in wonder behind. Below this group are several singular looking figures: men, with the horns of an ox, with arms, hands, and fingers extended as if in astonishment, and with clawed feet. Following the curved line, we come to the circle, enclosing a Spanish caballero, who extends his hands in amity to the naked Indian standing without. Next appears a group with an officer and a priest bearing the emblem of Christianity.

PLATE 29.



Pictographs at Rocky Dell creek.

The carvings are of horses and men, with combinations of right lines and curves, producing various hieroglyphic figures. A favorite symbol is the track of a moccasin. Systems of lines, like tallies, are also numerous. Seven is the number most frequently noted, reminding one of Chisholm's remarks. The men discovered among the sand several arrows and feathered ornaments, placed there as offerings, probably, to the deity of the place. We were here visited by Pueblo Indians from New Mexico, and copies of the inscriptions were shown to them. They recognised them, and said that this place was once a favorite buffalo range, and here their fathers hunted, feasted, and danced, and then, sitting by the water-side, recorded their thoughts and deeds upon the rocks. Figures 1 and 2 they decided to be representations of Montezuma, placed there to sanctify the spot, and secure a perpetual supply of water. They confirmed what the others had said in regard to the power of Montezuma, and his expected advent from the east. An explanation was asked regarding the singular animal represented at the top of plate 29. They said it was the great water-snake, created by Montezuma to give rain, and preserve the lives of those who should pray to him. They described it as being as large round as a man's body, and of exceeding great length, slowly gliding upon the water, with long wavy folds, reminding one of the accounts of the Nahant sea-serpent.

PLATE 30.

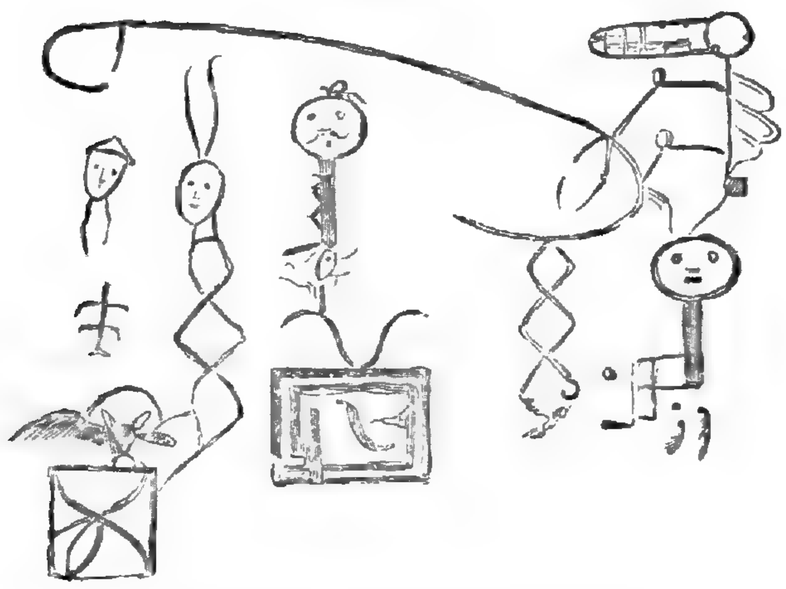
Inscriptions at Rocky Dell creek.

They say there is but one God, but that Montezuma is his equal. Inferior to them is the sun, to whom they smoke and pray, because he looks upon them, knows their wants, and answers their prayers. The moon is younger sister of the sun, and the stars are their children. All are worshipped. Besides these is the Great Snake, to whom, by order of Montezuma, they are to look for life.* Turning to the inscriptions, and pointing to the horned men, they said that this was a representation of the buffalo dance, from time immemorial a national festivity, at which they crowned themselves with horns and corn-shucks.

We saw no more Indian inscriptions until we reached the cañon upon Santa Fé river, where the half-vitrified surfaces of the rocks contained many representations of snakes, four-footed beasts, and men. They are rude, like those upon the banks of Rio Gila. Being disconnected, they seem designed to tell no story, and hence the copies are suppressed.

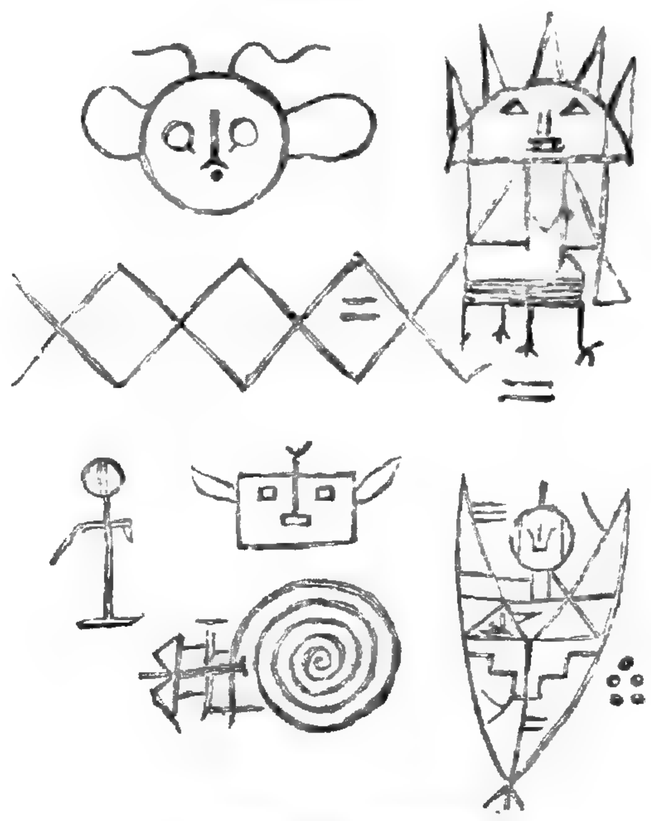
The next series of carvings was found at El Moro (Inscription rock) where Spanish adventurers and explorers, from as early a period as the first settlement of Plymouth, have been in the habit of recording their expeditions to and from Zuñi. But these have all been fully described by Captain Simpson, in his report upon the Navajo expedition, and therefore will not be repeated here. The Indian figures are evidently more ancient than the oldest of the Spanish inscriptions.

PLATE 31.



Etchings upon rocks at Ojo Pescado.

PLATE 32.



Etchings at Arch spring.

*Plate* 31 represents some of the etchings upon rocks in the vicinity of the ruins at Ojo Pescado. The figures are curious, and might safely be pronounced centuries old. They have been defaced by time only, there being no trace of a modern hand about them.

In *plate* 32 are copies of a few of the figures found cut upon rocks at Arch spring, near Zuñi. There seems to be a faint similarity between the first two images, and those said to represent Montezuma at Rocky Dell creek.

In the valley of Zuñi there is a singular spring, surrounded by high walls of earth, upon the top of which are many earthern jars fixed in an inverted position. A sketch, and some remarks upon it, may be found in the following chapter upon Indian antiquities and arts. Pedro Pino, governor of this frontier pueblo, visited our camp, and was questioned regarding this fountain. He replied: "We live in a country without acequias, and, for the growth of our crops, depend

* Vincente says, that when he was a captive among the Comanches, he was bitten by a rattlesnake. The Indians scarified the wounded foot with a flint, rubbed it with a weed, bruised the snake, caught it, and told him to take hold of it. He was afraid to do so; but they told him he would die if he did not. He then grasped it convulsively, and they coiled it around the wound. He was cured, of course; and his foot now bears the scar.

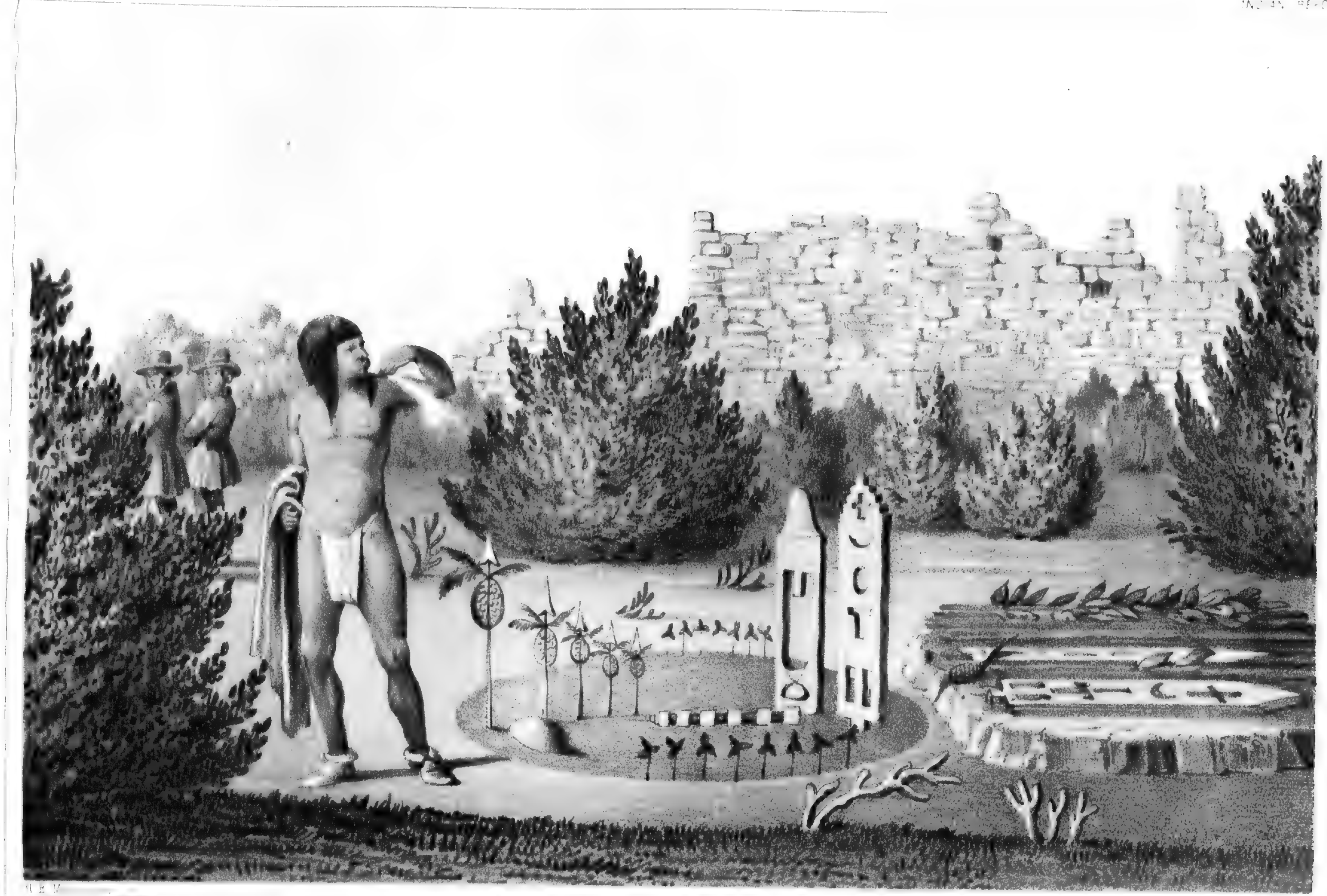
upcn rain. To obtain this blessing from the Great Spirit, it is necessary for us to perform the rites and observe the ceremonies of our ancestors. This spring has ever been held sacred to the rain god. No animal may drink of its waters. It must be annually cleansed with ancient vases, which, having been transmitted from generation to generation by the caciques, are then placed upon the walls, never to be removed. The frog, the tortoise, and the rattlesnake, represented upon them, are sacred to Montezuma, the patron of the place, who would consume by lightning any sacrilegious hand that should dare to take these relics away."

He also told a wonderful story of a sudden freshet that anciently swept over the country, des roying all men an l beasts that did not fly from the valleys to mountain-tops. The Zuñians that escaped built the town, which is now in ruins, upon a high mesa; and a yellowish horizontal vein, near the top of the stratified mount, marks the line of high water.

The caciques are priests as well as governors, and Pedro Pino is the high priest and master of their peculiar ceremonies. His especial duty is to officiate before the water deities. He seeks upon the hill-side for twigs of certain trees, which he carefully cuts into sticks a few inches in length, and trims with feathers. Upon the top of each he binds, first, four turkey feathers; then four eagles' feathers; and finally, below, the same number of ducks' feathers. Some sacred spot is then selected; and these sticks, united by threads like a snare, are planted in the ground. This is an invocation for rain. It is dedicated to Montezuma, or to the lesser divinities of water—frogs, turtles, and rattlesnakes. The Great Spirit, in consequence of these ceremonies, gives them rain in due season, enabling them to produce fine crops without irrigation. The people believe that their superior sanctity in the observance of these rites has caused them to be thus favored above the Spanish population. Although tolerating in their pueblo a church of the cross, and occasional visits of a Christian priest, they seem to have little regard for the Catholic religion. In secret they glory in loyalty to Montezuma. They endeavor to keep their Spanish neighbors ignorant of their ceremonies, but say that Americans are brothers of the children of Montezuma, and their friends; therefore they hide from them neither their sacred dances in the courts, nor the midnight meetings of caciques in the estufa. Beneath the apparent multiplicity of gods, these Indians have a firm faith in the Deity, the unseen Spirit of Good. His name is above all things sacred, and, like Jehovah of the Jews, too holy to be spoken. Montezuma is His son and their king. The sun, moon, and stars are His works, worthy of their adoration. Rattlesnakes, frogs, turtles, and all animals living near water are sacred, from association with one of the most esteemed among the Creator's blessings.

José Maria, the war-chief, upon another occasion, after having confirmed the traditionary legends of Pedro Pino, repeated the story of the flood; stating that, in ancient time, the waves rolled in from the west, and water gushed from the earth. It was at midnight. Many fled to the top of the mesa and were saved; the rest perished in the sea of waters. Navajos, Apaches, and even wild beasts, except such as found safety upon mountain-tops, suffered the same fate. The Zuñians, upon their lofty eminence, built a pueblo to await a subsidence of the waters. But as time passed, and waves still resounded from the sandstone cliffs which begirt their island of refuge, it was evident that the Great Spirit was angry. A sacrifice was devised to appease him. A son of the cacique and a beautiful virgin were the chosen offerings. Girded with sticks trimmed with feathers, they were let down from a cliff into the deep. The waters rolled back, leaving the young man and the maid statues of stone, which remain to this day. The people returned to the valley, deserting the city upon the hill until the arrival of the Spaniards; then again they climbed the heights, fortifying at every turn two steep approaches, the only points at which they were assailable. The town was rebuilt, and, by hurling stones upon their invaders, for a long time they retained their freedom. At length the enemy was victorious. The heights were scaled; and the Zuñians say that in the solid rock may now be seen, as if it were in clay, the foot-print of the first white man that reached the summit.

These various traditions regarding old Zuñi created a desire to visit the ruins. Therefore, with infinite labor we ascended the nearly perpendicular walls of the mesa mountain upon which



INDIAN ALTAR AND RUINS OF OLD ZUNI.

they are situated, from ten to fifteen hundred feet above the valley. Our Indian guide, with whom we had no medium of communication, probably intending to show us the greatest curiosity of the place, led us across the flat top of the mountain, and pointed to an isolated sandstone pillar, several hundred feet in height, the top of which had been curiously worn into shapes resembling statues of human beings. This was evidently the rock which had perpetuated the tradition of the pair who had been sacrificed at the flood. There were represented, as in *plate* 33, four distinct figures—an apparent discrepancy. But a view was taken from the present town of Zuñi; and though the artist was ignorant of the legend, the sketch shows but two statues. The others were not visible from that point.

PLATE 33.

Legendary statues.

When we had visited the famous ruins of Old Zuñi, our conductor led us to one of Pedro Pino's sacred spots, adorned with notched sticks, feathers, shells, and netted twine. A view of this curious altar is shown in *plate* 34. It was interesting to find that one of the governor's most improbable tales proved strictly true. When we left, the guide scattered flour over the place, and muttered a prayer. One of the most remarkable circumstances regarding the insignia

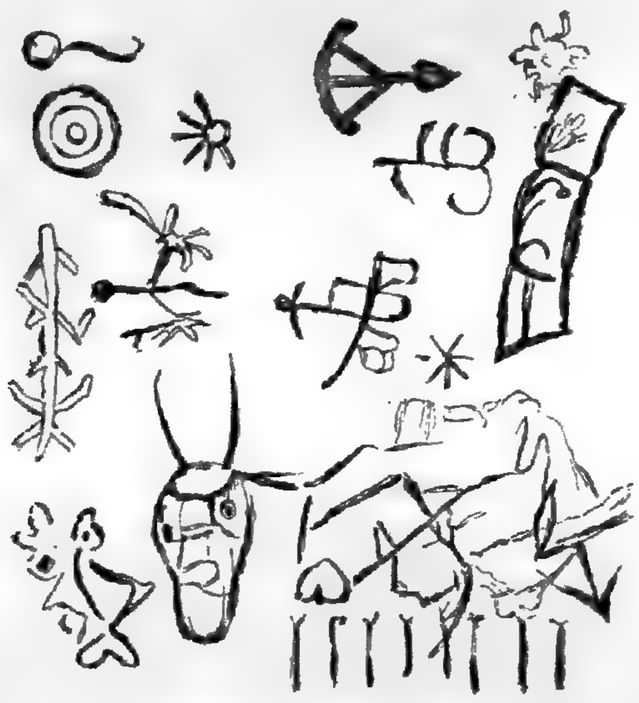
represented was the regularity with which the sticks were carved. There were, probably, hundreds, lying in a pile, cut into the same figures as represented in this sketch, and differing only in the degree of decay which time had produced.

One, who for many years had been a prisoner among the Navajos, gave the following account of their customs. The ceremony of marriage consists simply of a feast upon horse-flesh. A plurality of wives is allowed, and a man may purchase according to his ability, the price being paid in horses. Hence, the wealthy often possess from ten to twenty women. The wife last chosen is always mistress of her predecessors. There are among them medicine-men, who deal in roots, and songs, and incantations, blowing ashes and muttering spells upon the invalid to be cured. Navajos believe in one Great Spirit; to him they make, like the Zuñians, offerings of flesh and flour, asking favors and seeking good fortune. They also make altars of stones, and sticks trimmed with feathers. The sun, moon, and stars are sacred, as the authors of seasons of rain and of harvest. But here the resemblance to Pueblo Indians ceases. They do not acknowledge Montezuma, nor is he, in any way, referred to in their traditions. Neither they, nor any other Apaches, consider rattlesnakes as sacred, though they have some superstition which leads them to pay particular veneration to bears. They will neither kill nor eat them. Pork, also, they have been known to refuse, even when suffering from hunger.

In *plate* 35 are representations of paintings at Yampais spring, near Williams river. The spot is a secluded glen among the mountains. A high shelving rock forms a cave, within which is a pool of water, and a crystal stream flowing from it. The lower surface of the rock is covered with pictographs. None of the devices seem to be of recent date.

*Plate* 36 contains copies of some of the figures carved upon rocks at Paiute creek, about

PLATE 36.



Etchings at Paiute creek.

thirty miles west of the Mojave villages. These are numerous, appear old, and are too confusedly obscure to be easily traceable.

From the Mojave villages we were accompanied, for about a hundred miles, by two Indian guides. By signs, and a few Spanish words, which they had gathered, they generally succeeded in making themselves understood. One evening, desiring to learn something of their ideas regarding the Deity, death, and a future existence, we led one of them to speak upon those subjects. He stooped to the ground, and drew in the sand a circle, which he said was to represent the former *casa* or dwelling-place of Mat-e-vil, who was the creator of earth (which was a woman) and heaven. After speaking for some time with impressive, and yet almost unintelligible earnestness, regarding the traditions of that bright era of their race, which all Indians seem to delight in calling to remembrance, he referred again to the circle, and, suiting his action to the word, added: this grand habitation was destroyed, the nations were dispersed, and Mat-e-vil took his departure, going eastward over the great waters. He promised, how-

ever, to return to his people and dwell with them forever; and the time of his coming is believed by them to be near at hand. The narrator then became enthusiastic in the anticipation of that event, which is expected to realize the Indian's hopes of paradise upon earth. Much that he said was incomprehensible. The principal idea suggested was the identity of their deliverer, coming from the east, with the Montezuma of the Pueblo Indians; or, perhaps, the Messiah of Israel; and yet the name of Montezuma seemed perfectly unknown to our Indian guide. His ideas of a future existence appeared to us somewhat vague and undefined. The Mojaves (he said) were accustomed to burn the bodies of the dead; but they believe that an undying soul rises from the ashes of the deceased, and takes its flight over the mountains and waters eastward to the happy spirit-land.

Leroux says that he has been told by a priest in California, that the Colorado Indians were Aztecs, driven from Mexico at the time of the conquest by Cortez. He thinks the circle represents their ancient city, and the water spoken of refers to the surrounding lakes. This idea derives some plausibility from the fact, mentioned by Alarcon, that in his memorable expedition up the Colorado river in 1540, he met tribes that spoke the same language as his Indian interpreters who accompanied him from the city of Mexico or Culiacan.

It is to be regretted that we had not a better medium of communication with this people, as, upon this subject, much that is interesting might be learned from them. They have not yet received from white men any impressions to conflict with, or to change, the traditions handed down from their ancestors. They seem to be isolated, even from the Pueblo Indians of New Mexico. Although a blanket made by Moquis, and a sash of Zuñi manufacture, were found among them, they stated that these had been brought to them by Paiutes and Yampais Indians.

## CHAPTER IV.

### *Illustrations of Indian Antiquities and Arts.**

One of the most pleasing of primeval customs, was the respect paid to springs of water. Arising in the first wants and best impulses of our nature, it was cherished in warm climates, and at length became fostered in all. The "worship of fountains" is still prevalent throughout the eastern hemisphere. It is not obsolete in Great Britain and Ireland; for people are there yet found presenting annual offerings to them, just as the ancient worship of fire is, in some districts, ignorantly kept up.

Early incorporated, with other pagan superstitions, into the Christian church, strenuous efforts were made to abolish it; for in Europe, as in Asia, it was universal. Miraculous cures, as well as quenching thirst, were ascribed to certain fonts, and hence arose throughout Christendom swarms of "holy wells," of which numbers have not yet, in popular estimation, lost their virtue. Reverence to them was carried to an idolatrous excess.

In the tenth century a schism took place in Persia among the Armenians; one party was accused of despising "the holy well of Vagarscriebat." In the reigns of Canute and Edgar, edicts were issued in England prohibiting well-worship. Hereward, the Saxon hero, witnessed his hostess invoking the spirit of a fountain in her garden. In the last century, persons in Scotland performed pilgrimages to wells; and in England they were decorated with wreaths and flowers, hymns were sung over them, and even reading portions of the Gospel was a part of the ceremonies. Some critics, says Hearne, observe that what is translated "will worship" in Colossians ii, 23, should be *well-worship.* The Hindoos, Chinese, Moors, and Mahommedans, have their sacred wells. The people of Algiers sacrifice fowls to certain fountains. But to what extent these figure in sacred and classical history, every reader is familiar.

It is an interesting fact, that in the New World as in the old one, untutored man was moved by the same principle of gratitude to express his thankfulness for water; and as he knew not to whom he was indebted, he also imagined spirits presided over fountains, and to them made what he supposed were acceptable acknowledgments. While the motive that animated him was the same that influenced his species elsewhere, his manifestations of it were different. He is not known to have polluted his offerings with blood.

So keenly alive to the importance of the fluid in agriculture were the semi-civilized people of Central America, Peru, Mexico, and New Mexico, that it is very probable, had they been left to work out their destiny undisturbed by white men, fountains of water would have played as prominent a part in their mythology as they did in that of Egypt, Greece, and Rome. An example of the homage paid by the red race to genii of fountains, is furnished in the sacred spring of the Zuñis, represented on *plate* 37.

This basin of fine water is located near the table-land, on a branch of the river Zuñi, between the ruins of Ojo Pescado and the present pueblo of Zuñi. It is between seven and eight feet in diameter, and around it a low circular wall, from fifteen to twenty feet across, has been raised. The spring is cleared out every year, when an offering is made to the spirit of the font, of one or more *water-pots,* which are placed on the wall. A dozen or more whole ones were observed, while fragments abounded. Some of the remaining vases are reputed to have been offered centuries ago by the pueblo caciques. Specimens were brought away, (see next plate,) notwithstanding the tradition that whoever abstracted one would be struck by lightning. As the

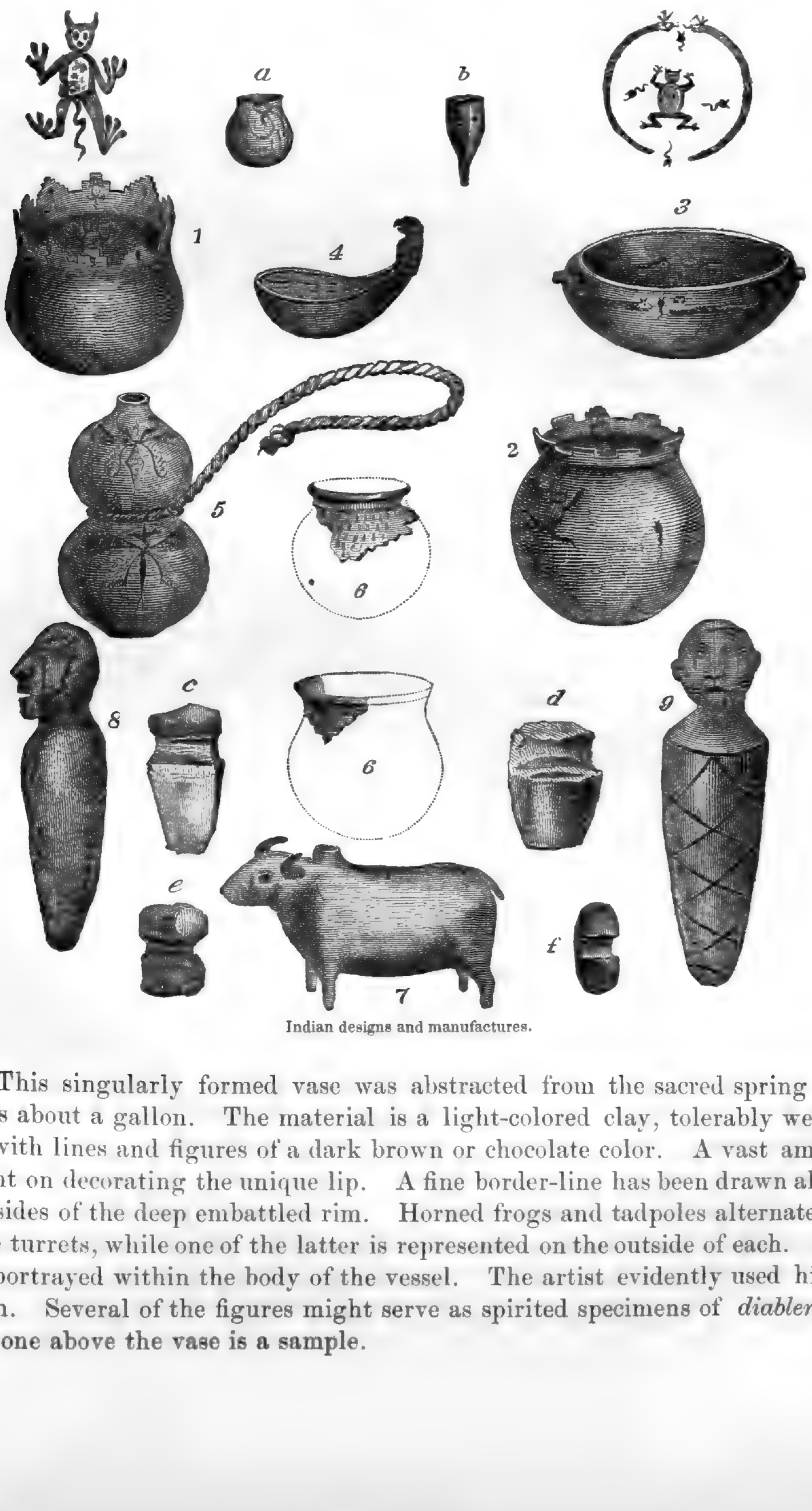
* By Thomas Ewbank.

ZUÑI SACRED SPRING.

Zuñi Indians do not have recourse to artificial irrigation, they depend entirely on rain; and it is their belief that, if they neglected the annual ceremonies at this spring, their crops would be destroyed by drought.

Of indications of man's movements in remote times, none are more durable and reliable, and surely none are associated with more agreeable reflections, than wells and fountains. Architectural and other remains occur in the vicinity of this spring, and throughout all the regions of New Mexico; but, compared to the date of its enclosure and use, they are but of yesterday.

PLATE 38.




Indian designs and manufactures.

*Figure* 1. This singularly formed vase was abstracted from the sacred spring of the Zuñis. Its capacity is about a gallon. The material is a light-colored clay, tolerably well burnt, and ornamented with lines and figures of a dark brown or chocolate color. A vast amount of labor has been spent on decorating the unique lip. A fine border-line has been drawn along the edge and on both sides of the deep embattled rim. Horned frogs and tadpoles alternate on the inner surface of the turrets, while one of the latter is represented on the outside of each. Larger frogs or toads are portrayed within the body of the vessel. The artist evidently used his brush with much freedom. Several of the figures might serve as spirited specimens of *diablerie;* of which the enlarged one above the vase is a sample.

*Figure* 2. A large vase, and also an ancient offering to the spirit of the spring. Its rim is partially embattled. An encrusted piece is formed on the interior surface of the lip, and on it a frog in the act of leaping from the vessel, as if disturbed by some one's approach. The outline of this vessel is identical with that of the classical cauldrons of antiquity and of our own times. Decorated by a different hand, and possibly in a different age or century from the preceding, another variety of Batrachians is introduced. This introduction of figures of water animals on vases dedicated to the genii of fountains, is peculiarly characteristic and appropriate.

*Figure* 3. A vase, which exhibits considerable taste in its outlines. It is five inches deep at the centre, ten across the widest part, and eight at the lips. There are four projecting pieces, or studs, at equal distances from each other, on the swelled part, as if designed to support the vessel on the perforated plate of a stove—a common practice of ancient and modern Peruvians. As usual, there are no signs whatever of the potter's wheel having been employed in the fabrication of this or the other vessels figured. The material is a light clay, and but poorly burnt. Both surfaces have been coated with bright glazing, approaching to white, and, though cracked all over, it presents, in clear relief, the umber-colored decorations. This interesting vessel was also taken from the Zuñi fountain; and it is observable that the paintings on it are confined to appropriate subjects—the crested serpents being probably intended for rattle or water snakes.* The figures in the interior are shown above—*i. e.*, a frog, three snakes, and four tadpoles.

*Figure* 4. A scoop or dipper from the Mojave tribe, and as neat and original an article in earthen-ware as could well be designed by a civilized potter. The material, and ornamental work are, of course, inferior. The shank is formed after the throat and head of a bird. The throat is hollow, and communicates with a perforation behind the open bills. It forms a weak rattle, having had some minute matters introduced before being baked.

*Figure* 5. The shape of this vessel is derived from the double gourd, which it perfectly resembles, and which is so common in some parts of Texas and New Mexico that it is in universal use by travellers. It is swung by a cord over the shoulders, or secured to the saddle by horsemen. It is the more valuable in warm countries, because the porous nature of the substance allows sufficient evaporation, from the sides of the vessel, to keep the water cool within. The specimen is of modern Zuñi manufacture. The figures painted on it are intended to represent butterflies.

*Figures* 6, 6. Two ancient vases, restored from fragments found on the Little Colorado. This class of earthen-ware is known to be of remote antiquity in America, as also on the eastern hemisphere. Colors are seldom employed—the ornament consisting of raised and indented designs, somewhat resembling our moulded glass-ware. The uniformity with which the patterns are often worked out is surprising, rivalling, as they do, modern work. These fragments are, in every view, interesting: the recurved lips are as neatly turned as if done on a wheel, and the material as regularly thickened and thinned at the edges. The plain bands that terminate the indented work are regular in width. The material is a light-colored clay, porous, and retains no indications of having been glazed. Altogether, the relics are fine specimens of the potter's art in past times. Nothing like it is now made by North American Indians, but old Peruvian vases exhibit the same style of ornament. Fragments of encrusted pottery have also been found in the mounds of the Mississippi valley. (See also some on *plate* 40.)

The animal vase (*figure* 7) is from Zuñi. It was bought of an Indian by a messenger sent to purchase canteens or casks. *Figures* 5 and 7 were brought to the camp. The latter has been modelled in imitation of the Rocky mountain or indigenous sheep. Of the ordinary light-colored clay, it has had a white silvery glazing, which age or use has worn half off. It has been tolerably well baked, and rings well. Its capacity rather exceeds half a gallon. This

* I do not know that, upon this continent, any animal has been found similar to that figured upon this Zuñi vase. It would seem to be of Eastern origin; for in Harper's Magazine, among sketches from the ruins of Pompeii, there is the representation of a snake, with a tuft, like the one before us. In Egypt there is a horned snake quite venomous. It has the habit of burying itself in sand, and protruding its horns, probably to attract birds for prey. It is much feared by the natives. A. W. W.

kind of vessel is common with the present Pueblo Indians; and it was as common in ancient Mexico and Central America, for several have been dug up. In the cabinet of Dr. Davis, of New York, is a fine specimen from Palenque. It is impossible to compare ancient and modern specimens, without perceiving that in this branch of art no change, or next to none, has taken place in the countries named from times anterior to the discovery.

*Figures* 8 and 9. Images of unbaked clay kept in their dwellings by the Mojaves. They remind one of similar things kept by and buried with the Egyptians; and yet they do not appear to be intended for idols. Whether designed to preserve memorials of the dead, for children's toys, or used by the medicine-men in their incantations—or whatever else their purpose is—was not ascertained. They vary in dimension, from a few inches to twelve and upwards. Some are elaborated into rude statuettes, and better finished in every respect than the two here figured. That they are not idols, may be inferred from the fact that when one was accidentally seen and purchased, quite a number were offered for sale. Brazilian Indians have wooden images representing the head and shoulders of men. (Lieut. Gibbon's Report on the Exploration of the Amazon, p. 299.)

*Figure a*. A minute pot, not larger than a large orange, from the Pimas Indians. *b*. A pipe of the Pinal Leños, a rude affair, and either used without a tube or inserted into a reed. With it was obtained a specimen of their tobacco, or kinik-kinik—an Algonquin word, and used by the Ojibwa Indians, now in Washington, for the same thing.

*Figures c*, *d*, and *e*. Stone axes, presenting no particularly marked features. *d* is the most, and *c* the least perfect. The latter has been used as a hammer, and the heads of all show how this wide class of primeval implements were employed as wedges, quite as much as edge-tools. That a moderate-sized tree was ever cut down by a stone axe is extremely problematical. *Figure f* has a rounded end, reminding one of similar convex hammers of Aztec and Peruvian silver-smiths: the opposite end is extremely blunt. This instrument was found at a Casa Grande, on the river Salinas. As it and *d* have grooves only on three sides, they were obviously used without a withe handle. In what manner, then, were they used? The answer was given by four Ojibwa Indians, part of a delegation now in Washington. While drawing up this paper, they paid me a visit, and at once explained that the grooves were for the thumb and forefinger. The grooves prevent the instrument from slipping out of the grasp.

In Dr. Davis's cabinet are twenty-five axes and hammers from mounds in the Mississippi valley, some very large and heavy. Of these, sixteen have grooves only on the sides and one edge.

*Plate* 39.—Among other relics, the usual arrow-heads of flint, quartz, &c., occurred throughout the survey; also numerous fragments of painted pottery, the material of which is commonly dark colored and porous; occasionally light red, with a closer grain; and sometimes grey, and still more compact. In some specimens, the inside of the vessel (known by the concavity of the piece) has alone been painted; in others, the outside; and in some, both sides. The pieces here figured are sufficient to show the turn of the Indian mind in this branch of ornament.

No. 1 is light and porous, cracked and corroded.

No. 2, a dark clay, and sombre colored. On the other side, white lines, nearly obliterated, have been drawn on a dull brown ground.

No. 3, the concave side of a fragment whose convex surface is shown at No. 8.

No. 4. From its very slight concavity, it appears to have been a portion of a large vase—much larger than any of the other scraps belonged to. It is thick, of a dark colored and open clay. The opposite side is rough and uncolored.

No. 5, of reddish clay and rather close grain, and better baked than most of the others. It is from the Colorado Chiquito (Flax River).

No. 6. Dark grey material, and both sides painted.

No. 7. From the hieroglyphic springs. Material, a dark grey; the black lines shine as if laid on with varnish. The opposite, or outside, is colored red.

No. 9. The convex side of an old fragment. The other side is rough, and of the dark color of the clay.

No. 10. The concave side; the clay light colored and compact. Remains of ornaments are on the other side.

No. 11. A portion of a vase from the Colorado Chiquito.

No. 12. Of yellow clay, and close grained. (Colorado Chiquito.)

No. 13. Material similar to No. 10.

No. 14. Portion from the upper edge of a vase. (Colorado Chiquito.) Fragments of Pah-

PLATE 39.

Ancient Indian pottery.

Utah pottery resemble this somewhat, though the only color is brownish red, laid over light-colored clay in broad bands.

No. 15. Coarse grained, cracked, and corroded. Both sides are painted; the black is shaded down into the red; the white lines have been put on, apparently, after the vessel had been baked; while in one very old fragment the white figures look like enamel, or pieces of embedded shell.

No. 16. Outside of a vessel, whose interior had been ornamented with black and red lines.

The fragments *a*, *b*, *c*, *d*, are from the ruins of a pueblo on the Little Colorado.

*Plate* 40 represents fragments in which two colors only are chiefly used—black or brown lines on a light-grey ground, and mostly the natural tint of the clay.

No. 1. From the big bend of Flax river.

No. 2. Part of the neck of a vessel.

Nos. 3 and 4. From Flax river.

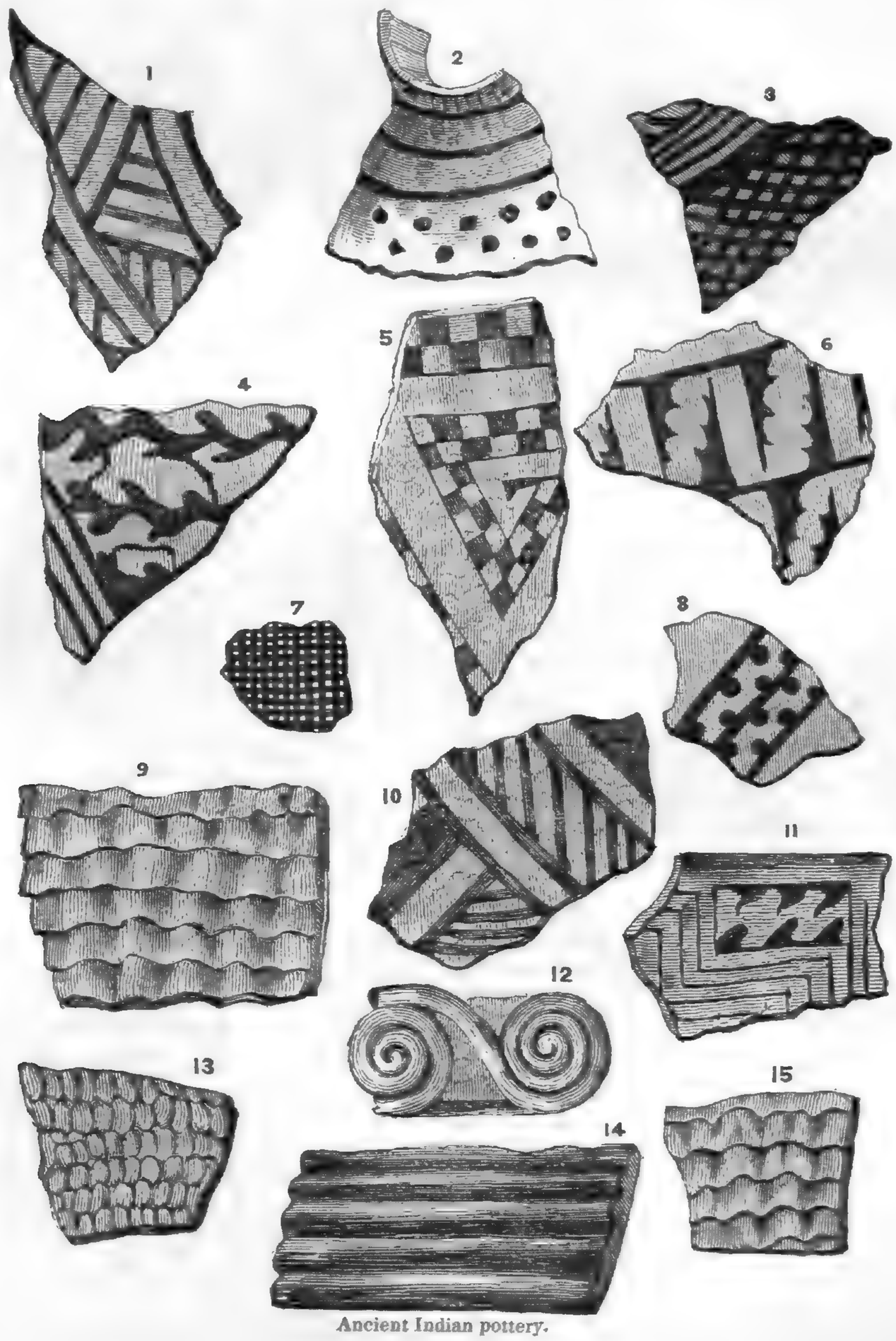
Nos. 5 and 6. Found near camp 70, in the vicinity of Zuñi. They are modern, and in appearance and hardness approach to our stoneware.

No. 7. A minute fragment, and observable only for its minute squares.

No. 8. Ornamented on the opposite side with white lines on a dark ground.

Nos. 10 and 11. From Colorado Chiquito. No. 11 is from the upper part of a bowl whose edge is tapered and neatly rounded.

PLATE 40.




Ancient Indian pottery.

The remaining four fragments are of the natural color of the coarse clay of which they have been made. They display attempts at ornament, by incrusting and otherwise marking the sur-

face, much on the plan of the restored vase in *plate* 38; though not one of the numerous specimens, from which the above have been selected, approaches to it either in design or execution.

No. 9. A portion of a large vase from Cosnino caves. The surface is broken by thin and narrow strips overlapping each other like continuous rows of shingles, or rather tiles; for depressions have been made in succession, by a tool, which, from the fine lines left by it, may have been a shell. These strips appear to have been laid on after the body of the vase had been hardened in the sun, and, as each was put on, the ribbed tool was used to press it down to its place.

No. 15 is another specimen on the same plan, much corroded. It is from the big bend of Flax river.

No. 13. A compact, close-grained clay; the impressions on the surface are very slight—probably made by a pointed instrument. It is from the Little Colorado.

No. 14 exhibits a rough species of beading or moulding, formed round a vase, and apparently by drawing a pointed stick along the plastic material.

While both ancient and modern aboriginal pottery present a coarse material, seldom equalling in closeness of texture our commonest ware, it would seem as if a better taste and greater skill had generally prevailed before the discovery than since. In forms and ornament, the old workmen—or rather workwomen, for they have been, and are, the chief artists in clay—excelled; a remark that applies to Chili, Peru, Brazil, and Central America, as well as to Mexico and New Mexico.

No. 12. An ancient fragment from the Little Colorado, one-third larger than the drawing, rough, and corroded by the elements and time. The black scroll is embedded on a reddish colored clay, and appears to have belonged to a large vessel. It would be interesting to know how this fruitful germ of modern scroll-work, and staple element in the decorative art of the nations of the East, was suggested to the Aztec modeller—whether by coiled worms, shells, vegetable tendrils, or imaginative impulse.

It may not have occurred to every reader that most, if not all, the elements of decorative art, as regards curved and straight lines, which are supposed to have originally occurred to the Egyptians, Assyrians, Greeks, and other advanced people of the eastern hemisphere, have been exhibited by the ancient occupants of the western one. In the relic just noticed, we have the line rolled spirally inwards and outwards—the involute and evolute. In other samples of pottery, the *guilloche*, or curved fillet, in various forms, is met with; also, waving lines, arched, invected, engrailed, radiant, embattled; the trefoil, cross, scroll, and numerous other initial forms, though less expanded and diversified than in the Old World. The fillet, frett, astragal, ogee, and cavetto, abound in the ruins of Palenque, Cusco, and in architectural remains in Central America.

PLATE 41 (lithograph).

*Figure* 1. A Yampais bow, 4½ feet long. Mojave bows are of similar form, from 4 to 6 feet in length, and are made of cottonwood. The quiver, full of arrows, and made of mountain-sheep skin, is shown at 4.

*Figure* 2. A Chemehuèvis bow, such as is used by every band of the Pah-Utahs. 5. The quiver, being the spotted skin of a species of wild cat.

*Figures* 3, 3, 3. Specimens of arrows.

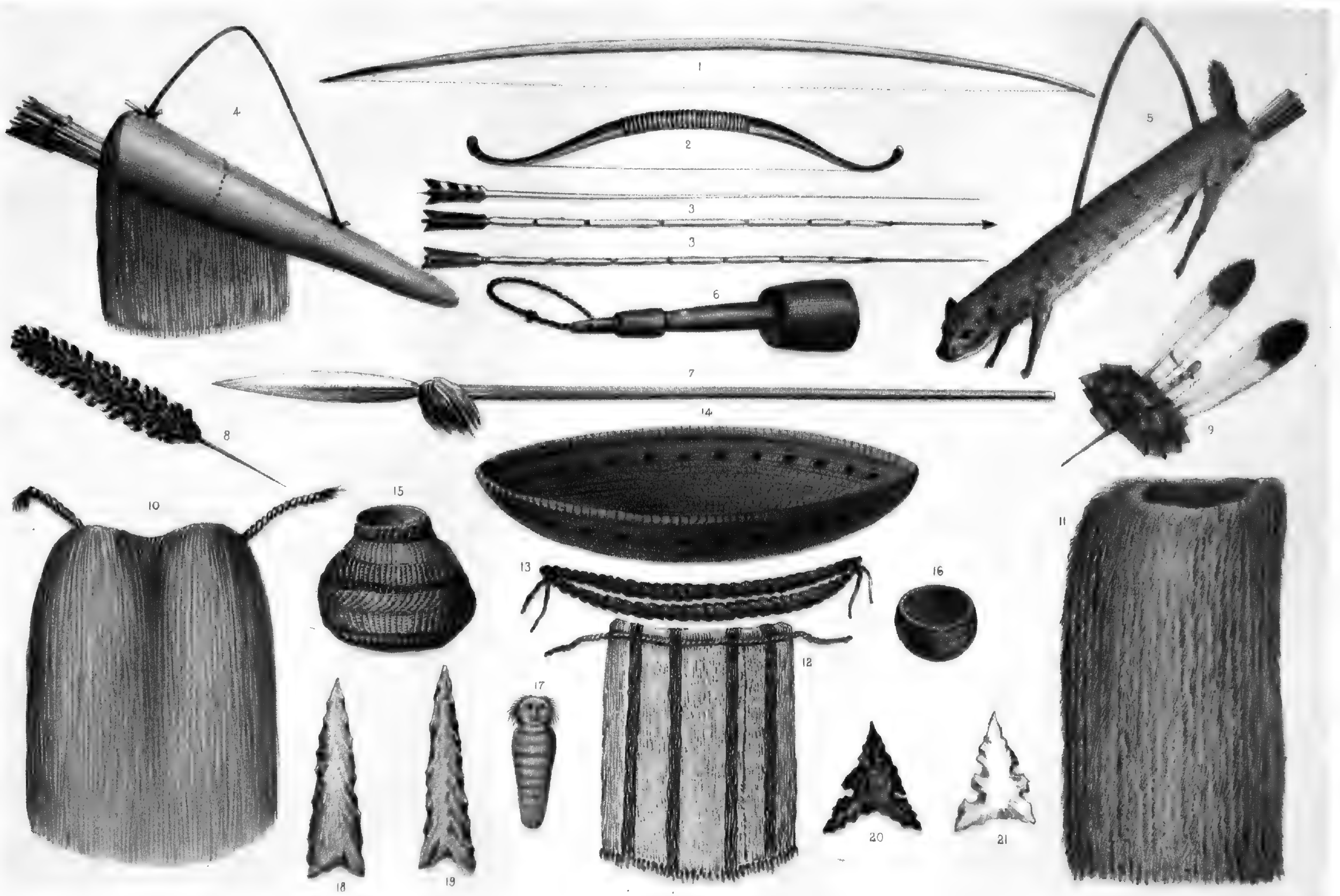
*Figure* 7. A Mojave lance.

*Figure* 6. Obtained from the Mojaves, and deemed by some of the party a war club.* It appears to be a domestic implement; the flat face is worn smooth, and apparently by pounding soft substances, probably boiled maize; the edges of the face are cracked, and the lower portion

* The particular specimen referred to may possibly have been used for domestic purposes; but it is as well known to be an implement of warfare as is the bow or the spear. From their frequent use of this weapon, one tribe is known as the Galloteros, or Club Indians. A. W. W.

F S. Del. T. Sinclair's Lith. Phil.a

INDIAN ORNAMENTS AND MANUFACTURES.




H. B. Mollhausen

T. Sinclair's lith. Philada.

INDIAN DESIGNS & MANUFACTURES.

of the swelled part is of a lighter color than the rest, as if it had been much used in crushing wet or moist materials. The wood is as light colored as hickory, but not near as heavy. It bears marks of laborious forming by an imperfect cutting-tool. Besides the one figured, another was obtained, similar to it, except there is no projection left on the handle. The entire length is 16, and the diameter of the face 3½ inches.

*Figure* 8. A Mojave plume for the head. Some are made of the downy feathers of the eagle, and are preserved with care, in reed cases, when not in use. *Figure* 9 is another variety of the feather ornaments.

*Figures* 10, 11, 12. The principal, and commonly the only, articles of female dress among the Mojaves; and although described by travellers and traders as petticoats, they are simply what our first parents wore—aprons; one being tied on before, and another behind. Of the latter, fig. 10 is a specimen, consisting of loose strips of the bark of the cottonwood, or of the alamo, and secured around the waist by a cord.

*Figure* 13. A Mojave squaw's front apron.

*Figure* 14. A basket, water-tight, and exhibiting considerable correct taste, as well as skill, in its construction. The slips of light colored reed, of which it is formed, are one-twentieth of an inch wide; the ornaments are a black edge, a row of small figures a little below the edge, and low down a circle of engrailed lines. Two of the baskets were captured from the Pah-Utahs—one 12 inches diameter, and 4 deep; the other 10½ inches diameter, and 2½ deep. The skill displayed in this species of manufacture is further seen in various vase-formed vessels, as figs. 15 and 16.

*Figure* 17. An unbaked image, similar to those on *plate* 38, drawn to a very small scale. The head is set off with hair and ear-rings.

*Figures* 18 and 21. Specimens of ancient arrow-heads, of jasper, quartz, obsidian, flint, &c., found among ruins at Moqui springs, Pueblo creek, Aztec pass, and on the Colorado and Gila rivers. On the latter was found a flat bead, of bright green stone, resembling the one attached to the nose ornament, fig. E, *plate* 42.

PLATE 42 (lithograph).

*Figures* A A. A gorgeous pair of aboriginal ear ornaments.* The rings are of stout brass wire, and nearly three inches in diameter. The drops are plates of pearl-shell, in which the tints of the rainbow gleam with unrivalled lustre and iridescence; they are connected to the rings by white and blue beads.

B. A shell ring, or ornament, evidently cut with much labor. It was found at a *casa grande*, (Chichilticale,) near the Pima villages, on Rio Gila. Another, almost a fac-simile, was found among the same ruins. The diameter of each is nearly three inches. The use to which they were put is unknown.

C. A slate-stone ear-drop of the Yampais. It is 1¾ inch long, smooth, and thin.

D. One of a pair of Shawnee ear-drops, full size, and remarkable only for being made by a native artist. The material is silver, probably hammered out of half or quarter-dollar pieces. The workmanship is tolerably good, though not sufficiently so to pass muster with our city jewellers. D′ is another variety.

E. Nose ornament of Cairuk, a Mojave chief. It consists of a large white bead of shell, and from it hangs a thin conical slip of a bright and light-blue stone. The small leather thongs were passed through the septum of the nose, and secured the gem to it.

F. A small tobacco-pouch, of buckskin, and tastefully set off with white, purple, and other colored beads. It was obtained from the Lipans.

H. A brass medal,† full size, obtained from the Mojaves. The figures have been struck in

* These were obtained from Lipans. Comanches and Kaiowas decorate themselves with similar appendages, made of shells, bead and wampum work.

† This medal is probably a relic left by Friar Pedro Font, or Father Kino, who visited the Colorado in 1700.

high relief, but are much worn. It bears no date. It is obviously one of the medallions distributed by the early Jesuits. The effigies of Loyola are on one side, those of St. Francis Borgia on the other.

I. Small shell gorget, worn by married women only. They part with it reluctantly, and seem to prize it as if it were a wedding gift.

K, L. A Mojave flute and fife; the former rather over two feet in length, and of the natural bore of an inch cane. It consists of a little more than two joints of the reed, with the natural diaphragms or partitions—one at the middle, and another near each end. The latter have been bored through at the centre, leaving irregular shaped openings $\frac{3}{8}$-inch diameter. The surface is very elaborately, though rudely, carved and colored. The extremities have bandages of red and blue cloth, set off with tassels formed of strings of buckskin, that hang over the orifices. The player puts his mouth to one end, and blows directly into the tube, just as South American Indians play on their bone fifes. Like them, too, these have stops for the fingers of but one hand. Unlike them, however, in another feature, these instruments give no sound till a finger is placed over the central opening. The finger, in fact, forms a part of the musical aperture or whistle, and, by varying its position and pressure, the tone is varied. As this may furnish a hint to our musicians and instrument-makers, a section of the flute is added. In fig. 3, *a* and *b* show the perforated diaphragms, and *c* represents the central one, which is left whole, and forms a tongue or side of the whistle; the oblong opening communicates with the interior on both sides of the diaphragm.

The fife acts precisely on the same principle, except that, instead of the player's finger, a thin band of leather goes around and is tied at *x*. This he slides down till it covers a portion of one or both openings.

These instruments* are common with the Coco-Maricopas, and Yumas, or Cuchans; and among the tribes on the Colorado, young men serenade their female friends with them.

Of numerous articles not figured in the plates, a few may be noticed here:

A piece of cedar, fifteen inches long, and four inches in diameter, part of a beam found *in place*, in the very ancient ruins on the summit of Inscription rock. There is nothing in its appearance that indicates the action of a cutting-tool. The remaining portion of the beam had been destroyed, or buried in the ruins.

Mojave armlets of thick leather.

A Navajo shield of raw hide, with an alleged head of Montezuma painted on it, and set off with streamers and feathers; apparently identical with those used before the discovery. Such are common among the Apaches, Navajos, and the Pueblo Indians. In battle, the Indians never stand still or straight, but keep moving and throwing up the shield to divert aside arrows, while at the same time they use their bows. This shield is represented on *plate* 21, page 30, in the figure of the Indian from whom it was taken.

Netting made of the fibre of the maguey or yucca plant. The cord is hard and strong, feeling like whipcord. Made by the Mojaves.

A cord of human hair, over twelve feet long, $\frac{3}{8}$ of an inch thick, and consisting of six double strands. The color is brownish black. It was obtained from the Pimas.

Several strings of "pook"†—one five feet long—consisting of bits of thin white shells, broken into pieces varying from $\frac{1}{4}$ to $\frac{3}{8}$ of an inch diameter, and drilled in the centre. The most interesting query about these and kindred things is the facility with which they are perforated.

A peace-offering of the Comanches, left on a mound at one of their deserted encampments, consisting of a few small strings of colored beads, and a bracelet of *soft* brass. Having no

* The form of this musical instrument is doubtless purely an Indian invention. The principle of its construction is believed to be different from any known among other tribes or nations.

† When I first visited the Colorado Indians in 1849, strings of this wampum were used by them as money—two yards of it representing about the value of a horse. I have known a young Indian to refuse $20 for his necklace.—A. W. W.

elasticity, the ring was easily opened to pass over the wrist, and the ends as readily pressed together to keep it in its place.

Two Mojave necklaces of sea-shells, uniform in color and dimensions, and resembling somewhat the one figured 13, *Plate* 41.

A necklace of pieces of medicinal and fragrant root, strung on a thong of leather—a charm prescribed by the "medicine-men" among the Colorado tribes.

A large head of a spear of bone, 6 inches long and $\frac{3}{8}$-inch thick, plain at one edge, and double-barbed at the other; used by Indians on the Colorado in spearing fish.

A Colorado chieftain's head-dress—a conical cap of soft leather, whitened outside with a pigment, apparently of clay, punched full of holes, and edged with a red band. A bunch of dark feathers is secured at the crown, and a number of lighter and pendant ones incline in one direction from it.

A Choctaw wampum belt, eleven feet long, consisting of narrow strips of red and blue braids, all edged with white beads, and connected to an ornamental band at the middle.

## CHAPTER V.

### *Vocabularies of North American Languages.**

Of the vocabularies of North American aboriginal languages, which here follow, those of the Cuchan and Diegeno were collected by Mr. Whipple, in an expedition made from San Diego to the Colorado in the year 1849. Those of the Pinal Leño, Pima, and Coco-Maricopa were obtained while engaged in the Mexican Boundary Expedition, in the years 1851-'53; and the remainder during the survey for a Railway route to the Pacific ocean, made in the years 1853 and 1854.

Of these vocabularies the five just mentioned—viz. the Cuchan, Diegeno, Pinal Leño, Pima, and Coco-Maricopa—are imperfect, and very irregular in the choice of words, excepting the Cuchan, which is pretty full. These irregularities and imperfections were owing partly to the want of a standard selection of words to be asked for, and partly to the fact that the Indians frequently tire of being questioned, and of having their minds directed into so unusual a channel; in which case, they will communicate only such words as strike their fancy, and with these the collector must be content.

The greater part of them, however, were obtained in the course of the Pacific Railroad Survey; in making which the War Department very properly directed that attention should be given to "the location, character, habits, traditions, and languages of the Indian tribes." In order to carry out properly this last branch of his instructions, Mr. Whipple provided himself with blanks, containing lists of about two hundred words in English and Spanish, prepared by the American Ethnological Society, and printed at the expense of the Smithsonian Institution; and these were adhered to as far as was found practicable. Some irregularities, however, are here also observed: occasionally certain words, owing to the imperfect medium of communication, could not be obtained, or want of time would not allow the tedious operation to be completed of filling out the list; and sometimes a few extra words were procured.

Many of these vocabularies will be found of especial interest and value to the ethnographer, from the fact that they are the first ever published of their respective languages.

In the five vocabularies first obtained, the words were taken down in the rude fashion usual with those to whom the irregular orthography of the English language has been familiar from childhood. Mr. Whipple thus describes the powers given to the vowel characters:

*a* is sounded as in *ah*.
*e* as in *me*; *ĕ* as in *met*; *è* as *a* in *fate*.
*i* as in *pine*; *ĭ* as in *pin*.
*o* as in *note*; *ŏ* as in *not*.
*u* as in *flute*.

In the orthography adopted for the later vocabularies (*scil.*, those of the Pacific Railroad Survey) greater precision was attempted, in accordance with the suggestions prefixed to the blanks alluded to. The system is thus described:

| | |
|---|---|
| *a* is sounded as in *father*; | *ă* as in *fat*. |
| *e* is sounded like *a* in *face*; | *ĕ* as in *met*. |
| *i* is sounded as in *marine*; | *ĭ* as in *pin*. |
| *o* is sounded as in *go*; | *ŏ* as in *got*. |
| *u* is sounded like *oo* in *food*; | *ŭ* as in *but*. |

* Collected by A. W. Whipple; classified, with accompanying remarks, by Wm. W. Turner.

(It will be found, however, that the sound of long *u*, or English *oo*, is often denoted by Mr. Whipple, especially at the beginning of a syllable, by the combination *ou*. This combination is also frequently used to represent the sound of the English *w*, or one very near it, as in the syllables *oui*, *oua*, for *wi*, *wa*.)

*ai* has the sound of the *i* in *line*.
*ow* or *ŏw* is sounded as in the word *now*. (The proper spelling would have been *au*.)
*g* is always hard, as in *go*.
*ch* or *tch* is sounded like *ch* in *church*, or *tch* in *witch*.
*qu* is pronounced as in *queen*.
*h'* prefixed to a word denotes a very strong aspiration.
*s'* prefixed shows that the word begins with a sharp, hissing sound.
*t'* prefixed indicates that the tongue is to be pressed forcibly against the teeth.

In the Comanche vocabulary, an apostrophe (') after a word denotes an almost inaudible grunt, so as to faintly sound the letter *i*. In Caddo, it signifies that the word is abruptly stopped.

In the Kichai and Hueco, *tc*, *tk*, or *tlk* is a click, made with the tongue against the roof of the mouth.

In the Navajo, *j* represents the sound of that letter in French.

In the Choctaw, the orthography of which is that established by the Mission, *au* is sounded like *ow* in *now*; *a*, *e*, *i*, *o*, *u*, when printed in italic letters, are nasalized; and *hl* denotes an aspirated *l*, like the *ll* in Welsh.

An attempt was made to reduce the orthography of all the vocabularies to a uniform and more strictly scientific system, correcting at the same time the irregularities observed in the application of the rules laid down; but, after a fair trial, it was abandoned as impracticable. Accordingly, the words are placed before the reader precisely as they were taken down on the spot, excepting that the acute accent, indicating the emphasized syllable, is the only one retained, and that, when the syllable ends in a consonant, the short mark over the vowel is usually omitted as unnecessary.

Had the vocabularies coincided completely, or nearly so, as to the words adopted, they would have been arranged together in one comparative table; but, from causes already mentioned, they vary so considerably—some being much longer, and others much shorter than the standard adopted for most of them, added to which there are many discrepancies in the choice of words—that it was found better to place each affiliated group by itself. The following is the order adopted, each group or single vocabulary being followed immediately by the remarks relating to it:

| | | | |
|---|---|---|---|
| I. Delaware. | Algonkin. | XIII. Kiwomi. | Keres. |
| II. Shawnee. | Algonkin. | XIV. Cochitemi. | Keres. |
| III. Choctaw. | | XV. Acoma. | Keres. |
| IV. Kichai. | Pawnee? | XVI. Zuñi. | |
| V. Huéco. | Pawnee? | XVII. Pima. | |
| VI. Caddo. | Pawnee? | XVIII. Cuchan. | Yuma. |
| VII. Comanche. | Shoshonee. | XIX. Coco-Maricopa. | Yuma. |
| VIII. Chemehuevi. | Shoshonee. | XX. Mojave. | Yuma. |
| IX. Cahuillo. | Shoshonee. | XXI. Diegeno. | Yuma. |
| X. Kioway. | | | |
| XI. Navajo. | Apache. | | |
| XII. Pinal Leño. | Apache. | | |

# ALGONKIN.

| | I. Delaware. | II. Shawnee. |
|---|---|---|
| God | ki-she-a-la-mŭc′-cong | ou-wis′-i-man-i-toh′ |
| Devil | math-tan′-to | match′-i-man-i-toh′ |
| Man | len′-no | il-le-ni′ |
| Woman | h'que′-'i | s'squaw-o-wah′ |
| Boy | pi-lai-e′-chit | s'sque-lai-thi-thah′ |
| Girl | quai′-chitz | s'squaw-the-e-thah |
| Infant, child | mi-e-min′-let | ah-be-lo-tha-ki |
| Father | nu′-uh | no-thah′ |
| Mother | gai′-ez | nīk-yah′ |
| Husband | oui-che′-ok | oui-se-ah′ |
| Wife | na-hŏw′-shum | ni-wah′ |
| Son | ni′-chat | ni-qui-thah′ |
| Daughter | dŏh-quai-chit′-chum | dah-nai-thah′ |
| Brother | ni′-mŏc-tŭs | jai-nai-nah |
| Sister | dŏh-quai′-em | nit-que-quai-o-mah′ |
| Indian | me-ŏh-ke-oh-cus′-sid | del-noi-eh′ |
| Head | ouil (or) wil | oui-i-si′ |
| Hair | mi-lah'k | oui-thai-ah′ |
| Face | ouis-king'h | e-shi-que-chi′ |
| Forehead | la-ohk-ka-lai′ | lah-oui-ki-leh′ |
| Ear | houit′-ow | h'tow-wa-cah′ |
| Eye | tŭk-que′-ling | s'ski-si-coh′, ski-she-quih′ |
| Nose | oui-ki′-o | ki-tschar-si |
| Mouth | oui-tun | ki-tor-ni′ |
| Tongue | oui′-la-no | ki-lar-ni′ |
| Tooth | oui-pi′-ta | ki-be-tar-leh′ |
| Beard | oui-tu′-na-yac | qui-ni′-lu-nar-o-lih′ |
| Neck | h'quai-can′-ya | k'quai-e-ka-ker |
| Arm | wa-nŭh'k′ | ki-neh-ki |
| Hand | pŭc′-ka-lenge | ki-leh-chi′ |
| Fingers | de-lo-i′-ka | ki-leh-chi′ |
| Nails | hi′-cath-shat | x-kas-sah′ |
| Body | hac′-cah | ni-i-yah′ |
| Belly | mut′-tai | beh-quoi-tah′ |
| Breasts | ..... | ul-le-ne′ |
| Man's privates | ..... | pas-sah-tih |
| Woman's do | ..... | mas-sih |
| Leg | hĭc′-cah | t'kar-chi′ |
| Foot | zit | ni-thi-chi′ |
| Toes | en-dŭs′-i-ak-sit-a′ | ni-thi-tah-lish′ |
| Bone | h'cun | h'kah-nih′ |
| Heart | hut-e′ | ki-te-hi |
| Blood | muk | ps'qui |
| Town, village | u-te′-na | ou-te-ou-wel′ |
| Chief | sa-ki′-ma | ou-ki-mah′ |

## ALGONKIN.—Continued.

| | I. Delaware. | II. Shawnee. |
|---|---|---|
| Warrior | ski′-no | ne-noth-tu′ |
| Friend | ni′-tis | ne-kah-noh′ |
| House, hut | ouig-wăm | oui-qu-ah′ |
| Cup | | tip-hi-cah′ |
| Kettle | wah-shum-oui-thŭc | s'couth-quoi′ |
| Bottle | | oui-tha-quuc-quoi′ |
| Arrow | a-lunth′ | il-le-na-lui′ |
| Bow | a-ta′-pe | il-le-nah-qui′ |
| Axe, hatchet | to-ma-hi′-ca | te-kah-ah-kur′ |
| Knife | shi′-ka | mah-ne-thi′ |
| Canoe, boat | mŏh-holdt | ou-la-kai-i-sih′ |
| Moccasins, shoes | chi-poth′-co | m'ki-thai-nah′ |
| Bread | hath-pon | te-whoir′ |
| Pipe, calumet | ha-bo′-ca | h'quoi-a-ker′ |
| Tobacco | qu-tschar′-tai | t'thai-a-mer′ |
| Sky | mu′-shuc-'qu | s'spem-e-ke |
| Heaven | ki-shel-a-me-cŏn′-gui | |
| Sun | kis-co-quit′-tah | ki-sah-thoi′ |
| Moon | ki′-shŭ'h | te-beth-ti-kish-thoi′ |
| Star | a-lanq' | ah-la-ah-quoi′ |
| Day | kis-qui'k | qui-si-qui′ |
| Light | o-he-e | te-o-pah′-cou-li′ |
| Night | pis-ke | te-beth-ki |
| Darkness | a-pis-ken-quei′ | pai-bai-ke-char′ |
| Morning | o′-pah | pi-ai-tah-cou-tha-mou′ |
| Evening | lo-qui′-ke | pak-e-se-mou |
| Spring | tup′-peg | me-loh-cak-me′ |
| Summer | ni′-pan | ni-pai-n'oui′ |
| Autumn | tah-co′-co | pah-co-tai′ |
| Winter | lu′-wan | pai-pou-n'oui′ |
| Wind | shăh′-han | p'si-cah-n'oui |
| Lightning | sāh-pe-le′-he-le | pah-pah-n'oui |
| Thunder | pe-tak′-han | nen-nem-ki |
| Rain | su′-ke-lan | que-mou-ah-n'oui |
| Snow | ku′-no | co-o-nah′ |
| Hail | hu′-co-me ha-pi′-he-le | p'ou-quoi-mah′ |
| Fire | tun′-dai'h | s'cou-te |
| Water | bih | ne-bi′ |
| Ice | cun | ki-pat-te-nui′ |
| Earth, land | huc′-ki | a-shis-ki′ |
| Sea | shŏh′-e-pe | k'chi-cak-mi′ |
| River | sik′-po | t'hi-bi′ |
| Creek, small river | | meth-te-qui |
| Lake | me-nĭp′-pek | p's-ske-o-qui′ |
| Valley | en-dŭsh-in′-geg | ki-kah-ka-mi-ka-tui′ |
| Hill | oh-chŭ′ | ma-quoi-ki |

## ALGONKIN.—Continued.

| | I. Delaware. | II. Shawnee. |
|---|---|---|
| Mountain | ki′-tŏh-ten | p's ske-mu-quoi-hi-ki |
| Island | mi-nah′-te | me-ne-thi′ |
| Stone, rock | ŏh-sen′ | she-quo-nur′ |
| Salt | si′-cai | |
| Copper | mŭh′-cŏh-sen | ou-thow-o-qu-quah′ |
| Iron | sŭh′-cŏh-sen | pou-cou-pe-lo-qui′ |
| Maize | hŭs′-quim | tar-mi′ |
| Tree | hic-tok | te-qui′ |
| Wood | tah′-ha-na | ut-e-qui |
| Leaf | cum′-buh-co | sis-qui |
| Bark | hŏk′-kes | ou-la-ge-qui′ |
| Grass | ski′-i-ko | p's qui-te-qua-loh′ |
| Oak | oui-pun′-go'k | wah′-bah-co-me-shi′ |
| Pine | ku′-we | s'she-quoi′ |
| Flesh, meat | oui-us′ | oui-or-thi′ |
| Beaver | te-mar′-que | er-meh-quoi′ |
| Otter | | quit-ta-teh′ |
| Deer | ah-tu′ | p'sceke-thi′ |
| Bison, buffalo | si-zil′-ia | p'thu-thoi |
| Bear | mŏh'q | pu-quoir |
| Wolf | tum-meh | ptwe-o-wa′ |
| Dog | mŏi′-ca-ne | with-si′ |
| Fox | ŏc′-quis | wa-cu-cha-thi′ |
| Squirrel | hah-nik | an-e-quoi |
| Rabbit, hare | chi-mam′-mŭs | pet-a-ke′-ne-thi |
| Snake | h'couke | man-e-toh′ |
| Bird | chu′-linth | ouis-ke-lo-tha′ |
| Egg | ŏr'l | oua-oui′ |
| Goose | ca-hawk′ | ska-ki′ |
| Duck | qui-e-quin′-go | shi-shi-a-pŭh′ |
| Chicken | ti-pas | |
| Pigeon | a-mi-mi′-yok | poi-i-tha-ki′ |
| Partridge | oui-e-lin-kin′-gok | que-qua-la-soi-tha-ki′ |
| Turkey | chi′-ke-no | pe-le′-o |
| Fish | la-mes′ | no-me-tha′ |
| White | o′-pe | wŭh′-ker-ne-kah′ |
| Black | sic′-ke | p'cat-e-wah′ |
| Red | mŏh′-ke | p'squaw-oui′ |
| Blue | ah′-ne | pski-pah-cah′ |
| Yellow | oui-sah′-e | ou-thow-wa′ |
| Green | as-cas′-que | pski-pah-cah′ |
| Great, big | hing′-que | psai-wi′ |
| Small, little | tan-ge′-to | match-squa-thi′ |
| Strong | chi′-ta-ne | oui-shi-cat-tu-oui′ |
| Old | ho′-eh | pas-shi-tu-e-tha′ |
| Young | ouis′-kŭn | mai-ah |

## ALGONKIN.—Continued.

| | I. Delaware. | II. Shawnee. |
|---|---|---|
| Good | shi′-e-ki | oui-sah′ |
| Bad | ta-cou′-le-tu′ | mat-ou-oui-sah′ |
| Handsome | wa-lis′-so | u-le-thi′ |
| Ugly | ma-ta-si′-so | mat-e-thi-i-thi |
| Alive, life | le-a-le′-i-he | li-nou-e-oui′ |
| Dead, death | ŭn′-ge-la | ne-poi′, chi-pah′ |
| Cold | tah-co′-cho | oue-bi |
| Warm, hot | slŭn′-de | ah-quoi-te-ti |
| I | ni | ni-la′ |
| Thou | ki | ki-lŭh′ |
| He | ne | yah-ma |
| We | ki-lo′-na | ni-la-weh′ |
| Ye | ki-lu-wa | ki-lŭh-weh′ |
| They | i-ka-li wi-ca′-tin | la-neh-ke |
| This | ŭ′-ne | la-yah-mah |
| That | se-e-nin-ne | la-nah |
| All | wai′-o-mi | tscha-yah-ki |
| Many, much | hai′-o-lok | met-chi′ |
| Who | ah-wen′ | ne-thow-we |
| Near | nic-hic-wa-ti-a-wen′ | ma-ketch-e-ne-lu |
| Over | | kit-te |
| To-day | u-que-kis-qui'k | e-no-ke-kah-she-ki-ki′ |
| Yesterday | lo′-que-e | u-la-o-co |
| To-morrow | ah-lŭp′-a | wah-pah-keh′ |
| Yes | co-hŭn′ | hah-hah′ |
| No | ha-cou′ | mat-tah′ |
| And | ŏh (a mere grunt) | |
| Times, (Fr. *fois*) | tŭm | |
| One | co′-te | ne-co-ti |
| Two | ni′-sha | ni-e-sui |
| Three | na-ha′ | t'thoui′ |
| Four | ne′-e-wah | ni-e-oui′ |
| Five | pah-le′-nah'k | ni-ah-la-nui |
| Six | cot′-tasch | ni-co-toi-thi |
| Seven | ni′-shasch | ni-shaw-thi |
| Eight | hahsch | t'tha-shik-thi |
| Nine | pes′-co | tcha-cat-thi |
| Ten | te′len | met-a-thi |
| Eleven | te-len-ŏh-co′-te | kit-te-ne-co-ti′ |
| Twelve | te-len-ŏh-ni-sha | kit-te-ni-e-sui |
| Thirteen | te-len-ŏh-na-ha′ | kit-te-t'thoui |
| Twenty | ni-shi′-na-ki | ne-suoi-pit-a-ki |
| Twenty-one | ni-shi-na-ki-ŏh-co-te | ne-suoi-pit-a-ki-te-ne-co-ti |
| Twenty-two | ni-shi-na-ki-ŏh-ni-sha | |
| Thirty | na-ha-te-len | t'thoi-pit-a-ki |
| Forty | ne-e-wah-te-len | ni-e-oi-pit-a-ki |

ALGONKIN.—Continued.

| | I. Delaware. | II. Shawnee. |
|---|---|---|
| Fifty | pah-le-nah'kt-te-len | yah-ba-noi-pit-a-ki |
| Sixty | cot-tasch-ten-te-len | ne-co-toi-a-shi |
| Seventy | ni-shasch-ten-te-len | ne-shoi-a-shi |
| Eighty | | thaw-a-shi′ |
| Ninety | | tscha-a-ka′ |
| Hundred | te-len-tŭm-te-len | te-pe-e-weh′ |
| Thousand | quo-tun-te′-len-tah'p′-puc-ki | meta-the-ne-the-pe-a-weh′ |
| Eat | mit′-se | oui-then-e-luh′ |
| Drink | men-el′ | men-e-luh |
| Run | k'schaw-meth′-en-la | me-me-qui-luh |
| Dance | ken′-te-kah, | men-i-e-de-luh′ |
| Gō | at-lump′-scha | weh-pe-theh |
| Come | wŭn-da-hal′ | pe-e-wah′ |
| Sit | la-mŏt′-hath-po | |
| Stand | ni-po | |
| Sing | a-su′-elthl | na-ca-mo-loh′ |
| Sleep | cah-wil | ne-pah-loh |
| Speak | a-chi′-mouil | atch-mo-loh |
| See | ki-ne′-o | ni-ne-e-meh′ |
| Love | da-how′-i-la | dah-que-le-mah |
| Kill | t'hi′-la | tschi, tsi |
| Walk | mūs-cah | pam-the-loh′ |
| Bury | | ne-pe-ka′ |
| Who is that? | ah-wen-hutch-nah? | |
| Black Beaver | Sec-sid Te-mar′-que | |
| Canadian river | | Ki-ne-e-ti′ |

Remarks.

*Delawares* (*Le-ná-pe*).—According to Mr. Gallatin, the Delawares belong to the Eastern or Atlantic, and the Shawnees to the Western division of the Algonkin stock. The remnants of these two once powerful tribes are now located north and south of the Kansas river.

A number of vocabularies of the *Delaware* language have already been published from time to time; but this does not render the collection and publication of others undesirable. The old vocabularies are, for the most part, very imperfect; the selection of words is not well made, their orthography is rude and ambiguous, and they are often disfigured by errors of the press. Accordingly, until such time as the whole treasures of the language are collected in a dictionary, it is desirable that new vocabularies, drawn up on improved principles, should be constructed and accurately printed as occasions present themselves; for, besides that each new one supplies some deficiency, corrects something erroneous, or decides something dubious in preceding ones, a comparison of the later with the earlier specimens of the language may be expected to throw light on the changes it has undergone.

Mr. Whipple's vocabulary, which was obtained from a chief of the tribe, named Black Beaver, agrees remarkably, allowing for differences of hearing and spelling, with those in Gallatin's Synopsis of the Indian Languages, and in the second volume of Schoolcraft's History, Condition,

and Prospects of the Indian Tribes, now publishing under the direction of the Bureau of Indian Affairs.

The following plural formations are given by Mr. Whipple:

| | | | |
|---|---|---|---|
| a-lanq' | star. | zit | foot. |
| a-lan-goque | stars. | zit-a | feet. |
| a-lunth' | arrow. | de-lo-i-ka | finger. |
| a-lunth-al | arrows. | duth-the-a-co-lan-gar | fingers. |

According to Zeisberger, the plural terminations in the Delaware language are: animate, *ak;* inanimate, *all.* This accounts for the two first examples, *star* being classed with animate nouns; the other two need explanation.

*Shawnees* (*Sow-on-no,* plur. *Sow-on-o-ki*).—Mr. Whipple says: "Considerable intimacy exists, and intermarriages occur, between the Shawnees and Delawares. There is also some resemblance in personal appearance, both wearing the moustache."

The Shawnee vocabulary, like the Delaware, will be of use to show the changes which the language may have undergone. It was obtained from one of the tribe, and agrees very closely with that in Gallatin's Synopsis, which, however, is made up from several sources, and is very imperfect; where the two appear to differ, a comparison with that in the second volume of Schoolcraft's work will clear up the apparent discrepancies.

The following plural formations are given:

| | | | |
|---|---|---|---|
| Man | il-le-ni | *plur.* | il-le-ni-ki. |
| Leaf | p'sis-keh | " | p'sis-ke-a-ki. |
| Foot (my) | ni-thi-chi | " | ni-thi-tah-lish. |
| Bone | h'kah-nih | " | h'kah-ne-lish. |
| Shoe | ho-quoi-thow-weh | " | he-quoi-thou-weh-nah. |
| Tree | te-qui | " | te-cou. |

These agree with the statement of Vater in the Mithridates. He says: "The usual plural ending is *lic.* In some words I find *kie, chie,* or *enna.*"

It will be observed that the accent is almost invariably on the final syllable.

# CHOCTAW.

| | III. Choctaw. | | III. Choctaw. |
|---|---|---|---|
| God | chi-to′-ka-ka (the great one) | Warrior | tŭsh-ka |
| Devil | shi-lom′-bish ok-pu′lo (spirit bad) | Friend | *i*-ka-na (his-friend) |
| | | House, hut | chu-ka |
| Man | ha′-tak | Kettle | a-so′-nek |
| Woman | o-ho′-yo | Arrow | us′-ki na′-ki (cane bullet) |
| Boy | ŭl-la nak′-ni (child male) | Bow | i-ti ta-nam′-po (wood gun) |
| Girl | ŭl-la tek (child female) | Axe | is-ki′-fa |
| Infant | ŭl-lo-si | Hatchet | is-ki-fu′-shi |
| Father | *i*′-ke | Knife | bŭsh′-po |
| Mother | ish′-ke | Canoe | pe-ni |
| Husband | *i*-ha′-tak (her-man) | Boat | i-ti ku-la (wood dug-out) |
| Wife | tek′-chi | Indian shoes | shu′-lush |
| Son | u′-shi | Bread | pŭs-ka |
| Daughter | u-she′-tik | Pipe, calumet | hak-chu-ma a sh*u*-ka (tobacco where smokes) |
| Brother | i-ti-ba-pi′-shi (together suck) | Tobacco | hak-chu-ma |
| | | Sky, heaven | shu′-tik |
| Sister | *i*-tek (his sister) | Sun | hŭ′-shi |
| An Indian | ha′-tak ŭ-pi hom′-ma (man trunk red) | Moon | hŭsh ni′-nak *a*′-ya (sun night goes-along) |
| Head | nish-ko-bo | | |
| Hair | p*a*-shi | Star | fi′-chik |
| Face | na-shu′-ka | Day | ni′-tak |
| Forehead | i-bi-tak′-la | Light | toh-wi-ke′-li |
| Ear | hak′-so-bish | Night | ni′-nak |
| Eye | nish′-kin | Darkness | ok-hli-li |
| Nose | i-bi-shak-ni | Morning | on-na-hin′-li |
| Mouth | i′-tih | Evening | o-pi-a |
| Tongue | i-sun-lush | Spring | to-fah′-pi (first-of-summer) |
| Tooth | no-ti | Summer | to′-fah |
| Beard | nu-tak′-hish | Autumn | hŭsh-to-lah′-pi (first-of-winter) |
| Neck | i-kon′-la | | |
| Arm | shak-ba | Winter | hŭsh-to-la |
| Hand | ib′-bak | Wind | mah′-li |
| Fingers | ib-bak u′-shi (hand sons-of) | Lightning | ma-but′-ha |
| Nails | ib-bak chush | Thunder | hi-lo′-ha |
| Body | hak′-nip | Rain | um′-ba |
| Belly | ik-fo-ka | Snow | ok-tu′-sha |
| Leg | i-yi | Hail | ha-t*a*′-fo |
| Feet | i-yi | Fire | lu-ak |
| Toes | i-yu-shi (foot-sons-of) | Water | o′-ka |
| Bone | fo-ni | Ice | ok-ti |
| Heart | ch*u*′-kŭsh | Earth, land | yak′-ni |
| Blood | is′-sish | Sea | ok-hŭ-ta |
| Town, village | tŭm-a-ha | River | ok-hi-na (water-road), bok |
| Chief | m*i*′-ko | Lake | ok-hŭ-ta |

## CHOCTAW.—Continued.

| | III. Choctaw. | | III. Choctaw. |
|---|---|---|---|
| Valley | ok′-fa | Yellow | lak-na |
| Hill | nŭ′-nih | Pale green | ok-cha′-ko |
| Mountain | nŭ-nih cha′-ha | Bright green | kilăk-o′-ba |
| Island | ta-sha′-yi. | Great, big | chi-to |
| Stone, rock | tŭ′-li | Small, little | is-ki-ti′-ni |
| Salt | hŭ′-pi | Strong | kŭl′-lo |
| Copper | a-so′-nak lak-na | Old | si-pok′-ni |
| Iron | tŭ′-li | Young | hi-mit′-ta |
| Maize | tan′-chi | Good | a-chuk′-ma |
| Tree | i′-ti | Bad | ok-pu′-lo |
| Wood | i′-ti | Handsome | pi′-sa a-chuk′-ma (to-see good) |
| Leaf | i-ti hi-shi (tree hair) | | |
| Bark | hak-shup | Ugly | pi′-sa ik a-chuk′-ma (to-see not good) |
| Grass | ha′-shuk | | |
| Oak | nu-sŭ′-pi | Alive | ok-chα-ya |
| Pine | ti-ak | Dead | il′-li |
| Flesh, meat | ni′-pi | Cold | ka-pŭs′-sa |
| Beaver | kin-ta | Warm | li-bi′-sha |
| Deer | is-si | Hot | lŭsh-pa |
| Bison, buffalo | ya′-nŭsh | I | ŭ′-no |
| Bear | ni′-ta | Thou | chish′-no |
| Wolf | na-sho′-ba | We (exclusive) | pish′-no |
| Dog | o′-fi | We (inclusive) | hŭ-pish-no |
| Fox | chu′-la | Ye | hŭ-chish-no |
| Squirrel | fŭ′-ni | This | i-lŭp-pa |
| Rabbit | chuk′-fi | That | yŭm-ma |
| Hare | pŭ-ta kŭt-ta | All | mo-ma |
| Snake | sin′-ti | Many, much | lau-a |
| Bird | hu′-shi | Who? | kŭ′-ta |
| Feather | shi-ko-pa | Near | o′-lan-li |
| Wings | sa-nah′-chi | To-day | hi-mak ni-tak (now day) |
| Egg | u-shi lo-bun-chi | Yesterday | pi-la-shash |
| Goose | shi-lak-lak | To-morrow | ou-na-ha |
| Duck | ok-fi-chush | Yes | yaw |
| Pidgeon | pŭ-chi | No | ke-yu |
| Partridge | ko-fi chi-to (quail big) | Name | hoh-chi-fo |
| Turkey | fa′-kit | Affection | isht-*i*-hol-lo |
| Fly | shu′-shi | One | a chŭ′-fa |
| Mosquito | i-sa-pun′-tak | Two | tuk-lo |
| Tortoise | ha-cho-tak′-ni | Three | tu-chi-na |
| Fish | nŭ′-ni | Four | ush-ta |
| White | toh′-bi | Five | ta-hla-pi |
| Black | lu′-sa | Six | ha-na-li |
| Red | hom′-ma | Seven | un-tuk-lo |
| Deep blue | ok-cha-ma′-li | Eight | un-tu-chi-na |
| Pale blue | ok-cha′-ko | Nine | cha-ka′-li |

## CHOCTAW.—Continued.

| | III. Choctaw. | | III. Choctaw. |
|---|---|---|---|
| Ten | po-ko-li | Eat | im′-pa |
| Eleven | au-ah-chŭ-fa | Drink | ish′-ko |
| Twelve | au-ah-tuk-lo | Run | ma-le-li |
| Thirteen | au-ah-tu-chi-na | Dance | hi′-hla |
| Twenty | po-ko′-li tuk-lo | Go | i′-a |
| Twenty-one | po-ko-li tuk-lo a-ku-cha a-chŭ-fa | Come | min-ti (to start off), ŭ-la (to arrive) |
| Twenty-two | po-ko′-li tuk-lo a-ku-cha tuk-lo | Sit | bi-ni-li |
| | | Stand | hi-ki-a |
| Thirty | po-ko′-li tu-chi-na | Sing | ta-li-a |
| Forty | po-ko′-li ush-ta | Sleep | nu-si |
| Fifty | po-ko′-li ta-hla′-pi | Speak | a num-pu′-li |
| Sixty | po-ko′-li ha-na-li | See | pi′-sa |
| Hundred | ta-hle′-pa | Love | ho li-tob-li |
| Thousand | ta-hle′-pa si-pok-ni (hundred old) | Kill | ŭ′-bi |
| | | Walk | no′-wa |

### Remarks.

*Choctaw* (Missionary spelling, *Chăh-ta*).—This vocabulary is drawn up by the Rev. Cyrus Byington, who has resided over forty years as a missionary among this people. He has written the only grammar that exists of the language; and this, together with a dictionary, he is now engaged in preparing for publication.

The vocabulary is essentially the same as that derived by Mr. Gallatin from the Rev. A. Wright's Spelling-Book. The orthography, however, which is the excellent one of the late Mr. Pickering, is more correct and uniform, and the analysis of compound terms is both interesting and instructive. The terms "sons of the hand" for *fingers*, "tree-hair" for *leaves*, "water-road" for *river*, "night-travelling sun" for *moon*, by showing the manner in which these familiar objects are regarded, so different from our conceptions, and so poetically original, make us better acquainted with the native mind, by affording some glimpses of its operations. From the expressions "cane-bullet" for *arrow*, and "wooden gun" for *bow*, it would appear that these primitive implements have been so long out of use in the tribe that their original names have been forgotten. These analyses show us, moreover, something of the grammatical structure of the language: they show us that the members of a compound term bear the same relative position to each other that they do in English, as *iti-hishi*, tree-hair; that if two vowels concur, the first is elided, as *iyushi*, toes, from *iyi*, foot, and *ushi*, son; that possessive pronouns are placed, as in English, *before* the noun to which they belong, as *i-kana*, his friend; and that adjectives, on the contrary, are placed *after* their nouns, as *kofi chito*, partridge (lit. big quail).

This analysis of compound terms is so absolutely necessary to an intelligent comparison of vocabularies, that when we are ignorant of the elementary terms which enter into the composition of words, we feel that, in attempting such comparisons, we are constantly treading on uncertain ground. The reason is, that cognate tribes, whose languages are radically the same, will not unfrequently invent totally different sets of expressions for the same objects, in consequence of regarding them from different points of view, and thus greatly obscure the connexion of the languages to the observer who looks upon each word as an undivided whole.

## PAWNEE(?).

| | IV. Kichai. | V. Hueco. |
|---|---|---|
| God | ah-ho′-ki-tou | kid-i-ash′-i-kitz |
| Devil | wit-ar-e-ki-te | |
| Man | cai-u-qua-no′-quts | to′-de-kitz |
| Woman | chĕ-quoike′ | cah′-he-ic |
| Boy | chōts′-kek | wex′-e-ki |
| Girl | cha′-kitsk | chad′-ax-e-ki |
| Infant, child | cha′-wa-dotz | we′-di-kitz |
| Father | | tad′-da |
| Mother | chache | ats′-iâ |
| Husband | | nŭt-te′-ki-di |
| Wife | | nŭt-te′-o-ki |
| Son | chi-wa′ | nŭt-te-ya′-hi |
| Daughter | chōs | nŭt-te-re-wa′-was-ki |
| Brother | | nŭt-tŭt-re-at-si |
| Sister | | nŭt-te-tat-si |
| Indian | | ni-hash-quatz |
| American | In′-ni-kin-nish | |
| Head | qui′-tat-so | at-ski-es′-ta-cak |
| Hair | it′-sco-so | ish-ke′-ste-atz |
| Face | it′-scot | ich-cŏh′ |
| Forehead | ni′-cŏk-hen′-ne | ni-cŏk |
| Ear | a′-tik-o-ro-so | ortz |
| Eye | qui′-di-e-co | ki′-dik |
| Nose | chus′-ca-rai-o | tisk |
| Mouth | hŏk′-in-nik | ah′-cok |
| Tongue | hah′-tok | hŏtz |
| Tooth | ath′-ne-sho | ah-tk′ |
| Beard | hah′-ca-rai-us | kid-e-wek′-ste-ask |
| Neck | qui′-tot-hen-ne | ke-tisk′ |
| Arm | he′-te-que-o | weh |
| Hand | ich′-shen-e | isk'tc |
| Fingers | its-squit-a-he′-ok | is-kitz′-ĕ |
| Nails | x'-squi′-e-to | is-quitz |
| Body | to′-na-no | kek |
| Belly | can′-na-hen-ne | co′-wesh |
| Leg | | cŏsh |
| Thigh | kŭs-in′-ic | |
| Calf (of leg) | kish-ta-to | |
| Foot | ŭs-in′-ic | ŏs |
| Toes | ŭs-quits-ats-hen-e | ŏs-kitz |
| Bone | | ŏs-tots-kesk (ankle-bone) |
| Heart | ki-shi-ke′-e-to | shi-kitz |
| Blood | | watz-kitz |
| Town, village | | ed-a-ta′-cuc-ki |
| Chief | | e′-kĕr-quash, ē-de |

## PAWNEE.—Continued.

| | IV. Kichai. | V. Hueco. |
|---|---|---|
| Warrior | | e-de-ar′-te-da |
| Friend | | e-ta-tatz′-wŭs-tuc-e |
| House, hut | | ŭ-cah′ |
| Kettle | | ech-cŭr-resh |
| Arrow | | te′-quatz |
| Bow | | kchets |
| Axe, hatchet | | ta-ha-kes′ |
| Knife | | ta′-ha |
| Canoe, boat | | ar-ke-os |
| Shirt | oh-ca-we′-o-no | |
| Indian shoes | | ŏs-set |
| Bread | | kid-es-cod-es |
| Ring | tscho-coi-ta-ria | |
| Pipe, calumet | qui′-o-cak | weh-ketz |
| Tobacco | | weh′-ec |
| Sky, heaven | | ŭs′-cah |
| Sun | | sah′-ki |
| Moon | | mŏr |
| Star | | he′-qui-dic-co |
| Day | | toc’ |
| Light | | wah-quish |
| Night | | hitz |
| Darkness | | wich-tah′-cu-cŏs |
| Morning | | hah-dĕ′-ten-ne |
| Evening | | ŭl-la-shoh-kesk |
| Wind | | du-ĕh |
| Lightning | | ŭd-du-wŏk’ |
| Thunder | | te-kin-nicksh |
| Rain | | tah-hai-dŭsh |
| Snow | | hid-ork’ |
| Fire | ye′-ce-ni′-e-to | hatz’ |
| Water | ki′-o-kōh | kits′-ah |
| Ice | | dŏh-hitz-e |
| Earth, land | | hi-dŏw′-at |
| Sea | | tets-kit-sŭs |
| River | | tŭts-pid′-e-wa-sa |
| Lake | | e-cu′-ak |
| Valley | | stĕr′-e-co-ta′-hitz |
| Hill | | ke-es-tid′-e-kit-squa |
| Mountain | | tŭts-kid-e-wa-squa |
| Island | | kit-ti-kitz |
| Stone, rock | | i′-coh’ |
| Copper | | a-quitz′-is-quatz |
| Iron | | a-quitz′-is-cŭt |
| Maize | | task |

## PAWNEE.—Continued.

| | IV. KICHAI. | V. HUECO. |
|---|---|---|
| Tree | | ha-tq |
| Grass | | hŏd-itz |
| Sumach | | wah′-hah-tŭt-se |
| Flesh, meat | | ŭd′-ĕrsh’ |
| Beaver | | ki-tish′-ca-ta-its |
| Deer | | dŏh’ |
| Bison, buffalo | | tad’ |
| Bear | | wid-oc’ |
| Wolf | | kit′-tux |
| Dog | | kit-si′-el |
| Fox | | ke-tŭc-kesh |
| Squirrel | | watz′-ah’ |
| Rabbit, hare | | co′-kish |
| Snake | | e-chach′-cŭr-ri-kitz |
| Rattle-snake | ki′-nitz | he′-ich |
| Bird | | et′-sit |
| Fish | | catz |
| White | | a-ha′-cŭtz |
| Black | | a-ha′-cod-i |
| Red | | a-with-quach |
| Yellow | | chish |
| Green | | a-had-os-kitz |
| Great, big | | tatz-tid′-e-watz |
| Small, little | | te-eth-tid′-e-kitz |
| Good | scoo-no-nia | ŭt′-stetz-i |
| Cold | | kitz-i-te′-oc’ |
| Yes | ah-i′, wah-tlk | a-he′ |
| No | ho-ŏh′ | kid′-de |
| One | a-rish′-co | cheos |
| Two | cho′-sho, cho′-so | witz |
| Three | tah′-with-co. | tŏw |
| Four | kith-nŭc′-o-te | tah′-quitz |
| Five | xs’tŏw-e-o | ish′-quitz |
| Six | na-hi-tŏw | ki′-ash |
| Seven | tsŏw′-e-ta-te | ki-o′-whitz |
| Eight | nai-ki-nŭc-a-te | ki-a′-tŏw |
| Nine | tan-i-ro-kat | chosh-kit-te |
| Ten | x’s-ka-ni | skit-te-was |
| Eleven | x’ka-ni-a-ni-ni-a-rish-co | che-os-te-kit-te |
| Twelve | x’ka-ni-a-ni-ni-cho-so | witz-chitz-e-dach |
| Thirteen | x’ka-ni-a-ni-ni-tah′-with | tow-a-titz-e-dach |
| Twenty | a-ris-qui-ni-ke′-ri-co | steds-ki-shi’ |
| Twenty-one | a-ris-quin-i-ke-ri-co-a-ni-ni-a-ris-co | steds-ki-shi-che-o-te-kit-te |
| Twenty-two | a-ris-quin-i-ke-ri-co-a-ni-ni-cho-so | steds-ki-shi-witz-titz-a-dad’ |
| Thirty | tah-with-quin’n’ | ŏs-teds-ki-shi-tith-kitz-i |
| Forty | | witz-steds-ki-shi |

## PAWNEE.—Continued.

| | IV. KICHAI. | V. HUECO. |
|---|---|---|
| Fifty | | witz-steds-ki-shi-tith-kitz |
| Sixty | | tow-witz-steds-ki-shi |
| Seventy | | tow-witz-steds-ki-shi-tith-kitz |
| Eighty | | tow-quith-teds-ki-shi |
| Ninety | | tow-quith-teds-ki-shi-tith-kitz |
| Hundred | | squets-tetz-ki-sha |
| Thousand | | teth-kitz |
| Sleep | | te-hed′-its-cos |
| Sit down | na′-oui | |
| Canadian river | Kit′-sa-te | |
| Hueco river | | Tal′-le-wit-sŭs |

### REMARKS.

*Kichais* (*Keechies*, *Kechies*).—"They live," says Mr. Whipple, "on the Canadian river, near Choteau's old trading-house. Since he was killed, the place has been entirely in their possession. The tribe is supposed to contain no more than five hundred warriors, perhaps less." Captain Marcy places the number at only about one hundred.

*Huecos*.—The name is Spanish, and is sometimes corrupted by our writers into *Wacoes*. The native appellation, according to Mr. Whipple, is *Tal′-le-wit-sus*. The Hueco and Witchita villages are located near each other, between the Washita and Red river, in about W. long. 98° 20′. "The Wacos," says Captain Marcy, "live about a mile above the Witchitas, in a village constructed precisely like the other. There are twenty lodges in this village, and about two hundred souls; their habits and customs are similar to the Witchitas, with whom they frequently intermarry, and they are upon the best and most friendly terms." (Exploration of the Red river of Louisiana, p. 78.)

The Huecos and Witchitas are said by Gregg to have received, in consequence of their profuse tattooing, the name of *Pawnee Picts*. Hence it is probable that they are remnants of the Pawnees or Towiaches of Red river, described by Dr. Sibley. And these latter, from the former of their two names, have been supposed (though this, in the absence of specimens of their language, has been doubted) to be a branch of the great Pawnee nation, whose home is on the Platte and Kansas rivers. The accompanying Kichai and Hueco vocabularies, both obtained from individuals of these tribes, and the first ever published, enable us to make a comparison with the Pawnee proper; the result of which is that these languages really do, in all probability, belong to the Pawnee stock. For the purpose of this comparison, a few words are selected from the Pawnee vocabulary of Dr. Say (with the orthography slightly altered) and the Riccaree (or Black Pawnee) of Prince Maximilian. The Witchita vocabulary of Captain Marcy, which I was formerly unable to place, here also finds its appropriate location.

| | PAWNEE. | RICCAREE. | KICHAI. | WITCHITA. | HUECO. |
|---|---|---|---|---|---|
| Woman | tsa-pat | sapá | che-quoike | kah-haak | cah-he-ic |
| Mother | a-ti-rah | schächti | cha′-che | nut-ti-co-hay′-he* | ats′-iâ |
| Ear | at-ka-ru | atkahähn | a′-tik-o-ro-so | | ortz |
| Nose | tshu-shu | siniht | chus-ca-rai-o | duts-tis′-toc* | tisk |

| | Pawnee. | Riccaree. | Kichai. | Witchita. | Hueco. |
|---|---|---|---|---|---|
| Mouth ... | tska-u..... | hah-káu ..... | hok-in-nik ..... | hāw-coo* ..... | ah′-cok |
| Tongue.. | ha-tu ..... | háh-tu. ..... | hah′-toh ..... | hutske*..... | hŏtz |
| Hand .... | ik-shi-ri ..... | éschu..... | ich-shen-e..... | sim-he′-ho*..... | isk'tc |
| Foot..... | ash-u ..... | ..... | ŭs-in′-ic..... | dats′-oske* ..... | ŏs |
| Sun..... | sha-ko-ru..... | scha-kúhn ..... | ..... | kee′-shaw..... | sah′-ki |
| Water ... | kīt-su ..... | stóh-cho ..... | ki′-o-koh..... | keetche ..... | kits-ah |
| Dog ..... | a-sha-kish..... | chahtsch..... | ..... | keetch′-ah..... | kit-si′-el |
| Black .... | ka-tīt..... | tecatéh..... | ..... | co′-rash ..... | a-ha′-cod-i |
| One ..... | as-ku..... | áchku..... | a-rish-co..... | cha′-osth..... | cheos |
| Two..... | pīt-ku..... | pittcho..... | cho′-sho..... | witch..... | witz |
| Three.... | tau-wīt..... | táh-uitt ..... | tah′-with-co..... | taw-way ..... | tow |

* The Witchita words marked with an asterisk are from Schoolcraft's Hist., Cond., &c., V., 709 ; the rest are from Marcy's Exploration of the Red River.

# CADDO.

| | VI. Caddo. | | VI. Caddo. |
|---|---|---|---|
| Man | su′-oui | White | hŭc′-ca-io |
| Woman | nŭt′-ti | Great, big | hai-mai |
| Boy | si′-ast-si | Small, little | hŭp′-pŭn-nŭs-chik |
| Friend | te′-i-sa | Strong | hai-cai |
| Water | cŏr′-co | Old | hŭn′-nis-ti |
| Maize | ki-sĭ′′ | Good | ha′-hŭt-ti |
| Deer | ’n-da′ | Cold | hac′-co-ho-do′′ |
| Bison, buffalo | tŏu′-na-ha | Many, much | y-ah′ |
| Bear | nort′-si’ | Near | pit-tith′-ti |
| Wolf | ya′-ha | To run | pa-ta-ni′ |

## Remarks.

The *Caddos*, says Mr. Whipple, live on Red river. The tribe is small. (According to the latest information, the whole number of the Anadahkoes, Caddoes, and Ionies, is but 500 souls.) They wear clothes, and look like Delawares. They have many guns. Their bows and arrows look like those of the Comanches.

The vocabulary—of only twenty words—agrees well, as far as it goes, with that of Gray in Gallatin's Synopsis, and that of Marcy in the fifth volume of Schoolcraft's great work. Dr. Sibley, in speaking of the "Keyes or Keychies," says they "have their peculiar native language, but mostly now [1805] speak Caddo, intermarry with them, and live together in much harmony." These, as well as several other nations on like terms of intimacy with the Caddoes, he says, "look up to them as their fathers, and join them in all their wars." Hence Dr. Vater considers that their languages, though now different, had probably a common origin with the Caddo. Whether the following resemblances to languages of the Pawnee stock are owing to such relationship, or to long and intimate intercourse, is, for the present, left undetermined.

| | Caddo. | Pawnee Affinities. |
|---|---|---|
| Tongue | hahdehto | hatu (Pawnee), hahtu (Riccaree), hahtok (Kichai) |
| Sun | sako | shakoru (Paw.), shakoona (Ric.), sahki (Hueco) |
| Water | koko | kiokoh (Kich.) |
| Stone | see eeko | icoh (Hueco) |
| Two | behit | pitku (Paw.), pitco (Ric.), witch (Witchita), witz (Hueco) |
| Three | daho | tauwit (Paw.), towwit (Ric.), taway (Wit.), tow (Hueco) |

# SHOSHONEE.

| | VII. Comanche. | VIII. Chemehuevi. | IX. Cahuillo. |
|---|---|---|---|
| God | | pu-ant′ | hem′-nok |
| Devil | | | te′-o-lŭv-el |
| Man | den′-nath-pŭk | ta-watz′ | na′-ha-nes |
| Woman | wai′-ith-pŭk | ma-ru′-qua | ni′-kil |
| Boy | tu′-i-nŭth-pŭk | ai′-patz | ke′-at |
| Girl | teith′-tuch-te wai′-ith-pŭk | nai-its′-it | i′-nis-mal |
| Infant, child | ŏh′-nah | | pa′-nis-pu′-li |
| Father | ni-ah′-pŭk (my) | mu′-o | ne′-na |
| Mother | ni-bi′-a " " | | ne′-yĭh |
| Husband | ni-wuth′-nuth-pŭk " | | nō-wel′-is-u |
| Wife | ni-qu′-ŭr " | | mu-ke′-a-di |
| Son | ni-e-tu′-er " | | no-mail′-yo |
| Daughter | ni-ve′-ti " | | e-mail′-yo |
| Brother | ni-a-tam-i " | par-vitch′ | nac′-is |
| Sister | ni-nŭm′-mi " | | ni-yul′ |
| An Indian | a′-ta-bitz | nin | ta′-hal-shut |
| Head | pa′-pi | mu-ta′-co-wa | ni-yul′-u-ka |
| Hair | pa′-pi | tor-pip′ | pi′-i-ki |
| Face | cai′-if | co-ba′-nim | ne′-push |
| Forehead | | mu-ta′-can | nu-i′-yi |
| Ear | nŭk′ | nan-ca′-ba | na-nŏck′-a |
| Eye | u-pou′-i | pu-oui′ | na′-push |
| Nose | mo′-bi | mu-vi′ | ne′-mu |
| Mouth | tŭp′ | tim-pou′-o | ne-tam′-a |
| Tongue | e′-con | a-go′ | ne-nŭn |
| Tooth | tam′-an | tow-wa′ | ne-tam′-a |
| Beard | o-mŏrtz′-ŏn | mut-za′ | nul-tam′-an |
| Neck | o-toi′-yop | cu-ran′-nim | nu-cus′-pi |
| Arm | per′-don | an-ga′-wa-nim | ne-mŏk |
| Hand | o-math′-pan | ma-si′-wa-nim | ne-mo-hem′-osh |
| Fingers | o-mŏh′ | | ne-mo-aks′-o-wish |
| Thumb | | ma-to-wa-nim | |
| Fore finger | | ma-cou-yo | |
| Middle finger | | ma-ou-ra-nim | |
| Third finger | | ou-win-e-re-itch | |
| Little finger | | ma-cou′-a-wi-nim | |
| Nails | o-mas′-it | ma-dit-som | ne-mo-nim′-yo-mim |
| Body | | nu-a′-nim | ne′-to |
| Belly | pis′-po, u-sap′ | sha-pu′-nim | ne-ti-i |
| Leg | u-tŏh′-hŏb | pun-ca′-wim | ni-chi′-na |
| Foot | na′-pe | nam′-pan | ne′-ik |
| Toes | | ta-pun′-ie | ne-sal′-o |
| Bone | suf′-nip-a | mai-i′-gan | ne′-ta |
| Heart | o-pih′′ | pi-in′ | ne′-sun |
| Blood | pŭh′-pis-ta | pai′-i-pi | ne′-o |

## SHOSHONEE.—Continued.

| | VII. Comanche. | VIII. Chemehuevi. | IX. Cahuillo. |
|---|---|---|---|
| Sweat | | pah-ca′-ba | |
| Town, village | sōh′-ti-cath-ni-ca-ti′ | car-nia, cut′-can | mi′-bi-pe-bo-kish′ |
| Chief | tek′-huen-e-wŭp’ | to-wŭn′-io | net′-i |
| Warrior | na′-bi-te-cot | now′-i-qui | wil′-nit |
| Friend | hai′-ich | te′-gi-bu | ne-tath′-lo |
| House, hut | cah′-ne | ca′-ni | kish |
| Kettle | pi-mo-ro′ | pam-pu′-ni | me′-to-wil-kish′ |
| Arrow | pa′-can | nu | hul |
| Arrow point | | ou-nap′-pe | |
| Bow | hu′-et | atz | chu-quil′-no-pish |
| Gun (rifle) | pi′-ai-et | | |
| Axe, hatchet | ho-wŭn-ni | ta-ca′-be-ne-pa | tu-qush′ |
| Knife | wih’ | ouitz | tu-qush′ |
| Canoe, boat | | pah-ga′-ba | kel′-o-wŭt |
| Ship | qua′-ha-di | | |
| Moccasins | nap’p | pah-gap′-a | ne-wak′-a |
| Bread | ti′-a-sath-ta | sah-mit′-i-wap | sa′-wish |
| Pipe, calumet | tŏh′-i | tshu | yu′-lil |
| Tobacco | pah′-mon | co-ap′-e | pi′-bŭt |
| Sky, heaven | | tu-up′ | tu-qush-a′-mi-ca |
| Clouds | tom′-ork | | |
| Sun | tab’b | ta′-ba-putz | ta′-mit |
| Moon | měn′-i | mi-a′-go-ro-pitz | men′-yil |
| Star | tatz′-i-no’p | put′-sip | che′-hi-am |
| Day | hues-tai′ | tu-war′-u-wit | tam′-yit |
| Light | eh-cah′-cuis-chi | ta-si′-va | ki′-sish |
| Night | tu′-can’ | tu-wŭn′ | tuc-mar′-pish |
| Darkness | | tu-wab’′-i | ai-tol-sŏw′-wi |
| Morning | pŭh′-et-sko | ta-bar′-e-wik-it | pai-i-pa |
| Evening | i′-ir-ho-měh | ta-ba′-butz-i-pa | toh-pa′-hi-pa |
| Spring | pa′-tets-ŏ-pe | ta-man′ | |
| Summer | tah′-ma-roi | term | |
| Autumn | | yo-wŭn | |
| Winter | etz′-e-it | | |
| Wind | | ni-gat′ | yah′-i |
| Whirlwind | | tu-run′-ia | |
| Lightning | e′-cak-quitz-el | ya-ga-nŭc | ai-tul-sow′-wi |
| Thunder | to′-mo-yah’k | to-nan′-nŭc | ait-zow-mi |
| Rain | ir′-mad | pah-pitz | wi-win′-cŭl |
| Snow | tah’′-cab | nu-a-ve | yu-yŭt |
| Fire | cūn | cūn | cūt |
| Smoke | | quip | |
| Water | pa | pah | pal |
| Spring (of water) | | pi-ca′-bo | |
| Ice | tah’′-cab | | |

## SHOSHONEE.—Continued.

| | VII. Comanche. | VIII. Chemehuevi. | IX. Cahuillo. |
|---|---|---|---|
| Earth, land | sŏc′-co-be | te-wip | te′-mŭl |
| Sea | | ot-zip | hil′-i-wit |
| River | pi′-ap-ti-ho′-us | pah | wa′-nish |
| Lake | | pah-ga′-ri | we′-wu-nit |
| Valley | te′-ith-tis-chi-ho′-no | u-nu-wip | te′-mŭl-tat′-chow |
| Hill | tŏi′-yab | caib | ŏw′-so-ni |
| Mountain | pi′-ap-si tŏi′-yab | te-witz-e-caib | tu′-quush |
| Island | | pah-run-o-quitz | |
| Stone, rock | tŭp′-pist | timp | cŏw′-wish |
| Salt | or′-na-bist | u-a′-ve | |
| Copper | eh′-ca-ui | | tul′-nik-ish |
| Iron | tath′-con | pah-nŭh′ | te′-mŭl |
| Maize | hŭn′-i-bist | hah-wib′ | pa′-ho-with-lim |
| Tree | pi′-ap-thi hoth′-pist | u′-wip | |
| Wood | | cou′-cŭp | |
| Leaf | pu′-hip | po-wi′-uk | |
| Bark | pŏh′-ap | | |
| Acorns | pah′-sah-pu-ni | | |
| Grass | shŏw′-ni’p | shu′-bŭt | |
| Pine | wŏr-co-bith | | |
| Cedar | wath′-pith | | |
| Flesh, meat | tuth′-cŭp’ | tu′-quoi | wa-′i |
| Beaver | hah′-nis | pah-winch′ | |
| Deer | ad′-e-cah | te′-e | su′-quut |
| Elk | | pa-ri | |
| Antelope | | want′-zit | |
| Mountain sheep | | nahgt | |
| Bison, buffalo | cuth’′-son | cooch′-o | u′-cha-nŭt |
| Cow | ouis′-tu-wa | | |
| Bear | wid′-der | pah-pŏw′-o | hu′-nu-it |
| Wolf | cŭth′-se-i-na | shi-i-nap′ | is′-o-wit |
| Dog | sad′-di | sha-rich | a′-wul |
| Fox | wah’′-nic | tu-cu′-mich | |
| Panther | toi-a-duth-co | | |
| Squirrel | wah′-co-woi | | |
| Rabbit, hare | tah′-bon | cam | su′-ish |
| Snake | nu′-hia | cu′-yatz | |
| Rattle-snake | | | se′-wit |
| Bird | huth’l′-su | | pa′-hin-chim |
| Feather | si′e | pi-ta′-o | |
| Egg | u-no′-io | wi-o-nat′-ko | wit′-chu-cŭl-ba |
| Goose | | ya′-ra-ke | |
| Duck | pen′-yan | chu′-ke | |
| Partridge | tid′-e-eth-cu-yo-nis-te | ca-car′ | |
| Turkey | pi′-apth-e-cu′-yo-nis-te | | |
| Fish | pe-e-que | pah-ge′ | |

## SHOSHONEE.—Continued.

| | VII. Comanche. | VIII. Chemehuevi. | IX. Cahuillo. |
|---|---|---|---|
| White | tŏs′-a-fit | tu-sha′-ga-re | te′-wish-nik |
| Black | tu′-huft | sha-wa′-ga-re | tu′-liksh |
| Red | e′-cof-te | en-ca′-ga-re | sel′-nik-ish |
| Blue | e′-fift | shaw-wa′-muk | tu′-quik-nish |
| Yellow | | hŭr-ben-ca-re | te′-sik-nish |
| Green | ef′-fift | tu-pai′ | |
| Great, big | pi′-apth’ | ac-conte′ | om′-now-it |
| Small, little | te′-ath-tes-te | yŭh′-pu-itz | i′-nis-mal,i-nis-el-at-tai |
| Strong | cuth′-ta-with′-to-nets, nŏt′-sut | cu-it′-zic | |
| Old | su′-cuth-pur | na-nap′-per | nis′-lo-gul |
| Young | tu′-i-bis-chi | o-coch′-tim | pa′-nis |
| Good | ptschat, chat | at’ | at′-tai |
| Bad | tith′-chit | cu-cha′, cat-tu-sho′-a | e-lel′-quish |
| Handsome | | naitz | e′-i-to |
| Ugly | tis′-chit | ma-ma′-o | e-lel′-quish |
| Alive, life | kes-te′-yait | ni-nu-yesh′-ma | pa′-cŭl |
| Dead, death | pues-te′-yait | ni-ai′-qua | mu′-qush, yu-i-mi-e-si |
| Cold | ŭtz-ait, quih′-ni | shu-i-ya′ | e-si |
| Warm, hot | ŭrd-eit | con-shu′-i-go-nŭc | si′-wu-mai |
| I | net′-za | nŭ-u′ | neh |
| Thou | ŭn′-nt’ | hai′-i-co | eh |
| He | or′-dt-za | ein-pa′ | peh |
| We | nen-net-za | | che′-mim |
| You | nah′-meh-co | | eh′-mim |
| They | or′-di-et′-za | | i′-wim |
| This | i′-nŏc-wi-ti | | i-wi |
| That | or′-dit | | peh |
| All | or′-yoc | ma-no-ni | u-mim |
| Both | nŭth′-meh’-co | | |
| Many, much | di-bitz-sort | avat′ | met′-e-wit |
| Who | | | a-ta-ha-eh′ |
| Near | mi′-stis-chi | sa-gatch | sun′-chi |
| Far | | mi-o′-ni | |
| To-day | ta′-ben | a-u′-bit | chi′-va |
| Yesterday | kŭt′-to | | pai-can |
| To-morrow | pĕu-et-sko. | ach′-e-cusht | pai′-i-pa |
| Yes | haa | u-wai′ | hēc |
| No | ke | cach | ki′-il |
| One | sim-m’ | shu′-ish | su′-pli |
| Two | wah′-hat | wai′-i | me-wi′ |
| Three | pa′-hist | pai′-i | me-pa′ |
| Four | hai′-o-do-quit | wat-chu′ | me-wi′-chu |
| Five | moi′-be-ca | ma-nu′ | no-me-quad-nŭn |
| Six | o′-yoh-pa-fist | na-bai′ | quad-nŭn-sup′-pli |
| Seven | tah’t-suth | mo-quist′ | quan-mun-wi′ |

## SHOSHONEE.—Continued.

| | VII. Comanche. | VIII. Chemehuevi. | IX. Cahuillo. |
|---|---|---|---|
| Eight | něm′-me-waht-sut | natch | quan-mun-pa′ |
| Nine | se′-er-man-o | u-wip′ | quan-mun-wi′-chu |
| Ten | se′-er-man-o-wump′-net | ma-shu′ | no-ma-chu′-mi |
| Eleven | | | pe-ta-su′-pli |
| Twelve | | | pe-ta-wi′ |
| Thirteen | | | pe-ta-pa′ |
| Twenty | | wai-ma-shu. | wis′-no-ma-chu′-mi |
| Thirty | | pai-i-ma-shu | pas′-no-ma-chu′-mi |
| Forty | | wat-chu-i-ma-shu | no-me-quad-nun-no-ma-chu-mi (50 ?) |
| Hundred | | mat-shu′-i-ma-shu | |
| Eat | tith′-ca-doh | te-ca′-ba | wai′-e-cun |
| Drink | pues-n'e-hi′-be (I drink) | he-bi′-ba | pa′-ka |
| Run | tu′-netht'ch | no-quin′-na | nu′-win-nish |
| Dance | nith′-cat | wi-no′-mi-no | chen′-ge-nŭt |
| Sit | ih-card | ca-re′ | |
| Stand | warn | wi-nin′-na | |
| Go | | pai′-que | mu′-luk |
| Come | kim | pai′-ik | |
| Sing | te′-ni-quer | ho-bit′-to | wa′-e-hi |
| Sleep | ĕrth′-pu-i-do-i | o-pŭn′-io | ha-ne-chim-cu′-pa |
| Speak | te′-qua-den | em-pa′-no | cuk′-tish |
| See | ŏh′-co-bon | pu-ni′-ca | ne-te′-ik |
| Love | o-cŭm′-ma-cŭ't' | pi-a′-much, a′-shin-teic | |
| Kill | ou-beth′-ca-ne' | pa-cai′ | me′-ca |
| Walk | | pa-gan′-no | |
| Negro | to′-oh-tai-bo | | |
| White man | pa′-bo-tai-bo | | |
| Rich man | ti-bitz-cha-nath′-co-te | | |
| Old woman | hr′-bis-chis-chi | | |
| Young woman | nai′-bist | | |
| Very good | ti-bits-chat | | |
| Almost day | tah′-kin | | |
| Water is too far | man′-ak-quie-te-pa′ | | |
| Make a fire | coth′-to | | |
| Hunt for it | o-weh''-iki | | |
| Come eat | tith′-cak | | |
| Not dead yet | kes-te′-yait | | |
| Who is that? | hu-si-ha′-card | | |
| I go | net′-za mia-doi | | |
| Thou goest | ŭn′-nt' mia | | |
| He goes | or′-dt-za miad | | |
| We go | nen-net-za miad | | |
| Ye go | nah-měh-co miad | | |
| They go | or-di-et′-za miad | | |

## SHOSHONEE.—Continued.

| | VII. Comanche. | VIII. Chemehuevi. | IX. Cahuillo. |
|---|---|---|---|
| I went this way..... | i′-bo-ne-ha-mia | | |
| Where are you going? | n'na-ha′-ca-po-mîa-ai | | |
| It is raining..... | er′-ma-io | | |
| It is going to rain..... | er′-math-kin | | |
| It almost rains..... | em-ho′-mia | | |
| Red river ..... | E′-cow-o-que | | |
| Canadian river ..... | Tu-so-ho-o-qui, or Pas′-i-ho-no | | |
| *Names of Chiefs.* | | | |
| Crooked Stick..... | Eh′-co | | |
| Big Belly ..... | Bi-a-bis′-po-ca-te | | |
| Coon Breast..... | Pah′-doh-co-nin′-nŭp | | |

### Remarks.

The natives who speak these languages belong to the great Shoshonee, or Snake family: which comprehends the Shoshonees proper, of Southern Oregon; the Utahs, in the region around the Great Salt lake; and then, extending south and west, the Pah-Utahs, west of the Colorado, and the Indians of the Missions of Southern California, the Kizh (of San Gabriel), the Netela (of San Juan Capestrano), and the Kechi (of San Luis Rey); and on the south and east, the Comanches of the prairies.

The *Comanches* (called also *Hietans*, or *Ietans*, and *Paducas*) range from the sources of the Brazos and Colorado rivers of Texas, over the great prairies of the West, stretching from the Indian territory to the spurs of the mountains that bound the valley of the Rio del Norte, and as far north as the upper waters of the Arkansas. Their chief dependence is on the buffalo, and with these animals they roam from south to north in the spring, and from north to south in the autumn. According to Lieutenant Whipple, they are on friendly terms with the Lipans, Huecos, Hainais, Kichais, Witchitas, and Tancoways, and all range together. They fear the Osages.

The first Comanche vocabulary published was that of Mr. Bollaert, printed in the second volume of the Journal of the London Ethnological Society. It consists only of some translated proper names, and the numerals as far as *twenty*. Other and much fuller vocabularies have since been published by Berghaus, Schoolcraft, and Marcy. That of Mr. Whipple was taken down at Beavertown, on the Canadian river, from the dictation of an intelligent Cherokee, named Jesse Chisholm, a man well acquainted with the neighboring tribes and their languages. From the phrases appended to the vocabulary, no definite conclusion can be drawn. They probably contain many inaccuracies.

The *Chemehuevis* are a band of *Pah-Utahs*, (called *Pa-Yutes*, *Pai-Utes*, *Piutes*, *Piuches*, &c.,) *i. e.* "Utahs of the River," of whose language, a vocabulary, obtained from the chief of the band, is here for the first time made public. It agrees most nearly with Simpson's Utah, and Hale's East Shoshonee.

*The Cahuillos* (or *Ca-wi′-os*).—Of these a rancheria was met with near the Pacific, between the sources of the San Gabriel and Santa Anna. The vocabulary was obtained from an old Indian who had lived with the priests at San Luis Rey until the breaking up of the mission. It exhibits the closest affinity to the Kechi and Netela, especially the former. Its affinity to the Kizh is equally evident. The following comparative table will make this plain. The Kechi

words are from a manuscript vocabulary taken by the Hon. John R. Bartlett, while engaged on the Mexican Boundary Survey; the Netela and Kizh are from Hale's Philology of the Exploring Expedition.

| | Cahuillo. | Kechi. (*San Luis Rey.*) | Netela. (*San Juan Capestrano.*) | Kizh. (*San Gabriel.*) |
|---|---|---|---|---|
| Father | ne′-na (my) | peh-nah′ (his) | nanā | anāk |
| Mother | ne′-yĭh | peh-yo′ | noyō | āök |
| Head | ni-yul′-uka | po-ya′ | nuyū | apoān |
| Ear | na-nock′-a | no-nak′ | nanakŭm | anāna, nājas |
| Eye | na′-push | pu-sun′-o-push | nopūlum | atshotshon |
| Nose | ne′-mu | ne-ma′-bi | nomūŭum | comēpin, mūpin |
| Arm | ne-mŏk | no-ma′ | namā | amān, mān |
| Heart | ne′-sun | no-shôn | nosūn | ahūng, sūn |
| Blood | ne′-o | no-ôh | noö′ | akhain |
| Chief | net′-i | nôt | nōt | tomēr |
| House | kish | ki′-cha | nikī | kītsh, kīn |
| Arrow | hul | no-hu′ | hul | tshūar, nihūn |
| Bow | chu-quil′-no-pish | kô-to-pis | kūtupsh | páitkhŭar, páitōkh |
| Sun | ta′-mit | te-met′ | temét | tāmet |
| Moon | men′-yil | moi-la | mo-ï′l | mō-ár |
| Fire | cūt | kût | mughāt | tshāwot, tōina |
| Water | pal | pa-la | pāl | bar |
| Bear | hu′-nu-it | hu′-nu-it | hūnot | hūnar |
| Deer | su′-quut | su-kŭt | sukot | shukāt |
| Wolf | is-o-wit | i-sunt | īsot | īshot, īsot |
| Dog | a′-wŭl | a-wal′ | aghwāl | wausī, wasi |
| I | neh | no | no | noma |
| Thou | eh | om | om | oma |
| He | peh | w'nal | wanál | ahē, pa-e |
| One | su′-pli | su-pul | pukū | pukū |
| Two | me-wi′ | weh | wehē | wehē |
| Three | me-pa′ | pai | pāhe | pāhe |
| Four | me-wi′-chu | wah-sah′ | watsā | watsā |

It will be observed that, in those languages of the Shoshonee family which we have been considering, the place of the accent is reckoned, not from the end, as in the classical tongues, but from the *beginning* of the word. In Comanche the accent is on the first syllable, with but few exceptions, as when a possessive pronoun is prefixed. Sometimes there is a secondary accent; this appears, for the most part, when the word contains more than four syllables, and is generally placed on the fifth from the beginning, as *te′-ith-tis-chi-ho′-no*, valley. In Chemehuevi and Cahuillo the accent is less regular: but in the former it is usually on the second syllable; and in the latter, on the first.

# KIOWAY.

| | X. Kioway. | | X. Kioway. |
|---|---|---|---|
| God | pu′-ha-sun | Friend | ’tzah |
| Devil | dŏw′-o-kî-i | House, hut | tu |
| Man | ki-añ′-i | Kettle | ’tzu |
| Woman | ma-yi′ | Arrow | arc-u′ |
| Boy | tu-quois | Bow | zip′-co |
| Girl | ma′-tŏn (*n* nasal) | Axe, hatchet | hŏut′-ho |
| Infant, child | tal-yi′ | Knife | tlick-ho |
| Father | tŏw-wath-tŏw′-i | Canoe, boat | tzu |
| Mother | coh’ | Indian shoes | tu′-ti |
| Husband | ki-iâ | Bread | co′-ot-oui |
| Wife | ki-u*n*′ | Pipe, calumet | so′-o-tu |
| Son | a-tu′-a | Tobacco | ta′-po |
| Daughter | se-i-tŏnc | Sky, heaven | ki-a′-coh |
| Brother | pa-pi′-e | Sun | pai |
| Sister | tŏnc | Moon | pa |
| An Indian | co′-tat-sen | Star | tah |
| Mexican | ta′-be-bo | Day | ki-ŭth′-pa |
| American | cor′-nu-co-ya′ | Light | bu′-u |
| Head | ki-a-ku′ | Night | gi-i-ki |
| Hair | o-o′-to | Darkness | ki-ha-u′-ti |
| Face | ca-u′-pa | Morning | kai′-ñe-co |
| Forehead | ta-u′-pa | Evening | te-hi′ |
| Ear | ta-a′-ti | Spring | tuh’ |
| Eye | ta-a′-ti | Summer | so′-ol-pups |
| Nose | mau-cŏn′ | Autumn | suh’ |
| Mouth | sŭr′-ol | Winter | tuh |
| Tongue | dĕn | Wind | gum′-ti |
| Tooth | zun | Lightning | bu′-im-pa-yip′-co |
| Beard | sen′-poh | Thunder | pŏth′-suth |
| Neck | k’coul | Rain | seip′-toh |
| Arm | mŏr′-ta | Snow | ’tul |
| Hand | mŏr′-ta | Hail | ’tĕn |
| Fingers | mŏr-ditz-on′ | Fire | pi′-a |
| Nails | mŏr-ditz-on′ | Water | ’tū |
| Body | cu′-kiâ | Ice | ten′-kī-a |
| Belly | buh’ | Earth, land | pai |
| Leg | pa′-ras | Sea | se′-it-zo |
| Foot | ŏn-sut′ | River | o′-si |
| Toes | mŏr-ditz-on′ | Lake | coi-tal′ |
| Bone | ton′-sip | Valley | ke-a-ku′ |
| Heart | tĕn | Hill | pi′-e-ti |
| Blood | um | Mountain | ki-a-tah′-pa |
| Town, village | tu-ôi | Island | gum′-ki-ath-tonc’ |
| Chief | tan-gu′-a | Stone, rock | ’ts’u |
| Warrior | ten-cŏn | Copper | o-tŭ′-i-te |

## KIOWAY.—Continued.

| | X. KIOWAY. | | X. KIOWAY. |
|---|---|---|---|
| Iron | onc′-i | I | no |
| Maize | e′-tahl | Thou | am |
| Tree | ai | He | kin |
| Wood | sa′-os | We | ki-mi′ |
| Leaf | ai′-te | Ye | tu-sa |
| Bark | tou-cŏi′ | They | cu-ta |
| Grass | son | This | tom′-ki |
| Oak | suh | That | u′-ī-ta |
| Pine | i′-pah | All | ti |
| Flesh, meat | ki | Many, much | ōi |
| Beaver | pu′-i-to | Who | u′-i-te |
| Deer | ton-ki′-e-ni | Near | ki-at-si′ |
| Bison, buffalo | col | To-day | i′-ho |
| Bear | tam′-til | Yesterday | cañ′-i-co |
| Wolf | al-pa-gōi | To-morrow | tip-ho′-i |
| Dog | ’nt-se′-iō | Yes | ho′-o |
| Fox | ba′-o | No | ho′-a-ni |
| Rabbit, hare | ki-ai′-ol | One | pah′-co |
| Snake | sa-o-ni′ | Two | gi′-ă’ |
| Bird | cu′-a-toh | Three | pa′-o |
| Egg | ten-tah′ | Four | i′-a-ki |
| Goose | kai-pah-tul | Five | ŏn′-to |
| Duck | ah-coh′-i | Six | mŏs′-so |
| Pigeon | tohl-qua | Seven | pan′-tsa |
| Partridge | cu′-pe-sa | Eight | i-at′-sa |
| Turkey | cu′-pe-sa | Nine | coh′-tsu |
| Fish | tom′-ke-a-su | Ten | cōk-hi |
| White | ’tai | Eleven | pa′-ta |
| Black | con′-ki | Twelve | gi′-a-ta |
| Red | gu-ŏr′-dl-tŏh | Thirteen | pa′-o-ta |
| Blue | săw′-hai | Twenty | i′-ŭth-ki′-a |
| Yellow | cŏr′-ta | Twenty-one | pa′-ta |
| Green | tu-ta | Twenty-two | i-uth-ki-a-ta gi-a-ta |
| Great, big | it | Thirty | pa′-o-ki |
| Small, little | sŏn | Forty | i-at-ki′-a-ki |
| Strong | cut | Fifty | on′-tok-i |
| Old | com′-toh | Sixty | mŏs-so-a-ki |
| Young | tu′-quoil | Hundred | co′-to-ki |
| Good | tu′-se-nŏw | Eat | a-to′-hi |
| Bad | pu′-u | Drink | ki-a-tun′-to |
| Handsome | tah′-ki | Run | yi-aith′-po |
| Ugly | (tlick)-ŏn′-ta | Dance | be-gu′-in |
| Alive, life | pe′-he | Go | a-pa′-to |
| Dead, death | pe′-toh | Sing | bi-do′-pait |
| Cold | tuh | Sleep | bi-moh′ |
| Warm, hot | sahl | Speak | em-tum′-ki |

## KIOWAY.—Continued.

| | X. KIOWAY. | | X. KIOWAY. |
|---|---|---|---|
| See | ah-boh′ | Kill | em-hult′ |
| Love | e-ma′ | Walk | em-to′-ki |

### REMARKS.

*Kioways* (*Cai′-gua*).—It was the opinion of Lewis and Clarke, as well as of Pike, that the Kioways belong to the same stock and speak the same language as the Comanches and Utahs, with whom they have long been associated. Long, however, speaks of the language as "exceedingly difficult," and "abounding in strange sounds;" whereas it is well known that the Comanche is sonorous and pleasant to the ear. Captain Marcy, too, in his recently published Exploration of the Red River, says, "these tribes have similar habits, but speak different languages." The Kioway vocabulary taken by Dr. Say was unfortunately lost; so that in the one presented us by Mr. Whipple, which was obtained from Andres Nuñares, a Mexican who had been for five years a captive in the tribe, we have for the first time the means of judging for ourselves of the correctness of these different opinions. A comparison of this vocabulary with those of the Shoshonee stock does, it is true, show a greater degree of resemblance than is to be found in any other direction. This resemblance, however, is not sufficient to establish a radical affinity, but rather appears to be the consequence of long intercommunication.

| | KIOWAY. | SHOSHONEE AFFINITIES. |
|---|---|---|
| Son | a-tu′-a | ituć (W. Shosh.), ner-too′-ah (Com.) |
| Brother | pa-pi′-e | po-pêt (Kechi) |
| Face | ca-u′-pa | hobá (W. Shosh.), cobanim (Chem.), koveh, cai-if (Com.) |
| Tooth | zun | tang-wa (Shosh.), tah-nee (Com.) |
| Neck | k'coul | kuró (Shosh.), kolph (Utah) |
| Hand | mor′-ta | moh, masseer (Utah) |
| Bone | ton-sip | tso-nip, so-nip, suf-nip-a (Comanche) |
| Kettle | 'tzu | tsidá (W. Shosh.) |
| Star | tah | ta-arch (Com.) |
| Great | it | yoit (Kizh) |
| Strong | cut | cu-it-zŭ (Chem.), keatūh (Com.) |
| I | no | nu-u (Chem.), no (Netela, Kechi), ne (Com.) |
| Thou | am | oma (Kizh), om (Netela, Kechi) |
| Yes | ho′-o | aha (W. Shosh.), oho (Kechi), ha, haa (Com.) |
| One | pah-co | puku (Kizh, Netela) |
| Two | gi-a' | wai-i (Chem.), wehē (Kizh, Netela), wa-ha (Com.) |
| Three | pa-o | pahaiu (W. Shosh.), pāhe (Kizh, Netela), pa-hu (Com.) |

Some resemblances are likewise to be observed between the Kioway and the languages of the southern and western tribes of the Sioux or Dakota stock; and it even appears to contain a few Athapascan words. All these, however, are doubtless to be attributed to the wandering life of the Kioways, which brings them into contact with many different tribes.

# APACHE.

| | XI. Navajo. | XII. Pinal Leño. | | XI. Navajo. | XII. Pinal Leño. |
|---|---|---|---|---|---|
| God | bos | | Gun | | pay-dil-tooh |
| Devil | da-dith'-hal | | Powder | | tah't-lic |
| Man | hŭst-tkin' | pay-yah'-nay | Ball | | cah't-a-chu'-lee |
| Woman | est'-san-ni | et-sunny | Frying-pan | | is-saw |
| Boy | esh-ki' | ashkmyee | Jar | | eis-sah |
| Girl | et-tei' | pay-sen-diltch | Cup | | payth'l-con |
| Infant, child | et-te'-et-is-si | | Basket | | eet-taye |
| Father | shi-je-ec' | ish-ee-kaie | Wooden platter | | ut-tzar |
| Mother | she-ma'' | sunne-hai | Axe, hatchet | 'tsin'-il | |
| Husband | sha-a-at | | Knife | pesch | paysche |
| Wife | sist-san'-ni | | Needle | | pay-nay-cot-ee |
| Son | shi-oe'-ec | has-tee-you | Awl | | sat'l |
| Daughter | shi-nal'-li | | Moccasins | tene'-wi-ke-ec | |
| Brother | shi-nai'-e | | Sandals | | kay-ah, kay |
| Sister | shi-te-ji' | | Straw hat | | chat-lee-kay |
| An Indian | nash-taj'-je | | Black hat | | choth-il-hith |
| Head | bet-si' | | White beaver hat | | choth-lee-pan-hith |
| Hair | tchlit | setz-e-zil' | Coat | | ay-tonc |
| Face | ni'-la | | Shirt | | il-kaye-ke |
| Ear | tschar | sitz-chār | Blanket | | chee-day |
| Eye | nin-nar' | chin-dār | Navajo blanket | | chee-dil-hith |
| Nose | nit-chi' | chin-chee | Serape | | chith-lee-kaye, chee-doe-tliz |
| Mouth | | chin-gou | | | |
| Tongue | bi'-das-cho | | Serape colorado | | chith-lee-chee |
| Tooth | bi-go' | | Serape pinto | | chi-nas-conc |
| Beard | bi-da-ga' | chit-ah'-gor | White clothes | | souch-claiee |
| Neck | bith-lōt' | | White trowsers | | as-nas-tu'-le-kayee |
| Arm | shith'-lit | aal-hot-dit-ton | Cotton trowsers | | na-du-conc, as-nas-tic |
| Hand | shi-lat-tai-e-te | chi-con | Leggins | | ist-klai |
| Fingers | shi'-lat-sit | chun'-lah | Hunting dress | | chi-nan-denc-conc |
| Nails | shi-lash'-cat | chil-a-con | Canvas | | tal-a-way-zis |
| Body | at-zat' | coat-see | Red cloth | | na-day-coth-le-chic |
| Belly | tchat | | Finger-ring | | chay-con bassay-onde |
| Leg | t'clat | see-chat | China | | tay-bethl-nee |
| Feet | t'ke-e | sitz-kay | Wood (manufac'd) | | dilt-chic |
| Toes | shi-lat-sit' | | Halter | | cloath'l |
| Man's privates | | chil-ah | Soap | | ait-ap-tan-goose |
| Woman's do. | | chose | Paper | | nalt'-sose |
| Heart | e-che'-i | | Large book | | nalt-sose-en-char-hith |
| Blood | tith'l | | Bread | les-an'-ni | |
| Town, village | yat-kin' | | Tobacco | nat'-to | nat-toe, nat-oh-tith-hilth |
| Chief | heu'-jeu-nats-olt | | Sky, heaven | tath'-lit | |
| Warrior | hain'-gli | | Sun | da'-cos | yah-eye' |
| Friend | si-t'kiss | | Moon | 'tsa'-di | eel'-sone-sayer |
| House, hut | ho-gun' | co'-wan (nasal) | Star | ol-che'-ec | ail-son-sat'-you |
| Spear, lance | | ail-lot-tai | Light | ni'-lath-lit | |
| Arrow | t'kar | h'char | Night | dat-le-da | |
| Bow | al-ti-hin'' | ithl-tine | Darkness | hi-nol-che'-ec | |

## APACHE.—Continued.

| | XI. Navajo. | XII. Pinal Leño. |
|---|---|---|
| Morning | is-car'-go | |
| Evening | ca-det'-a-i-a | |
| Summer | nes-tan'-ni | |
| Winter | nes-tan'-es-cus | |
| Lightning | cli'-pa-not | |
| Rain | hŭn-il-ti-hun | |
| Snow | yas | |
| Fire | 'tcou | |
| Water | 'thu | to |
| Ice | satz | |
| Earth, land | klish | tlez |
| Sea | t'huth-la' | |
| River | t'huth-la' | |
| Lake | shithl-gash | |
| Valley | chi-ōt' | |
| Hill | ba-gan'-go | |
| Mountain | ba-gand'-zat | i-check |
| Stone, rock | tse-ec | tshayer |
| Salt | hish-in | ish'-ee |
| Obsidian | | olien |
| Iron | tsit | |
| Tree | se-detz-o-bitz-it | |
| Bush | | m'cliz |
| Wood | tsin | chiz |
| Leaf | dat-tar' | |
| Bark | qui-hi | |
| Grass | chithl | chlow |
| Oak | ha-wish | |
| Pine | ha-shi | |
| Mezquit | | ee'-yah |
| Mezcal | | nat-tar |
| American straw | | pi-ta-ca-yo |
| Flesh, meat | et-si' | ait-sinc, ait-chee-got'l |
| Deer | pi | non-wan-jai-day' |
| Bison, buffalo | kil-cho' | |
| Bear | sha-she | sasch |
| Wolf | mait-zo | |
| Coyote | | boch |
| Dog | le-chonc' | |
| Squirrel | zŭr-je' | chinch-on-you-daier' |
| Horse | | cleenc (nasal) |
| Mule | | chan-day'-zic |
| Ass | | tig-ool-coy-air' |
| Rabbit, hare | 'cai-ŭr-je' | |
| Snake | 'tclis'-je-i | |
| Rattlesnake | 'tclisch | |
| Bird | tscit | |
| Feather | | toz-zee |

| | XI. Navajo. | XII. Pinal Leño. |
|---|---|---|
| Egg | cho-ki | |
| Duck | elt-ze-di | |
| Partridge | 'tcli-vat-cli-gi | |
| White | 'tclac-hai | |
| Black | tcli-gi' | |
| Red | cli-chi | |
| Blue | dot-clish' | |
| Yellow | clit-zo' | |
| Great, big | nint-sa' | |
| Small, little | tscis'-si | |
| Strong | dal-chu' | |
| Old | haist'-ti | |
| Young | elt-zis'-si | |
| Good | ia'-shu | |
| Bad | ta-ia'-shu-da | |
| Handsome | ni-zen-ni | |
| Ugly | tŭh-ni-tschu' | |
| Dead, death | dŭst-sa' | |
| Cold | dest-tcas | kar-keh' |
| Warm, hot | sit-to' | ast-chou |
| I | ni | |
| Thou | shi'-do-ta | |
| He | nil'-lad | |
| They | nil-lad | |
| This | ail'-la | |
| All | dalt'-zo | |
| Many, much | thlao | |
| Who | ha'-la-ai (who is it?) | |
| Near | a-han'-ne-gi | |
| Yesterday | e-ta'-da | |
| To-morrow | is-car'-go | hai-eel-conc |
| Yes | shi | |
| No | do-la' | |
| One | tath-lai' | |
| Two | na'-ki | |
| Three | t'ha | |
| Four | t'hi | |
| Five | est-cla' | |
| Six | has-tar' | |
| Seven | tsot-zi | |
| Eight | tsep'-pi | |
| Nine | nast-tai' | |
| Ten | ni-eth-nc' | |
| Eleven | cla-da'-ta | |
| Twelve | na-ki-da-ta | |
| Thirteen | t'ha-da-ta | |
| Twenty | nat-tin | |
| Thirty | t'hat-tin | |

## APACHE.—Continued.

| | XI. Navajo. | XII. Pinal Leño. | | XI. Navajo. | XII. Pinal Leño. |
|---|---|---|---|---|---|
| Eat | tain-yar | | Bring water | | tai-to |
| Drink | tai-clanc | | Como se llama? | ti'-dŏw-ol-ge' | |
| Run | hil-goth'l | | Pinal | | Del-chid-dee-gil-lay |
| Dance | il'-jish | | Cibolo | | Pis-is-chit |
| Go | ca-de'-na-is-ta' | | Pueblo de Moqui | hut-kin-go | |
| Come | os-de'-ni-a | | Rio Grande | | Kay-ee |
| Sit | na'-dit-ta | | Rio Gila | | Kay-eel-chow |
| Stand | sen'-si-go | | Rio San Pedro | | Tooch-o-sayer |
| Sing | hot'-hŏl | | Rio Colorado | | Tool-chee-air |
| Sleep | el-hush | | Agua Pinta | | Toos-eel-hec |
| Speak | e-chi-al'-tin | | Sierra Grande | | Sid-in-tell |
| See | nish-i | | Sierra Blanca | | Chid-lee-casa-an' |
| Love | a-ha'-la-ni | | Pleiades (seven stars) | | Ais-lat-as-char-ah' |
| Kill | di-ol-hil' | | Principal chief (name) | | Ash-inc-cou'-ah |
| Walk | ha no-nŭh' | | Second prin'l chief (name) | | Natch-tai-tish |

### Remarks.

Both the Navajos and Pinal Leños are subdivisions of the great Apache nation, which may be said, in general terms, to occupy, or rather to roam over, the triangular space included between the pueblos of New Mexico, the river Colorado, and the Gila; besides which, they extend far down into the province of Chihuahua, and almost to the Gulf of Mexico. They seem to have acted as an obstacle to the southern descent of the Shoshonee tribes, who stretch away on either side, the Pah-Yutes and Mission Indians on the west, and the Comanches on the east. As the Coco-Maricopa word for "man" is *apache* or *ee-pache*, and as the native term for "man" is often converted into the proper name of an Indian tribe, Mr. Gallatin concluded that the Coco-Maricopas belonged to the Apache stock. Now, however, that we have the means of comparing the languages of the two peoples, this is shown not to be the case. Hence it appears that the name *Apache* did not originate with the nation to whom it is applied, but was adopted by the Spaniards from the Yuma tribes.

The *Navajos* (or *Navahoes*), called by the Spanish writers *Apaches de Nabajoa*, "are a powerful tribe of Indians residing on the tributaries of the river San Juan, west of the Rio Grande and east of the Colorado, and between the 35th and 37th parallels of north latitude. They probably number 8,000 souls." "They are a fierce, intelligent, and warlike tribe of Indians. They possess more wealth than all the other wild tribes in New Mexico combined; are rich in horses, mules, asses, goats, and sheep; and they raise, by the cultivation of the soil, a sufficiency of grain for all purposes of consumption. They are the manufacturers of a superb quality of blankets that are water-proof, as well as of coarser woollens." (Indian Commissioner's Report for 1854.) The only vocabularies of their language, heretofore published, are those of Lieut. Simpson and of Capt. Eaton (in Schoolcraft's History, &c., IV, 216.) That of Lieut. Whipple was obtained from a Mexican herder, who had been a captive among the Navajos for nine months, and had learned their language. It agrees with that of Col. Eaton quite as well as could be expected under the circumstances.

*Pinal Leños*—called by Emory *Piñon Lanos*, and by Bartlett *Piñol Indians*, *Piñols*, and *Pinaleños*. The latter says they embrace about five hundred souls, and range over an extensive circuit between the Sierra Piñal and the Sierra Blanca; both of which mountains are near

the upper San Francisco river, about five days' journey north of the Gila. The Apaches acknowledge them as belonging to the same great tribe as themselves. They are the Indians who carried off the unfortunate Inez Gonzales, whose story forms so romantic an episode in Mr. Bartlett's "Personal Narrative."

That the Apaches and their congeners belong to the Athapascan family, which extends across the northern portion of the continent from Hudson's Bay almost to the Pacific ocean, I have shown in a paper read before the American Ethnological Society, and published in the Literary World of April 17, 1852. Mr. Hale had already shown that small fragmentary tribes belonging to this widely extended stock reach down, near the shores of the Pacific, as far south as the Umkwa river. From the *Hoopah* vocabulary, since published in Mr. Schoolcraft's work, it is evident that these people wandered still further in the same direction—at least as far as the

| | | Hudson's Bay. (*Dobbs.*) | Chepewyan. (*Mackenzie.*) | Dog-Rib. (*Richardson.*) | Tacully. (*Harmon,*) |
|---|---|---|---|---|---|
| 1 | Man | ..... | dinnie..... | tchel-a-qui ..... | ten-nee ..... |
| 2 | Head ..... | tenet-thee ..... | edthie ..... | tzat-the ..... | pit-sa ..... |
| 3 | Hair ..... | tenet-thea-cau.... | thiegah ..... | setz-thè-rgha ..... | ote-zega ..... |
| 4 | Ear ..... | tenet-'tsaw..... | ..... | setz-r-rgha..... | o-cho..... |
| 5 | Eye ..... | tene-naw ..... | nack-hay ..... | tzen-nhae ..... | o-now..... |
| 6 | Nose ..... | tene-chee ..... | ..... | tze-etze ..... | pa-nin-chis..... |
| 7 | Tongue ... | tene-thoon ..... | edthu..... | tze-tthou ..... | tsoo-lâ..... |
| 8 | Tooth ..... | tene-hough ..... | goo..... | tze-o-who (?) ..... | oh-goo..... |
| 9 | Neck ..... | tene-cassan ..... | ..... | tze-e-e-cottle ..... | ..... |
| 10 | Hand..... | tene-law ..... | law ..... | ssa-la..... | o-lâ..... |
| 11 | Leg ..... | tene-cha-thee..... | edthen ..... | tze-thunna ..... | o-ca-chin..... |
| 12 | Foot ..... | tene-crah ..... | cuh ..... | tze-ka ..... | o-ca ..... |
| 13 | Blood..... | dell ..... | dell..... | ..... | sko ..... |
| 14 | Knife..... | pace ..... | bess..... | pa-as ..... | ..... |
| 15 | Sun ..... | saw ..... | sah..... | ssa ..... | sâ..... |
| 16 | Fire ..... | o-del-chat ..... | counn ..... | kkon ..... | koue ..... |
| 17 | Water..... | ic-too..... | toue ..... | two ..... | too ..... |
| 18 | Stone..... | ..... | thaih..... | ..... | tsay ..... |
| 19 | Dog..... | a-nel-wosh ..... | sliengh..... | cle ..... | cling,clee-chay (bitch) |
| 20 | Fish ..... | cloo-he-za ..... | slooeeh..... | clou-a ..... | cloo-lay ..... |
| 21 | I..... | she..... | see ..... | ..... | se..... |
| 22 | One..... | zodeneah ..... | slachy..... | en-clai ..... | clot-tay ..... |
| 23 | Two ..... | chellatelle..... | naghur..... | nak-ka ..... | nong-ki ..... |
| 24 | Three ..... | elthoi..... | tagh-y ..... | tta-rgha ..... | toy ..... |
| 25 | Four..... | tenetthee ..... | dengk-y ..... | tting..... | ting-kay ..... |

• The manuscript of the present paper on Lieutenant Whipple's vocabularies was delivered to Mr. Whipple in January of this year (1856); and now, in the month of May, as it is going through the press, I have received a copy of Dr. Buschmann's learned and highly interesting treatise on the Athapascan family of languages, (Der Athapaskische Sprachstamm dargestellt von Joh. Carl Ed. Buschmann,) printed in Berlin in the present year. Dr. Buschmann mentions repeatedly (pp. 154, 254) that the discovery of the Athapascan relationship of the Apache nation is due to me ; but he claims at the same time, as his own discovery, the fact that a similar relationship exists between the Athapascans proper and the Navajos. This claim, however, cannot be admitted ; because in the above-mentioned paper, published in the Literary World, I treat both of the Apaches and of "*their congeners the Navahoes.*" The affinity of the Apaches and Navajos had been repeatedly asserted by Spanish and American writers. I need quote only the excellent authority of Gregg. He says: "The principal wild tribes which inhabit or extend their incursions or peregrinations upon the territory of New Mexico are the *Navajóes*, the *Apaches*,

Trinity river, on which a tribe of them is now found, extending to its junction with the Klamath. My view of the affiliation of the Apache and Athapascan tribes has been adopted by Mr. Schoolcraft, in the recently published fifth volume of his History, &c., of the Indian Tribes, (p. 173 *note*, and pp. 202, 203,) though apparently with some hesitation.* To establish the fact of the radical connexion of their languages beyond reasonable doubt, I have constructed the following comparative table of words selected from vocabularies already published, excepting that of the Apaches of the Copper Mines, for which we are indebted to the liberality of the Hon. John R. Bartlett. It may be well to remind the reader, that in comparing the names of the parts of the body, the pronoun or other word attached to the name must be rejected: thus, in the Hudson's Bay vocabulary the expression is *man's head, man's hair*, etc.; in the Dog-Rib, *my head*, etc.

| | Umkwa. (*Hale.*) | Hoopah. (*Schoolcraft.*) | Navajo. (*Schoolcraft.*) | Apache. (*Bartlett.*) |
|---|---|---|---|---|
| 1 | tílsŭn, tŭne | quais-tai′ | ten-nai′ | n'de |
| 2 | sŭgha, si | ok-heh | hut-zee | shi-tzi |
| 3 | zugha, sala | tse-wok | hut-zee | si-ra′ |
| 4 | tshighe | hot-che-weh | hut-jah′ | she-cha′ |
| 5 | naghe | hun-nah | hun-nah′ | ko*n*-da′ |
| 6 | mintshesh, shish | hun-tchu | hut-chih′ | si*n*-chi |
| 7 | lásom, sántkhlo | sast-ha | hut-tso′ | she-za′-re |
| 8 | uó, cughú | how-wa | hur-go′ | she-go′ |
| 9 | kwash, shusoatkhl | ho-se-watl | hur-koce | she-cos′ |
| 10 | shláa, shilá | hol-lah | hul-lah | she-n'la′ |
| 11 | tsŭne, stse | hot-sinne | hut-jast′ | she-cha′-di |
| 12 | shkhe | hom-mit-laht-hut-sinne | hur-ka′i | she-ke′ |
| 13 | shtŭle | | tilh | t'ilch |
| 14 | clestay | me-kus-tem-meh | pesh | pês |
| 15 | sha | hwah | cho-ko-no-i′ | chi-go-na-kai |
| 16 | kho*n* | hoh | konh | co*n* |
| 17 | tkho, to | tah-nahn | tonh | t'ho-cho*n* |
| 18 | seh, se | | tsai | tzi |
| 19 | tkhli, tkhli*n*e | schlunh | klee-chah′-ee | klin-cha-ne |
| 20 | | kloke | hloh | chlui |
| 21 | shi | wheh | sheenh | shi |
| 22 | áitkhla | kleh-wunna | tlah′-ee | ta-shte′ |
| 23 | nákhŭk | nah-nih | nah-kee′ | na-ki |
| 24 | tak | hah-kin | tanh | ta'i |
| 25 | tŭntshik | in-kin | tee | t'igh |

the *Yutas*, the *Caiguas* or Kiawas, and the *Comanches*. Of the latter I will speak in another place. *The two first are from one and the same original stock, there being, even at the present day, no very important difference in their language.*" (Commerce of the Prairies, I, 285.) The publication of Lieutenant Simpson's vocabularies simply confirmed this statement; accordingly, there is no discovery in the matter. If the Apaches are Athapascans, and the Navajos are a part of the Apache nation, it follows of course that the Navajos are Athapascans too. I may add, that the name *Ticorillas*, as written throughout by Buschmann, has its origin in a misprint in Simpson's report. It should be *Jicarillas*, as given by Gregg, in connexion with the passage above quoted, and many other authorities. In conclusion, be it observed, that the slight errors here pointed out are not to be considered as detracting in any sensible degree from the great merit of Dr. Buschmann's work. The eminent ability and the faithful diligence displayed in it, which can be duly appreciated only by those who have gone through similar laborious and perplexing investigations, will make it a standard authority on the subject of which it treats.—W. W. T.

## KERES.

| | XIII. Kiwomi. | XIII. Kiwomi. | XIV. Cochitemi. | XV. Acoma. |
|---|---|---|---|---|
| God | sŭrch-a-nŭch | | | |
| Wicked spirit | shu′-wa-chup | shu′-watz | | |
| Man | hahch′-tse, te′-wa | hatch′-the | hach′-the | hah′-trat-se |
| Woman | co′-i-yo-i | cu′-yau-wi | co′-you-i | cu′-hu |
| Boy | i′-o-wŭs | | shru′-i-a-ti | i′-at-tr |
| Girl | ma′-sitch | | ma′-sitch | ma′-a-sit-tr |
| Infant, child | u′-wak | | u′-ak | sai′-i-at-tr |
| Father | u′-mo | | ta-latch | nai′-ish-ti′-a |
| Mother | yah′-yah | | yai′-yah | nai′-i-a |
| Husband | cah′-nŭs-chi | | ca′-tri-si | |
| Wife | cah′-nŭ-ye | | | |
| Son | k’sah′-e-wŭsh-i | | | sa-mier′-ti |
| Daughter | cu′-i-yah | | | |
| Brother | thu′-mi | | | |
| Sister | mem′-me | | | |
| An Indian | ha′-no | | | hant′-no |
| Head | nash′-ke | | | nŭsh-kai′-i-ne |
| air | ha′-dre | ha′-tre | | hah-trat′-ni |
| Face | scu′-o-wah | sku′-o-wa | | ho-wa′-win-ni |
| Forehead | si′-up | | | |
| Ear | yŭ′-o-pi | | | |
| Eye | ca′-a-na | sha′-a-na | | ho′-o-na′-i-ne |
| Nose | wi′-e-shin | | | oui′-i-su′-i-ne |
| Mouth | stchi′-i-ca | chi′-a-ca | | oui-i-ca-ni |
| Tongue | wa′-chin | | | wa-itch-hunt-ni |
| Tooth | hahtch′-i-ni | | | |
| Beard | mush′-es-oi | | | |
| Neck | sca′-o-witz | | | |
| Arm | sca′-o-yu-mi | | | |
| Hand | mar′-quin | nash′-kai-ni | | ha-match-ti-i-ni |
| Fingers | che′-o-wŭtz | | | |
| Nails | ha′-o-wŭtz-in | | | |
| Body | ca′-o-wutz-i | si′-e-ni | | sin-ni |
| Belly | sco-o-mŭtch | | | |
| Leg | se′-e-ma | | | ha′-ma-ni |
| Feet | has′-ten | | | ha-ash-ti-e-ni |
| Toes | se′-e-mŭtz | | | |
| Bone | hai′-skin | | | |
| Heart | oui′-nas-ka | | | oui′-nosh-ka |
| Blood | mat′-zi | | | maat-si |
| Town, village | ha′-stitz | | | sa-ash-ti-ist |
| Chief | hu′-i-chin | | | ta-puft |
| Warrior | si′-et-chu-ia | | | cow-wats-ou-hats-i′-ta |
| Friend | sŏw′-o-kin | | | sŏw-kin′-i |

KERES.—Continued.

| | XIII. Kiwomi. | XIII. Kiwomi. | XIV. Cochitemi. | XV. Acoma. |
|---|---|---|---|---|
| House, hut | ai′-it-chin | | | cat′-tu-i-ta |
| Kettle | cu′-mas-a-wa | | | |
| Arrow | es′-to-wa | | | |
| Bow | wes′-chick | | | |
| Axe, hatchet | ok′-po-wĕn | | | |
| Knife | kes′-ka | | | |
| Indian shoes | ha′-shup | ha′-shum | | |
| Bread | pa | | | |
| Pipe, calumet | ach-can | chā-quck′ | | |
| Tobacco | ha′-o-mi | ha′-mi | | |
| Sky, heaven | hu′-wuc-ca | | | |
| Sun | o′-sŭtz | o′-shŭtz | | o′-shutz |
| Moon | ta′-o-watz | tah′-o-watz | | ta′-ho-watz |
| Star | shi′-a-chŭtz | shi′-chut-i | | shi′-ki-ŭt |
| Day | sai′-ech | | | |
| Light | ma′-su | | | |
| Night | no′-i-ya | | | |
| Darkness | cahps | | | |
| Morning | na′-cai-ya | | | |
| Evening | cha′-puc-ca | | | |
| Spring | ti′-etz | | | |
| Summer | ca′-sha-te | | | |
| Autumn | tu′-o-na | | | |
| Winter | coke | | | |
| Wind | cu′-you-tow-i | | | |
| Lightning | put′-so-isk-i | | | |
| Thunder | cŏw′-o-mŭtz | | | |
| Rain | he′-i-nut-i | | | |
| Snow | ha′-o-wi | | | |
| Hail | ha′-o-mañ-i | | | |
| Fire | ha′-i-kan-i | | | |
| Water | ’tsetz | | | |
| Ice | ha′-ha-mi | | | |
| Earth, land | ya′-’i | | | |
| Sea | ’tsist′-tsu-o-wi | | | |
| River | chi′-na | | | |
| Lake | cu′-o-wat-si | | | |
| Valley (cañon) | chi′-nai-ya | | | |
| Hill | cu′-yo-cats | | | |
| Mountain | co′-te | | | |
| Island | cots′-anch | | | |
| Stone, rock | ya-o-ni | | | |
| Iron | thi′-mŭs-chŭch | | | |
| Maize | ya′-o-ca | ya′-chi | | |
| Tree | man-za′-na | | | |
| Wood | hah′-ñi | | | |

KERES.—Continued.

| | XIII. Kiwomi. | XIII. Kiwomi. | XIV. Cochitemi. | XV. Acoma. |
|---|---|---|---|---|
| Leaf | ma′-sa-ni | | | |
| Grass | a′-shen | ah′-shi | | |
| Pine | hah′-ñi | | | |
| Poplar | hi′-e-tran | | | |
| Flesh, meat | i′-she-ni | | | |
| Beaver | cu′-o-ho | | | |
| Deer | ki-ah′-ni | | | |
| Bison, buffalo | mu′-shatch | mu′-shuck | | |
| Bear | cu′-hai | | | |
| Wolf | ca-chan | | | |
| Dog | ti | | | |
| Fox | quish′-shotz-un | | | |
| Squirrel | bi-a-lin | | | |
| Rabbit, hare | le′-ich | | | |
| Snake | skŭ′-i-ska | | | |
| Rattle-snake | shru′-o-wi | | shru′-wi | |
| Bird | si′-o-lo | | | |
| Egg | tschi′-o-la | | | |
| Goose | cai′-po | | | |
| Duck | ti′-e-wit-e-wik | | | |
| Pigeon | huk | | | |
| Partridge | cahs′-cark | | | |
| Turkey | ’tsi-na | | | |
| Fish | cahsh | | | |
| White | ca′-sha | | | |
| Black | mu′-na-ken | | | |
| Red | cu′-can | | | |
| Blue | quisk | | | |
| Yellow | cu′-chin | | | |
| Green | cu′-shat-im | | | |
| Great, big | mat′-sitch | | | |
| Small, little | lus′-kitch | | | |
| Strong | si′-shŭtz | | | |
| Old | nai′-stchu-a | | | |
| Young | lŭ′-ca-shat | | | |
| Good | la′-o-wa | | | |
| Bad | cu′-wa-sa | | | |
| Handsome | cin′-mo-ta-wa | | | |
| Ugly | cha′-lis-ka | | | |
| Alive, life | si′-yan | | | |
| Dead, death | tschu′-o-mo | | | |
| Cold | i′-o-ma | | | |
| Warm, hot | catch′-a | | | |
| I | hi′-no | | | |
| Thou | hish | | | |
| He | weh’ | | | |

KERES.—Continued.

| | XIII. Kiwomi. | XIII. Kiwomi. | XIV. Cochitemi. | XV. Acoma. |
|---|---|---|---|---|
| We | hi′-no | | | |
| You | kēch-e′-o | | | |
| They | e′-ot-za | | | |
| This | weh’ | | | |
| That | u′′-weh’-o | | | |
| All | se′-how-o′-pa | | | |
| Many, much | ep′-ma | | | |
| Who | how′-o | | | |
| Near | lu′-o-ma | | | |
| To-day | hi′-wo-saitch | | | |
| Yesterday | so | | | |
| To-morrow | nah′-cai-a | | | |
| Yes | hah | | | |
| No | tsah | | | |
| One | isk′-a | isk | | ish′-ka |
| Two | ’tsu′-o-mi | ’tu′-o-mi | | ku′-o-mi |
| Three | ’tscham | tschab′-i | | cha′-mi |
| Four | gi-a′-na | ki-a′-na | | ki′-a-na |
| Five | ta′-hm | ta′-o-ma | | ta′-ma |
| Six | stchis | chisth | | chi′-sa |
| Seven | mai′-cha-na | mai′-cha-na | | mai′-ca-na |
| Eight | co′-con-shi | co′-cŭm-shi | | co′-co-mi-shia |
| Nine | mai′-ec-o | mai′-e-co | | mai′-e-co |
| Ten | ’tcahtz | cahtz | | ’tkatz |
| Eat | tshu′-peh | chu′-pe | | |
| Drink | us′-ke-a | | | |
| Run | atz-o-muk | | | |
| Dance | a′-chintz-tscha | | | |
| Go | hi′-na | | | |
| Sing | su′-ut-a | | | |
| Sleep | yi′-a-pat-a-si | si′-paak | | |
| Speak | eh′-nŭtz-a-si | saht′-sa | | |
| See | si′-u-kutch-i | | | |
| Love | te′-ñi-si | | | |
| Kill | sa′-ot | | | |
| Walk | nu′-o-wa-pot-sen. | | | |
| Smoke | | chas′-ka | | |
| Apaches | | Chah′-shm | | |
| Kai-o-was | | Cai′-guas | | |
| Mexicans | Ca′-ste-la (Span.) | | | Cash′-tiil-da (Sp.) |

Remarks.

*Kiwomi and Cochitemi.*—In reply to questions respecting the sources whence the three first vocabularies were procured, Mr. Whipple says, speaking of them in the order in which they are printed:

"Upon the Canadian river, while accompanied by a trading party of Mexicans from San Juan de los Caballeros, we met Indians from the pueblo of Santo Domingo. The Mexicans stated that they were known as *Teguas;* but they called themselves *Kï'-o-a-me,* or *Kï'-wo-mi.* One vocabulary of their language, obtained from the chief, is nearly complete. The second, communicated by another individual of that party, may be useful for comparison, giving confidence to those corresponding words which, in both, express similar sounds."

"At Rocky Dell creek another party of Indian traders made their appearance. They informed us that the Indian name of their tribe was *Co-chi-te-mi'*, though by Spaniards called *Qui'-me;* and that their homes were in New Mexico, south of the Kiwomi—at Zandia or Isleta, perhaps. The vocabulary of their language was not completed, because it seemed to be nearly identical with that of the Kiwomi."

The general conclusion to be drawn from this is, that we have here vocabularies of the language spoken in Santo Domingo and the neighboring pueblos; and this conclusion is supported by a comparison of them with Simpson's brief specimen of the language, the only one heretofore published, with which it agrees tolerably well.

One or two particulars, however, in the statement are difficult to account for. It is said that the tribe are called by the Mexicans *Teguas.* Now, the ancient and proper name of the tribe to which the people of Santo Domingo and the neighboring pueblos belong, as we are informed by Pike and Gregg, is *Keres,* or in the Spanish orthography *Queres;* whereas the Tegua tribe are found further to the north, in the pueblos of San Juan, Santa Clara, Nambe, Pojuaque, &c., and speak a different language. Again, the third vocabulary is that of people who called themselves *Cochitemi'*. This we would naturally suppose to mean people of the pueblo of *Cochiti'*, who are known to belong to the Keres tribe; but they represented themselves as living to the *south* of the Kiwomi, while Cochiti is the most northerly pueblo of the Keres. These difficulties could probably be easily resolved by persons residing in the country.

It will be observed that in these three vocabularies the accent, or stress of the voice, is almost uniformly on the first syllable of the word.

*Acóma.*—The people of this pueblo also belong to the tribe of Keres. The vocabulary before us is a brief one, containing but twenty-eight words. Mr. Whipple says, speaking of these Indians: "We tried to write a vocabulary of their language; but the words given were so long, and so difficult to pronounce, that we gave up the task." This, though it differs from the three preceding ones more than they do from each other, evidently represents the same language, and apparently in an older and purer form, its words being longer and presenting a more uniform character than those of the other vocabularies, which appear to have been abbreviated and corrupted from them. May not this be owing to the Acucans' being more separated by their almost inaccessible position from the Mexicans? Indeed Lieutenant Abert says: "These people cannot have associated much with the Mexicans, for they scarce know a word of the language." It is desirable that we should have a complete vocabulary of this dialect.

Our interest in the people of Acoma and their language is heightened by the fact that their pueblo is one of the few places in New Mexico visited by the first explorers of the country under Coronado, in the middle of the sixteenth century, which it is now possible to identify. It had been supposed that the present pueblo of Acoma, remarkable for its lofty position and difficulty of access, which proved its safeguards on that occasion, was the *Acuco* of the invaders. This supposition is now fully confirmed by the testimony of Colonel J. H. Eaton, who says: "In a conversation with a very intelligent Zuñi Indian, I learned that the pueblo of Acoma is called, in the Zuñi tongue, *Hah-koó-kee-ah* (Acuco); and this name was given to me without any previous question which could serve to give him an idea of this old Spanish name." (Schoolcr., Hist. Cond., &c., IV, 220.)

# ZUÑI.

| | XVI ZuÑi. | | XVI. ZuÑi. |
|---|---|---|---|
| God | o′-na-wil-li | War captain | i′-thlŭck-ni-cha-mo′-si |
| Wicked spirit | ish′-u-we | Warrior | son′-ta-lo-qui |
| Man | ot′-si | Friend | cu′-a-yi |
| Woman | o′-kia | House, hut | kia′-quim-ni |
| Boy | sa′-ba-ki | Kettle | wa′-kish-i |
| Girl | e′-lesh-to-ki | Arrow | shaw′-o-li |
| Infant, child | chat′-se-ki | Bow | pi′-tlan-di |
| Father | ta′-chu | Axe, hatchet | ki-e-li |
| Mother | si′-ta | *Hacha Azteca* | o′-la-ki-e-li |
| Husband | o′-ye-me-shi | Knife | a′-chi-en-di |
| Wife | o′-ye-me-shi-li | Canoe, boat | thle′-lo-ni |
| Son | cha′-li | Indian shoes | mo′-quou-o-wi |
| Daughter | hom-kat′-ski | Bread | mu′-lon-di |
| Brother | su′-e | Pipe, calumet | te′-pok-li-nen |
| Sister | i′-ka-na | Tobacco | he′-to-co-ni |
| An Indian | ho′-i-te | Sky, heaven | ja′-la-oue |
| Head | o′-sho-quin | Sun | ja′-tŏk-ia (ya′-tok-ya) |
| Hair | tai′-a-oue | Moon | ja′-chu-ne |
| Face | no′-po-nim | Star | moi′-a-chu-we |
| Forehead | ha′-quin | Day | ja′-toi-e |
| Ear | la′-shŏk-tin | Light | te′-co-han-na |
| Eye | tu′-na-oue | Night | teth′-lin-ai-e |
| Nose | no′-e-lin-de | Darkness | te′-quin-na |
| Mouth | a′-wa-tin | Morning | te′-wa-ni |
| Tongue | ho′-nin-ne | Evening | zu′-na-cha |
| Tooth | oh′-nŏw-e-we | Spring | o′-lok-i′-yer |
| Chin | tle′-we-chin | Summer | te′-cath-li |
| Beard | si′-po-ni-we | Autumn | taw′-wă-nai-e |
| Neck | ki′-sin-de | Winter | tel′-se-ti′, tet-se-na′ |
| Breast | po′-ha-tan-de | Wind | thlit′-te-quai-nai′-a |
| Arm | a′-si-o-we, chu′-ti-o-we | Lightning | ul′-tok-ai |
| Hand | a′-si-kat-so-wa, ash-ti-shok-ta | Thunder | pi′-nai-ia |
| | | Rain | thlit′-to-ia |
| Fingers | kets′-pil-to | Snow | ou′-pi-nai-oe |
| Nails | shaun′-chi-o-we | Hail | mo′-pi-nai-oe |
| Body | te′-lon-de | Fire | ma′-qui (ma′-ki) |
| Belly | tsu′-o-le | Water | ki′-a-we |
| Leg | o′-yin | Ice | ’tchath-le |
| Foot | oue′-qui-o-we | Earth, land | so′-wi |
| Toes | tok′-no-o-we | Sea | ki-a′-tuth-u′-lŭp-nai-e |
| Bone | sam′-me | River | ki-a′-wa-nai-e |
| Heart | i′-ke-o-nŭn-ne | Lake | ki-a′-tu-lin-ni |
| Blood | a-′te | Valley | pe′-we |
| Town, village | thlu′-a-lŭn | Hill | te′-po-keth-la′-oe |
| Chief | an′-i-sa-to-ni | Mountain | ja′-la-oe |

## ZUÑI.—Continued.

| | XVI. Zuñi. | | XVI. Zuñi. |
|---|---|---|---|
| Island | cā-bul′-la-o-pi | Dead, death | hap′-pa |
| Stone, rock | a′-we | Cold | tet′-se |
| Salt | ma′-we | Warm, hot | te′-su |
| Copper | te′-se-li-li | I | hoh′-o |
| Iron | thle′-cai-a-we | Thou | toh′-o |
| Maize | mi′-we | He | luk′-yĕ |
| Tree | ta′-ne-ai-we | We | hoh′-no |
| Wood | thle′-lo-e-we | Ye | luk′-no |
| Leaf | ha′-we | They | lak-ti′-no-na |
| Grass | pe′-we | This | luk′-yer |
| Pine | a′-she-ki | That | uk-si′ |
| Flesh, meat | shi′-le | All | tem′-thla |
| Beaver | pi′-ha | Many, much | te′-u-cha |
| Deer | shaw′-hi-ta | Who | chu′-a-pi |
| Bison, buffalo | tūsh-ke′-o-wŭn-na | Near | lo′-te |
| Bear | ain′-she | To-day | la′-ki |
| Wolf | yu′-na-wi-co | Yesterday | te′-shu-quoi |
| Dog | wats′-ta | To-morrow | ich′-e-toi-thli |
| Fox | ma′-wi | Yes | ia |
| Squirrel | ye′-e-yi | No | ho-lo′ |
| Rabbit, hare | ok′-shi-co-ni | One | to′-pa |
| Snake | mit′-cath-li | Two | qui′-li |
| Rattlesnake | chit′-to-la | Three | hah′-i |
| Bird | wots′-a-na-o-we | Four | a′-wi-te |
| Feather | la′-we | Five | ap′-te |
| Egg | to′-co-co-mo-we | Six | to′-pa-lik-ya |
| Duck | e′-yer | Seven | qui′-de-lik-ya |
| Turkey | to′-na | Eight | hai′-e-lik-ya |
| Fish | ’tshash′-i-ta | Nine | ten′-e-lik-ya |
| Shell | shaw′-ton-ni | Ten | as′-tem-thla |
| White | co′-han-na | Eleven | to′-pa-yath-to |
| Black | quin′-na | Twelve | qui′-li-yath-to |
| Red | shi′-lo-wa | Thirteen | hah′-i-yath-to |
| Blue | ’thlit′-on-na | Fourteen | a′-wi-ten-yath-to |
| Yellow | thlut′-sin-na | Fifteen | ap-ten-yath-to |
| Green | ash′-e-na | Sixteen | to-pa-lik-yath-to |
| Great, big | thlan′-na | Seventeen | qui-li-lik-yath-to |
| Small, little | ’tsan′-na | Eighteen | hai-e-lik-yath-to |
| Strong | ’tsum′-mi | Nineteen | ten-e-lik-yath-to |
| Old | ’tlash′-shi | Twenty | qui-lik-yin-ath-tem-thla |
| Young | chi′-mo-na | Twenty-one | qui-lik-yin-ath-tem-thla-to′-pa-yath-to |
| Good | cok′-shi | Thirty | hai-yik-in-ath-tem-thla |
| Bad | quok′-cok-sha-ma | Forty | a-wi-kin-ath-tem-thla |
| Handsome | soh′-ya | Fifty | ap′-te-nik-in-ath-tem-thla |
| Ugly | hoh′-i-sam′-mo | Sixty | to-pa-lik-in-ath-tem-thla |
| Alive, life | hoh′-i | | |

## ZUÑI.—Continued.

| | XVI. ZUÑI. |
|---|---|
| Hundred | asi-ath-tem-thla |
| Thousand | asi-ath-tem-thla-ath-tem-thla |
| Eat | i′-to, i-to′ |
| Drink | tu-tu |
| Run | ye′-la-ha′ |
| Dance | o′-ti-e-we |
| Go | so-a′-ne |
| Come | kath′-li-ma-ni |
| Sit | i′-mu |
| Sing | te′-na-u |
| Sleep | a′-la |
| Speak | pe′-ye |
| See | u-na′ |
| Love | an′-te-sho-ma′ |
| Kill | ai′-i-na |
| Walk | ya′-ta-shlot-ya |
| One who has killed an enemy (*matador*) | pith-la-shi-wa-ni |
| I wish to know | ai′-yi-ya-no-ke-nŭh′ |
| I have eaten enough | i′-ton-a-we |
| Zuñi | Shi′-oui |
| Zuñi chief (name of) | Lai′-ai-ai-et-za-lu′ |

### REMARKS.

A few miles from the present pueblo of Zuñi are situated on a mesa, or elevated table-land, the ruins of the old town which Mr. Squier has demonstrated to be the *Cibola* that figures so largely in the account of the first explorers of New Mexico under Coronado. For in the narrative of Espejo's visit to that country about forty years afterwards, as given by Hakluyt, it is said, "Twenty-four leagues from hence, towards the west, they came to a certain province *called by the inhabitants themselves* ZUNY, *and by the Spaniards* CIBOLA."

The only Zuñi vocabularies heretofore published are one in the report of Lieut. Simpson, and another, furnished by Capt. Eaton, in Schoolcraft's fourth volume. That of Mr. Whipple, which was obtained by himself from a native of the tribe, agrees very well with both the preceding. Here, too, it will be observed that the accent is, almost without exception, on the first syllable of each word. It has been remarked by the judicious Gregg that there are but three or four different languages spoken among the Pueblo Indians, and that these may be distantly allied to each other. A comparison of the Zuñi vocabulary with those of the Keres would not lead us to infer any radical affinity whatever between the languages. It is to be hoped that, of the intelligent men now permanently settled in New Mexico, and especially the missionaries stationed among these interesting peoples, some may be willing to devote themselves to a study of the grammatical structure of their languages, so that we may ascertain the exact nature of the relationship in which they stand to each other.

# PIMA.

| | XVII. Pima. | | XVII. Pima. |
|---|---|---|---|
| Man | or'-ter, chee-ort' | Mountain goat | chu'-son |
| Woman | oo-oove' | Horse | cah'-vay-yo (Sp. *caballo*) |
| Old man | ku'-lee | Crow, raven | hah'-win |
| Boy | ah'-lay | Scorpions | cokes |
| Girl | churche'-o | Ant | quar'-tic |
| Wife | oo-if | Fish | vah'-top |
| Hair | moh | Good | skooek'r |
| Eye | oupe'-we | Bad | moo'-mo-co |
| House | hūch-yū-lah-chook' | None | nune |
| Arrow | *n'oo'-oo* | To-morrow | say-ah'-ly |
| Head-band | saw-a-key-wah | One | her-mah |
| Spur | is'-pul | Two | coke |
| Shoes | sah'-pat | Three | vaique |
| Beads | pai'-ou-ker | Four | keek |
| Blanket | ix | Five | her'-tus |
| Belt | soe-her-up'-and-kay-her-pah' | Six | chou'-ote |
| Hat | soo-mah-der' | Seven | wee'-o-ker |
| Tobacco | vib | Eight | kee'-kick |
| Mezcal | ah'-o-ly | Nine | hoo'-mook |
| Music | cooh | Ten | wis'-to-mah |
| Sun | tasch | Eleven | vas-her'-mah |
| Moon | mas'-sar | Twelve | vas-o-coke |
| Water | soo'-e-ty | Thirteen | vas-o-vaique |
| River | see'-o-pit | Twenty | co-co-wis-to-mah |
| Mountain | toe'-ark | Thirty | wee-co-wis-to-mah |
| Stone, rock | hote'-ay | Forty | kee-co-wis-to-mah |
| Sand | terre-whit' | Fifty | her-tus-co-wis-to-mah |
| Tree | ah'-ou-pah | Sixty | chou-ote-co-wis-to-mah |
| Leaf | hah'-hah-ketz, ser'-quy | Hundred | way-co-wis-to-mah |
| Corn | ou'-in, oo-oon | How do you do? | see'-co |
| Teazel | wy'-wy | Apache | Orp |
| Cereus giganteus | har'-say | Gila river | Ack'-o-mah |
| Syrup of the cereus | sees'-tor | Casa Blanca | Huch-oo-la-chook-vache' |
| Coyote | pa'-hu | | |

## Remarks.

*Pimas* (by some corrupted into *Pimos*).—Humboldt says the northernmost part of the intendancy of Sonora bears the name of Pimeria, from a numerous tribe of Indians called Pimas, who inhabit it.

The first of our people who visited and described the Pimas of the Gila, the only ones with whom we are as yet acquainted, were Colonel Emory and Captain A. R. Johnston, who accompanied the invading army of General Kearny in 1846. The fullest and most satisfactory account of them is that given by Hon. John R. Bartlett, in the second volume of his "Personal Narrative." They and the Coco-Maricopas live in a very friendly manner in two neighboring villages on the south side of the Gila, about midway of its course. Mr. Bartlett estimates the population of the two villages of these peaceful and industrious communities at about 2,000 souls, of whom two-thirds are Pimas.

Of the Pima language a few words and some account of its grammatical structure are given in the Mithridates from Father Pfefferkorn's work on Sonora. A brief vocabulary by Dr. Coulter is published in the eleventh volume of the Royal Geographical Society's Journal; and a much fuller one, drawn up by Dr. C. C. Parry, in the third volume of Schoolcraft's History, &c., of the Indian Tribes. The short vocabulary obtained by Lieutenant Whipple agrees well with those of his predecessors, as far as they coincide in the choice of words.

# YUMA.

| | XVIII. Cuchan. | XIX. Coco-Maricopa. | XX. Mojave. | XXI. Diegeño. |
|---|---|---|---|---|
| God | coo-coo-máh-at | | mat-e-vil′ | |
| Devil | mas-tam-hóve | | | |
| Man | é-patch, è-páh | ee-páche | i-pah′ | ay-cóotchet |
| Woman | seen-yack | sin-chay-aíx-hutch | sin-yax′ | seen |
| Boy | her-máiº | ho-márche | hu′-mar | el-mám |
| Girl | měsĕr-háiº | mes-a-háitz | mes-a-haitz′ | |
| Infant, child | hail-pĭt | | hŭr-quil′-ya | |
| Parents | hon-o-waiº | | | |
| Father | loth-mo-cúl | | ni-qui-oche′ | nile |
| Mother | n′taieº | | hun-taiche′ | tile |
| Compadre | matio-habeé-èº | | | |
| Husband | na-vĕre | | n′ya-betch′ | |
| Wife | o-shúrche, o-soº | | ni-cu-ratch′ | |
| Son | ho-maieº | | ho-maiche′ | |
| Daughter | m′chaieº | | ho-marche′ | |
| Brother | socheº | | | |
| Sister | am-yuckº | | | |
| Indian | m 1-è-páieº | | n′yith′l | |
| Head | é-cout-such-è-rówo, oom-whelitheº | | ca′-wa-wa | estár |
| Hair | o-con-o,º e-ĕtche | | i-mi′ | |
| Face | e-dótche, ee-yuº | | i-hal-i-me′ | wa |
| Forehead | ee-yu-calóqueº | | yah-ma-pul′ | |
| Ear | smyth′l, è-sĭm-ile | | e-smailk′ | ha-mát′l |
| Eye | e-dotche-ée, ee-yu-sune-ya-oº | aye-dotch | i-dotz | a-yon (a-wŭc, pl.) |
| Nose | e-hotche, ee-hóo | yay-hay-oóche | i-hu | hoo |
| Mouth | ee-yu-qua-ófeº | ee-zátch | i-a | ah |
| Tongue | e-pulche, ee-pailche | | i′-pail-ya | |
| Teeth | are-dóche | | i-do′ | |
| Chin | a-tuc-sáho, ee-a-tuc-suche | | | |
| Beard | ya-bo-mĕh | yay-bo-mitz | ya-bu′-meh | |
| Neck | n′yeth′l | | hu-nak′ | |
| Shoulder | ee wee | | | |
| Arm | ee-seth′l, è-see′l | | i-sail′ | cu-wis |
| Hand | ee-sálche | | i-sail-que-se-rap′ | sith′l |
| Fingers | ee-salche serap | | i-sail-que-se-rap′ | a-sac′l |
| Nails | ee-sálche calla-hotche | | sa-cul-ya-ho′ | |
| Body | ee-mátche, ta-wa-coamº | | i-wah′ | hamato |
| Back | a-tanº | | | |
| Belly | | | i-to′ | |
| Leg | mee-sith′l | | mi-sil | e-with′l |
| Knee | | | | toon |
| Foot | e-mětch-slip-a-slap-yah | | i-mi-lap-e-lap | ha-meel-yáy |
| Toes | e-metch serap, e-mee-cas-sao | | mi-que-se-rap-a | |
| Heart | ee-éieº | | wi-at, i-wa′ | |
| Blood | a-whutº | | ñi-a-whut′ | |
| Town, village | he-paith-láoº | | n′yo-ha-ble-yimp′ | |

## YUMA.—Continued.

| | XVIII. Cuchan. | XIX. Coco-Maricopa. | XX. Mojave. | XXI. Diegeño. |
|---|---|---|---|---|
| Chief | co-hóte* | | quo-hote′ | |
| Warrior | con-níee* | | at-chi-ber-ce-but | |
| Friend | n′yet′l* | | n′yithl | |
| House | n′ye-valyay, een-ou-wa* | | ah′-ba | a-wáh |
| Hut | een-ou-mŭt* | | | |
| Kettle | | | mu′-hulk | |
| Arrow | n′yee-páh | ou-teese | a-kim | |
| Do. of reed | n′yee-pah-táh | | | |
| Do. of wood | n′yee-pah-é-sáh-be | | | |
| Bow | o-tées-a, ar-tim* | | i-pa′ | |
| Gun | | | a′-ti-is | |
| Flute | | cah-vo-cah-varpk | | |
| Axe, hatchet | a-ta-cárte | | toc-yat′ | |
| Knife | n′è-ma-ró* | | ah′-que | |
| Scissors | chim-in-yeich | | | |
| Canoe, boat | e-cal-hor* | | | |
| Indian shoes | n′hum-au-óche | an-hum-en-yeous | hum′-n′yo-wa | |
| Hat | a-pee-árpe* | coo-póos | | apée-ĕl |
| Beads | su-cool | hut-qua-soose | | |
| Do. of pierced shells | pook | | | |
| Blanket | | hut-chóche | | tayhéeth, cucháo |
| Breech-cloth | way-mah-coutche | | | |
| Belt, sash | | soe-her-up-and-kay-her-páh | | |
| Do. different colors | | soe-her-up-and-kay-her-whiltz | | |
| Trowsers | | away-tíc-er-hab-itz | | |
| Cloth | | ham-arlk | | |
| Red cloth | | hah-whétz | | |
| Paper | manúrke | | | |
| Bread | | | mu-dil′ | me-yert′l |
| Flour | | en-pay-mah-barrache | | |
| Pipe | | | mail′-ho | |
| Cigar | nee-ca-chain | | | |
| Tobacco | a-óobe | oh-oúbe | a-u′-ba | |
| A light | a-ah-oche | | | |
| Brandy | | | | quarquuc |
| Whiskey | ha-rup | | | |
| Money | | | | coo-quit′l-hue, iris-co-quit′l-hue |
| Sky, heaven | am-mai | | a-mai′-ya | |
| Sun | n′yatch | n′yatz | n′yatz | |
| Moon | huth′l-ya, hull-yar | hull-ash | hull-ya′ | |
| Star | klup-wa-taie, hutchar | hummah-sísh | ha′-mu-se | |
| Day | no-ma-súp | | cu-tin-ya′-ma | |
| Noon | pue-n′a-pin | | | |

## YUMA.—Continued.

| | XVIII. Cuchan. | XIX. Coco-Maricopa. | XX. Mojave. | XXI. Diegeño. |
|---|---|---|---|---|
| Light | met-n'yum | | en'-yaik | |
| Night | n'ye-as-cup | | nya'-ha-bit | hoon |
| Midnight | n'yat-a-so-arpe | | | |
| Darkness | n'yat-col-see | | tin'-yamk | |
| Morning | esta--no-sup | | tin-ya'-ma | |
| Evening | n'yat-an-n'aee | | ñyat-in-ai'-am | |
| Spring | oo-cher | | | |
| Summer | o-mo-caahe-pué | | | |
| Autumn | ha-ti-ól | | | |
| Winter | n'ya-pin | | | |
| Wind | mĕt-har | | mŭt'-ha | |
| Lightning | n'ya-col-see | | o'-ra-ba | |
| Thunder | mĕt-hár-co-nó | | wo'-ca-ta | |
| Rain | muh-heé | | cu'-ba-wa | |
| Snow | ha-lúp | | o'-ha-cha | |
| Hail | n'awo-cope' | | | |
| Fire | a-a-wo | áh-ooch | a'-wa | |
| Water | a-há | | ah'-ha | ahá |
| Spring (of water) | | | hutch-i-pa' | |
| Ice | sho-kine | | | |
| Earth, land | o-mut | | a'-mar-tar | |
| Sea | a-ha-t'hlow-o | | | |
| River | ha-with'l, ha-weèl | | ha-wil | |
| Rivulet | | | he-row-ok | |
| Lake | ha-sha-cut | | | |
| Valley | ha-mut-ma-tarré | | | |
| Hill | wee-qua-taiè, ha-beé | | ha-bi' | |
| Mountain | | | itz-i'-bi-la | |
| Island | ha-mut-ma-tarre-quel-marm | | | |
| Road | | on-ñitz | on-yĕ' | |
| Stone, rock | o-wee | | | |
| Salt | e-sith'l | | | |
| Iron | n'yer-ma-ró | | an-yo'-rum | |
| Maize, corn | tĕr-ditch | ter-dĭtz | ter'-di-cha | |
| Beans | | | se-van' | |
| White beans | marique (mareek) | | | |
| Beans (small, with black spots) | ah-ho-mah, marrico-tah | | | |
| Mezquit long bean | ee-yah (ee-yahts, plur.) | | | |
| Do. screw bean | e-eesse | | | |
| Beans cooked | | | maríque-cu-ta' | |
| Melon | | que-dóu-ix | | |
| Musk-melon | ché-mĕt-a-qúis | | | |
| Water-melon | ché-mĕt-on-ya, ché-m t-toh | | | |
| Tree | e-eesh | | e-metsk' | |
| Wood | e-eé, e-eetch | | e-i' | |
| Leaf | ee-eetch-a-berr-beerrch | | | |

## YUMA.—Continued.

| | XVIII. Cuchan. | XIX. Coco-Maricopa. | XX. Mojave. | XXI. Diegeño. |
|---|---|---|---|---|
| Fruit | | | | ach-a-má-cha |
| Grass | | hut-chitz | ich-i'-wi-la | |
| Grass-seed | ae-o-táie | | | |
| Cereus giganteus | | ah-áh-chy | | |
| Flesh, meat | ta-sóu-o | | i'-tho-ik | |
| Horse | huts | ah-quactus | | mo-quúc, hut |
| Mule | | mel-ah-co-lish | | ah-hút, moolt |
| Wolf | | | at-ol-weh' | |
| Dog | hoo-wée | | hatch-ot-soc' | |
| Mountain buck | | ah-bee-bubber | | |
| Snake | | | ah-beh' | |
| Bird | a-her-máh | | | |
| Feather | sah-with'l | | | |
| Eagle | es-pátch | | | |
| Eagle's feather | sor-měh | | | |
| Raven | | cáche-set | | |
| Fish | a-cheé | cheé-ish | e-chi' | |
| White | ham-arlk | vach | ha-quik' | |
| Black | quim-ele, n'yéelk | | a-que'-ra | |
| Red | a-cha-whut | | che'-whŭt-a | |
| Blue | ha-woo-surche | | e-chur'-wa-su-cha | |
| Yellow | a-quesque | | il-i'-ma-sa-ba | |
| Green | at-so-woo-surche | | ach-ha'-ga | |
| Great | o-teieque | be-táchy | hu'-mik | |
| Very great | e-páilque-n'ya-mook | | | |
| Small, little | o-noc-oque | oh-nóc-oque | a-to'-we-nok | |
| Old | | | cu-rak' | |
| Good | a-hote-kah, a-hotk | a-hot'k | ah'-hotk | han, hánna |
| Very good | a-hoték-a-han-ac | | | |
| Bad | ha-loolk | poo-ſk | a-laik' | |
| Very bad | ha-lúlk-a-hán-ac | | | |
| Handsome | e-hanc, e-hán-ac | | at-so-cam'-puk | |
| Ugly | n'-ya-a-nŭc | | hut-churk' | |
| Generous | | es-coo-áilk | | |
| Stingy | mez-queeno (Span.) | mez-quée-no (Span.) | | |
| Alive, life | | | ha-bin-n'ya-baik' | |
| Dead, death | | | ter-pou'-ik | |
| Cold | huts-ule | hut-chúnk | hŭt-churk' | |
| Warm, hot | ep-eelk | | he-pil'-ka | |
| I | n'yat | in-yátz | i-ma'-ta, n'yatz | n'yat |
| Thou | mantz | mantz | in-i-cak, mantz | |
| He | ha-buitzk | | pe'-pa | poo |
| All | | | qui-bŭc | |
| Many, much | e-pailque | ė-páilque | a'-taike | |
| Little | | | o-noc'-oc | |
| None | | cobarrk | | |
| Nothing | | | | omuc'l, omah-o |
| Near | | | hi-pau'-ac | |

## YUMA.—Continued.

| | XVIII. Cuchan. | XIX. Coco-Maricopa. | XX. Mojave. | XXI. Diegeño. |
|---|---|---|---|---|
| Far | ac-corque | | a-miche′ | |
| Here | | | | pee |
| To-day | queel-yóh | | | en-yát'l |
| Yesterday | ten-igh | | | |
| To-morrow | qual-a-yoque | | hul-i-yom′ | mát-in-yat'l |
| Shortly | ac-coúrt | | | |
| Yes | ah-ah, oh | | e | ho |
| No | co-bár-ro, co-barque | es-eélsch | co-bar′-ro | |
| One | sin, asi-én-tic | | set′-to | hinc |
| Two | ha-wick, ha-vick′ | | ha-vi′-ca | ha-wŭc |
| Three | ha-móok | | ha-mo′-co | ha-móok |
| Four | cha-póp | | june-pap′-a | cha-póp |
| Five | se-rap′ | | se-rá-pa | seráp[9] |
| Six | hum-hook′ | | sin′-ta | |
| Seven | path-cayé | | vi′-ca | |
| Eight | chip-hook′ | | mook′-a | |
| Nine | hum-ha-mook′ | | pai′-a | |
| Ten | sah-hook′ | | a-ra′-pa | |
| Eat | as-á-o, atch-a-mam | | o-ma′-o | as-á-o |
| Drink | a-sée, ha-súc | | i-thi′-o | ay-sáie |
| Run | co-no | | a-ba-bé-rum | |
| Dance | a-heese, chee-muk | | hŭc-am′ | |
| Sit | au-nuc | | | |
| Stand | a-boúck | | | |
| Go | n'yee-moom, at-co-bér-quic | | n'yi-moom′ | |
| Come | que-díque (ker-deek), n'yuc-a-yuc | | | |
| Sing | atch-ar-see-várch | | i-mak | |
| Sleep | a-see-máh | | es-o-ma′om | |
| Be sleepy | a-ee-póve | | | |
| Speak | quer-quer, atch-ak-quérk | | hutch-e-querrk | |
| See | o-ook | | ich-e-uk′ | |
| Love | o-moo-han | | at-co-que′-but | |
| Desire | a-woo-noorch | | | |
| Kill | au-u-suc | | at-a-pou′-yop | |
| Wash | et-sims | | | |
| Walk | | | ar-a-o′-ik | |
| Wait | | | ath-i-pam | |
| Stay | | | qui′-bak | |
| Smoke | ass-ee-poo | | | |
| Trade | | | et-er-ab′ | |
| Shoot | | ac-quee-árm | | |
| Be drunk | | | | asér-mĕrāyo |
| Apache | | Yah-bay-páiesh | | |
| Yuma | | Cou-chan | | |
| Mexican | Hĕr-cóh | | | |
| American | Pain-gote-sáh | Pain-gote-sahch | Pain-gote-satch′ | |
| California | N'ya-háp | | | |

## YUMA.—Continued.

| | XVIII. Cuchan. | XIX. Coco-Maricopa. | XX. Mojave. | XXI. Diegeño. |
|---|---|---|---|---|
| Rio Colorado | Ha-weel-cha-whoot (Red river) | | | |
| Rio Gila | Ha-qua-sĭ-eél (Salt river) | Hah-quah-sie-eel-ish | | |
| Rio Azul | ---------- | Hush-yen-tís | | |
| Emory's Hill | Ha-bee-cohá | | | |
| Pyramid Hill | Ha-bee-co-a-chis | | | |
| Capitol Dome Hill | Ha-bee-to-cúe | | | |
| Pilot Knob | Ha-bee-co-la-la | | | |
| Pilot range | Que-you-so-win-a | | | |
| Chimney Rock | Mel-ee-keet-a | | | |
| Casa Blanca | ---------- | A-vuc-hoo-mar-lish | | |
| Ursa Major | ---------- | ---------- | | Ah-chi'-cu-ta-bech'-a |
| Orion | ---------- | ---------- | | A'-mu |
| Pleiades | ---------- | ---------- | | Hut-char' |
| Polaris | ---------- | ---------- | | Mās-a-ke-ha'-ba |
| Sirius | ---------- | ---------- | | A-mo-tu-ca-be'-ra |
| Rich man | ---------- | ---------- | | i-pah han |
| Good melon | ché-met-a-hán | | | |
| River's bank | n'yeém-cot-a-bár-bah | | | |
| Mountain range | ---------- | ah-bee-i'll-hatsch | | |
| Go | ---------- | ---------- | | qui-imk' |
| Come here | que-dique (ker-deek) | her-deék | | que-dic' |
| Sit down | ---------- | ---------- | | qui-nŭc' |
| How do you do? | qui-yáy-vay-may-deek? | matah-hah-wíck? | | |
| *Como se llama?* | ---------- | ---------- | | cu'-cha? |
| *Quien sabe?* (don't know) | es-mé-deék | ---------- | | es-e-me-dic |
| I am hungry | mè-cham-pou-ee-ka | | | |
| Give me | en-cáique | | | |
| Give me tobacco | o-oobe-ĕn-cáique | | | |
| Let it alone | ---------- | ---------- | | cur-be-nailk' |
| To the town | ---------- | ah-bah-paílque | | |
| The man is ugly | ee-páh-n'ya-a-nŭc | | | |
| The woman is handsome | seen-yac-n'ye-hánac | | | |
| This girl has pretty eyes | ---------- | mesahaitz-aye-dotz-a-hot'k | | |
| I speak | ---------- | ---------- | | cu-ca-nar-buk |
| I wish | n'yats-hes-sailk | | | |
| I have none | n'yo-pike | | | |
| Have you none? | no-py-ám? | | | |
| You have some | ho-wo-dówk | | | |
| I am going | n'ye-moom | | | |
| I go shortly | ac-court-n'ya-moom | | | |
| I am going above | mè-tue-a-deek | | | |
| I am going to California | n'ya-hap me-ye-moom | | | |
| I am going home | at-co-bĕr-quic-n'ye-vál-yay-ye-moom | | | |
| It is well that I am going home | at-co-bérquic-n'ye-valyay-me-moom-ah-trole'k | | | |
| Am | ---------- | ---------- | ---------- | tawa |

## YUMA.—Continued.

| | XVIII. Cuchan. | XIX. Coco-Maricopa. | XX. Mojave. | XXI. Diegeño. |
|---|---|---|---|---|
| He wants money | ---------- | ---------- | ---------- | pootivurris-coo-quit'l-hue |
| I am here | ---------- | ---------- | ---------- | n'ya-pee-táwa |
| He was there | ---------- | ---------- | ---------- | poo-ee-pia-a |
| I eat meat | ---------- | ---------- | ---------- | n'ya-coquayo-asa-ho |
| I drink water | ---------- | ---------- | ---------- | n'ya-ahá-asáy |
| I drink rum | ---------- | ---------- | ---------- | n'ya--quar-quac-asée |
| I have a horse | ---------- | ---------- | ---------- | n'ya-hut-n'yay-pilyay |
| I had a horse yesterday | ---------- | ---------- | ---------- | n'ya-hut-pour-y'ayo |
| I shall have a horse to-morrow | ---------- | ---------- | ---------- | n'ya-hut-meton-yat'l-ninia |

### Remarks.

The *Yumas* are a nation of aborigines divided into a number of tribes, which dwell on either side of the Rio Colorado.

*Cuchans.*—According to Whipple, this branch of the Yuma nation numbers about 5,000 persons. They live in villages on both banks of the Rio Colorado, within about twenty miles of the Rio Gila. They are a noble race, well-formed, active and intelligent. Their clothing consists of the breech-cloth, and they exhibit the usual Indian fondness for paint. They are proud of their hair, and take great pains in dressing and trimming it. In front it is cropped off level with the eyebrows; but behind it is matted into plaits, and falls upon the back, reaching nearly to the ground. This fashion is followed by all the cognate tribes. Their women, besides attending to household duties, cultivate fields of maize and melons; Mr. Whipple remarks that he never knew one of them to be ill-treated. The Yumas are sprightly, full of life, gaiety, and good humor.

The Cuchan vocabulary, which was collected by Mr. Whipple in the year 1849, during a sojourn of two months with the tribe, is believed to be the only one yet published. It was first printed in "Extract from a Journal of an Expedition from San Diego to the Rio Colorado, by A. W. Whipple," and again in the second volume of Schoolcraft's History, &c., of the Indian Tribes. Of the language of the Cuchans, Mr. Whipple says: "It seems wanting in none of the sounds we have in English, and they pronounce with great ease any English or Spanish word which they hear spoken." For the system of orthography employed in this vocabulary, see introductory remarks. Mr. Whipple says in a note, "The words marked with an asterisk (*) were learned from Pablo (Pablo Coelum, by birth a Comoyei, but formerly chief of the Yumas or Cuchans); some of them were found to be of his native tongue, Comoyei, and probably nearly all are. Those not marked have been tested by a reference to the native Cuchans. The phrases given were in daily use among us, and were well understood to convey the meaning given."

*Coco-Maricopas.*—This tribe was encountered by Father Kino at the end of the seventeenth century, and they are represented to have occupied the country south of the river Gila, near 150 miles in length from its mouth upwards. Colonel Emory says: "We know the Maricopas have moved gradually from the Gulf of California to their present location in juxtaposition with the Pimos. Carson found them, so late as the year 1826, at the mouth of the Gila; and Doctor

Anderson, who passed from Sonora to California in 1828, found them, as near as he could reckon from his notes, about the place we are now encamped in." Their present position, as already mentioned, is in a village on the northern bank of the Gila, a few miles west of that of the Pimas, in about west longitude 112°.

In describing them Colonel Emory says: "They live in cordial amity with the Pimos, and their habits, agriculture, religion, and manufactures are the same. In stature they are taller, their noses are more aquiline, and they have a much readier manner of speaking and acting. I noticed that most of the interpreters of the Pimos were of this tribe, and also the men we met with in the spy-guard." He bears the same testimony to their honesty that Lieutenant Whipple does to that of their brethren of the Colorado. A very complete and graphic account of these interesting people, and their neighbors, the Pimas, their characters, habits, various branches of industry, &c., is found in the second volume of Bartlett's Personal Narrative.

A comparison of their language with that of the Colorado tribes shows that the early accounts, which represent them, then as now, as at deadly feud with the Yumas, yet speaking essentially the same language, are correct. The only vocabulary heretofore published is one of twenty words communicated by Colonel Emory to Mr. Gallatin, and printed in the second volume of the American Ethnological Society's Transactions. That of Mr. Whipple, which, though incomplete, is much more extensive, agrees well with it, as far as the two coincide in the choice of words.

*Mojaves* (called by themselves *A-moc-há-ve*).—Mr. Bartlett says: "At Fort Yuma we heard of a tribe called *Mohavi*, who occupy the country watered by a river of the same name, which empties into the Colorado about 150 miles above the fort. They are said to be a fine, athletic people, exceedingly warlike, and superior to the other tribes along the river." This tribe was met with by Mr. Whipple on the east of the Colorado, above Bill Williams's Fork. They are described by him as muscular and well-proportioned, tall and erect, with a step as light as a deer's. From the abundance of grain and vegetables with which they supplied the party, they appear to be industrious tillers of the soil. The vocabulary, obtained from one of the tribe, is the first ever published. In it the vowel *i* has the sound of *ee* in the others of this table.

*Diegeños* (*Diegeenos*, *Llegeenos*).—These Indians are so called from the chief place near which they are found. Mr. Bartlett says they are the same who were known to the first settlers as the *Comeya* tribe; but Mr. Whipple asserts that the tribe of the desert called *Como-yei*, or *Quemaya*, speak a different language. They are said to occupy the coast for some fifty miles above, and about the same distance below San Diego, and to extend about a hundred miles into the interior. The effect of their connexion with the Spanish missions seems to have been the reverse of improvement. Mr. Bartlett describes some of them as "a filthy-looking set, half-clad, and apparently half-starved, who spend ten times as much labor in collecting the roots, seeds, and other wretched food they live on, as would be necessary, by cultivating the soil, to produce bread, fruits, and meats in abundance." Yet, says Whipple, "they possess the greatest reverence for the church of Rome, and, glorying in a Christian's name, look with disdain upon their Indian neighbors of the desert and the Rio Colorado, calling them miserable gentiles. According to the statement of their chief, the tribe numbers about 8,800 persons."

A vocabulary of their language, furnished by Doctor Coulter, was published in the eleventh volume of the Royal Geographical Society's Journal. That of Lieutenant Whipple, obtained from their chief, Tomaso, and which is also very brief, has appeared in the same publications as the Cuchan. Where the choice of words in the two coincide, which is but rarely, they agree tolerably well. As to the numerals, it will be perceived that Mr. Whipple gives only the five first. He, however, adds in a note, "According to Tomaso (chief of the Diegeños), the Diegeenos have but five numerals; although others of the tribe hesitatingly gave me ten, apparently erroneously taken from the Yumas." That this suspicion, however, is not correct, will appear from the following comparison of the numerals thus obtained with those given by Doctor Coulter. See especially numbers *five* and *ten*. Mr. Whipple had no

idea that the Diegeños belong to the Yuma stock. It should be observed that in this instance both the Cuchan and Diegeño vocabularies have had the benefit of his corrections.

*Diegeño Numerals.*

| | COULTER. | WHIPPLE. |
|---|---|---|
| One | siha | hinc |
| Two | xahuac* | hawoc |
| Three | xamoc | hamook |
| Four | tchapap | chay-pop |
| Five | xetlacai | shuckle-akayo |
| Six | xentchapai | sumhook |
| Seven | | sérap |
| Eight | tchapap-tchapap | sahook |
| Nine | sihnt chahoi | chiphook |
| Ten | ñamat | yamat |

*Yabipais* (*Yabapais, Yampais, Yampaio, Yampaos*).—These people, who live to the northeast of the Mojaves, also belong to the Yuma stock. A couple of them visited Mr. Whipple's camp. He describes them as "broad-faced fellows, with Roman noses and small eyes, somewhat in appearance like the Diegeños of California." Their language also resembled that of the latter, as is evinced by the words *hanna*, good; *n'yatz*, I; *pook*, beads. Their hair he describes as clipped short over the forehead, in the fashion of the Gila and Colorado Indians, and as hanging from the back of the head nearly down to the waist; but nothing is said of the long beards ascribed to them by Humboldt on the authority of the early missionaries.

There are still other Yuma tribes (see Whipple's Extract from a Journal &c., pp. 16. 17; Schoolcr. Hist., &c., II, 115. 116); but the above are all of whose languages we as yet possess specimens.

* It is evident that Doctor Coulter uses *x* to denote the guttural usually represented by *kh* or the Greek χ.

## CHAPTER VI.

*Condition of the Aborigines of New Mexico upon its discovery by Spaniards.*

From regarding the present condition of the wild natives of the interior of our country, the mind naturally turns to an inquiry concerning their past history. From themselves, little can be learned. Indians are a wary people, cautious in all their intercourse with whites, and guard with religious fidelity the secrets of their tribes and race. Of their numerous traditions, it is probable that few have been communicated to us, and those are generally in meager outlines, partly from the want of a common language by which the savage might express his ideas. Therefore, for a history of the tribes under consideration, we must seek materials in the reports of early Spanish explorers, and allow the balance of the web to be woven with what can be collected from traditions, superstitions, antiquities, arts, customs, and from a comparison of their physiological developments and language with those of other nations.

From the same sources only can be found a solution to other questions equally interesting. Frequently, at this day, are discovered extensive ruins, which must have been the abodes of a large population, at a considerable distance from permanent springs or streams of water; and it has been suggested by some, that the climate and nature of the country must have undergone a radical change since the occupation of those pueblos. At present, the regions of Moqui and Zuñi contain, during certain seasons, only a scanty supply of water; while, according to vague traditions of the Indians, in the palmy days of their ancestors, not only the valleys, but the extensive mesas also, which are now usually waterless and comparatively barren, were fertilized by rain, and yielded abundant crops to the cultivators of the soil. The rains that have lately flooded that country—probably for the first time during many years—seem to add interest to the theory of a change, which, according to an ancient Indian prediction, handed down from generation to generation, and fully believed in by that superstitious people, is now to be reversed. Hence, to elucidate these points, as far as material may be found for it, the records of the explorers of the sixteenth century become matter of interest. Many of them are yet in manuscript, and enclosed in the archives of Spain or Mexico. Those which were published had a limited circulation, and are now rarely to be met with. Among the rare and valuable works upon American history in the extensive library of Col. Peter Force, of Washington, are found printed and manuscript documents illustrative of the condition of this continent upon its first discovery by Spaniards. Here we have access to Hakluyt's description of voyages, published in 1600. As it contains much that is interesting regarding early explorations in the region between Rio Grande and the Colorado, and may be useful for a comparison with the preceding, a brief recapitulation of those portions which relate to the country and people under consideration will constitute the remainder of this chapter.

### "RELATION OF THE REVEREND FATHER FRIAR MARCO DE NIÇA TOUCHING HIS DISCOVERY OF THE KINGDOM OF CEVOLA."

In execution of the instructions of the right honorable lord Don Antonio de Mendoça, viceroy and captain-general for the Emperor's majesty in New Spain, Friar Marco de Niça departed from the town of San Miguel, in the province of Culiacan, on Friday, the 7th of March, in the year 1539. His companion was Friar Honoratus, and he carried with him a negro named

Stephen, and certain Indians of the town of Cuchillo, whom the viceroy had made free. He proceeded to Petatlan, where he rested three days, and then left his companion Honoratus sick. Thence, "following as the Holy Ghost did lead," he travelled twenty-five or thirty leagues, seeing nothing worthy of notice, saving certain Indians from "the island of Saint Iago, where Fernando Cortez, of the valley, had been;" and he learned that among the islands were "great store of pearls." Continuing through a desert of four days' journey, accompanied by the Indians of the islands and of the mountains which he passed, he found other Indians, who marvelled to see him; having no knowledge of any Christians, or even of the Indians from whom they were separated by the desert. They entertained him kindly, and called him "Hayota," in their language signifying "a man come from heaven."

The desert referred to is between Rio Yaqui and Rio Sonora, a distance of something more than one hundred miles. Mr. Bartlett, in his "Personal Narrative," describes the portion of it which he crossed from Hermosillo to Guaymas, thirty-seven leagues, as being "destitute of streams," "barren and uninteresting." The Indians found beyond this desert consequently occupied the valley of the Sonora river, called by Vasquez de Coronado, as we shall see hereafter, the valley of Coraçones. Here Friar Marco was informed that four or five days within the country, at the foot of the mountains, "there was a large and mighty plain, wherein were many great towns, and people clad in cotton." And when he showed them certain metals which he carried, "they took the mineral of gold," and told him "that thereof were vessels among the people of that plain, and that they carried certain round green stones hanging at their nostrils and at their ears, and that they had certain thin plates of gold wherewith they scrape off their sweat, and that the walls of their temples are covered therewith." But as this "valley" (previously called a plain) was distant from the sea-coast, he deferred "the discovery thereof" until his return.

By a reference to modern maps, it will be perceived that this valley, or plain, which he is informed lies four or five days' travel within the country, corresponds nearly with that of Rio de las Casas Grandes, where, at this day, are ruins, about one hundred and fifty miles east from the valley of Rio Sonora. These ruins are minutely described by Mr. Bartlett, and, at the time of Friar Marco's expedition, must have been famous cities among the Indian tribes.

Marco de Niça travelled three days through towns inhabited by the people of the Coraçones, and then came to a "town of reasonable bigness," called Vacupa, forty leagues distant from the sea. This place corresponds nearly with Magdalena, on Rio San Miguel, and its inhabitants were probably ancestors of the Cocopas, now scattered over the deserts northwestward, and many residing near the mouth of Rio Colorado. The people of Vacupa, he states, showed him "great courtesies," and gave him "great store of good victuals, because the soil is very fruitful and may be watered." Here the negro, Stephen, was sent in advance, to reconnoitre. At the end of four days Father Marco received a message from Stephen, stating that wonderful accounts had been told him of a great city, called Cevola, thirty days' journey distant. The negro pushed on, without waiting as he was ordered, and succeeded in making the discovery of that people, who finally killed him.

Upon the same day that Niça received these messengers from Stephen, there came to him three Indians of those whom he called Pintados, because he saw their faces, breasts, and arms painted. "These dwell further up into the country, towards the east, and some of them border upon the seven cities." The Pintados probably belonged to the tribe now called Papagos, or Pimas; for I believe the Papagos and Pimas of the present day are one nation, speaking the same language. They are still scattered over the country referred to by the reverend father, from the Santa Cruz valley to Rio Gila, which perhaps may be said to border on the kingdom of Cibola.

With these Pintados he departed from Vacupa upon Easter Tuesday; and having travelled three days northward, the way that Stephen had gone before him, he was informed that a man might travel in thirty days to the city of Cevola, which is the first of the seven. He was told,

also, that besides the seven cities, there were three other kingdoms, called Marata, Acus, and Totonteac. He asked of these Indians why they travelled to Cevola, so far from their houses. They said that they went for turquoises, ox-hides, and other things which they received in payment for labor in tilling their ground. They described the dress of the inhabitants of Cevola to be "a gown of cotton down to the foot, with a button at the neck, and a long string hanging down at the same; and that the sleeves of these gowns are as broad beneath as above."* "They gird themselves with girdles of turqueses;"† and besides these "some wear good apparel; others, hides of kine,‡ very well dressed." The Pintados carried certain sick folks to see him, that he might heal them; and the invalids sought to touch his garments for that purpose.

He continued his journey five days, always finding inhabited places, great hospitality, and many "turqueses," and ox-hides. § He then understood that after two days' journey he would find a desert, where there was no food. Before he reached this desert, he arrived at a "very pleasant town, by reason of great store of waters conveyed thither to water the same."‖ Here he met with many people, both men and women, clothed in cotton, and some covered with ox-hides, "which generally they take for better apparel than that of cotton."¶ "All the people of this village," he states, "go in caconados; that is to say, with turqueses hanging at their nostrils and ears, which turqueses they call cacona."**

The "lord of this village," and others, visited him, "apparelled in cotton," "in caconados," and each with a collar of turquoises about his neck. They gave him conies, quails, maize, and nuts of pine-trees, and offered turquoises, dressed ox-hides, and fair vessels to drink in, which he declined. They informed him that in Totonteac was a great quantity of woolen cloth, such as he himself wore, made from the fleeces of wild beasts.†† These beasts they told him "were about the same bigness of" two spaniels which Stephen carried with him.

The next day he entered the desert, and where he was to dine he found bowers made, and victuals in abundance, by a river's side.‡‡ Thus the Indians provided for him during four days that the "wilderness" continued. He then entered a valley,§§ very well inhabited with people, who were dressed also in cotton robes, with turquoise pendants from their ears and nostrils, and numerous strings of the same encircling their necks.

Through this valley, which was inhabited by "a goodly people," he travelled five days' journey.‖‖ The country was "well watered, and like a garden," "abounding in victuals," "sufficient to feed above three thousand horsemen." The boroughs and towns were from a quarter to half a league long. Here he found a man born in Cevola, having escaped "from the governor or lieutenant of the same; for the lord of the seven cities liveth and abideth in one of those towns, called Ahacus, and in the rest he appointeth lieutenants under him." This townsman of

* This description is simply that of a Pima cotton blanket thrown over the shoulders, and pinned by a wooden button at the neck. The natural folds of this garment would produce "sleeves as broad beneath as above." In thus modifying the account, I would not impeach the veracity of the narrator. It is easy to conceive how, with imperfect means of communicating with the Indians, a lively imagination might lead to exaggerations such as he was afterwards charged with.

† Probably Pima or Zuñi belts, ornamented with green stones.

‡ Buckskin or buffalo robes.

§ Probably buffalo robes.

‖ This is the present site of Tucson, a rich and fertile valley, watered by acequias.

¶ If allowed for "ox-hides" to read *buckskin*, the account will apply to the Pimas of the present day.

** It is usual for all the principal Indian chiefs of the Gila and Colorado, as well as those of Zuñi, to wear blue stones pendant from the nose.

†† Possibly the long hair of the big horn wild sheep, which are abundant in these parts, may have been woven into cloth.

‡‡ I cannot conceive what river he speaks of; possibly some rivulet might have appeared upon the desert, between Tucson and Rio Gila.

§§ This was the valley of Rio Gila.

‖‖ He must have crossed over to the Salinas, (Rio Azul,) and ascended that river. It is surprising that he makes no mention of large buildings or ruins upon its banks.

Cevola "is a *white man*,* of good complexion, somewhat well in years, and of far greater capacity than the inhabitants of this valley," or those left behind. Friar Marco thus relates his description of Cevola: It is "a great city, inhabited with great store of people, and having many streets and market-places; in some parts of this city there are certain very great houses, of five stories high, wherein the chief of the city assemble themselves at certain days of the year. The houses are of lime and stone; the gates and small pillars of the principal houses are of turqueses; and all the vessels wherein they are served, and other ornaments of their houses, are of gold. The other six cities are built like unto this, whereof some are bigger, and Ahacus is the chiefest of them. At the southeast there is a kingdom called Marata†, where there were wont to be many great cities, which were all builded of houses of stone, with divers lofts; and these have and do wage war with the lord of the seven cities, through which war the kingdom of Marata is for the most part wasted, although it yet continueth and maintaineth war against the other."

"Likewise the kingdom of Totonteac‡ lieth toward the west—a very mighty province, replenished with infinite store of people and riches; and in the said kingdom they wear woolen cloth, made of fleeces of those beasts previously described; and they are a very civil people." He told also of another kingdom called Acus.§

Here they showed him a hide, half as big again as the hide of an ox, which they said belonged to a beast with one horn. The color of the skin was like that of a goat, and the hair was a finger thick.

The inhabitants requested him to stay here three or four days, because from this place there were "four days' journey into the desert, and from the first entrance into the same desert unto the city of Cevola are fifteen great days' journey more." Accompanied by thirty of the principal Indians, with others to carry their provisions, he entered this second desert on the 9th of May. He travelled the first day by a very broad and beaten way, and came to dinner unto a water, and at night unto another water, where the Indians provided him with a cottage and victuals. In this manner he travelled twelve days' journey. At that point he met one of Stephen's Indians, who, "in great fright, and covered with sweat," informed him that the people of Cevola had at first imprisoned, and afterward killed the negro.

Father Marco himself then became fearful of trusting his life in the hands of that people. But he told his companions that he "purposed to *see* the city of Cevola, whatsoever came of it." So he ascended a mountain, and viewed the city. He describes it as "situated upon a plain, at the foot of a round hill,‖ and maketh show to be a fair city; and is better seated" than any that he has seen in these parts. The houses "were builded in order," according as the Indians had told him; "all made of stone, with divers stories and flat roofs." "The people¶ are somewhat white; they wear apparel, and lie in beds; their weapons are bows; they have emeralds and other jewels, although they esteem none so much as turqueses, wherewith they adorn the walls of the porches of their houses, and their apparel and vessels; and they use them instead of money through all the country." "Their apparel is of cotton and of ox-hides, and this is their most commendable and honorable apparel." "They use vessels of gold and of silver, for

* It is remarkable that, at the present day, many of the Indians of Zuñi are white. They have a fair skin, blue eyes, chestnut or auburn hair, and are quite good looking. They claim to be full-blooded Zuñians, and have no tradition of intermarriages with any foreign race. The circumstance creates no surprise among this people, for from time immemorial a similar class of persons has existed in the tribe.

† I believe this to have been at Casas Grandes, near Corralitas.

‡ Totonteac is doubtless the country lying upon the waters of Rio Verde and Pueblo creek. Civilization and the arts must have made considerable progress there; but if the Tontos, who now roam over a large part of this country, are descended from that race, they have wofully degenerated.

§ The position of the kingdom of Acus is not mentioned. It may have been upon the Colorado Chiquito, or upon the Cañon de Chelly; at both places there are ancient ruins, well described by Captains Sitgreaves and Simpson.

‖ This description answers quite well for Zuñi at the present day.

¶ The following he could not have seen, but probably states on the authority of his informers.

they have no other metal, whereof there is greater use and more abundance than in Peru; and they buy the same for turqueses in the province of the Pintados,* where there are said to be mines of great abundance." Of other kingdoms, he says he could not obtain so particular instruction.

When he told the Indian chiefs that were with him what a goodly city Cevola seemed, they told him that it was the least of the seven cities, and that "Totonteac was the greatest and best of them all, because it had so many houses and people;" "that there was no end of them."

Having set up a cross, and made a heap of stones, he named that country El Nuevo Reyno de San Francisco. Then, "with more fear than victuals," he returned. In two days he overtook the people he had left behind, crossed the desert, hurried from the valley, and passed the second desert. Having arrived at the valley of Santa Cruz, he determined to visit the great plain he had been informed of, toward the east; but, for fear of the Indians, did not go into it. At its entrance he saw "but seven towns, of a reasonable bigness, which were afar off in a low valley, being very green, and having a most fruitful soil, out of which ran many rivers."† He was informed that there was much gold in this valley, and that the inhabitants worked it into vessels and thin plates; but they did not suffer those of the other side of the plain to traffic with them. Having, as usual, set up crosses and taken possession, he returned to San Miguel, in the province of Culiacan, and finally to Compostella.

### "THE RELATION OF FRANCISCO VASQUEZ DE CORONADO, CAPTAIN GENERAL OF THE PEOPLE WHO WERE SENT, IN THE NAME OF THE EMPEROR'S MAJESTY, TO THE COUNTRY OF CIBOLA,‡ NEWLY DISCOVERED."

On the 22d of April, 1540, Coronado, with "part of the army," set out from the province of Culiacan, and after great hardships arrived at the valley§ of the people called Caraçones on the 26th of May. Here, the corn not being ripe, he sent over to the Valle‖ del Señor, where some was purchased. Leaving the Caraçones, he endeavored to keep as near as possible to the sea-coast; but, when he arrived at Chichilticale,¶ he found himself ten days' journey from the sea. Having rested here two days, he entered the desert country beyond, on St. John's eve (23d of June). For the first few days there was a scarcity of grass. The mountains and bad passages were worse than he had before found. In this last desert he lost many horses and some of his friendly Indians; one Spaniard and two negroes also died for the lack of food. Coronado says, in describing this part of his route, "it is a most wicked way, at least thirty leagues and more, because there are inaccessible mountains."** "But," he continues, "after we had passed these thirty leagues, we found fresh rivers, and grass like that of Castile; and especially of that sort which we call scaramonio; many nut trees and mulberry trees, but the nut trees differ from those of Spain in the leaf; and there was flax, but chiefly near the banks of a certain river, which therefore we called *El Rio del Lino*," (river of flax).†† Here he was met by some of the people of Cibola. At first they appeared friendly; afterward they attacked his army very valiantly, but at length retired, "sounding a certain small trumpet in token of retreat." Afterward, he says, "the Indians here and there made fires, and were answered

* In mountains near the valley of Tucson and Santa Cruz, where I have located the Pintados, there are known to be rich mines of silver; and gold is said to be abundant. As that region now belongs to the United States, it is probable the mines will be worked.

† We have already referred to this plain as the present Casas Grandes, or the ancient kingdom of Marata.

‡ Coronado changes the spelling of Friar Marco, from Cevola, which doubtless corresponded to the Indian pronunciation, to Cibola, which word is now used throughout Mexico to denote buffalo. Probably the term for the latter was derived from this country, where so many hides were reported to have been seen.

§ Valley of San Miguel river. ‖ Rio Sonora.

¶ "Chichilticale," meaning *Red House*, is the often-described ruin of the present day, in the valley of Rio Gila, near the Pima villages.

** Sierra Mogoyon, between the Pima villages and Zuñi.

†† *El Rio del Lino* is the Colorado Chiquito.

again* afar off, as orderly as we for our lives could have done, to give their fellows understanding how we marched and where we arrived." As soon as he came within sight of the city of Cibola, (which he names Granada,) he sent messengers thither; but they were ill treated and fired upon. Upon his arrival at the spot, after an attack and skirmish without the walls, Coronado boldly assaulted the city, which, after considerable resistance, yielded to his valor. The Indians fought with bows and arrows, and threw stones upon them from the walls. Coronado himself was twice unhorsed, but his Spanish armor saved him.

Entering the town, they found plenty of corn, of which they were greatly in need; several persons, as has been said, having starved upon the way.

Coronado's description of Cibola is given in his own words: "It remaineth now to testify your honor of the seven cities, and of the kingdoms and provinces whereof the father provincial made report to your lordship; and to be brief, I can assure your honor he said the truth in nothing that he reported; but all was quite contrary, saving only the names of the cities and great houses of stone; for although they be not wrought with turqueses, nor with lime, nor bricks, yet are they very excellent good houses of three or four or five lofts high, wherein are good lodgings and fair chambers, with ladders instead of stairs; and certain cellars under the ground very good and paved, which are made for winter; they are in manner like stoves; and the ladders which they have for their houses are all in a manner moveable and portable; which are taken away and set down when they please, and they are made of two pieces of wood, with their steps as ours be. The seven cities are seven small towns, all made with these kind of houses that I speak of; and they stand all within four leagues together; and they are all called the kingdom of Cibola, and every one of them have their particular name; and none of them is called Cibola, but altogether they are called Cibola. And this town, which I call a city, I have named Granada; as well because it is somewhat like unto it, as also in remembrance of your lordship. In this town, where I now remain, there may be some 200 houses; all compassed with walls, and I think that with the rest of the houses, which are not so walled, there may be together 500. There is another town, near this, which is one of the seven; and it is somewhat bigger than this, and another of the same bigness that this is of; and the other four are somewhat less; and I send them all painted to your lordship with the voyage; and the parchment, whereon the picture is, was found here with other parchments. The people of this town seem to me of reasonable stature and witty; but they seem not to be such as they should be, of that judgment and wit to build their houses in such sort as they are. For the most part they go all naked, except their private parts, which are covered; and they have painted mantles like those which I send unto your lordship. They have no cotton-wool growing, because the country is cold, yet they wear mantles thereof, as your lordship may see by the shew thereof; and true it is that there was found within their houses certain yarn made of cotton-wool. They wear their hair on their heads like those of Mexico; and they are well nurtured and conditioned; and they have turqueses, I think good quantity, which with the rest of the goods which they had, except their corn, they had conveyed away before I came thither; for I found no women there, nor no youth under fifteen years old, nor no old folks above fifty; saving two or three old folks who staid behind to govern all the rest of the youth and men of war. There were found in a certain paper two pints of emeralds, and certain small stones broken, which are in colour somewhat like granates very bad and other stones of crystal. * * We found here certain guinie cocks, but few. The Indians tell me in all these seven cities that they eat them not, but that they keep them only for their feathers. I believe them not, for they are excellent good, and greater than those of Mexico. The season which is in this country, and the temperature of the air, is like that of Mexico; for sometime it is hot and sometime it raineth; but hitherto I never saw it rain, but once there fell a little shower with wind as they are wont to fall in Spain. The snow and cold are wont to be great; for so say the inhabitants of the country, and

* Such signals by fires and smokes are practised by Indians at the present day.

it is very likely so to be, both in respect to the manner of the country and by the fashion of their houses, and their furs, and other things which this people have to defend them from cold. There is no kind of fruit nor trees of fruit. The country is all plain, and is on no side mountainous; albeit there are some hilly and bad passages. There are small store of fowls, the cause whereof is the cold, and because the mountains are not near. Here is no great store of wood, because they have wood for their fuel sufficient four leagues off, from a wood of small cedars. There is most excellent grass within a quarter of a league hence, for our horses, as well to feed them in pasture as to mowe and make hay. * * * The victuals which the people of this country have is maize, whereof they have great store, and also small white peas; and venison which by all likelihood they feed upon (though they say no), for we found many skins of deer, of hares, and conies. They eat the best cakes that ever I saw, and every body generally eateth of them. They have the finest order and way to grind that we ever saw in any place. And one Indian woman of this country will grind as much as four women of Mexico. They have most excellent salt, in kernel, which they fetch from a certain lake a day's journey from hence. * * * Here are many sorts of beasts, as bears, tigers, lions, porkenspikes (porcupines?) and certain sheep* as big as an horse, with very great horns and little tails. I have seen their horns so big that it is a wonder to behold their greatness. Here are also wild goats, whose heads likewise I have seen, and the paws of bears, and the skins of wild boars. There is game of deer, ounces, and very great stags. * * * They travel eight days' journey into certain plains, lying toward the North sea. In this country there are certain skins well dressed, and they dress them and paint them where they kill their oxen, for so they say themselves."

* * * * * * * * * *

"The kingdom of Totonteac, so much extolled by the father provincial, which said there were such wonderful things there, and such great matters, and that they made cloth there, the Indians say is a *hot lake*†, about which are five or six houses; and that there were certain other, but that they are ruinated by a war. The kingdom of Marata is not to be found, neither have the Indians any knowledge thereof. The kingdom of Acus is one only small city, where they gather cotton which is called Acacu. * * Beyond this town (Acus) they say there are other small towns which are near to a river‡ which I have seen and have had report of by relation of the Indians."

Coronado states that these people abandoned their town, and fled to the hills with their wives and children and all their goods; and that, with all his persuasions, he could not induce them to come down from their strongholds. It was then, probably, that old Zuñi was rebuilt. This agrees quite well with what I was told by the Zuñians themselves.

Coronado relates that they assured him that, "above fifty years past, it was prophesied among them that a certain people like us should come, and from that part that we came from, and that they should subdue all that country."

He adds: "that which these Indians worship, as far as hitherto we can learn, is the water; for they say it causeth their corn to grow, and maintaineth their life; and that they know none other reason but that their ancestors did so."

To his inquiries of other countries, they tell him of "seven cities § which are far distant from that place, which are like unto theirs, except the houses are of earth, and small; and that among them much cotton is gathered." The chief of these towns is called Tucano. But Coronado thinks they do not tell him the truth. Among the curiosities which Coronado sent to the viceroy of Mexico, was a garment excellently embroidered with needlework. He sent also some

* Big horn sheep—in the Yuma language called *cerbats*.

† There may be a hot lake in the volcanic region of San Francisco mountains. If these people were friends of those at Totonteac, they were wise in giving the conqueror a bad opinion of that province.

‡ Rio del Norte.

§ The description will not answer for the seven pueblos of Moqui. The valley of Rio Verde may be referred to; for upon the lower portion of it there are adobe ruins.

clothes painted with the beasts of the country; which he says were not well done, as the Indian painter was occupied but one day in painting them. He had seen pictures on the walls of the houses in the city executed in much better style. There were also an "ox hide" (buffalo robe), "turquoise ear-rings, combs, and tablets set with turquoises." They told him that they killed the negro, Stephen, because "he touched their women." He adds, that "in this place is found some quantity of gold and silver, very good," but he cannot learn whence it comes, as they refuse to tell him the truth in all things.

## CORONADO'S EXPEDITION CONTINUED.

*"The rest of the history of this voyage to Acuco, Tiguex, Cicuic, and Quivira, by Francisco Lopes de Gomara."*

They agreed to pass further into the country, which was told them to be better and better. So they came to Acuco*, a town upon an exceeding strong hill. And from thence Don Garcias Lopez de Cardenas went with his company of horsemen unto the sea; and Francisco Vasquez went to Tiguex, which standeth on the bank of a big river.† There they had news of Axa and Quivira: where, it was said, "was a king, whose name was Tartarrax, with a long beard, hoary-headed, and rich; which was girded with a Bracamart; which prayed upon a pair of beads; which worshipped a cross of gold and image of a woman the queen of heaven."

In the country of Tiguex there were "melons, and white and red cotton, of which they made large mantles." "From Tiguex they went, in four days' journey, to Cicuic," a small town, "and four leagues thence they met with a new kind of oxen‡, wild and fierce, whereof, the first day, they killed fourscore, which sufficed the army with flesh." From Cicuic they went to Quivira, which, by their account, is almost 300 leagues distant, "through mighty plains and sandy heaths, smooth and wearisome, and bare of wood," so that they made heaps of ox-dung for want of stones and trees, that they might not lose themselves upon their return; "for three horses were lost in that plain, and one Spaniard, who went from his company on hunting." "All that way, and the plains are as full of crooked-backed oxen as the mountain Serena in Spain is of sheep; but there is no people but such as keep those cattle." * * "One day it rained in that plain a great shower of hail, as big as oranges." * * At length they came to Quivira, and found Tartarrax, whom they sought, a hoary-headed man, naked, and with a jewel of copper hanging at his neck, which was all his riches. The Spaniards, seeing the false report of so famous riches, returned to Tiguex, without seeing either cross or show of Christianity, and thence to Mexico. In the end of March, 1542, Francisco Vasques fell from his horse in Tiguex, and "with the fall fell out of his wits and became mad; which some took to be for grief, and others thought to be counterfeited; for they were much offended with him because he peopled not the country." "Quivira§ is in 40°; it is a temperate country, and hath very good waters, and much grass, plums, mulberries, nuts, melons, and grapes, which ripen very well. There is no cotton, and they apparel themselves in ox-hides and deer-skins."

"It grieved Don Antonio de Mendoça very much that the army returned home; for he had spent about threescore thousand pesos of gold in the enterprise, and owed a great part thereof still. Many sought to have dwelt there; but Francisco Vasquez de Coronado, which was rich, and lately married to a fair wife, would not consent, saying they could not maintain nor defend themselves in so poor a country and so far from succour."

Gomara, after describing the buffalo, adds: "There are also in this country other beasts as

* Acuco—the pueblo of Acoma.

† Rio del Norte.

‡ This appears to be the first instance in which wild buffalo were seen by Spaniards upon this expedition.

§ The latitude of Quivira is probably near 34°. The great barren plain crossed from Tiguex must have been in the direction from Santa Fé southward; east of Zandia and Manzana mountains. No other route would have presented the plain they describe.

big as horses, which, because they have horns and fine wool, they call them sheep; and they say that every horn of theirs weigheth fifty pounds weight. There are also great dogs, which will fight with a bull, and will carry fifty pound weight, in sacks, when they go on hunting, or when they remove from place to place with their flocks and herds."

## THE RELATION OF THE NAVIGATION AND DISCOVERY OF RIO DE BUENA GUIA (RIO COLORADO) WHICH CAPTAIN FERNANDO ALARCON MADE BY ORDER OF RT. HON. LORD DON ANTONIO DE MENDOÇA, VICE-ROY OF NEW SPAIN.

On Sunday, 9th May, 1540, he set sail up the Gulf of California; and, after much difficulty from shoals and a narrow channel, "it pleased God that, after this sort," they should "come to the very bottom of the bay; where they found a mighty river, which ran with so great fury of a stream that they could hardly sail against it. So they entered two boats, which his men towed along with ropes from the shore. Meeting Indians, with great prudence he cultivated friendly relations with them, and they afterwards not only furnished him with food, but also assisted to draw his boats up the stream. He found Indians exceedingly numerous, having abundance of maize and peas and gourds. It appears that they painted their faces after various fashions; and some "carried visars before them of the same color, which had the shape of faces."* They wore on their heads a piece of deer-skin, like a helmet, ornamented with sticks and feathers. Their weapons were bows and arrows, and maces hardened in the fire. He says "this is a mighty people, well featured, and without any grossness." They had pendants from their ears and noses; and all wore girdles of various colors, and in the middle was "a round bunch of feathers, hanging down behind like a tail." Their bodies were striped with black, their hair was cropped before, while behind it hung down to the waist. The women were naked, excepting a girdle of feathers, and their hair was worn like the men. When Alarcon understood that they worshipped the sun, he told them, by signs, that he came from the sun. They wondered greatly, and afterwards treated him with distinguished kindness. Having passed various tribes without being able to communicate, except by signs, at length he reached a people who understood the language of an Indian he had brought with him from Mexico.† To them, by means of the Indian interpreter, he communicated more freely; stating that he came from the sun, and desired them to cease from wars. The chief complained of a certain people that lived behind a mountain and made war upon them. He also related a tradition, saying, "Now you see how, long ago, our ancestors told us that there were bearded and a white people in the world, and we laughed them to scorn; I, which am old, and the rest which are here, have never seen any such people as these." Afterwards, as he ascended the river, Alarcon found other Indians, whom his interpreter could not understand. But he was informed that further up the river he would again find a tribe speaking the language of his interpreter. He learned, also, that twenty-three languages were spoken by the different nations bordering the river, and that above were other tribes unknown to his informers.

The old chief described a warlike race of men who dwelt in a town near a mountain. They were apparelled in long robes cut with razors, and sewed with needles made of deer's bones. They had great houses of stone, but, as their fields of maize were small, they came yearly to the river to traffic. He learned that, in consequence of the annual overflow of the river (Buena Guia), the people, after harvest time, removed to the foot of the mountains, where the winter was spent; that marriage ceremonies were celebrated with singing and dancing, but those of near kin were never united in marriage; that the dead were burned; and they had no definite notions of a future state.

* Probably a hunting mask made from the skin of a deer's head.

† This agrees with a tradition which I have heard, that the Mojaves and Yumas were originally from the city of Mexico.

At length he learned of Cevola, from one who had seen that city, "that it was a great thing, and had very high houses of stone." He was told that the people wore long garments and blue stones; and that, by a path along the river, it was forty days' journey thither. Afterward, ascending the river, he reached a town, belonging to the lord of Quicoma, which was occupied only for the time of planting and harvest. There was cotton here, but the Indians knew not how to use it. Among them was an Indian who understood the language of the interpreter whom Alarcon had brought with him.

At length he inquired the distance to Cevola, and was informed that there was the space of ten days' journey without habitation—the rest of the way not being counted, because there were inhabitants to be found. Alarcon then wished to go to Cevola; but the Indians discouraged him, saying that there would be danger in passing the lord of *Cumana*,* whom they greatly feared. When he went forward to the next town above, called Coama, the people of Cumana sent an enchanted person, who placed canes on both sides of the river, to prevent his passing. He had now ascended the river† eighty-five leagues, to where it forms a straight channel between high mountains. He set up a cross, and returned to the Gulf, and thence sailed for the port of Colima.

"VOYAGES TO NEW MEXICO, BY FRIAR AUGUSTIN RUYZ, A FRANCISCAN, IN 1581, AND ANTONIO DE ESPEJO, IN 1583.—THE LAND IS SITUATED NORTH OF NEW SPAIN, FROM 24° TO ABOVE 34° NORTH LATITUDE."

Augustin Ruyz and others, departing from Santa Barbara, which lies 160 leagues from the city of Mexico, travelled 250 leagues north, into a country called the Province de los Tiguas. Here, one of the fathers having been killed by Indians, the soldiers returned to Mexico, leaving the other priests alone with the savages. Another expedition, under the command of a citizen of Mexico, called Antonio de Espejo, left the valley of San Bartolo, November 10, 1582. Directing his course north, he met with great numbers of Conchos, who dwelt in villages, or hamlets, of cottages covered with straw. These Indians went nearly naked; cultivated maize, pumpkins, and melons; and were armed with bows and arrows. They worshipped neither idols nor aught else. The caciques sent information of the expedition from one town to another, and the party was well treated. They passed through the Passaguates, the Tobosos, and the Jumanes, whom the Spaniards called Patarabueyes. Their villages are upon Rio del Norte; their houses are flat-roofed, and built of mortar and stone. These people were well clothed, and seemed to have some knowledge of the Catholic faith. Soon ascending the great river, they discovered another province of Indians, who showed them many curious things made of feathers, with divers colors, and many cotton mantles, striped blue and white, like those brought from China. These people showed by signs that, five days' journey westward, there were precious metals.

Journeying thence northwardly, along the Rio del Norte, they were well received among a numerous population. Here they were told, by a Concho Indian who accompanied them, that, fifteen days' journey towards the west, could be found a broad lake, and great towns, with houses three and four stories high. They noted especially the excellent temperature of the climate, good soil, and abundance of precious metals.

From this province they travelled fifteen days without meeting people, but passing through woods of pine-trees, bearing fruit, like those of Castile. Having thus travelled fourscore leagues, they arrived at villages where there was much excellent white salt. Ascending the

* Probably the Totonteac of Father Marco de Niça; the region bordering the valley of Rio Verde. This may be identical with Tucano, the chief of the seven cities described by the Zuñians to Coronado in the same year. Espejo describes a place of the same name near Rio del Norte.

† This agrees pretty well with Captain Sitgreaves' survey from the mouth of Williams river to the Gulf; and by the description, the mountains also correspond with those which impinge upon the river below the junction of that stream with the Colorado.

valley of the aforesaid great river twelve leagues further, they arrived at the country which they called New Mexico. Here, all along the shore of the river, grew mighty woods of poplar, in some places four leagues broad, and great store of walnut-trees and vines, like those of Castillia. Having travelled two days through these woods, they arrived at ten towns, situated upon both sides of the river, where were about ten thousand persons. Here were houses of four stories in height, with "stoves for the winter season." They had "plenty of victuals and hens of the country." "Their garments were of cotton and deer-skins, and the attire, both of men and women, was after the manner of Indians of Mexico." "Both men and women wore shoes and boots, with good soles of neat's leather—a thing never seen in any other part of the Indies." "There are caciques who govern the people, like the caciques of Mexico; with sergeants to execute their commands, who go through the towns proclaiming, with a loud voice, the pleasure of the caciques." In this province were many idols, which were worshipped; and "in every house was an oratory for the devil, wherein was placed for him meat." There were also "certain high chapels, in which they say the devil useth to take his ease, and to recreate himself as he travelleth from one town to another; which chapels are marvellously well trimmed and painted." "In all their arable grounds, whereof they have great plenty, they erect on the one side a little cottage, or shed, standing upon four studs, under which the laborers eat and pass away the heat of the day, for they are a people much given to labor." "This country is full of mountains and forests of pine-trees." Their weapons were strong bows, and arrows pointed with flints. They used also targets, or shields, made of raw hides.

Having remained four days in this province, not far off they came to another, called the province of Tiguas, containing sixteen towns, in one of which (Paola) the two friars, Lopez and Ruyz, had been slain. Hence the inhabitants fled. The Spaniards, entering the town, found plenty of food, hens, and rich metals. Here they heard of many rich towns far toward the east. In two days' journey from the province of Tiguas, they found another province, containing eleven towns, and about 40,000 persons. The country was fertile, and bordered on Cibola, where was abundance of kine. Here were signs of very rich mines.

Having returned to Tiguex, they ascended Rio del Norte, six leagues, to another province, called Los Quires. Here they found five towns, and 14,000 persons, who worshipped idols. Among the curious things seen at this place, were a pie in a cage, and "shadows, or canopies, like those brought from China," upon which were painted the sun, moon, and stars. The height of the pole-star led them to believe themselves in N. latitude $37\frac{1}{2}°$.

Pursuing the same northerly course, fourteen leagues thence they found another province, called the Cumanes (or Punames), with five towns, of which Cia was greatest, having 20,000 persons, eight market-places, and houses plastered and painted in divers colors. The inhabitants presented them with mantles curiously wrought, and showed rich metals, and mountains near by, where were the mines. Having travelled six leagues northwest, they came to Ameies, where are seven great towns, and 30,000 souls. One of the towns was said to be very great and fair; but as it stood behind a mountain, they feared to approach it. Fifteen leagues west, they found a great town called Acoma, containing above 6,000 persons, and situated upon a high rock, which was above fifty paces high, having no entrance except by stairs hewed into the rock. The water of this town was kept in cisterns. Their corn-fields, two leagues distant, were watered from a small river, upon the banks of which were roses. Many mountains in this vicinity showed signs of metals; but they went not to see them, because many warlike Indians were dwelling upon them.

Twenty-four leagues westward from Acoma, they arrived at Zuñi, by the Spaniards called Cibola, containing great numbers of Indians. Here were three Christian Indians, left by Coronado in 1540. They informed Espejo that "threescore days' journey from this place there was a mighty lake, upon the banks whereof stood many great and good towns, and that the inhabitants of the same had plenty of gold, as shown by their wearing golden bracelets and

ear-rings.'' They said that Coronado intended to have gone there; but having travelled twelve days' journey, he began to want water, and returned. Espejo, desirous of seeing this rich country, departed from Cibola, and, having travelled twenty-eight leagues west, found another great province,* of above 50,000 souls. As they approached a town called Zaguato, the multitude, with their caciques, met them with great joy, and poured maize upon the ground for the horses to walk upon. And they presented the captain with 40,000 mantles of cotton, white and colored, and many hand towels with tassels at the four corners, and rich metals which seemed to contain much silver. Thence, travelling due west forty-five leagues, they found mines, of which they had been informed, and took out with their own hands rich metals, containing silver. The mines, which were of a broad vein, were in a mountain,† easily ascended by an open way to the same. In the vicinity of the mines there were numerous Indians pueblos. "Hereabout they found two rivers,‡ of a reasonable bigness, upon the banks whereof grew many vines bearing excellent grapes, and great groves of walnut-trees, and much flax, like that of Castile. The Indians here showed, by signs, that behind those mountains was a river eight leagues broad.§

Captain Espejo then returned to Zuñi. Thence he determined to ascend still higher upon Rio del Norte. Having travelled sixty leagues toward the province of Quires, twelve leagues thence, toward the east, they found a province of Indians, called Hubates, containing 25,000 persons, well dressed in colored mantles of cotton and hides. They had many mountains full of pines and cedars, and the houses of their towns were four or five stories high. Here they had notice of another province, distant one day's journey from thence, inhabited by Indians called Tamos, and containing 40,000 souls. But these people having refused admittance to their towns, the Spaniards returned; and following one hundred and twenty leagues down a river called Rio de las Vacas,‖ united again with the Rio del Norte, and went homeward in July, 1583. In conclusion, the author adds: "Almighty God vouchsafe his assistance in this business, that such numbers of souls redeemed by His blood may not utterly perish; of whose good capacity, wherein they exceed those of Mexico and Peru, we may boldly assert that they will easily embrace the gospel, and abandon such idolatry as now the most of them do live in."

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## COUNTRY OF THE MOQUIS.

Miguel Vinegas, a Mexican Jesuit, in his History of California, dated 1758, states that the province of Moquis joins to the northwest part of the kingdom of New Mexico; its inhabitants had been wholly converted and reduced by the zeal of the Franciscans; but in 1680 they apostatized, and, after massacring the persons who instructed them, revolted, together with the other Indians of New Mexico. The fathers, however, after inexpressible labors, restored tranquillity and religion in that kingdom; but all their diligence could not overcome the obduracy of the Moquinos, who for many years opposed all offers of their coming among them. In 1723 the viceroy was directed to attempt their reduction, and the enterprise was proposed to the Jesuits. They could enter Moqui only from Sonora and Upper Pimeria. "Moqui lies to the northward of the Missions of Tibutama, Guebavi, and others of Pimeria; but the distance between Tibutama and the river Gila is not less than eighty leagues, and all inhabited by Indians, with whom, indeed, a friendship has been concluded, but the far greater part of them are declared infidels. Next to these are the savage Apaches, implacable enemies to the Spaniards, and all Indians connected with them. Beyond these are the Moquis, inhabiting an extensive, but mountainous country. Consequently there was no direct way for the Jesuits to penetrate into this province; and therefore, the attempt could only be made either through the

* Mohotze. (Moqui ?) † Probably San Francisco mountain, near which are large ruins described by Capt. Sitgreaves.
‡ Probably the Colorado Chiquito (Rio del Lino) and Rio Verde.
§ Rio Colorado, probably confounded with the Gulf of California. ‖ Rio Pecos.

country of the Sobaypuris, or Pimas, now called Papagos, extending along the river Gila, to the country of the Coco-Maricopas, who were professed infidels, and perpetually at war with the Nijoras, selling their Nijoran prisoners to the Pimas, and these to the Spaniards.'' Nothing, however, was done until 1742, when the order for the reduction of Moqui was renewed, and Father Ignacio Keler, missionary of Santa Maria Suamca, directed to make the attempt. This father, in the preceding years, had been several times as far as the river Gila, both to visit his neophytes, and to keep up a friendship with the Indians, who were enemies to the Apaches. In September, 1743, he set out from his mission with a very small guard; came to Rio Gila, and continued his journey some days further to the northward, till he came among rancherias, where a different language was spoken, and the people were quite unknown. By these Indians he was attacked, and driven back to his mission.

In October, 1744, Father Jacob Sedelmayer set out upon a similar expedition from his mission of Tibutama, and, after travelling eighty leagues, reached Rio Gila, where he found six thousand Papagos, and near the same number of Pimas and Coco-Maricopas, dwelling in different rancherias. These Gila Indians threw so many obstacles in the way of his going to Moqui, that Father Sedelmayer was obliged to abandon the attempt. But, with consent of the Coco-Maricopas, he took a view of the whole territory they inhabited on each side of the Gila, went into the inward parts of their country, and returned from thence to the river Colorado and the country of the Yumas, who were enemies of the Coco-Maricopas, though in all appearance a branch of their nation, for the interpreter who accompanied the party sufficiently understood the language of the Yumas. The accounts of Father Sedelmayer show that the banks near the source of Rio Gila are inhabited by Apaches. At some distance below, that river is joined by the Azul, which is thought to issue from the mountains, and water the pleasant and fruitful country of the Nijoras till its influx into the Gila. Afterwards, on both sides of this river, there is an uninhabited tract of about twenty leagues, at the end of which are three large rancherias of Pimas, the greatest of which, called Judac, occupies fourteen leagues of a pleasant, fertile country, well watered by means of trenches, which, the country being level, are easily carried from the Gila. Twelve leagues further towards the northeast (NW.?) is the new-discovered river De la Assumption, composed of two rivers, namely, El Salado and El Verde, which, in their way to the Gila, run through a very pleasant, level country of arable land, inhabited by the Coco-Maricopas, who are separated from the Pimas by a desert, though united to them in consanguinity. Their kingdom is bounded on the west by a desert and mountainous country extending to the rancherias of the Yumas, who live along the river Colorado, but below its junction with the Gila. Over the desert, the Coco-Maricopas pass to the river Colorado, though there is a much shorter way by the conflux of the two rivers.

Across this desert they led Father Sedelmayer, who, it seems, did not visit the above-mentioned junction of the rivers, which Father Kino saw and named San Dionysio; nor did he know anything of the Achedomas, who, according to Kino, inhabit the eastern shore of the Colorado, northward from that place. The Yumas are inveterate enemies of the Gila Coco-Maricopas; yet the two tribes speak the same language. On the western side of the Colorado, there are likewise rancherias of Coco-Maricopas, allied to those of the Gila, and living in a valley thirty-six leagues in length, and for the space of nine leagues remarkably fertile and pleasant, cultivated for kidney beans, calabashes, melons, and other esculent vegetables, and by their industry well watered. * * * * * * *

The Apaches are those within the circular tract of ground extending from the river Chiguagua, by the garrison of Janos Fronteros, Anterenate or Guevavi, to the Gila. It is bounded on the north by the country of the Moqui and New Mexico; on the east by the garrison of Paso; and on the south by the garrison of Chiguagua. Within this circuit of three hundred leagues, the Apaches reside in their small rancherias, erected in the valleys and the breaches of mountains. The country also is of very difficult access, from the cragginess of the mountains and the scarcity of water. According to some prisoners who have been ransomed, they are

exceedingly savage and brutal. They have very little cultivated land, nor does their country supply them with any plenty of spontaneous productions. They are cruel to those who have the misfortune to fall into their hands; and among them are several apostates. They go entirely naked, but make their incursions on horses of great swiftness, which they have stolen from other parts, a skin serving them for a saddle. Of the same skins they make little boots or shoes of one piece, and by these they are traced in their flight. They begin the attack with shouts, at a great distance, to strike the enemy with terror. They have not naturally any great share of courage, but the little they can boast of is extravagantly increased on any good success. In war, they rather depend on artifice than valor; and on any defeat, submit to the most ignominious terms, but keep their treaties no longer than suits their convenience. His majesty has ordered that if any require peace, it should be granted, and even offered to them before they are attacked. But this generosity they construe to proceed from fear. Their arms are the common bows and arrows of the country. The intention of their incursions is plunder, especially horses, which they use both for riding and eating; the flesh of these creatures being one of their greatest dainties.

These people, during eighty years past, have been the dread of Sonora; no part of which was secure from their violences. * * * Of late years, the insolence of these savages has been carried to the most audacious height, from the success of some of their stratagems, principally owing to the variances and indolence of the Spaniards. * * * The Apaches penetrate into the province by difficult passes, and, after loading themselves with booty, will travel in one night fifteen, eighteen, or twenty leagues. To pursue them over mountains is equally dangerous and difficult, and in the levels they follow no paths. On any entrance into their country, they give notice to one another by smokes or fires, and, at a signal, they all hide themselves. The damages they have done * * in the villages, settlements, farms, roads, pastures, woods, and mines, are beyond description; and many of the latter, though very rich, have been forsaken.

# CHAPTER VII.

## *History of the Apache Nations and other Tribes, near the parallel of 35° north latitude.*

In the historical library belonging to Col. Peter Force, of Washington, is found an unpublished manuscript, dated 1799, giving what appears to be a truthful description of the Indian tribes then inhabiting "the northern provinces of New Spain." It was written in the form of a report, by Don Jose Cortez, an officer of the Spanish royal engineers, when stationed in that region, and was doubtless transmitted to the King. How it escaped from the royal archives of Spain is not known. But by some means it reached London, and thence was brought to the United States, where now it very properly belongs. Those portions of it which follow, relate to the region through which we passed, and will be found of considerable interest. The remainder contains valuable information, and it is hoped that some individual or society will make a generous contribution to literature by publishing the report entire.

The translation has been made by Mr. Buckingham Smith, now secretary to the American legation at Madrid, whose name is a sufficient guarantee for its accuracy.

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### SECTION I.

*Territories occupied by the Apache and other tribes, to the northward of the province of New Mexico.*

1. That the tribes of wild Indians who inhabit the territory beyond the frontier of the internal provinces of New Spain may be understood with all possible accuracy, and likewise the localities which they occupy, it will be necessary to define the lines that separate them. Those that are known as the Apaches will be treated of in an article apart; then others, commonly called those of the north, will be spoken of as eastern tribes; and afterwards, others as western tribes. In every particular the clearest statements will be given, from the most authentic sources, and the knowledge that exists, omitting nothing that can be of any value in this curious and interesting history. I proceed to treat of the tribes of wild Indians who inhabit the northern countries of the Spanish empire in this quarter of the world, unfolding thereby not a little that should excite admiration.

2. The Spaniards understand by Apache nation the Tonto Indians, the Chiricagüis, Gileños, Mimbreños, Taracones, Mescaleros, Llaneros, Lipanes, and Navajós. All these bands are called by the generic name of Apache, and each of them governs itself independently of the rest. There are other tribes, to whom it is usual to give the same name, such as the Xicarilla Indians. Of them, and of the situations other tribes occupy, that have been seen to the northward of New Mexico, we will speak in the second part.

3. The *Tonto* Indians (or *Coyotero*, which is a name they equally bear) are the westernmost of the Apaches, and the least known to the Spaniards. On the west they are bounded by the nations of the Papagos, Coco-Maricopas, and Yavipais; on the north by the Moquinos; on the south by the Chiricagüis and Gileños; and on the east by a country between the Mimbreños and Navajós.

4. The *Chiricagüi* nation takes its name from the principal mountain it inhabits. On the north it adjoins the Tontos and Moquinos; on the east the Gileños; and on the south and west the province of Sonora.

5. The *Gileños* inhabit the mountains immediately on the river Gila, from which they take their name. They are bounded on the west by the Chiricagüis; on the north by the province of New Mexico; on the east by the Mimbreño tribe; and on the south by our frontier.

6. The *Mimbreños* are a very numerous tribe, and take their name from the river and mountains of the Mimbres.* They are bounded on the west by the Gileños; on the north by New Mexico; on the east by the same province; and on the south by the frontier of Nueva Vizcaya.

7. The *Taracone* Indians compose also a very large tribe, and are believed to be a branch of the Xicarillas. They inhabit the mountains between the river Grande del Norte and the Pecos; are bounded on the west by the province of New Mexico; on the north by the same; on the east by the Mescaleros; and on the south by a part of the frontier of Nueva Vizcaya.

8. The *Mescalero*† nation inhabits the mountains on both banks of the river Pecos, as far as the mountains that form the head of the Bolson de Mapimi, and there terminate on the right bank of the Rio Grande. Its limit on the west is the tribe of the Taracones; on the north, the extensive territories of the Comanche people; on the east, the coast of the Llanero Indians; and on the south, the desert Bolson de Mapimi.

9. The *Llanero*‡ tribe is very numerous, and has a great many warriors. It occupies the great plains and sands that lie between the Pecos and the left bank of the river Grande del Norte. This tribe consists of three divisions—the Natajes, Lipiyanes, and Llaneros. They are bounded on the west by the Mescaleros; on the north by the Comanches; on the east by the Lipanes; and on the south by our frontier of the province of Cohagüila.

10. The *Lipanes* form one of the most considerable of the savage nations in the north of New Spain. They extend over a vast territory, the limits of which, on the west, are the lands of the Llaneros; on the north, the Comanche country; on the east, the province of Cohagüila; and on the south, the left bank of the Rio Grande del Norte; there being on the right the military posts (*presidios*) of our frontiers of Cohagüila.

11. The tribe of the *Navajó* Indians is the most northern of the Apaches. They inhabit the table-lands and mountains of the territory called Navajó, from which the tribe gets its name.§ They do not change their seats, like the rest of the Apache nation; and they have formed in that country their places (*lugares*), or fixed habitations, known by the names of Sevolleta, Chicoli, Guadalupe, Cerro Cavezon, Agua Salada, Cerro Chato, Chusca, Tumicha, Chellé, and Carrizo. They are all governed by the captain, whom they respect, and whose appointment is, in reality, subject to the approval of the governor of the province of New Mexico. They are bounded on the west by the Moquinos, on the north by the Yutahs, on the east by the Pueblos of New Mexico, and on the south by the Gileños and Chiricagüis.

12. The *Apaches Xicarillas* anciently inhabited the forests of that name in the far territories to the north of New Mexico, until they were driven out by the Comanches, and now live on the limits of the province, some of them having gone into the chasms (*cañadas*) and mountains between Pecuries and Taos, which are the last towns of the province.

* A Spanish word signifying willows.

† *Mexcal*, a spirituous liquor distilled from the American aloe or magüey; the meaning of the name, probably, is drinkers of mescal.

‡ The people of the plain—from the Spanish word *llano*.

§ Mrs. M. H. Eastman, in writing of these tribes of the Apaches, says: "Their name is said to signify 'men,' and to it the Spaniards have, long since, added other words to distinguish the several tribes. These names are taken from some animal, or from a feature of the country, or peculiar product of the soil which they inhabit and wander over. Navajó, if Spanish, could well enough have come from navajo, 'long knife,' a name this people give to a mountain whereon there is obsidian, or volcanic glass, which the native inhabitants split into instruments for cutting." *Chicora:* 1854.

13. The *Yutah* nation is very numerous, and is also made up of many bands, which are to be distinguished only by their names, and live in perfect agreement and harmony. Four of these bands, called Noaches, Payuches, Tabiachis, and Sogup, are accustomed to occupy lands within the province of New Mexico, or very near it, to the north and northeast. Beyond these, after passing a country of more than two hundred leagues in extent to the northward, thence to the northwest, other Indians inhabit, called Zaguaganas, whose number is very considerable.

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## SECTION III.

*Of the language of the Apache Indians, and of their physical characteristics.*

1. The language which all the nations speak, that bear the name of Apache, is one and the same. Some differ from the rest in their accent, or in having, here and there, a peculiar local word; but without this difference ever being sufficient to prevent them from understanding each other, even though the territories in which they may have been born should be far apart. The utterance of the language is very violent, but it is not so difficult to speak as the first impression of it would lead one to suppose; for the ear, becoming accustomed to the sound, discovers a cadence in the words. It is to be remarked that it has great poverty, both of expression and words; and this is the cause of that burdensome repetition which makes conversation very diffuse, abounding with gesture. What is most remarkable is the sound produced at the same time by the tongue and throat, which the speaker impels with unnatural force, that he may thereby render himself the more intelligible.

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## SECTION VII.

*State of agriculture, arts, and commerce among the Apache tribes, and of the use they make of coin.*

1. The genius of the Apache is little agricultural, and with the gathering of wild seed he satisfies his present want; though some of the tribes, aware that with very little labor they may subsist, by the exuberance of the soil, with comparative ease, plant the grain and pulse obtained from us, and of which they are becoming fond. But among the hordes that have inclined most to this species of natural industry, it is not the men who have engaged in it; the women, besides the duties already described, and the more material ones of carrying wood and water, plant and rear the cereals, protecting them until ripe, and then seek others that grow wild.

2. The Coyotero Indians raise small quantities of maize, beans, and a few legumens. The Navajós plant, in their season, maize, pumpkins, and some other fruits and vegetables, all which they raise in great plenty, and have store for the year round. The Xicarillas also plant maize, beans, pumpkins, and some little tobacco, in the chasms (*cañadas*) of the mountains where they live.

3. Except the Navajós, none of the nations have turned their attention to the breeding of animals, notwithstanding the wonderful facilities they have for so doing. They raise sheep and cows in considerable numbers, and a few droves of horses.

4. All their arts and manufactures are comprised in dressing well the skins with which to cover them, and to traffic in the Spanish settlements; the perfection of this skill being greatest among the Mescaleros, Lipanes, Xicarillas, and Yutahs. However, the Navajós have manufactures of serge, blankets, and other coarse cloths, which more than suffice for the consumption of their own people; and they go to the province of New Mexico with the surplus, and there exchange their goods for such others as they have not, or for the implements they need.

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# THIRD PART.

## SECTION I.

*Of the nations to the east of the Rio Grande del Norte.*

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### OF THE CAMANCHES.

2. The Camanche nation is doubtless the most numerous of the many people that are known to exist in the vicinities of our most distant provinces of North America. They occupy a beautiful and extensive country to the eastward of the province of New Mexico, and consist of four hordes, known by the names of Cuchanticas, Tupes, Yampaxicas, and the Eastern Camanches (Orientales). They are commanded by a general and a lieutenant-general, chosen from among themselves, with the consent of the governor of New Mexico, and the approval of the *comandante* of the internal provinces. Those chieftains are acknowledged and respected by the heads of every settlement (rancheria); and every Cumanche* renders them obedience, such as is permitted by his constitution and government. He listens with like submission to their counsels, and conscientiously follows them. These people keep faith in treaties, observe truth and hospitality, and their customs, in general, are not so barbarous as those of the Apaches.

3. These Indians are intrepid in war, bold in their enterprises, and impetuous in action. They are at peace with no other people than the Spanish, and maintain a constant war with all the other neighboring nations. The four tribes live in close friendship; their people form close alliances; their private quarrels never extend beyond insignificant disputes, and terminate where they begin. Their interests are common, and they share in them an equal fortune.

4. In their intercourse with the Spaniards, the Cumanches show a sense of honor and the most rigid justice. The traveller in their country is hospitably entertained, respectfully served, and treated with the greatest friendship. At the moment of his arrival, they take charge of his horses and equipage; and if an animal should be missing at his departure, they detain him until it can be found. If it should be discovered that the estray has been produced with evil inclination, an exemplary chastisement is administered to the delinquent, in the sight of the Spaniard. In this manner do the Indians behave to our wayfarers who journey among their hordes; and they accompany them on their departure with an escort, until coming to some point at which they may be relieved by warriors, and have the guides of another town.

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## SECTION IV.

*Of the nations to the westward of the upper part of the province of New Mexico, and of those of the upper coast of Sonora.*

1. The province or territory of the Moqui (or Moquino) Indians lies to the westward of the capital of New Mexico. The nation revolted towards the close of the seventeenth century, driving out the Spaniards from the towns; and from that time no formal attempt has been made to reduce them to submission by force of arms; nor does a hope exist of its being accomplished by means of kindness, which, on several occasions, has already been unavailingly practised. The towns in which they reside and are established are seven in number—Oraibe, Taucos, Moszasnavi, Guipaulavi, Xougopavi, Gualpi; and there is also a village, which has no name, situated between the last town and Tanos, the inhabitants of which are subordinate colonists to the people of Gualpi.

* The translator has preserved the original spelling of the names of tribes and villages, in which there are some inconsistences, and a considerable difference from modern usage.

2. The Moquinos are the most industrious of the many Indian nations that inhabit and have been discovered in that portion of America. They till the earth with great care, and apply to all their fields the manures proper for each crop. The same cereals and pulse (*semillas*) are raised by them, that are everywhere produced by the civilized population in our provinces. They are attentive to their kitchen gardens, and have all the varieties of fruit-bearing trees it has been in their power to procure. The peach-tree yields abundantly. The coarse clothing worn by them, they make in their looms. They are a people jealous of their freedom; but they do no injury to the Spaniards who travel to their towns, although they are ever careful that they soon pass out from them.

3. The towns are built with great regularity, the streets are wide, and the dwellings one or two stories high. In the construction of them, they raise a wall about a yard and a half above the pave of the street, on a level with the top of which is the terrace and floor of the lower story, to which the owners ascend by a wooden ladder, which they rest thereon, and remove as often as they desire to go up or down. On the terrace, upon which all the doors of the lower story open, is a ladder whereby to ascend to the upper story, which is divided into a hall and two or three rooms; and on that terrace is another ladder, with which to ascend to the roof, or to another story, should there be one.

4. The town is governed by a cacique; and for the defence of it, the inhabitants make common cause. The people are of a lighter complexion than other Indians; their dress differs but little from that worn by the Spanish-Americans of those remote provinces, and the fashion of their horse trappings is the same. They use the lance and the bow and arrows.

5. The women dress in a woven tunic without sleeves, and in a black, white, or colored shawl, formed like a mantilla. The tunic is confined by a sash, that is usually of many tints; they make no use of beads or ear-rings. The aged women wear the hair divided into two braids, and the young in a knot over each ear. They are fond of dancing, which is their frequent diversion. For it, there is no other music than that produced by striking with two little sticks on a hollowed block, and from a kind of small pastoral flute. At the assemblages, which are the occasions of the greatest display, there is not a Moqui, of either sex, whose head is not ornamented with beautiful feathers.

### OF THE SERIS, TIBURONES, AND TEPOCAS.

1. The *Seri* Indians live towards the coast of Sonora, on the famous Cerro Prieto, and in its immediate neighborhood. They are cruel and sanguinary, and at one time formed a numerous band, which committed many excesses in that rich province. With their poisoned shafts they took the lives of many thousand inhabitants, and rendered unavailing the expedition that was set on foot against them from Mexico. At this time they are reduced to a small number; have, on many occasions, been successfully encountered by our troops; and are kept within bounds by the vigilance of the three posts (*presidios*) established for the purpose. None of their customs approach, at all, to those of civilization; and their notions of religion and marriage exist under barbarous forms, such as have before been described in treating of the most savage nations.

2. The *Tiburon** and *Tepoca* Indians are a more numerous tribe, and worthy of greater consideration than the Seris; but their bloodthirsty disposition and their customs are the same. They ordinarily live on the island of Tiburon, which is connected with the coast of Sonora by a narrow inundated isthmus, over which they pass by swimming when the tide is up, and when it is down, by wading, as the water then only reaches to the waist, or not so high. They come on to the continent, over which they make their incursions, and, after the commission of robberies, they return to the island; on which account, no punishment usually follows their temerity. It is now twenty-three or twenty-four years since the plan was approved by his Majesty, and ordered to be carried out, of destroying them on their island; but, until the present season, no

* The Spanish word for shark.

movement has been made to put it into execution. To this end, the troops of Sonora are being equipped; a corvette of the department of San Blas aids in the expedition, and two or three vessels of troops from the companies stationed at the port of that name on the South sea. The preparations awaken a great deal of interest; and the force has grown to be so large that it may be said, with positiveness, not one-third can operate; and altogether there is reason to fear that the Tiburones and Tepocas will not be finally dealt with in the way that it has been hoped.

### OF THE PIMAS, PAPAGOS, AND COCO-MARICOPAS.

1. On the hither side of the Gila, and over the territory which extends to the boundary that is considered to limit the province of Sonora, are established the *Pimas Gileños*, also called *Pimas Altos*. The nation consists of twenty-five hundred souls, who live in the towns of San Juan Capistrano, Sutaquison, Atison, Tubuscabor, and San Seferino de Napgub. They are social and much united. Their weapons are those common to Indians, and they are generally at war with the Apaches, and some nation or other of the Colorado. They cover themselves with cotton and woolen blankets of their own manufacture. They cultivate the earth, and each proprietor lives near his field. They raise wheat, maize, cotton, and other crops, for the irrigation of which they have well-constructed canals (*acequias*). They have farms for the breeding of horses, sheep, and poultry.

2. The *Papagos*, a nation of four thousand persons, inhabit the country from the farthest limit of Sonora, along the sea, nearly to the mouth of the river Colorado. They speak the same language as the Pimas, and dress after the same manner. They are made up of several hordes; their customs are alike; and in their friendships, as in their enmities, they ever accord with their neighbors.

3. The *Opa*, or *Coco-Maricopa* Indians, as they are commonly called, live on the farther side of the river Gila, near the river Ascención. Their number is more than three thousand, and they are divided into several hordes. Their language is that of the Yumas; they are of the same character as the Pimas, and dress themselves like them. Without the necessity of irrigation, they gather two crops of grain from their fields in the year. In all other matters they differ but little from the Papagos and Pimas, with whom they live in great harmony.

## SECTION V.

*Of the nations of the river Colorado, and of those to the west and northwest of them, in succession, as far as the coasts of Upper California.*

1. The *Cucápa* nation consists of about three thousand souls, is divided into separate tribes, which are settled on the right bank of the river Colorado, from latitude 32° 18′ upward. On the opposite shore, and eleven leagues to the northeast, begins the *Talliguamayque* nation, about two thousand persons in number. They are very active, of a clearer complexion than any other people of those parts, and dress with much neatness. The *Cajuenches*, who are as many as three thousand, live in a delightful country, on the same bank with the Talligüamais, and very near them. These three nations raise maize, beans (*frijoles*), and pumpkins in great abundance, as they do also musk-melons and water-melons. The Cajuenches are accustomed to fishing, and sometimes subsist altogether on what they catch. They are of a vivacious nature, and amuse themselves with dancing, which is their chief pastime. They, as well as the Talliguamays, erect their huts (*jacales**) in the order of an encampment, enclosing them with stockades to shelter them in the event of attack, and to prevent surprise by an enemy.

2. The *Yuma* nation, consisting of three thousand persons, is established on the right bank of the Colorado. They are neighbors of the Cucapas, and their hordes, farthest down, begin

* From the Mexican word *xacalli*, a hut of straw.

at 33° of latitude. They are more civilized than the three nations which have been spoken of, and raise in abundance the same productions.

3. The *Tamajabs* have an equal number of people, are settled on the left bank of the Colorado from 34° of latitude to 35°. They are the best of the race that are known to inhabit this celebrated river. They are not thievish, nor are they troublesome; but they evince a high spirit, and, of all that people, are the most civil. The men go almost entirely naked, having nothing on them but a kind of blanket or robe made of the skins of conies or nutrias, which they get from the nations to the west-northwest. They show this disregard of covering in the severest part of winter, declaring that by so doing they are made hardy—as, in fact, they are, suffering hunger with constancy, and thirst for three or four days together. They are sound of health, and of fine stature. The women possess more manner and grace than the females of the other nations. They dress in an under skirt, and have covering like the Yuma women. The language is very strange; it is spoken with violent utterance and a lofty arrogance of manner; and in making speeches, the thighs are violently struck with the palms of the hands.*

4. The *Talchedums* live on the right bank of the Colorado, and their tribes first appear in latitude 33° 20′. They have the same customs as the other nations low down the river.

5. The Cucápas, Talliguamays, and Cajuenches speak one tongue; the Yumas, Talchedums, and Tamajabs have a distinct one; with the difference, that this last nation accompany their speeches and opinions with the gesticulation and haughtiness of manner that has been spoken of.

6. In consequence of the information given by several father missionaries, from visits made by them, at different times, to the nations of the lower part of the Colorado, representing and giving proofs of the disposition and desire of all those Indians to have missions introduced among them, a royal order was obtained that they should be undertaken; but, before it was issued, the principal chief of the Yumas, named Palma, came to Mexico, and, with many of his nation, received the sacrament of baptism, and afterwards returned to introduce their desired missions. These were established at the end of the year 1780, with the invocation of our Lord of the Conception, and of Saint Peter and Saint Paul of Vicuñez; but the natives soon became displeased with those permanent establishments, and, before the end of the year, they destroyed them, killing, perfidiously, four of the religious order, a troop of protection, and some persons in the vicinity who were to have been the first colonists in that new country. The women and boys were taken into captivity, but the greater part of them were relieved by expeditions set on foot to punish their conduct. From that time, nothing further has been known of the nations of the river Colorado; and their distance from Sonora has not permitted them to commit any injury in that province.

7. Journeying from the nation of the Tamajabs, to the west quarter northwest, at the end of twenty leagues begins the nation of the *Benemé*. They are an effeminate race; the females little cleanly; the dress no more than blankets of otter or rabbit skins. The territory they occupy is a fine pasture land, and has beautiful forests. Wild grape-vines are in the greatest quantity, and the plains are covered with hemp-grass. The people are very numerous, and continue to near the coast. They are peaceful and kind to strangers. A common demonstration of their satisfaction and good will is to cast at the passenger many of the white beads they get on the shores of the Gulf of California, and some of the acorns that grow wild in their country.

8. On the ridges of the northwest of the Benemé, and about thirty leagues from where the

* Cabeza de Vaca, in his wandering from Florida to Sonora, between the years 1528 and 1536, speaks of this strange custom as existing seemingly among some Indians to the east of the Mississippi river:

"At sunset we reached a hundred Indian habitations. Before we arrived, all the people who were in them came out to receive us, with such yells that were terrific, striking the palms of their hands violently against their thighs. They brought out gourds bored with holes, and having pebbles in them—an instrument for the most important occasions, and produced only at the dance, and to effect cures, and which none but they who have them dare touch."—*Naufragios*, chap. xxvii.

farthest of these people dwell, are the towns (*rancherias*) of the *Cuabajais*. The greater part are made in the form of a great square, and with two doors, one on the eastern and the other on the western side. They are divided by arches made of the limbs of trees, which are usually willow, and have a few windows on the interior, sufficient for the escape of smoke from the several fires, around each of which a family lives. Sentinels are stationed at the doors during the night-time. Throughout the country, wherever they have made their residences, the climate is very mild, the land rich, and covered with trees; and what, at the first sight, is most agreeable in these Indians, is the cleanliness of their persons, and tidiness of dress, in which they greatly surpass those of the Benemé nation.

9. Twelve leagues to the northward of the last town of the Cubajai nation, and on the banks of a full river, begins the nation of the *Noches*. Their lands are very rich, are covered with forest, and possess a variety of charms that only can be imagined. This people are very affable and kind. The men present a fine appearance; the women are very cleanly and neat, being attentive to their hair, and wearing an under skirt of buckskin and robes of skin. Their favorite pastime is bathing in the full rivers of crystal water, which everywhere abound. They likewise make use of the bath called tamascal,* which is taken in a subterranean room covered over like an oven, and having a small door in the side or in the roof. When they wish to take this bath, fire is kindled in it before they go in; and as there is no place of ventilation but the entrance, profuse perspiration follows on the body in a short time, which is endured as long as possible, and then they run and plunge into a river, where they thoroughly wash themselves. From this frequent practice, it is to be supposed, arises their great cleanliness, which distinguishes them among all the nations and tribes of Indians, and it may also be the cause of that delicacy of person which unfits them for walking.

10. All that vast country comprehended by the Sierra Madre of California and its eastern slope, and by its western as far as the sea-coast, is occupied by savage nations, in bands of unequal numbers. The principal qualities and customs which mark their character are, for the most part, those common to all Indians, with little exception, in a state of civilization, without being so peacefully inclined or of so soft a nature. Some of them have been visited, and others have been heard of, from the tribes of those regions who, at one time or other, have held intercourse with them. These are the *Cuñeil*,† who are on the borders of the port of San Diego, and whose towns continue to the outlet of the channel of Santa Barbara; the *Quemeyá*,‡ who likewise border on that port, and on the nations of said outlet; the *Tecuiche*, who have their hordes as far as the port of San Carlos; and the *Teniqueches*, who adjoin the Talchedums and the mission of Santa Ana. The Cuñeil and the Quemeyá have each their dialect, and the other two speak the same language with the Benemé. The Cobaji and the Noche have also a language apart; the former adjoin the nation of the Chemeque on the east, and the Noche on the west.

11. In the wide extent of country comprehended between the Gila, Colorado, and the southern part of the province of the Moquis, are many nations that have not been visited or seen, as those have on the Colorado, and those with whom relations of friendship have been formed in the mountains of California; but it is known that many tribes do exist there, and are of the most wandering character. The number of persons belonging to each of them is considered to be very small; but they are all Yavipais, adding for each an additional word to that given name. Those that we have knowledge of, from intercourse held with here and there one, and from the accounts that some of themselves have given, consist of the *Yavipais-tepia*, who have their particular tongue; the *Yavipais-mucaoraive*, who speak a dialect distinct from theirs, as do the *Yavipais-abema*, *Yavipais-cuernomache*, *Yavipais-caprala*, and *Tiqui-llapais*. North-

* *Temazcalli*, a Mexican word for a small house built like an oven, wherein to take sudorific baths.

† These are now called Dieginos.

‡ At present written *Comoyá* or *Comoyei*. The tribe is scattered from San Felipe across the desert, to the mouth of Rio Gila.

ward of the river Colorado live other bands, which may be considered as one numerous nation; they are the Chemeque-caprala, Cehmeque-sabinta, Chemequaba, Chemeque, and Payuches; all speaking the same language, with the exception of the last.

12. There is information, likewise, that to the northward of the last, are others settled, called Guamoa, Guanavepe, Guallivas, Aquachacha, Tapiel, Baqui-oba, and Gualta. Among none of these nations, nor among the many that have been found in the northwestern part of America, has the smallest idea of religion been observed, nor reasons for the suspicion of it from any acknowleged idolatry, though they generally respect and distinguish those whom they believe to be wizards—a natural trait in the character of all Indians.

## SECTION VI.

### *Of the nations to the north-northwest of the province of New Mexico.*

1. The reconnaissance by the Spaniards which has given the most light respecting the nations that live in the northern part of America, is the journey which was made in the year 1776 by the reverend fathers Friar Francisco Atanasio Dominguez, and Friar Francisco Valez Escalante. After having seen an extract from the long diary kept of this successful expedition, I had the good fortune to become acquainted with the Rev. Father Dominguez, a man of sound sense, of great probity, and acknowledged virtue. He states, with the naturalness and clearness that arise from one incapable of anything else than truth, that about two hundred leagues to the north-northwest of the town of Santa Fé, in New Mexico, he discovered the Indians called *Yutas Zaguaganas*, about whose several towns are three lakes, which are called in their language Timpanogotzis, or Timpanocuitzis, of which the first is at the height of 40° of latitude; and continuing one hundred and twenty leagues to the westward of those lakes, that you will arrive at the great valley and lake of the Timpanotzis, where live a people the most docile and kindly of any of the many that as yet have been found in the New World. The valley begins at 40° 49′ of north latitude: it has in the midst a very great lake; and into this lake, besides receiving many brooks and rivulets, there fall four rivers that pass through the valley, and water it at equal distances, in such manner that a rich province might be created there abundant in all kinds of grain and in herbs. Much brotherly feeling was manifested by this people, and a sincere desire to receive religion. They follow the chase, to supply them with skins for their covering, and they make use of the flesh; but, with them, their greatest delight is fishing, which supplies abundant food for their support, and without exertion.

2. Journeying from the lake of the Timpanotzis to the southwestward, and passing over thirty leagues of country, another numerous nation is arrived at, the men of which have very stiff and thick beards, that of some being so long as to give the aged who wear them the appearance of ancient anchorites. They have the cartilage of the nose bored near the exterior extremity, and wear in it a small bone of the stag, or some other animal. They look like Spaniards, not only in the beard, but in their physiognomy. In docility and kindness they are like the people of the lakes (*lagunos*), or Timpanotzis. They separated from the missionaries with expressive demonstrations of affection, showing great feeling at parting, to the extent of shedding tears. The name of this nation, in their own language, is *Tiransgapui*, and the valley in which they live begins in latitude 39° 35′ north.

3. The purpose of that expedition was to penetrate into several nations adjoining those on the coast of California, to explore down the Colorado river, and to continue, by the way of Moqui and Zuñi, as far as Santa Fé.

4. This narrative, affirmed to by two religious men of high character, and by others who composed their escort, persons selected to go into those distant and unexplored countries, of which nothing was known, is sufficient authority to disprove the assertions of some authors, who, treating of the Indians, have set down the absence of beard as characteristic of the race, merely

because it so happened that those they had seen, or of whom they had heard, were deficient in that respect. Although this certainly is correct in the greater number of instances, nevertheless it is true that some Indians have more beard than others; and now we perceive that there are nations that possess it as heavy and as long as it exists in any of the countries of Europe where man is most remarkable for this peculiarity of physiognomy.

5. The same may be said of the existence of Quivira, with the grandeur and populousness of which many have been deceived, notwithstanding that no one has been able to point out where it was, or to find any account describing this civilized people of the regions of North America. Nor is this all; for on many maps that I have had in my hands, the famous city occupies a determinate point on the globe, but the makers of them have omitted to put down the well-peopled places in the midst of those provinces which we have ruled from the earliest time of the conquest. I do not leave this question among the doubts of the celebrated Binaspore of India; but, with less casuistry, I venture to deny the existence of such a city, its having been seen, or there being the accounts of it that are said to have been written. Let the minute diaries be examined and read with care, that treat of the arduous journeys that for thirty years have been prosecuted into those parts by the reverend fathers Friar Francisco Garces, Friar Francisco Atanasio Dominguez, Friar Francisco Silvestre Valez Escalante, and several other religious men besides, and by military heads, who have penetrated into those remote countries; and examine also the itinerary made by the Rev. Father Friar Juan de la Asunción, in his enterprise among them of the year 1538, and the account of the march of the Captain Francisco Vasquez Coronado made in the year 1540, and that of Don Juan de Oñate of the year 1604—those early travellers who may be supposed to have made known the great city of Quivira; and after reading their accounts of the rivers they discovered, the distances between them, and the directions in which they went, we shall come to understand that the river Balsas, they speak of, is the Colorado of California; and that the information they received of another river was of that which we since know by the name of San Felipe, and the other is the Rio Grande, of which the Noche Indians and the other nations of that quarter speak. We recognise the same numerous bands now living, as then, in those regions, dressed in skins and buckskin; and doubtless the populous and walled Quivira must have been some town like those of the Moqui, that has been destroyed with the facility that many of the domicils of those Indians are now overthrown, or it may have been reconstructed as others in the same manner are, and whereby the seven towns of that territory still endure.

# PART IV.

EXPLORATIONS AND SURVEYS FOR A RAILROAD ROUTE FROM THE MISSISSIPPI RIVER TO THE PACIFIC OCEAN.

WAR DEPARTMENT.

ROUTE NEAR THE THIRTY-FIFTH PARALLEL, EXPLORED BY LIEUT. A. W. WHIPPLE, TOPOGRAPHICAL ENGINEERS, IN 1853 AND 1854.

# REPORT

ON

# THE GEOLOGY OF THE ROUTE.

WASHINGTON, D. C.
1856.

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BY WILLIAM P. BLAKE,

GEOLOGIST OF THE OFFICE OF THE UNITED STATES PACIFIC RAILROAD EXPLORATION AND SURVEYS.

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# No. 2.

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# RESUMÉ AND FIELD NOTES.

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BY JULES MARCOU,

GEOLOGIST AND MINING ENGINEER TO THE EXPEDITION, WITH A TRANSLATION BY WILLIAM P. BLAKE.


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## GEOLOGICAL ITINERARY FROM FORT SMITH AND NAPOLEON, [ARKANSAS,] TO THE RIO COLORADO OF CALIFORNIA. ORIGINAL AND TRANSLATION

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* All the wood engravings for this report are from the establishment of N. Orr & Co., N. York.

# ERRATA AND ADDENDA.

Page 2, 8th line, for "seventy" read *twenty*.
Page 3, 1st line, for "southward" read *south*.
Page 14, 2d line under the woodcut, insert after inclination, "except at one point."
Page 14, 12th line from bottom, for "15°" read 60°.
Page 14, 11th line from bottom, instead of "These are all slight inclinations" read *With one exception these are all slight inclinations.*
Page 16, 6th line from bottom, for "siliceous" read *silicious*.
Page 17, 3d line from bottom, for "siliceous" read *silicious*.
Page 23, 9th line, for "Zahara" read *Sahara*.
Page 37, 17th line, for "Irsocardia" read *Isocardia*.
Page 42, 18th line, for "mountains" read *mountain*.
Page 47, 7th line from bottom, for "since" read *west of*.
Page 49, 9th line from bottom, for "across" read *through*. After "but" insert *the line of the survey*.
Page 57, 20th line from bottom, for "stata" read *strata*.
Page 60, 6th line from bottom, for "its" read *their*.
Page 65, 6th line from bottom, for "Estucado" read *Estacado*.
Page 66, 18th line, after "commencing" insert *at*.
Page 67, 10th line. Owing to an error in the copy of the translation of the notes, an inclination of 60 degrees recorded by Mr. Marcou (August 9, p. 127) was overlooked.
Page 70, 26th line, for "gandstones" read *sandstones*.
Page 70, last line, insert "calcareous."
Page 71, 25th line from bottom, insert a comma after "line" and after "above."
Page 75, 9th line from bottom, for "get" read *yet*.
Page 76, 15th line from the bottom of the note, for "conchylieu" read *conchylien*.
Page 78, 5th line from the bottom, for "R. J. Murchison" read *R. I Murchison*.
Page 79, 9th line, for "Pitcherii" read *Pitcheri*.
Page 100. It should have been stated in connexion with the reference to the figures of Gryphæ Pitcheri, that they were copied from the figures published by Mr. Marcou.
Page 117, Nos. 7 and 8, for "rochenses" read *rocheuses*.
Page 118, No. 60, for "Lano" read *Llano*.
Page 118, No. 62, for "Colorada" read *Colorado*.
Page 118, No. 66, for "variagated" read *variegated*.
Page 127, 3d line from bottom of translation, for "pebbles of carboniferous silex" read *pebbles of silex, carboniferous*.
Page 127, 11th line of translation, for "fifteen" read *sixty*.
Page 129, 4th line from bottom of original, for "ros tre" read *rose très*.
Page 131, 23d line from bottom of translation, for "Nescomien" read *Nexcomian*; also in 4th line from bottom.
Page 135, 25th line, for "plateaus" read *plateau*.
Page 136, 11th line of translation, for "Turritellas" read *Turritellæ*.
Page 137, 11th line of translation, and line 14 and afterwards, for "cretaceous" read *Cretaceous*.
Page 138, 7th line from bottom of original and translation, and also in the foot-note, for "Marchii" read *Marshii*.
Page 139, in the foot-note, for "arcou" read *Marcou*.
Page 142, 18th line of translation, for "lumachelle" read *lumachel*.
Page 146, 4th line from bottom of translation, for "stonestone" read *sandstone*.
Page 150, 8th line of original, for "Plateaux" read *plateaux*.
Page 150, 8th line of translation, for "plateaus" read *plateaux*.
Page 152, 17th line from bottom of translation, for "semi-recticulatus" read *semi-reticulatus*.
Page 153, 3d line from bottom of translation, for "Encampment" read *Encamped*.
Page 154, 8th line from bottom of translation, for "reticulatis" read *reticulatus*.
Page 154, 25th line translation, for "on" read *or*.
Page 157, 25th line translation, for "Tertiaries inclining" read *Tertiary, inclining*.
Page 160, 2d line from bottom of original, for "protogene" read *protogine*.
Page 160, 2d line from bottom of translation, for "quartzose, protogine, and very fine" read *and quartzose, protogine, very fine*.
Page 164, last line, for "quartenary" read *quaternary*.

# ADDITIONAL ERRATA.

Page 19, 18th line from bottom, after Gryphæa Pitcheri insert var. navia.
" 62, 12th " " for P. pustulosus read P. rogersi.
" " " " " for T. roissyi read Spirifer lineatus.
" " 11th " " for Millipunctata read Millepunctata.
" " " " " for Spirifer musebachanus read Spirifer cameratus.
" " " " " for S. pilosus read S. Kentuckensis.
" 63, 2d " top, for Spirifer Pilosus read Spirifer Kentuckensis.
" " " " " for Millipunctata read Millepunctata.
" " 9th " " for Terebratula roissyi read Spirifer lineatus.
" 101, 13th " " after Terebratula, for Shwyd read Lhwyd.
" 119, No. 114, for Productus pustulosus read Productus Rogersi.
" " " 117, for Terebratula roissyi read Spirifer lineatus.
" " " 118, for Millipunctata read Millepunctata.
" " " 119, for Spirifer musebachanus read Spirifer cameratus.
" " " 119½, for Spirifer pilosus read Spirifer Kentuckensis.

NOTE.—The necessity of the changes of nomenclature in the references to the fossils here noticed are explained in one case by the note on page 102, and the synonymy under SPIRIFER CAMERATUS, same page, will explain the reason of the change in that instance. The fossil referred to PRODUCTUS PUSTULOSUS proves, on comparison, to be a distinct species; and the specimens referred to TEREBRATULA ROISSYI prove to be SPIRIFER LINEATUS—these species resembling each other in form. Mr. Conrad has very recently proposed for the narrow and much incurved variety of GRYPHÆA PITCHERI, (if it be indeed that species,) the name of *Navia*.

# No. 1.

# GENERAL REPORT

UPON

# THE GEOLOGICAL COLLECTIONS.

BY WILLIAM P. BLAKE,

GEOLOGIST OF THE OFFICE OF THE UNITED STATES PACIFIC RAILROAD EXPLORATIONS AND SURVEYS.

## INTRODUCTORY LETTER.

WASHINGTON, *September* 23, 1856.

SIR: I herewith submit a report on the geology of the route near the thirty-fifth parallel of latitude, prepared, agreeably to your instructions, from the collections and notes of Mr. Jules Marcou and other sources.

Very respectfully, your obedient servant,

W. P. BLAKE, *Geologist of the Office.*

Captain A. A. HUMPHREYS, *Corps Topographical Engineers,*

*In charge of the Office of U. S. Pacific Railroad Explorations and Surveys.*

# CHAPTER I.

## OBSERVATIONS UPON THE MOUNTAIN RANGES AND GENERAL RELIEF OF THE SURFACE ALONG THE ROUTE.

DIRECTION AND LENGTH OF THE LINE.—BAROMETRIC PROFILE.—SIX PRINCIPAL CHAINS CROSSED BY THE SURVEY.—SANDIA AND SANTA FÉ RANGES.—SIERRA MADRE.—AZTEC AND AQUARIUS RANGES.—CERBAT RANGES.—RANGES ALONG THE COLORADO.—PAI-UTE RANGES.—BERNARDINO SIERRA.—MOGOYON SIERRA.—ELEVATION PRODUCED BY THE VOLCANO OF SAN FRANCISCO.—TABLE-LANDS, PLAINS, MOUNTAIN SLOPES, AND VALLEYS.—CHARACTER OF THE EASTERN SLOPE OF THE ANAHUACHIAN CHAIN NEAR THE LINE OF SURVEY.—LLANO ESTACADO.—BLUFF BORDERS OF THE LLANO.—ITS EXTENT AND MEAN ELEVATION.—PLAIN BETWEEN THE SANTA FÉ AND ALBUQUERQUE MOUNTAINS, AND THE SIERRA MADRE.—ITS CHARACTER AND AVERAGE ELEVATION.—TABLE-LANDS AND SLOPES WEST OF THE SIERRA MADRE.—EXTENT WEST AND NORTH.—THE SLOPE ON THE WEST MORE GRADUAL THAN ON THE EAST.—STAIR-LIKE DESCENTS.—GENERAL ELEVATION.—VAL DEL CHINA.—VALLEY OF HAWIL-HAMOOK.—ITS DEEP NARROW CHARACTER.—PLAIN OR VALLEY BETWEEN THE CERBAT RANGE AND THE COLORADO RIVER.—VALLEY OF THE COLORADO.—GREAT BASIN.—ITS GENERAL CHARACTER FORMED BY A COMBINATION OF SHORT RIDGES AND SLOPES.—INCLINATION OF THE SLOPES AND THEIR ORIGIN.—PLAIN AND VALLEYS BORDERING THE PACIFIC.

Before commencing the observations on the geological structure of the line surveyed by Lieutenant Whipple, I propose to enumerate in a very brief manner the principal physical features of the route, and to give a general view of the configuration or relief of the surface, based chiefly upon the results of Lieutenant Whipple's survey, and the barometrical profile which is presented with his report. For full and complete information on the topography and general features of the route, reference should be had to that report. The following summary is intended merely as an introduction to the geology, and as a guide to the location of the geological phenomena which are described in the report.

The line surveyed follows, as has been indicated, the vicinity of the 35th parallel of latitude, and extends from Fort Smith, Arkansas—a point nearly due west from Memphis, Mississippi—westwardly to the Mojave river, and thence southwestward to the Pacific ocean, at San Pedro. The distance thus traversed is 1,892 miles, and the route is included between the meridians of 94°.26 and 118° 16′. From the Mississippi river, Fort Smith is reached by the navigable waters of the Arkansas river. The valley of the Canadian, which is properly a continuation of the Arkansas, is then followed for the greater part of the way to its head-waters at the eastern foot of the ranges of the great central mountain chain of the continent. This chain is crossed near Albuquerque, through the San Antonio Pass, about forty miles south of Santa Fé. Crossing the valley of the Rio Grande, the survey reaches the Sierra Madre one hundred miles west from Albuquerque. This range is traversed near latitude 35° by "Campbell's Pass," and one further south called *Camino del Obispo;* and the village and ruins of Zuñi are reached at its western base. From Zuñi, the valleys of the "Puerco of the West" and the Colorado Chiquito, the waters of which flow into the Pacific, are followed to the base of the great extinct volcano called San Francisco Mount, about three hundred and fifty miles west from Albuquerque. Ascending over the lavas of this mountain, the line passes the Aztec mountains and reaches the Aquarius range, which forms the eastern border of the valley of the Hawil-hamook or Bill Williams' fork of the Colorado river. Crossing that range through Cactus Pass, in longitude 113°, the valley of the river is reached and followed southeasterly for about seventy-five miles, then turning westwardly to its junction with the Great Colorado river in latitude 34° 17′.

Passing up the valley of the Colorado, nearly to the 35th parallel, the survey again turns

westward, and the ascent of the numerous ranges and ridges forming the eastern rim of the Great Basin is commenced. Crossing these at the end of the Mojave river, the Great Basin is traversed along the valley of that stream and the Mormon trail to the Cajon Pass in the transverse mountain chain, the southern prolongation of the Sierra Nevada, for which I have proposed the name Bernardino Sierra. After this chain is crossed, the broad and gentle slope extending to the Pacific is reached, and the line passes the rich and fertile valley of Bernardino, and crosses the valleys of numerous beautiful streams to the city of Los Angeles, and from thence to San Pedro, its seaport, seventy miles distant.

The country thus traversed presents a great variety of surface and diversity of scenery. It includes lofty mountain chains, isolated lava-covered peaks, broad elevated table-lands, fertile river-valleys, treeless wastes, deserts, and broad alluvial plains, burdened with vegetation.

The leading features of the relief of the surface are well presented by the barometric profile, which is the result of numerous and careful observations. This profile, however, being constructed to show the grades between each camp, for the whole line, and therefore being on a somewhat circuitous base, and passing over the mountain ranges at their lowest parts, does not give to us the most correct view of the relief of the surface along a direct line—a line transverse to the axes of the principal elevations and depressions. It is a *railroad* and not a *physical* profile. This difference has been regarded in the construction of the geological section, and the modifications which have been made will be explained when the section is described. For the present purpose, also, this difference has been noted, and the succeeding remarks on the physical geography are the result not only of examinations of the profile, but also of the topography, as shown on the map, and, in part, known from personal observation.

I propose to first present the most important particulars concerning the mountain ranges, then to consider the plains or plateaux and the mountain slopes, the rivers and their valleys, and lastly some general observations on the combination of these leading features.

The parallel of 35° between the Mississippi and the Pacific ocean is intersected by five prominent mountain chains or combinations of ranges, producing distinctly defined swells of the surface, and these are separated by broad and equally well defined valleys or plains. The line surveyed may be said to cross *six* chains; the sixth, that fronting the Pacific, being nearly coincident in its direction with the parallel of 35°. These chains may be enumerated in their succession from east to west, as follows: First, the Sandia mountains, Gold mountains, and Santa Fé mountains, bordering the valley of the Rio Grande on the east; second, the Sierra Madre, sometimes called *Sierra de Zuñi;* third, the Aztec and Aquarius mountains; fourth, the Cerbat mountains; and fifth, the Pai-Ute ranges, or the ranges forming the eastern rim of the Great Basin, and separating it from the Colorado river. The last or sixth chain is the Bernardino Sierra, of California. In addition to these lines of elevation we may add the prominent elevation produced by the volcano of San Francisco, and which, although the line of survey was at its southern base, produces a very striking modification of the profile, as if it traversed a mountain chain. This, however, so far as the topographical indications show, is not the case, and the elevation of that country shown in the profile is probably local, and not found several miles further to the north.

In addition to the lines of elevation enumerated above, there is one which does not appear in the profile, and which being contiguous to the line of survey, demands attention in this place. This is the *Sierra de Mogoyon*, which was seen beyond the Sierra Madre, at the south of the line of exploration, and which appeared to extend for a long distance nearly parallel to it.

*Sandia and Santa Fé Ranges.*—These mountains form the eastern border of the valley of the Rio Grande, and are the first abrupt elevations met with on passing west from the Mississippi river along the 35th parallel. At this point they do not present one continuous ridge, but are much broken and are traversed by several low and open passes. The line surveyed extends through one of these, and the highest point reached was 6,624 feet above the level of the sea. These mountains are a part of the southern prolongation of the Park mountains. Further

southward they connect with, and may be regarded as the continuations of the Organ mountains, which are also on the east of the Rio Grande, and which form the eastern border of the *Jornada del Muerto*.

Opposite Albuquerque, the Sandia mountains rise with a bold and rather precipitous front to the height of 12,000 feet above the sea.[1] The precipitous face is turned westward towards the river, while the opposite slope is much more gentle and gradual. The direction of this elevated range is a few degrees east of north, and it does not retain this great elevation for more than fifteen or twenty miles, when it breaks down into lower ridges.

*Gold Mountains.*—The Gold mountains rise about ten miles northeast of the northern end of the Sandia range, and are of much less importance in point of magnitude and elevation. The greatest length of their base is probably not over fifteen miles, this estimate being made from the map of that region.

*Santa Fé Mountains.*—The Santa Fé mountains rise to the northward of the route, and their southern extremity does not reach the line of profile. This range, however, appears to be geologically the equivalent of the Sandia range, and some fossils in the collection were obtained at Pecos village, on the eastern flank of its southern termination. This range is separated from the Gold mountains by the valley of Rio Galisteo. It extends northwards with an increasing altitude towards the Park mountains, from which it is separated by the *Sangre de Cristo* Pass at the head-waters of the Huerfano river. Its elevation probably exceeds that of the Sandia range, but it has not yet been instrumentally explored.

*Sierra Madre.*—The next great range is known as the *Sierra Madre*, and properly holds nearly the same relations to the Anahuachian chain as those just described. Its direction, however, is not so nearly meridional, its divergence towards the west being greater than the Sandia or Santa Fé mountains. This range has a very considerable extension to the north and south of the line. Moreover, it is the highest point reached by the survey, and is the great dividing ridge in that latitude between the waters of the two oceans. This summit of Campbell's Pass was found to be 7,750 feet in elevation, and *El Canino del Obispo*, by which the main party of the expedition crossed, has an altitude of 7,946 feet, and the adjoining peaks were considered to be from three to five thousand feet higher, and the general elevation of the highest points of the range to be not less than 12,000 feet. The same range, or its continuation northward, is known as the Chusca mountains, or *Sierra de Tunecha*, and was crossed by Lieutenant Simpson. The ascent to the summit of the pass (Campbell's Pass) from the Rio Grande, or from the Puerco, a few miles west, does not present any striking peculiarity. It is gentle and uniform, becoming more steep as the summit is approached, the grade changing from 23 to 35 feet per mile, while on the opposite or western side, the slope, though similar, has a grade of 19 feet to the mile, and is somewhat longer. In this case, the abrupt descent, if it can be called such, faces the east, the reverse of the conditions found in the Sandia range. It is most probable that this range does not extend far beyond Fort Defiance, but on the south it is probably prolonged to the Rio Grande, opposite the northern end of the Organ mountains.

*Aztec and Aquarius Ranges.*—These ranges are far to the westward of that just considered, and although having a general parallelism with it, have no connexion, and are united with a different group of mountains. The two ranges are also distinct; but being parallel, and near to each other, their mass constitutes one elevation, and appears as such upon the profile. This is true of the portion traversed by the trail; further south, the ranges are separated by a broad plain or valley. The Aztec mountains are the first great elevation west of San Francisco volcano, and from the summit of the pass by which they are crossed, the line descends to the base of Cactus Pass, in the Aquarius range, and after a short ascent, again descends to the valley of Hawilhamook, or Bill Williams' fork of the Colorado river. The elevation of Aztec Pass is 6,281 feet, and of Cactus Pass 5,182 feet. The Aztec range, south of the pass, reaches an elevation of about 8,000 feet, and, north of the pass, has a table-like summit, presenting a

[1] This elevation was determined trigonometrically by Lieutenant Ives. See Lieutenant Whipple's Report, Itinerary, p. 48.

gentle slope eastwardly. The Aquarius mountains are different in their topography, and are irregular and broken in outline. Their average elevation is probably near 6,000 feet. The trend or direction of the ridges is well marked; the Aztec range trends north 38° west, while the direction of the Aquarius range is more northerly, and thus the two ranges unite a short distance north of Cactus Pass.

*Cerbat Range.*—The Aquarius range is separated from the Cerbat by the valley of Bill Williams' fork, which flows southerly for a long distance between these two ranges. This valley was followed by the survey until it turned the southern point of the Cerbat range, and thus this elevation does not appear on the profile. The same valley was followed to its junction with the Colorado river, and there the valley of this stream was followed northward to a point nearly west of the Cactus Pass, or from the place where the valley of Bill Williams' fork was entered. The survey, in thus deflecting to the south, turned the southern end of a wide region which is traversed by mountain ranges. The breadth of this region measured southwest from Cactus Pass to the point where the Colorado was crossed, is about fifty-five miles. It is essential, in order to understand the connexion of the leading features of relief of the region with its geology, that the ranges or combination of ridges which traverse that space should be represented in their relations to the others. If the profile accompanying Lieutenant Whipple's report were intended to represent the relief of the region, the space which now exhibits a broad valley or depression occupied by Bill Williams' fork and the Colorado, should be filled by the outlines of one or more ranges equal in elevation and magnitude to those on either side. As we are without a profile of these ranges, determined by instrumental observations, their outlines and elevations can be only approximately given; but as the space which they occupy was seen from both sides, and the line of survey passed along and around their southern ends, the profile presented with this report and the estimates of altitude may be received with confidence.

According to Lieutenant Whipple, and Mr. Campbell, the civil engineer who accompanied him, the elevation of the Cerbat range is about 5,000 feet above the valley of Bill Williams' fork, and thus 6,500 feet above the sea. Its direction or trend is nearly north 40° west, or nearly northwest and southeast. It is probably composed of many ridges, with their trends oblique to the direction of the whole series, and they appear to abut upon and to cross the river at intervals, thus connecting with the Aquarius range on the other side. Their extent northwards is not known, but the chain probably does not retain its full altitude towards the Colorado river. It may, however, find a prolongation beyond this stream, and connect with the ridges which bound the Great Basin on the east. The great range of the Humboldt mountains is found on the lines of prolongation of the Cerbat and other adjoining ranges, if they are curved more towards the north so as to conform to the trend of the ranges in the southern part of the Basin.

*Ranges along the Colorado.*—Beyond the Cerbat range, to the west, a broad plain or slope was seen. This, in some directions, appeared to extend to the base of the ranges along the Colorado. Captain Sitgreaves, however, who crossed this space between the rivers a short distance further north, represents an intermediate range parallel with the others. I have, therefore, indicated one on the map and section. The ranges along the Colorado appear to be much broken, and some of the ridges trend obliquely across the river towards the northwest. At the point where the Colorado was crossed, a high range was visible in the north along the left bank of the stream, and the mountains on that side, at the crossing, appeared to be but the southern prolongation of this range. Captain Sitgreaves, who crossed this range further north, found it to consist of rugged ridges, and the highest part of his trail was elevated about 3,200 feet above the river. A short distance below the place of crossing, one of the ridges impinges on the river and appears to extend across it, shutting off the river towards the south, and thus forming the southern boundary of the alluvial valley or bottom-land of the Mojaves. Another range extends along the western or right bank of the stream, its southern termination being just north of the trail. This range forms a portion of the system which separates the Colorado from the Great Basin. The valley of the Mojaves, or *Ah-mok-āves*, as they are more

properly called, thus appears to be bounded by three mountainous ridges. According to Major George H. Thomas, U. S. A., who has been stationed among the Yuma Indians at the mouth of the Gila, the name Ah-mok-ăve signifies three mountains, and it probably refers to these ranges.[1]

*Ranges forming the eastern rim of the Great Basin—Pai-Ute Mountains.*—We now pass in our review to the ranges west of the Colorado, and within the limits of the State of California. On leaving the river, the route immediately ascends a succession of elevated ridges which, by their close proximity and combination, form one great swell of the surface dividing between the Colorado and Mojave rivers, or, we may say, between the Colorado and the southern end of the Great Basin. This line of elevation is highly composite; it is not one great mountain chain, but consists of many isolated peaks and short ranges joining and overlapping, and generally separated by narrow valleys or basins. In passing over this mass of mountains, the short ridges may be avoided by turning their points and keeping on the slopes; thus the profile along the trail does not show the real inequalities of the surface of the range. There, however, appear to be only three or four prominent ranges between the river and the Soda lake. The first, or that on the right bank of the Colorado, is called by Lieutenant Whipple the Havic-habi, or second mountain, while the others have not yet received any particular names, the whole group being called the Pai-Ute mountains.

The summit of these mountains where crossed by the survey was found to be about 4,900 feet above the Colorado, and 5,300 feet above the sea. The general elevation of the peaks does not much exceed this; they probably are not more than 600 feet higher. The two slopes of the range are very nearly equal in inclination, or rather, there is little difference shown by the profile. The direction or trend of this range is nearly north and south, although it is very probable that most of the ridges are northwest and southeast, trending obliquely to the main axis of elevation. The ridges along the Mojave river, according to my own observations, are nearly north and south, and this is the trend of the metamorphic schist and slates a short distance northeast from the first camping place on the river after leaving the Cajon Pass.

*Bernardino Sierra.*—From the valley of the Mojave river, or its termination in the Soda lake, at the western base of the range last described, the ascent of a long uniform slope leading to the summit of the last range crossed by the expedition is commenced. This borders or fronts the Pacific ocean, and is the southern boundary of the Basin. This is the chain for which I proposed the name *Bernardino Sierra* in order to distinguish between it and the Sierra Nevada and the Coast range, with which last it was in danger of being confounded for the want of any other and more appropriate name.[2] It forms the southern or southeastern prolongation of the great chain of the Sierra Nevada, with which it is connected at the Cañada de las Uvas near latitude 35°. Its direction is, however, very different; it deflects to the east and becomes nearly transverse to the Sierra Nevada and to the Coast mountains, and makes a like angle with the chain which forms the peninsula of California, and which commences at the peak of San Bernardino. This peak of San Bernardino is a lofty mountain, with a rounded, bare and hoary summit, rising high above the surrounding ridges, about one hundred miles west of the southern end of the Sierra Nevada. The mountains form a continuous chain from this peak westward towards Point Conception, but it

[1] On consultation with Captain Whipple on this subject, it became plain that this signification of the word is correct. It was soon seen that Ahmokave is nothing more than a combination of the two dissyllabic sounds which have been expressed by Captain Whipple in the words *Ha-mook* and *ha-bee;* the former signifying three, and the latter, mountains. The origin of the word Mojave or Mohave has long been in doubt; but the general substitution of the letter j, for the h, shows that it was regarded as Spanish. If we adhere to the most truthful expression of the two dissyllables or sounds, we should write Ha-mook-hä-bî instead of Mojave. As these three ranges are not known by any names, Captain Whipple proposes to call the principal range on the left bank, *Hamookhäbî*, the range crossing the stream on the south of the valley, (the Needles,) *Ascientic-häbî;* and that on the west, *Havìchäbî*. These names, although given provisionally, it being probable that other Indian names for them will be obtained, will be used in the succeeding descriptions.

[2] See Geological Report on the route surveyed in California by Lieutenant R. S. Williamson, and Proceedings of American Association, Providence, 1855, p. 223.

is broken at intervals by passes. The peak is regarded as between eight and nine thousand feet high; and being the highest point in that region, it was deemed appropriate to extend the name to the chain of which it forms such a prominent and well known feature.

The average elevation of the Bernardino Sierra may be regarded as 6,000 feet. The Cajon Pass, through which the exploration was made, has, according to the observations, an altitude of 4,689 feet; and according to those made by Lieutenant Williamson, in the month of November preceding, is 4,676 feet. The adjoining ridges on the west are probably 2,000 to 2,500 feet higher. The ascent from the Mojave river to the pass is very gradual and uniform, and presents a great contrast with the descent towards the Pacific, which is abrupt and short. On the Great Basin side, the gradual slope of the surface reaches to the very summit of the pass; while on the other, the upper edge of the gradual slope is 3,000 feet below it. From the western base of this chain, the line of the survey and the profile passes over a gently descending slope to the Pacific ocean, and there are no intervening ridges of any great magnitude.

*Mogoyon Sierra.*—This chain, although not traversed by the expedition, is nevertheless so near, and holds such an important relation to the line, that it is necessary to present a brief notice of it in connexion with those just described. After passing the Sierra Madre, the Sierra Mogoyon, or Sierra Blanca, were seen at the south, trending apparently a few degrees north of west and south of east. They were, to all appearance, continuous to a point nearly south of San Francisco volcano. Several streams take their rise in the range, and flow northward to the Colorado Chiquito. Mr. Marcou mentions this range particularly in his notes, and in his *Resumé*. The strata appeared to flank these mountains, and to dip away from them towards the north. According to the same authority, the direction of the range is "east east-south and west west-north." The apparent direction or trend is very different from that of the ranges crossed by the survey, and is similarly opposed to the direction of the mountain ranges south of them. This fact renders it somewhat questionable, whether the nearly east and west direction which was observed is not more apparent than real. The plotted notes and bearings to this range indicate that its direction is not so nearly east and west as was supposed, and show that the elevation probably extends northward as far as the volcano of San Francisco, which would thus appear to rise upon a continuation of the same elevated swell of the surface. The few notes and observations, also, go to show that the elevation at the volcano is formed, not by a ridge or line of sharp erupted rock, but by a swell of the underlying strata, producing an elevated table-land similar to that of the Aztec mountains.

This character of the surface is shown by the topography on Lieutenant Whipple's map. It will also be seen, by inspecting that map, that the Mogoyon mountains appear to extend in a curvilinear line southeasterly from the San Francisco volcano, and that the southeastern portion attains a nearly due east and west direction. The explorations a short distance south of this part of the range, on the Gila river, show that there the prevailing direction of the mountains is northwest and southeast. It is possible that this part of the chain consists of many parallel and short ranges, trending northwest and southeast, and which, by overlapping one beyond the other, produce the continuous appearance. This peculiarity is well seen in the Great Basin and along the eastern border of the Colorado desert, where isolated ridges seem to form continuous ranges. The direction which is apparent in this range is, however, very nearly that of the Bernardino Sierra, and the two chains are nearly upon the same parallel of latitude. The almost rectangular intersection of the Bernardino Sierra with other chains should prepare us for similar phenomena in other localities. I am, however, of the opinion that future exploration will show the composite character of the Mogoyon Sierra, and that it is formed by a series of ranges trending northwest and southeast, conformably to most of the ranges of that region.

*San Francisco Volcano.*—The description of this great elevation was not given in its geographical order among the mountain chains, as it is considered probable that it forms a local uplift, rather than a linear elevation. In the description of the Mogoyon Sierra we have seen that

this mountain appears to rise upon a great swell of the surface which has an extension towards the south, and yet is without the ridge-like character of a mountain chain. The line of the barometric profile passes along the southern base of the volcano and over the broad streams and fields of lava which have coursed down its sides and from its numerous secondary cones, until it appears as if the great mountain itself was formed by such accumulations. These accumulations of lava have doubtless modified the relief of the former surface to such an extent that it becomes visible in the profile, but the great swell or rise which is shown, is unquestionably over an extended uplift of the region, which, though possibly produced by the action of the volcano, is nevertheless independent of the great cone, which rises to an elevation of 4,673 feet above the surrounding region, and consequently to about 13,000 feet above the sea. With the exception of the Santa Fé mountains this is the highest summit in the vicinity of the 35th parallel. This mountain has a wide base, and does not consist of one single cone, but is flanked by a number of smaller craters or openings towards the east and south of the summit. Subordinate elevations, called Mount Kendrick and Mount Sitgreaves, adjoin it on the northwest.

## TABLE-LANDS, PLAINS, MOUNTAIN SLOPES, AND VALLEYS.

Having considered the dominant mountain chains which cross the line of survey, a glance must be taken of the valleys and plains by which they are separated and above which they rise.

The approach to the Santa Fé mountains from the Mississippi is by a gentle ascent from an elevation of 460 feet at Fort Smith to near 6,500 at the base of the mountains. To reach this elevation a horizontal distance of about eight hundred miles is traversed; and the rate of ascent being nearly uniform, or but slightly increasing with the altitude, the slope becomes imperceptible to the traveller, and the country over which he passes has the aspect of a wide plain. As the elevation is increased and the streams have worn deep valleys, the slope becomes a vast table-land. This is the character of the slope traversed by the expedition, and its uniformity is shown by the barometric profile taken along the valley of the Canadian and Washita rivers. If, however, we pass towards the mountains a short distance further south, or at a point where the plain has not been furrowed by streams, we shall probably find that the ascent becomes step-like and that a series of bluff ascents are reached, each one succeeded by a level area higher than the last. These sudden ascents, when compared with the whole elevation, are so slight that they become almost imperceptible when represented on a profile drawn to a scale equal for heights and distances. The most interesting modification to which this broad slope or table-land of the mountains has been subjected, is produced by the erosion of the streams, which have eaten out deep valleys, and have, as it were, "blocked out" vast areas of the surface. This slope, even along the Canadian, is characterized by the bluff-like margin of its highest levels, which mark the limits of the desert-plain known as *El Llano Estacado* or Staked Plain. These borders are not one continuous bluff, but are deeply indented and bordered by outlying hills, remnants of the plain from which they have been severed by the action of drainage water, and which are rapidly wearing away, so that the table-like summit will be reduced to a mere point, and the elevation become a conical hill.

The Llano has a wide extent in the latitude of the survey. It reaches from the Sandia mountains east about three hundred miles, being partly within the State of Texas, and terminating near longitude 101° 30′. It extends southerly towards the great bend of the Rio Grande, and was crossed by Captain Pope, in his survey along the 32d parallel. It also extends north of the Canadian, but its limits in this direction have not yet been explored. The line of the survey crosses a narrow part or projection of this vast plain between Camps 45 and 46; but the course of the exploration being in the valley of the stream, the uniform elevation of the surface of the Llano does not appear in the profile. For the purpose of giving a more striking view of the configuration of the plain, I have constructed the geological profile as if the line of observation had extended over its widest part. The elevation of the portion of the Llano crossed over was

found to be about 4,400 or 4,500 feet, the camp on the east side of the bluff being 4,128 feet, and on the west 4,207 feet. We may regard 4,500 feet as about the mean elevation of this great plain. The mean elevation further south, according to the measurements made under the direction of Captain Pope, along the route near the 32d parallel, is 4,500 feet;[1] but this result, although the same as we have deduced from Lieutenant Whipple's observations, is probably too high, for we have reason to believe that the Llano decreases in altitude towards the south. Captain Pope's observations were made by the theodolite, and the altitudes are possibly too high; the results obtained by the barometer are deemed the most reliable.

*Plain between the Sandia and Santa Fé mountains, and the Sierra Madre.*—This plain, or valley, between the mountains east of the Rio Grande, and the Sierra Madre on the west, has a width of nearly one hundred miles. The eastern side of the valley is traversed by the Rio Grande and the Puerco. The latter is a much smaller stream, but runs parallel with the first, and unites with it several miles below the line of survey. From the Puerco the ascent to the Sierra Madre is gradual, the grade being 23 feet to the mile. The surface of the plain is, therefore, not level, but has the character of a slope flanking the Sierra Madre, and is not unlike that east of the Santa Fé mountains. The topography of the plain is also similar; the streams cut grooves, or channels, below the general surface, and are bounded by bluff banks of horizontal strata. The barometric profile follows the course of the *Rio San José*, which, rising in the Sierra Madre, flows west to the Rio Puerco. It is interesting to note, that the long slope of this wide valley between the mountains is turned towards the east, and in this respect it resembles the slope from the Santa Fé mountains to the Mississippi. The average elevation of this gently ascending plain is about 6,000 feet, and it probably connects further north with the broad area of table-lands traversed by the tributaries of the Colorado river.

*Plain or table-land west of the Sierra Madre.*—After passing the range of the Sierra Madre, an immense expanse of table-land is spread out before the explorer. From this range to the volcanic cone of San Francisco, two hundred and fifty miles distant, there is not a single mountain ridge or sudden swell of the surface to break its monotony. It is a region of horizontally stratified rocks, cut and eroded by streams as on the eastern or Mississippi slope. The descent here, however, is towards the west, and is very gentle. The same or similar rock-formations are found on this side of the great dividing range, and in the same horizontal position: the topography is consequently similar. The erosions and bluffs produced by the head-waters and tributaries of the Canadian, on the elevated plateau of the Llano, find their counterpart on this side of the mountains in the Colorado Chiquito and its tributaries. As in approaching the mountains on the east, the survey followed the pathway thus cut out by the streams; so in descending on the west, the expedition followed similar paths, cut by the streams which flow into the Pacific. The extent of this wide area of table-land is not yet accurately known. It was seen stretching out indefinitely towards the north, and doubtless is continuous, and of the same character, as far as the head-waters of the Great Colorado, and Grand and Green rivers. The great cañon of the Colorado is also in this plain, and on the south it appears to extend to the base of the Mogoyon mountains. For a time after quitting the Sierra Madre, the line of survey passed over the upper strata of the plain; then reaching the waters of the Colorado Chiquito, this valley was followed to near the base of the volcano, where the valley was left, and the ascent of this elevation was commenced. Thus the barometric profile represents a continuous and nearly uniform descent westward for a distance of about two hundred miles. The slope of the surface on this western side of the Sierra Madre is, therefore, longer and more gradual than that on its eastern flank. The barometric profile in this case, as in the eastern slope, does not represent the stair-like descents from the higher levels of the plain to those below, for the simple reason that they do not appear in the valleys of the streams. In the profile constructed for the geology, however, this important topographical feature is represented. The lowest point of this slope reached

[1] See Report on the Geology of the route near the 32d parallel, p. 9, 4to. Washington: 1856.—[P. R. R. Ex. & Survey.]

by the survey is at the base of the volcano, where the valley of the Colorado Chiquito was left. The highest point on the level of the upper edge of the slope, a few miles west of the pass, is 7,400 feet. The mean altitude of the plateau may be considered as 6,000 feet, which is about that of the slope, or plain, between the Sierra Madre and the ranges on the east of the Rio Grande.

*Val del China.*—When compared with the vast region which has just been considered, this valley is of little importance. It is a narrow depression west of the volcanoes of San Francisco and Bill Williams' mountain, and serves to separate them and the Black Forest mountains from the Aztec range. The direction of the valley is nearly northwest and southeast, being parallel with the range on the west. The stream called Partridge creek, upon the map, flows through it towards the south, and unites with a tributary of the Gila river. The barometrical observations were commenced at the sources of this creek, and continued along its course until it was left to commence the ascent of the Aztec range. The lowest point reached was 4,867 feet, and the width of the depression is about eighty miles.

*Valley of Hawil-hamook, or Bill Williams' fork of the Colorado.*—The valleys west of San Francisco volcano are entirely different from the broad table-lands found between the ranges on the eastern side. They become more narrow and trough-like, the slopes on each side becoming more abrupt and decided. This valley is entered from Cactus Pass of the Aquarius mountains by a sharp and abrupt descent. The barometric profile presents the elevations along the course of the stream southward, but the profile presented as the basis of the geological section crosses the head-waters of the river, and thus the full depth of the valley reached by the survey is not represented. It is bounded on the west by the Cerbat range, with which it is parallel.

*Valley between the Cerbat range and the Colorado river.*—This depression was seen from the trail, but, as we have already explained, no observations for profile were made. The elevation of the region is approximately represented on the geological section, and its breadth is probably fifty miles. It probably corresponds in its general characters of surface to the slopes of the Great Basin presently to be described.

*Valley of the Colorado river.*—This is the deepest and most rugged valley crossed by the survey, and is the lowest point reached west of the valley of the Mississippi, and east of the Pacific slope. It is bounded on both sides by rugged and barren mountains rising in places directly from the stream, and in others leaving a narrow belt of low land or slopes at their bases. The elevation of the river where it was crossed is about 350 feet, and the valley of course increases in altitude towards the north.

*The Great Basin.*—On descending the western side of the Pai-Ute range west of the Colorado, the southern end of that vast region known as the Great Basin is reached. That this portion really belonged to the Basin, was determined by Lieutenant Williamson's explorations of the Mojave river, showing that it was not a tributary of the Colorado, as had been supposed, but that it became lost in the deep soil and sand of the lower part of the Basin. The general characteristics of the topography of the Basin may be enumerated in a few words. It consists of a combination of short ridges and ranges, isolated, but rising so closely together in places, that a series of small local basins is produced between their sides and ends. The general trend of these ranges is from north to south, so that they are ranged in parallel lines, or overlap one beyond another. It has generally been considered that the surface of the Great Basin was of nearly uniform elevation, and that it was like a plain or table-land. The point, however, reached by the survey, or the bed of the Soda lake, which is probably the end of the Mojave river, is very low, being only 1,116 feet above the sea, and very much lower than the average elevation of the surface of the Basin. It is indeed the lowest point of the Great Basin now known. From the Soda lake the valley or dry bed of the Mojave river furnished a gradual ascent until within twenty miles of the crest of the Bernardino Sierra, when the road leaves the river and commences the ascent of a gently rising slope, which terminates at the summit of the Cajon Pass. This slope may be regarded as a fair type of those which make up the wide

surface of the Basin, which is, in fact, but a combination of slopes flanking the ridges, producing by their intersection a series of basin-like depressions. The slope to the Mojave is perhaps unusually well defined and regular; but the same or a similar slope is found for the whole length of the southern end of the Basin, reaching from Bernardino mountain to the Sierra Nevada, and this last mentioned chain is flanked in a similar manner. The average inclination of these gradual descents is not over 50 feet to a mile. In passing either up or down the Mojave slope, the inclination of the surface is not very apparent, and becomes evident chiefly by the appearance of distant objects. When, however, the observer stands on a distant point and is able to view the surface at right angles to its direction of descent, the inclination is very apparent, and is so clearly defined and regular that it invites the use of the clinometer for its measurement.[1]

The surface of the Great Basin, unlike that of the great plain between the Sierra Madre and the San Francisco volcano, is not formed of horizontal strata, which leave table-like areas where cut by rivers or exposed to denudation. The materials composing the surface appear to be derived from the adjoining ridges and mountains, and are laid down around them with inclined surfaces, the coarser parts being nearest the elevations, while the finer materials are transported further out, and the sloping character of the surface is thus produced.

*Plain and valleys bordering the Pacific.*—At the foot of the Cajon Pass, on the west, the country stretches out with a gradual descent to the Pacific. The distance from the Pass to the beach at the nearest point is about fifty miles, and by way of the trail to Los Angeles and San Pedro is over eighty. Although this region is traversed by many streams, and there are local depressions and elevations of slight extent, the whole, for convenience of description, may be considered as a continuous and nearly unbroken slope, its upper margin being at an elevation of about 1,300 feet, its foot at the sea being on an average seventy miles distant.

[1] For further observations on the configuration of the Basin and the peculiarities of the slopes, see the author's report on the geology of the route in California, surveyed by Lieutenant R. S. Williamson.

# CHAPTER II.

## OBSERVATIONS ON THE GEOLOGY OF THE ROUTE, FROM THE MISSISSIPPI RIVER TO THE BASE OF THE SANTA FÉ AND ALBUQUERQUE MOUNTAINS.

ALLUVIAL FORMATION OF THE MISSISSIPPI AND ARKANSAS.—BLUFFS.—METAMORPHIC ROCKS AT LITTLE ROCK.—TERTIARY FOSSILS.—CARBONIFEROUS STRATA.—PETIT JEAN MOUNTAIN.—DARDANELLE ROCK.—TRAP DIKES.—BITUMINOUS COAL.—FORT SMITH —POTEAU MOUNTAINS AND SUGAR-LOAF.— COAL.—CARBONIFEROUS AROUND FORT SMITH.—COAL IN ARKANSAS.—VIEW NEAR FORT COFFEE.—DISTURBANCES OF THE CARBONIFEROUS STRATA.—SANS BOIS RANGE.—COAL AT RING'S PLANTATION.—COAL-PLANTS FOSSIL.—DELAWARE MOUNTAIN.—CARBONIFEROUS LIMESTONE IN RIDGES.—PROXIMITY OF OUTCROPS OF GRANITE.—DELAWARE MOUNTAIN TO ANTELOPE HILLS.—GYPSUM FORMATION —LITHOLOGICAL CHARACTERS.—DENUDATION MOUNTAIN.—ROCK MARY AND OTHER MOUNDS.—THEIR ORIGIN EXPLAINED —GYPSUM IN THICK BEDS.—DOLOMITE.—DISTURBED STRATA.—CRETACEOUS FORMATIONS AND FOSSILS.—ACCUMULATIONS OF PEBBLES; ALLUVIUM.—ANTELOPE HILLS.—WHITE SANDSTONE IN BLUFFS ALONG THE ROUTE.—TABLE HILL.—UPRAISED SANDSTONE NEAR THE LINE.—BLUFF FORMATION OR LOESS.—LLANO ESTACADO.—ITS VERTICAL BLUFFS.—ENCAMPMENT CREEK.—SECTIONS.—TUCUMCARI HILL.—PYRAMID MOUND.—COLORED SECTION.—FOSSILS.—PLAZA LARGA.—DEGRADATION OF THE STRATA.—CRETACEOUS FOSSILS.—ANTON CHICO.—CAÑON BLANCO AND CUESTA.—GALISTEO.—TRAP DIKE AND VOLCANOES.—GRANITE.

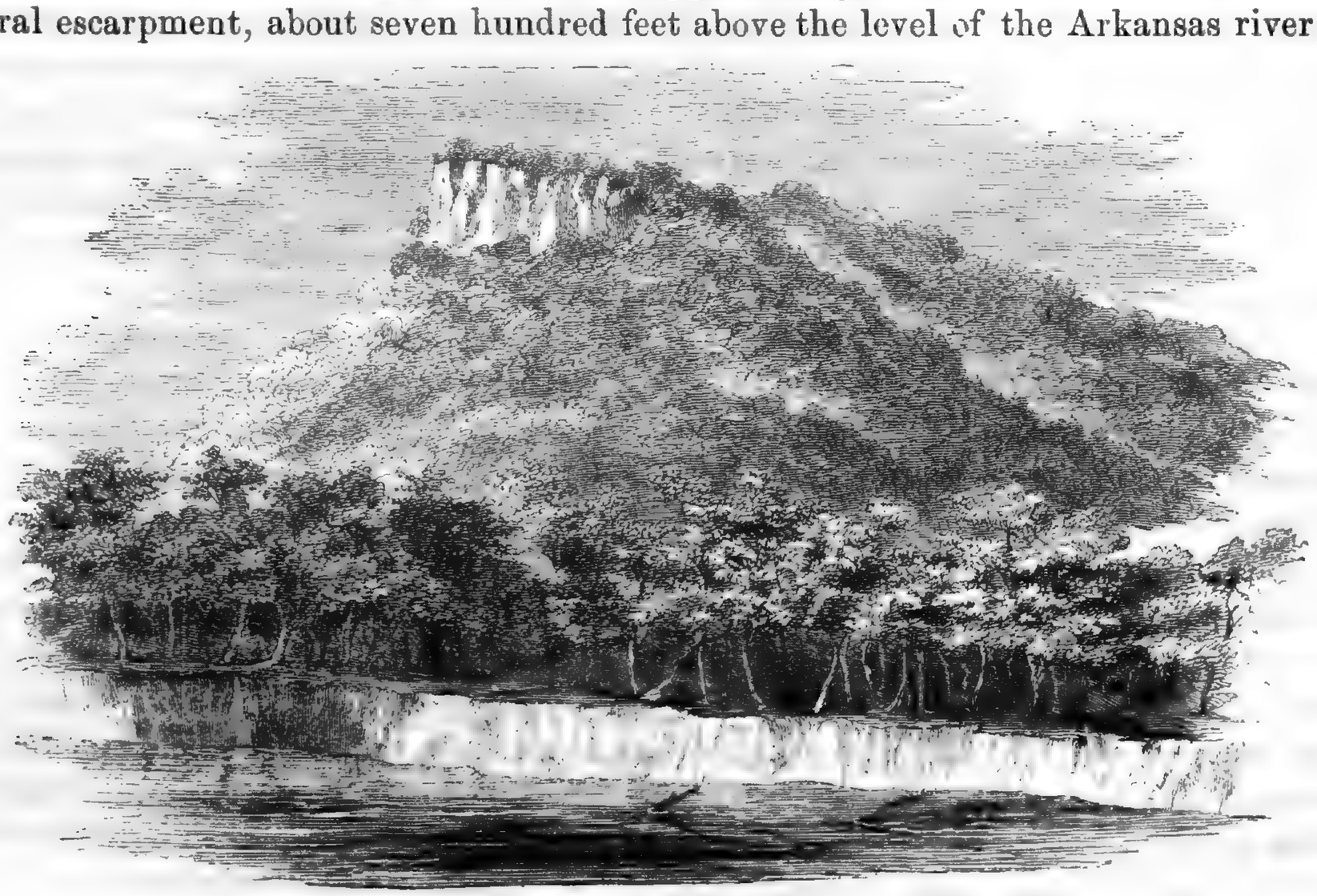
### I. MISSISSIPPI RIVER TO DELAWARE MOUNTAIN.

As the operations of the survey did not commence until the arrival at Fort Smith, there are comparatively few observations upon the topography or formation of the country along the valley of the Arkansas up to that point. The geology, however, of the starting point of our descriptions is very simple. We find along the Mississippi a broad area of alluvium, the surface of which is but little elevated above the stream. It is a broad alluvial plain, with nothing to break its monotony, if we except the numerous creeks with tortuous courses, bayous and elongated and curved lakes, horse-shoe like, which mark the former channel of the river, and testify to the ceaseless changes which are progressing from day to day along its whole course. A great portion of the plain consists of low swamps, which become flooded when the rivers are swollen, and then receive a fresh deposite of fine earth or clay. This alluvial formation borders the Arkansas on both sides up to Little Rock, where the first exposure of older and harder formations was found. A portion of the alluvial formation, however, is undoubtedly of much greater antiquity than the rest, and was formed when the general surface of the country was less elevated than it now is. This older alluvium forms high banks or bluffs which sometimes abut upon the stream, but more frequently rise above the level of the plain several miles back from the river. They are familiarly known as the *Bluffs*, and have been recognised by Sir Charles Lyell as the probable equivalent of the formation known as *Loess* along the Rhine. According to Mr. Marcou, the alluvium along the Arkansas resembles that of the Mississippi. Its color is reddish-yellow, and it is partly formed of a layer of yellowish sand which is easily washed away by the river from the more clayey portions above, and the course of the stream is thus rendered very crooked. These deposites are very fine, and no pebbles were seen until within one mile of Little Rock.

*Little Rock.*—The outcrop of rocks at this place forms a ridge raised about fifty feet above the stream. According to Mr. Marcou, the rock is of a black color, schistose, metamorphic, and much contorted. He also mentions sandstone and quartz veins, having a direction E.E.N. and W.W.S. (See notes.) This is, probably, the trend of the ridge. Similar

metamorphic slates were seen two and a half miles above the first outcrop, but their height above the river does not exceed ten to thirty feet; and, again, four miles above, the slates were seen supporting strata of sandstone of carboniferous age in an unconformable position. Thus, as Mr. Marcou observes, the uplift of the metamorphic schists appears to have been anterior to the deposition of the sandstone. I find on the maps of Arkansas a range of mountains indicated directly west of Little Rock, called the Washita mountains. They have an east and west trend, and are parallel with the line of elevations upon which Little Jean mountain is situated, and which will be presently referred to. It is probable, therefore, that the ridge of Little Rock is a continuation of this east and west line of elevation. Mr. Marcou (see notes) states, also, that a line of hills commence at that point, but they do not reach an elevation of more than 100 feet.

The formations of Little Rock were examined by Featherstonhaugh as early as 1834, and were described by him in his report as "grauwacke," and he considered it as the equivalent of that of the English geologists. He observes: "The grauwacke slate here is highly inclined, and, dipping S. by E., is traversed by very broad bands of quartz; no red sandstone is superimposed upon it at the river, but at a very limited locality on the bank I found a calcareous deposite containing marine fossil shells belonging to the Tertiary beds."[1] These fossils are said to be of the genera *Ostrea*, *Turritella*, *Calyptrea*, and *Cerithium*. The same deposite is said to be found three miles farther west in considerable quantities, and it was quarried there for making lime. The same writer observes, respecting the "old-red sandstone," (probably the Carboniferous,) that it forms ridges at a distance of about five miles from the town, which trend about east and west. "The Mammelle mountain, distant about eighteen miles from Little Rock, is an outlier of the same formation." "The southwest aspect of the cone is very imposing, and bears a strong resemblance to a pyramid; on approaching it, the whole façade presented a lofty mural escarpment, about seven hundred feet above the level of the Arkansas river, according to the computation I was able to make, with a broad talus at the bottom." "The southwest edge of this pyramid showed the truncated beds of the rock standing at an elevation of 75°, and in some places they were vertical."[2]



PETIT JEAN MOUNTAIN.

These elevated bluffs of the carboniferous formation are numerous in that region. One of the

[1] Report on the elevated country between the Missouri and Red rivers, pp. 59, 60.
[2] Ibid., p. 60.

most interesting, and which occurs on the line of the survey, is the elevation called Petit Jean mountain, which rises from the south bank of the Arkansas, above Little Rock, to the height of about 950 feet. This mountain, as will be seen by the accompanying sketch, presents a mural face at its summit, formed by the denuded edges of nearly horizontal strata. It is well wooded, and the alluvial deposites of the river are seen at its base. This elevation appears to be in the line of trend of mountains bearing the same name, traversing Scott and Yell counties, several miles west. Further west the same line of elevation is called *Poteau* mountains, and other but parallel ridges are known as Dutch Creek mountains and *La Fourche le Fave mountains*, their names being taken from the creeks which run parallel with them.

Beyond Petit Jean, another bluff called Dardanelle Rock faces the river; this, according to Lieutenant Whipple, is apparently 150 feet high;[1] and still beyond it, an elevation called Magazine mountain rises within three or four miles of the river to the height of about 1,100 feet. Mr. Marcou states, (see notes June 19th,) that these carboniferous hills are sometimes traversed by injections of trap in the form of dykes.

This carboniferous formation is found to extend uninterruptedly along the southern bank of the river, separated from it by a border of alluvium for the whole distance from the Petit Jean mountain to Fort Smith, and beyond it, to Delaware mountain, a distance of two hundred and seventy miles above. The same formations are found on the north side of the stream. They are mentioned near Ozark by Mr. Marcou, and again at Van Buren, opposite Fort Smith. The region drained by Piney river, a stream entering the Arkansas from the north, and a short distance above Dardanelle rock, abounds in bituminous coal.[2] Coal is also found at Little Jean mountain, and at many points above, on the south side of the river. The coal of Piney river, according to Lieutenant Whipple, is bituminous, and burns with a clear flame, and with little residuum. It is easily obtained, and is used in blacksmith shops, in grates, and by steamboats of that region.

*Fort Smith.*—Fort Smith, according to Mr. Marcou, is located upon the alluvium of the Arkansas. The hills of carboniferous sandstone, however, come very near to the river at that point, and Lieutenant Whipple states that the "hill which forms the basis of the fort is of a dark-gray micaceous sandstone in horizontal laminæ, and rises about thirty feet above the water. The river Poteau enters the Arkansas just above the fort, and at two or three hundred yards from its mouth, at the landing of the ferry-boat, we find a cliff of carboniferous sandstone, with beds of marly shales of a blackish color in the lower portions. (See translation of Mr. Marcou's notes, June 19.) The Poteau mountains are found directly south of the fort and several miles distant. Just north of them, and nearer the fort, there is an isolated mountain called "Sugar-Loaf," nearly two thousand feet high, and which consists entirely of the coal-measures and contains several beds of coal. (Notes, June 19.) Mr. Marcou also states that a bed of bituminous coal, twelve feet thick, is found twelve miles south of the fort.

The formations at Van Buren, nearly opposite Fort Smith, on the north side of the river, are sandstones of carboniferous age, and Mr. Marcou places them in the lower division. This region has been traversed by Dr. George G. Shumard, who accompanied Captain R. B. Marcy in his exploration of Red river, and made observations on the geology of the country. He states that the carboniferous sandstone is the prevailing rock between Fort Smith and Fort Belknap. It extends northward from Fort Smith into Arkansas, and in Washington, Crawford, and Sebastian counties is found resting upon beds of dark-gray and bluish-gray limestone. This limestone is said to form, with few exceptions, the surface rock in Washington county. It is charged with fossils, "and, in many places, beds of considerable thickness are almost entirely composed of crinoidea." "The following are the most abundant and characteristic species: *Archimedipora Archimedes, Agassizocrinus dactyliformis, Pentatematites sulcatus, Productus cora, P. punctatus, P. costatus, Terebratula subtilita, and Terebratula Marcyi.*"[3]

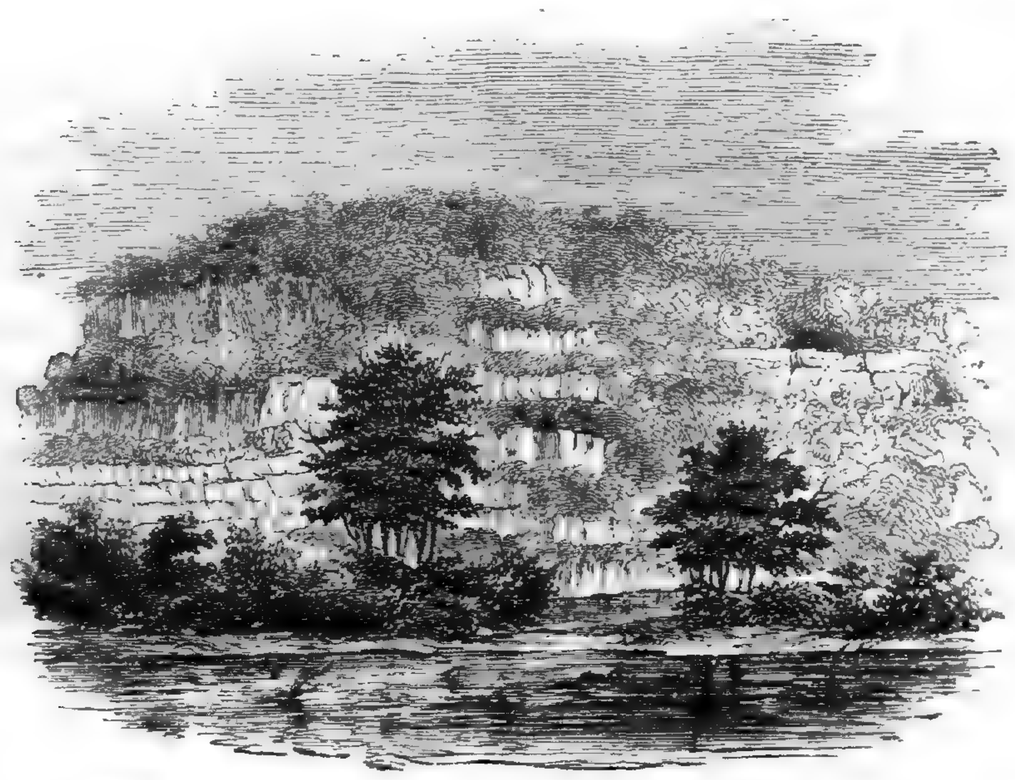
[1] Report in 8vo., p. 12. For a sketch of this elevation see Chapter VI.

[2] Report of Lieutenant Whipple, in 8vo., 1854, p. 12.

[3] Marcy's report on Red river of Louisiana. Remarks on the Geology, by Dr. G. C. Shumard, pp. 179, 180.

This limestone dips beneath the sandstone towards the south, and the sandstone forms hills "rising sometimes to the altitude of a thousand feet above the adjacent streams." "The sandstone is often highly ferruginous, and varies in color from a light gray to dark brown. It exists in heavy massive beds, made up of coarse quartzose grains, with intercalations of finer-grained sandstone, occasionally beautifully ripple-marked. It corresponds in its lithological features with that forming the Ozark range of mountains."[1] Dr. Shumard observes, respecting coal in these strata, "that bituminous coal exists in almost inexhaustible quantities throughout the county—Sebastian. The seams vary in thickness from a few inches to seven feet, and they lie in such a manner that they can be wrought easily."

*Fort Smith to Delaware Mountain.*—With the exception of a short distance from Fort Smith, where the line of survey passes over the alluvial deposites of the river, the route as far as Delaware mountain is constantly upon the sandstones and shales of the carboniferous formation, which, however, in the valleys are obscured or covered by recent alluvial or Tertiary deposites. These carboniferous strata are found rising into hills along the route, and frequently abut upon the river, and are worn away into bluffs, which disclose the lithological characters of the beds and their horizontal stratification. Near Fort Coffee the strata are very regular and rise from the stream stair-like, each terrace being covered with foliage.



STRATA OF CARBONIFEROUS SANDSTONE NEAR FORT COFFEE.

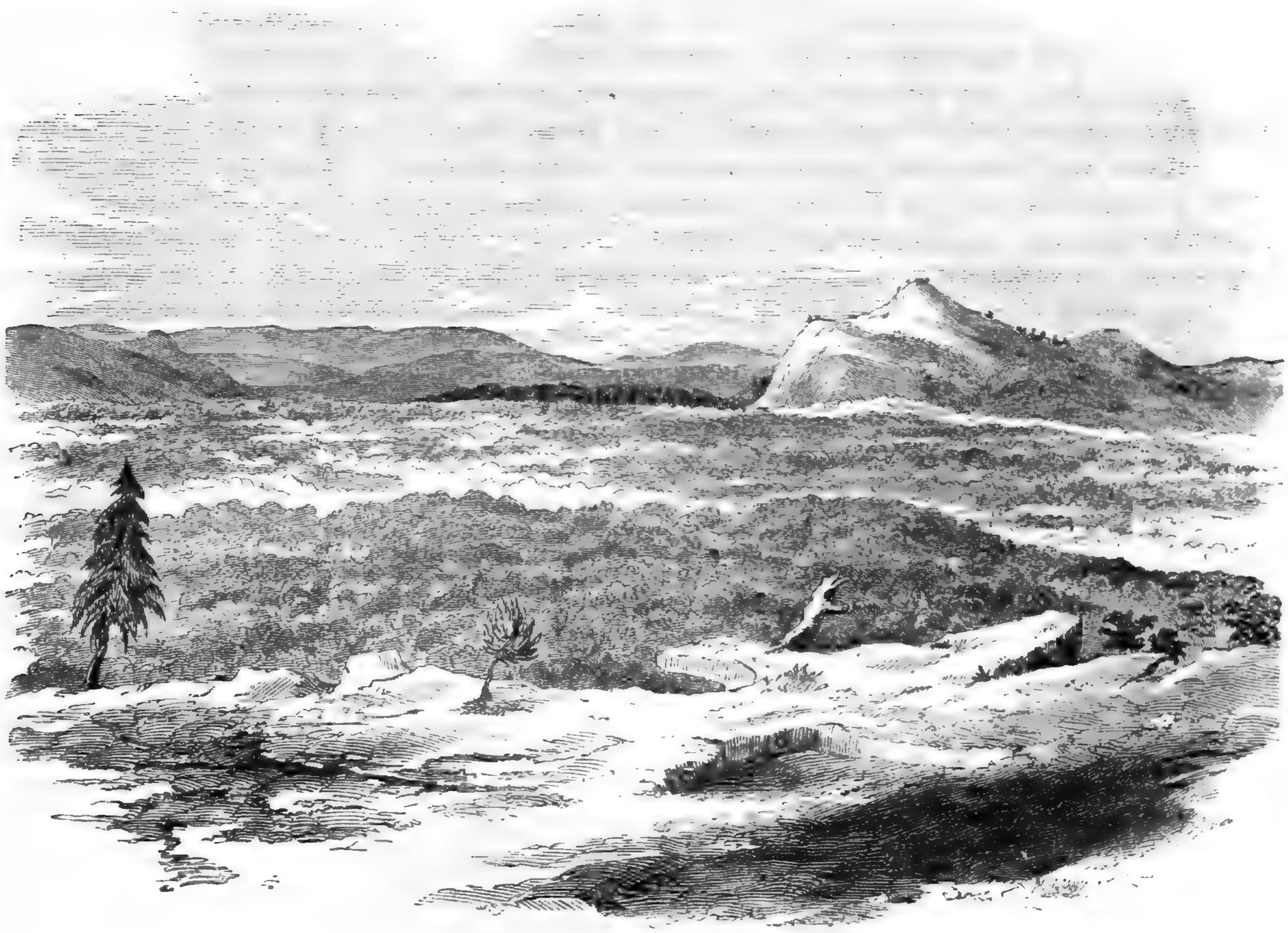
The strata, however, do not rest horizontally for the whole distance under consideration, but are disturbed at several points, the inclination not being found to exceed 20° to 30°. This amount of inclination was observed at one locality only, between Camps No. 8 and No. 9, and directly north of the Sans Bois mountains. On Gaines' creek the inclination is 15°; between Camps 11 and 12 it is from 10° to 15°, N.E. and S.W.; between 14 and 15, 15°, E.E.S.; and between camps 15 and 16, 15°, W.W.S. (See Mr. Marcou's notes.) These are all slight inclinations, and do not indicate a very violent disturbance of the beds. The prevailing trend, according to Mr. Marcou's observations, appears to be a little north of east and south of west, corresponding with the trend of the Petit Jean and Poteau mountains.

These mountains of stratified sandstone and shale constitute the most prominent feature of that region, where broad prairies or heavily-timbered alluvial plains predominate.

The *Sans Bois* mountains rise to a height of about 2,000 feet, above a heavily-timbered plain; and, as their name indicates, are nearly or quite without trees. Their characteristics and general appearance are shown in the accompanying sketch, by Mr. Möllhausen, taken from the top of an elevation at Pine Grove, near Camp 6. The whole valley between the point of view and the mountains is densely timbered.

[1] Shumard, in Marcy's Report, p. 180.

Lieutenant Simpson, who traversed this region along the Canadian in 1849, makes the following general observations on its surface: "Beginning at Fort Smith, a mixed country, well watered, composed of wooded heights, wooded plains, and wooded ridges, intermingled with



SANS BOIS MOUNTAINS

prairies, some gently rolling some more highly, some of small extent some of large, and all generally elongated in the direction of the route and lying between encroaching and parallelly disposed secondary mountain heights, characterizes the country as far as Delaware mount, a distance of one hundred and forty-six miles."[1]

Coal of good quality appears to be abundant over this section of the line. At Mr. Ring's plantation, near Camp 1, a well forty feet in depth crossed a coal-bed three feet thick. (See notes.) Coal is also found cropping out at several points along the Sans Bois and Coal creeks. Lieutenant Simpson mentions its occurrence on Coal creek, to which it owes its name.[2] Near Camp 7 it was found in horizontal beds. Characteristic coal-plants, fossilized, were found in the beds of the brooks, such as *Equisetum giganteum*, (August 2,) *Sigillaria*, (July 19,) and again (August 7) between Camps 12 and 13. This last specimen is in the collection, No. 99, and is described subsequently.

On approaching Delaware mountain Mr. Marcou found, in the bed of Little river, sandstones filled with "fossils of the lower carboniferous, such as *Bellerophon*, *Crinoids*, *Productus*, and bivalves." (Notes, August 13.) Similar fossils were found in the creek at Camp No. 17, and hence he concludes that the region of the coal-measures gives place to that of the Lower Carboniferous between Shawnee valley and Shawnee village.

[1] Report of Lieutenant Simpson, of the route from Fort Smith to Santa Fé, page 4.
[2] Ibid.

*Delaware Mountain.*—The elevation called Delaware Mount appears to constitute a dividing line between the wooded prairies of the coal formation and a treeless, undulating prairie beyond. The only information respecting the geological character of this mountain is given by Mr. Marcou, and the following description is gleaned from his notes.

The mountain is almost wholly formed of limestone, with alternations of sandstone. This limestone has a whitish-gray color; it is very hard, and breaks with a subconchoidal fracture; it is very regularly stratified, and separates readily when exposed to the air. It appears to be the Mountain limestone or Lower Carboniferous, and contains stalks of *crinoids*, and a bed of sandstone contains *Terebratula* and *Polypi*. These strata are not horizontal; they are upheaved, and at Camp No. 19 they dip towards the north. The direction of the mount is said to be S.S.W., or 30° west, to N.N.E.; whether this is the direction of the ridge or the trend of the strata does not clearly appear, nor is the angle of dip stated. This limestone formation appears to have been continuous for some distance beyond Camp No. 19, for hills of it with some sandstone beds were constantly passed, (August 16.) The whole series is said to have a thickness of from five to six hundred feet. I learn from Captain R. B. Marcy that the mountains or ridge directly south of Fort Arbuckle, and which is southwest of Delaware mount, is formed of thickly-bedded limestone.[1] Similar limestone is found a short distance further east, on the opposite side of the Washita river, and directly south of Delaware mountain. Still further east is another outcrop of limestone, which is mentioned by Dr. George G. Shumard, and is represented upon a geological section accompanying Marcy's report. By the assistance o Captain Marcy, I have been enabled to locate this outcrop of limestone on the map. These outcrops of limestone are disposed in nearly a straight line, trending east and west, and parallel with the several ranges of hills south of the Canadian, which have already been mentioned. Some of these ranges, or others just south of them, are called upon Captain Marcy's map, *Kimishi* and *Seven Devils mountains*. The former name and locality is already familiar to most geologists as the locality from which the Cretaceous fossil called *Gryphea Pitcheri* by Dr. Morton was first obtained. These ranges, prolonged in the direction of their trend, would reach the granitic and metamorphic region of the hot springs of Arkansas, and if the line deflected but a few degrees to the north of east would intersect Little Rock.

Dr. Shumard found an outcrop of granite between the limestone last referred to and Fort Washita. This, I learn from Captain Marcy, is about two miles south of Boggy Depot. He also informs me that large boulders or masses of granite are found on the banks and in the bed of the Washita, just above and below the old Caddo villages, a point directly west of the granite near Boggy Depot. From these facts I conclude that there is an axis of granite and metamorphic rocks trending nearly parallel with the course of the Canadian and Red rivers, or a few degrees north of east and south of west. From this axis the carboniferous limestone and coal measures dip each way at small angles of inclination. Delaware mountain may be regarded as one of the ridges of this line of upheaval. The trends and dips of the strata of the carboniferous sandstone between Delaware mount and Fort Smith, as observed by Mr. Marcou, conform to the direction of this line of upheaval.

Mr. Marcou several times mentions finding strata of brecciated sandstone, which I conclude, from his descriptions, are of comparatively recent origin. Near Camp No. 16 he found a bed of brecciated sandstone containing little angular pebbles of white clay and limestone. Again, in the creeks between Camps 17 and 18, beds of sandstone with siliceous and ferruginous breccias or conglomerates of white sandstone, without fossils, were seen. Half-way between Camps 19 and 20 a calcareous conglomerate, like *nagleflüe*, was passed. This appeared to have been formed from the wrecks of the surrounding rocks.

In these several localities the strata were without fossils, and thus we are without the means of determining their age.

[1] Marcy's Report, page 180.

## II. FROM DELAWARE MOUNTAIN TO THE ANTELOPE HILLS.

After passing Delaware mount, the hills of sandstone and shales, which, before reaching the mountains, were always in view underfoot or at the south, are no longer visible; and the country becomes an undulating plain, covered with grass. Here the vast deposites of red sandstones, red clays, and marls containing beds of gypsum, commence and extend without interruption or change over the entire section under consideration, and beyond to the mountains of Santa Fé.

Mr. Marcou considers this formation to be the equivalent of the formation known as the new-red sandstone, or Trias, and has so named and described it in his notes and Resumé. The same formation was traversed by Captain Marcy in his exploration of Red river; and Dr. Hitchcock, in describing his specimens and reporting on the geology of his route, does not assign its age, but calls it the "gypsum formation;" and I shall frequently use this name in the following descriptions.

As the mineral characters and appearance of the formation, as it was seen during each day's march, are very minutely given by Mr. Marcou in his notes, I refer to them for the details; but present here the description of some of the most interesting points along the line where the characters of the formation are well represented.

Immediately after leaving Delaware mountain, Mr. Marcou mentions passing hard, blue clays and fragments of gypsum. Between Camps No. 20 and No. 21, blue clays, overlying gypsum, and a coarse-grained and feldspathic sandstone, were traversed; and between Camps 21 and 22, blue clays overlying red sandy clay, and white shales, were seen. These strata were horizontal. Between Camps 22 and 23, red clays were found, overlaid by a sandy, red brecciated limestone, passing into a reddish grey sandstone; the strata dipping to the west-southwest at an angle of from five to ten degrees. At Camp 23, red sandstones, alternating with grey, were found. Fragments of gypsum became abundant beyond Camp 26.

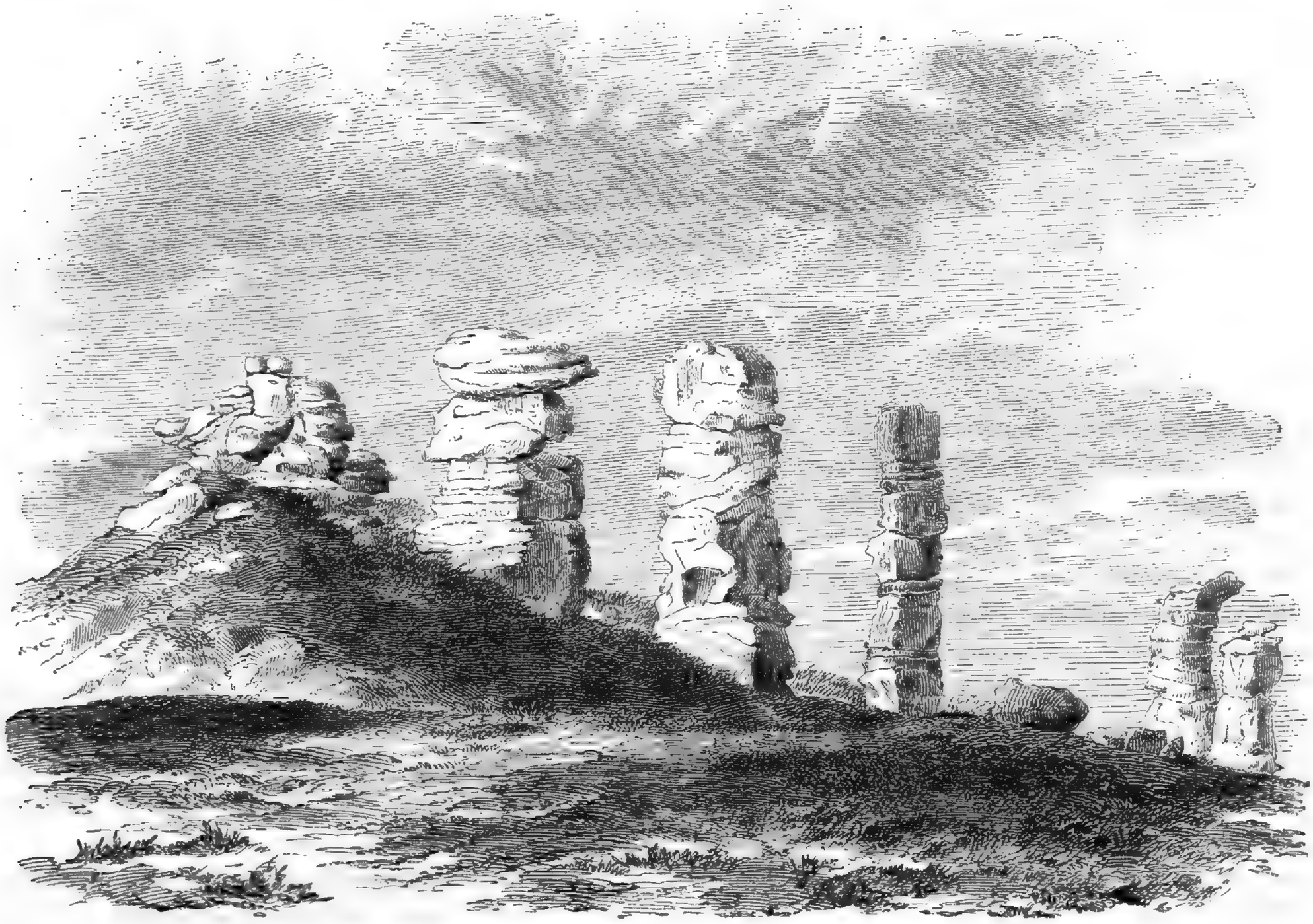
*Mounds and columns of sandstone.*—Denudation mountain, at Camp 29, is formed of horizontal strata, and results from the washing away of the surrounding country.

Rock Mary is of similar origin. This a well-known land-mark, and is a striking and interesting object to the traveller on the monotonous plains. Rock Mary owes its name to Lieutenant Simpson, who describes it in his report of 1850. He remarks: "The rock is situated solitarily in a prairie plain; its height some sixty feet, its base some two hundred feet in diameter. In form it is like a pound-cake well puffed up, and partially broken at its centre. Two turret-like projections are seen protruding from its top. In substance it is an unstratified sandstone, of a red color. In surface it is spirally corrugated, and in places somewhat gnarled, owing to the degradation caused by atmospheric and aqueous agents. During the latter part of our journey a number of these hills have been seen. Besides the one just mentioned, I ascended two others, one of them being about one hundred feet high. These two last have calcareous rock in association with red sandstone. On one of these, of abutment shape, I noticed amorphous red sandstone to be the basis rock; next in the ascending series, five feet of red shale, purely schistose; next, three feet of arenaceous limestone; and lastly, crowning the other formations, calcareous rock of massive character, containing crystals of carbonate of lime."[1]

Mr. Marcou mentions eight or ten great cones truncated at the summit, and from 60 to 100 feet high. The strata are horizontal, and thick strata of red sandstone predominate, with alternations of red shales more argillaceous and separating in thin leaves. Two or three beds of a siliceous limestone occur at the upper part, of a whitish grey color, very hard, and which has preserved the lower strata from denudation, forming natural mounds. This is a translation of Mr. Marcou's description.

[1] Simpson's report of the route from Fort Smith to Santa Fé, p. 8.

A group of these remnants of a higher plain, forming a colonnade of sandstone so regular that it seemed a work of art, was sketched by Mr. Möllhausen, and I present it as a fine example of the effects of degradation of horizontal strata.



COLUMNS OF SANDSTONE, SOUTH BANK OF THE CANADIAN RIVER.

The geologist does not need to be informed of the origin of these singular mounds and columns of rock, but as they are objects of wonder to many travellers and excite many fanciful speculations, the following explanation is presented: These mounds were originally connected together by a continuation of their horizontal strata so as to form a plain or table-land. By the action of streams and drainage water, deep ravines have been excavated in various directions, and a large part of the plain has been washed away, leaving a remnant of the strata, the flat-topped mounds or columns here and there.

*Gypsum.*—At Camp No. 30 a bed of white gypsum, twenty-five feet thick, was found in the bank of the creek. It rested on sandstone and shales, and above it a bed of dolomite was seen. The following is the succession of the beds, with the thickness of the exposures:

| | | |
|---|---|---|
| Argillaceous dolomite | 6 | feet. |
| White gypsum | 25 | " |
| Sandstone and argillaceous shales and red clay | 10 | " |

Beyond this point, beds of gypsum 25 to 30 feet thick were found interstratified with sandstone. The bed exposed in the section dips to the north at an angle of 15° near Camp 31. This region in the vicinity of Camps 30 and 31 appears to have been exceedingly rich in gypsum. The majority of the specimens in the collection are from this vicinity—from Gypsum and Comet creeks. These specimens are both red and white. See catalogue and descriptions Nos. 71 and 74 to 81.

Gypsum was again found in quantity between Camps 33 and 34. It is white and rose-

colored, and the beds are from one to twenty feet thick. A thin argillaceous dolomite is found below them. Thus it is seen that the strata along this part of the route are mainly composed of marls and sandstones of various colors—the red predominating—and of intercalated gypsum with beds of argillaceous dolomite. The latter are, however, quite thin, the bed mentioned in the section being only six feet thick. These strata are in the main horizontal, but at some localities have inclinations of from 10° to 15°, the line of trend being nearly east and west. This angle of dip corresponds with those observed in the sandstones east of Delaware mountain, and it is probable that they may be referred to the same line or axis of elevation. Upraised sandstone strata dipping at an angle of 30° to 40° were seen by Dr. Shumard several miles further west of these localities. It should also be observed that the Witchita mountains, which are composed of granite and greenstone, rise about forty miles southwest of Camp 31.

Under date of September 1st, we find in Mr. Marcou's notes the following record: "About two miles southwest of Camp No. 31 we find at the summit, and sometimes half way up the hills of red sandstone and clays, three or four broken beds and crinoids [?] disseminated here and there as if the ruins were formed of a lumachelle limestone of Neocomian age. This lumachelle is formed by the fragments of *Ostrea aquila* or *Couloni*, or a variety, for it is smaller." "It is possible to gather a quantity of this ostrea in a good state of preservation. I found also many small shells of *Pecten quinque costatus* and a debris of *Terebratula*." "Before coming to the lumachelle, which is in contact with the red argillaceous sandstone of the Trias, there is a greyish white calcareous sandstone, which passes to a white limestone slightly oolitic ——— [?] then the lumachelle of ostrea." "This bed of transition is only one foot thick; the four beds of *lumachelle* are two feet." In the Resumé Mr. Marcou describes the formation as follows: "I have mentioned two points between Topofki creek and Anton Chico, where the Triassic rocks are covered by more modern formations; the first of these points is upon one of the tributaries of the Washita river, near our Camp No. 31, where, upon the heights, are found the remains of beds of a limestone filled with shells, which I connect with the Neocomian of Europe, or, in other words, with the lower division of the Cretaceous rocks. This limestone is only five feet thick; it is of a whitish grey color, containing an immense quantity of *ostracea*, which I consider (provisionally) as the *Exogyra ponderosa*, Roemer; having the closest analogy with the *Exogyra* of the *Neocomian* of the environs of Neuchatel."

The only representative of this formation which I find in the collection, is the well known Cretaceous fossil *Gryphea Pitcheri*, No. 134 of the catalogue. This, indeed, is the only fossil I find in the collection brought from this section of the route. The observations in regard to the extent of this deposite laterally are not very definite. In the Resumé, Mr. Marcou states, that it "has been almost wholly destroyed and carried away by denudations, for it is only found on the summits of the hills, resembling the remains of ancient buildings; it occupies actually only the width of three or four miles." Captain Marcy, who passed over this region in 1849, mentions a "formation of gypsum and blue limestone ledges, in which he discovered petrifactions of oysters and muscles."[1] This is probably the same deposite, or a continuation of that seen by Mr. Marcou. It was between the Washita and Canadian rivers, near the sources of the former.

Lieutenant Simpson observes, respecting this region, that up to a point "within twenty miles of the Antelope hills, the country is richly characterized by the gypsum formation; the evidences of which appear in outcrops all around. This mineral can here be found in almost every form—earthy, fibrous, selenitic, and massive; and it is doubtless owing to it that the water of the region co-extensive with it is in many places so unpalatable and nauseous."[2]

*Alluvial deposites.*—Mr. Marcou frequently refers to accumulations of round pebbles, which he calls alluvium, found along the route, and, as I understand by his notes, above the beds of the creeks. Between Camps 20 and 21, this "alluvium" was formed of quartz pebbles the size of a pigeon's egg. Between Camps 25 and 26, pebbles of quartz, trap, agate, and jasper were

[1] Report on the route from Fort Smith to Santa Fé, p. 179.
[2] Report on the route to Santa Fé, p. 8.

found mingled with sand, varying from the size of a nut to that of one's fist, and all were much rounded and water-worn.

This deposite is from one to one and a half feet thick. The recurrence of a similar deposite between Camps 26 and 27 is mentioned. Again, near Camp 31, pebbles of quartz, carbonate of lime, silex, jasper, gneiss, and rolled fragments of ostrea, were found, which appeared to have come from the valley of the Washita. By far the most important deposite of this character recorded was found half way between Camps 33 and 34; it is "very thick, and is formed of large pebbles of quartz and granite the size of a gourd; there is also white sand often fifteen feet thick, and very hard." Numerous little hills of "diluvium" are mentioned under the same date. Similar deposites of pebbles were found the next day above the Canadian river, while near it, only white and red sand, without pebbles, was seen. Deposites of this character were found along the whole route, and their resemblance to the "drift," mentioned by Dr. Shumard and others in their reports and journals, will be subsequently noted.

### III. ANTELOPE HILLS TO THE EASTERN BASE OF THE SANTA FÉ AND SANDIA MOUNTAINS.

The Antelope hills, sometimes called the Boundary mounds, or Antelope buttes, are well known land-marks to the traveller of the valley of the Canadian. The first description of them, which I find, is given by Lieutenant J. W. Abert, who states, "that there are five of them, two of which appear perfectly conical, and the group forms one of the most noted land-marks in the whole country." Descriptions of them are given by both Captain Marcy and Lieutenant Simpson, who passed up the Canadian in 1849. Lieutenant Simpson[1] observes: "Their height, probably from 120 to 150 feet above the plain below, has caused them to be seen for the past two days, they having constantly appeared as if they were near at hand; and yet, when first seen, their distance off was under-estimated by some eight or ten miles. Their form is quite regular, four appearing, in the distance, of an oblong shape; the two others conical, and each of them capped by a well defined terrace, or rather table, of white vesicular sandstone, eighteen feet thick and horizontally stratified." Captain Marcy[2] also reports them as 150 feet high, and states that they are of porous sandstone. "They rise almost perpendicularly from the smooth prairie, are flat upon the top, and present every indication of having been raised out of the earth by volcanic agency."

The annexed outline sketch, which I have reduced from one by Mr. Möllhausen, will at once convey an idea of their appearance, and show their origin to the geologist.

ANTELOPE HILLS.

They are evidently of horizontal strata, which were once continuous, and which formed a plateau raised above the general level of the prairie, but which, owing to the denudation or wearing away by rain-water and streams, has been cut by ravines, and separated into many portions, which now constitute the flat-topped mounds.

Mr. Marcou found that the sandstone of these mounds was friable and of a dirty-white color. It is incrusted with carbonate of lime, and some of the upper beds are entirely of white lime-

[1] Report of a survey on the Upper Arkansas, and the country of the Comanche Indians, 1845, p. 57.

[2] Report of the route from Fort Smith to Santa Fé, p. 180.

stone. The strata were decomposing rapidly, and holes or cavities of all shapes were formed in them by the weather. I find a specimen of this sandstone in the collection. It is No. 68 of the catalogue, and its label by Mr. Marcou states that it is from the upper Trias. The description of this specimen in full will be found in the appropriate place, (Chapter X,) but I extract a few lines from it. The specimen presents a remarkable resemblance to several of the sandstone specimens collected by Captain Pope near the 32d parallel. The grains are siliceous, white and yellow, and are cemented by a large quantity of amorphous carbonate of lime; in fact the grains seem rather to be imbedded in a paste of carbonate of lime. It most resembles No. 29 of Captain Pope's collection, found on the surface of the Llano Estacado, forty miles east of the Rio Pecos.[1]

We thus have at this locality sandstone formations very different in aspect from the dark red and blue clays which contain the gypsum in such large quantities. A marked change in the geology commences at this part of the route, and we shall presently see that these isolated buttes are probably outlying portions of a widely-extended plateau—the Llano Estacado—which was partly traversed by the survey, and the base of which was followed for a long distance.

From the Antelope hills to Camp 40 the road was continually upon or near white or grey sandstone, and the gypsum does not appear to have been seen.

Mr. Marcou mentions mounds on the left, between Camps 36 and 37, the day's journey after leaving the Antelope hills, and buttes similar to the Antelope hills were mentioned by Captain Marcy in 1849, and are laid down by Lieutenant Simpson on his map as north of the road near his Camp No. 43. All that country, according to this last authority, is similar, as far as the margin of the celebrated plateau—the Llano Estacado or Staked Plain.

The following is a sketch of one of the table-hills three miles west of Shady creek, near camp.

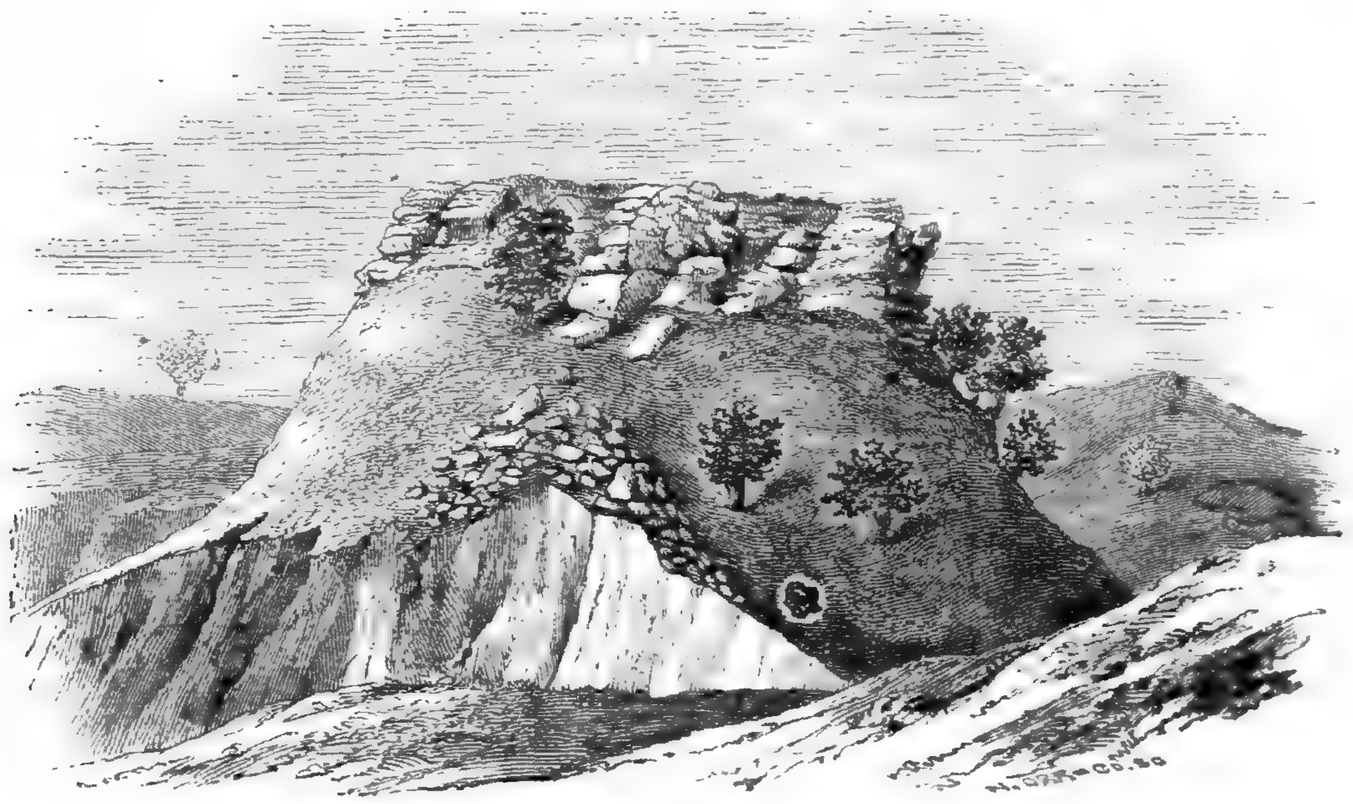


TABLE-HILL THREE MILES WEST OF SHADY CREEK.

It shows the mode of formation of these mounds very distinctly, the base of the mound being covered with the ruins of the hard stratum on the top. This layer is probably magnesian limestone, as it was found in similar positions in this vicinity by Mr. Marcou, and an outline figure of one of the hills, with the blocks on the slope, is given in his notes.

Between Camps No. 37 and No. 38, the trail crosses the valley of Dry river, so named by Gregg, which is bordered by steep and rugged escarpments of rock. This stream affords an excellent example of the denuding action of running water, and it is noticed by Lieutenant Simpson. He states that the soil and sub-strata are composed of a friable white sandstone. From a consideration of the appearances presented along the banks of this stream, Lieutenant Simp-

[1] See the writer's Report on the Geology of the Route near 32d parallel of latitude, U. S. Pacific R. R. Exploration and Survey, vol. ii.

son was led to give a very correct explanation of the origin and mode of formation of the numerous round, flat-topped mounds of that region.[1]

*Upraised sandstone strata.*—It should be remarked, before passing to a consideration of the portions of the line to the westward of this region, that Captain Marcy in his exploration of Red river passed within twenty-five or thirty miles of the south bank of the Canadian, and at one point crossed over to it. Dr. Shumard, who accompanied him, made some observations on the strata of the region, which will be interesting in this place, and tend to throw additional light upon the geology of the line. At a point several miles south of the trail, between Camps 36 and 38, Dr. Shumard found an outcrop of greyish yellow sandstone, presenting a dip of forty degrees to the west. Again, on the 9th of June, near Sweet Water creek, an outcrop of finely laminated red, ferruginous sandstone, presenting an irregular dip to the northeast of about thirty degrees, was found. It was also passed during the next day's march and presented evidence of violent disturbances; the strata being nearly perpendicular in some places. On Red river, about twenty miles east, horizontal strata of red and blue clay, containing gypsum, were seen, and they formed long ranges of bluffs. On the banks of Suydam creek there were similar bluffs, but without the gypsum. From these facts I conclude that the upraised sandstone is older than these gypsiferous strata, and that it was uplifted prior to their deposition. The upraised beds are probably similar in composition and age to the upraised carboniferous sandstones occurring east of Delaware mountains in the Sans Bois and other ranges.

*Loess.*—Another and a very interesting formation was found in that region by Dr. Shumard, on the banks of a creek just south of Dry river, and between Suydam and Buffalo creeks. This deposite consists of a grey calcareous loam, filled with shells characteristic of the *loess* formation—*Helix plebium, Succinea elongata, &c.* A similar deposite was found on Red river, twenty-six miles above Fort Washita. At this place it is "about twenty-five feet thick, and consists of an ash-colored calcareous loam, which, on inspection, was found to contain terrestrial and fluviatile shells of the genera *Lymnea, Physa, Planorbis, Pupa,* and *Helix*, the whole resembling species which we have observed at New Harmony, Indiana, and elsewhere in the Mississippi valley."[2] It is this formation which rises in bluffs along the Mississippi river, and which was deposited by the river when the land was slightly lower than at present; and now, owing to its uplift, the river has cut a path downward and carried away a great part of the deposite, but has left here and there a "bluff" or terrace to mark its former channel. These bluffs at Natchez attain an elevation of about 200 feet above the more newly deposited alluvium, and in these and at other places the land and fresh-water shells are found to be specifically identical with those in the adjoining swamps. Sir Charles Lyell, during his visit to this country, first recognised the similarity of these deposites to the *loess* of the Rhine.[3]

It is therefore probable that the region of the upper portion of the Red river has been subjected to changes of level similar to and synchronous with those which have affected the valley of the Mississippi. We should consequently look for similar evidences of disturbance along the Canadian, especially along that portion of it near Loess creek. It is very probable that such deposites exist at various points, and they may be very extensive and cover broad areas in the low valleys bordering the lower parts of the river, especially near its junction with the Arkansas.

Dr. Shumard also observed the occurrence of considerable quantities of "drift" scattered over the region, which must be similar to that met with along the line. This "drift" deposite will be considered after the description of the Llano Estacado has been given.

*El Llano Estacado, (the Staked Plain).*—At Camp No. 45, on the banks of the *Arroyo Amarillo*, the ascent of the bluffs of the Llano was commenced, and the surface of the plateau was followed for about twenty-seven miles, with the exception of the crossing of Encampment

[1] Report of the route from Fort Smith to Santa Fé, p. 10.
[2] Shumard in Marcy's Red River report, p. 182.
[3] Lyell's Second Visit to the United States, vol. ii, chap. xxxiv.

creek, where the stream has hollowed out a ravine. Of this portion of the route, Lieutenant Whipple observes, in his preliminary report, that it is an apparently boundless plain, without a shrub or tree as far as sight can penetrate. It is covered with a thick carpet of buffalo-grass, which is cropped by numerous herds of antelope and deer.[1] Captain Marcy, who crossed the Llano at this point, thus observes, in his report of 1849: "When we were upon the high table-land, a view presented itself as boundless as the ocean. Not a tree, shrub, or any other object, either animate or inanimate, relieved the dreary monotony of the prospect; it was a vast illimitable expanse of desert prairie—the dreaded Llano Estacado of New Mexico; or, in other words, the great Zahara of North America."[2]

A general sketch of the prominent physical features of the Llano has already been given. (See Chapter I.) The Antelope hills may be regarded as the commencement of this vast plain, although they are in fact but fragmentary outliers resulting from denudation. They are also, undoubtedly, much denuded on their tops as well as sides, and do not rise to the height of the bluff borders of the principal plateau. This main plateau is marked by a long line of bluffs—precipitous escarpments—which front upon the valley of the Canadian, hemming it in on both sides with grand natural walls. The point at which these vertical banks were first ascended was between Camps 45 and 46; and, although this part of the Llano is only a projecting point or peninsula of the great plateau which extends north, so as to impinge upon the river, its borders were well defined and presented a bold front across the route, looking like a great wall or barrier in the dim light of early morning. The sketch was taken one hour before sunrise, and shows a remarkable regularity of the sun's rays as they shot up behind the summit of the plain. The broken and denuded borders of the plateau are well shown, and the peculiar barren and treeless surface cannot fail to attract notice.

BLUFFS OF THE LLANO ESTACADO, (*one hour before sunrise, Sept.* 17.)

This was not the eastern borders of the Llano; they were passed some time previously, the commencement of the main line of bluffs being nearly south of Camp 41, at the western limit of the area of whitish sandstones around the Antelope hills. After leaving Camp 41, the trail passed for a long distance upon the red-colored strata bearing gypsum, and lying between the Llano and the river. The bluffs of the Llano, however, appear to extend further west on the north side of the Canadian than on the south, unless we consider the Antelope hills as forming

[1] Report of Explorations for a Railway Route, &c., H. Doc. 129, p. 18.
[2] Marcy's report of the route from Fort Smith to Santa Fé, p. 185.

the western limit. Mr. Marcou observes, under date of September 8th, that at Camp 38, "on the right and left banks of the Canadian we find the commencement of the Llano, a sort of plateau with some flat, isolated mountains as an advanced guard, similar to the *Alb* of Wirtemberg near Hedinger and Balenguen." After travelling further westward, Mr. Marcou formed the opinion that the strata of the Antelope hills, the grey sandstones, were not the extension of the strata of the Llano, but that they underlaid them and formed a part of the "Trias."

Captain Marcy, in his explorations at the sources of the Red river, travelled under the eastern border of the Llano, and enjoyed an excellent opportunity for locating it on his map and examining its characters. He travelled for several miles in a narrow ravine, bordered on both sides by vertical bluffs of the horizontal strata over 600 feet high. This was at the head of Red river, about fifty miles south of the Canadian. The water there gushes out in a spring and flows for a short distance over the white or greyish strata of the plateau. Dr. G. G. Shumard, who accompanied Captain Marcy, describes these bluffs as consisting of horizontal layers of drift, sandstone, and yellow clay; and on June 28th the bluffs, "six hundred feet high," were composed of horizontal layers of drift and sandstone interstratified with white limestone.[1] In the section which accompanies this description the "drift" is represented with a thickness of nearly 100 feet, and is succeeded below by grey and yellow sandstones interstratified with thin seams of non-fossiliferous limestone; and this again by gypsum and red clay. It is impossible to determine from the section how great a thickness is occupied by the grey and yellow sandstones, but it is certainly not less than 250 feet. It is, however, mentioned on page 192 that the inferior strata, or those between the base of the bluffs and the river, consist of gypsum and red clay. This leaves the legitimate inference that the yellow sandstones and limestones attain a thickness of 500 feet.

The composition of the bluffs along Encampment creek, a point about half way between Camps 45 and 46, the portion of the route which traversed the summit of the Llano, was thus observed and recorded by Mr. Marcou, (see notes, September 17):

White limestone.
Calcareous conglomerate.
Limestones.
Sandstone with numerous calcareous concretions.
Red sandy marls of the New Red.

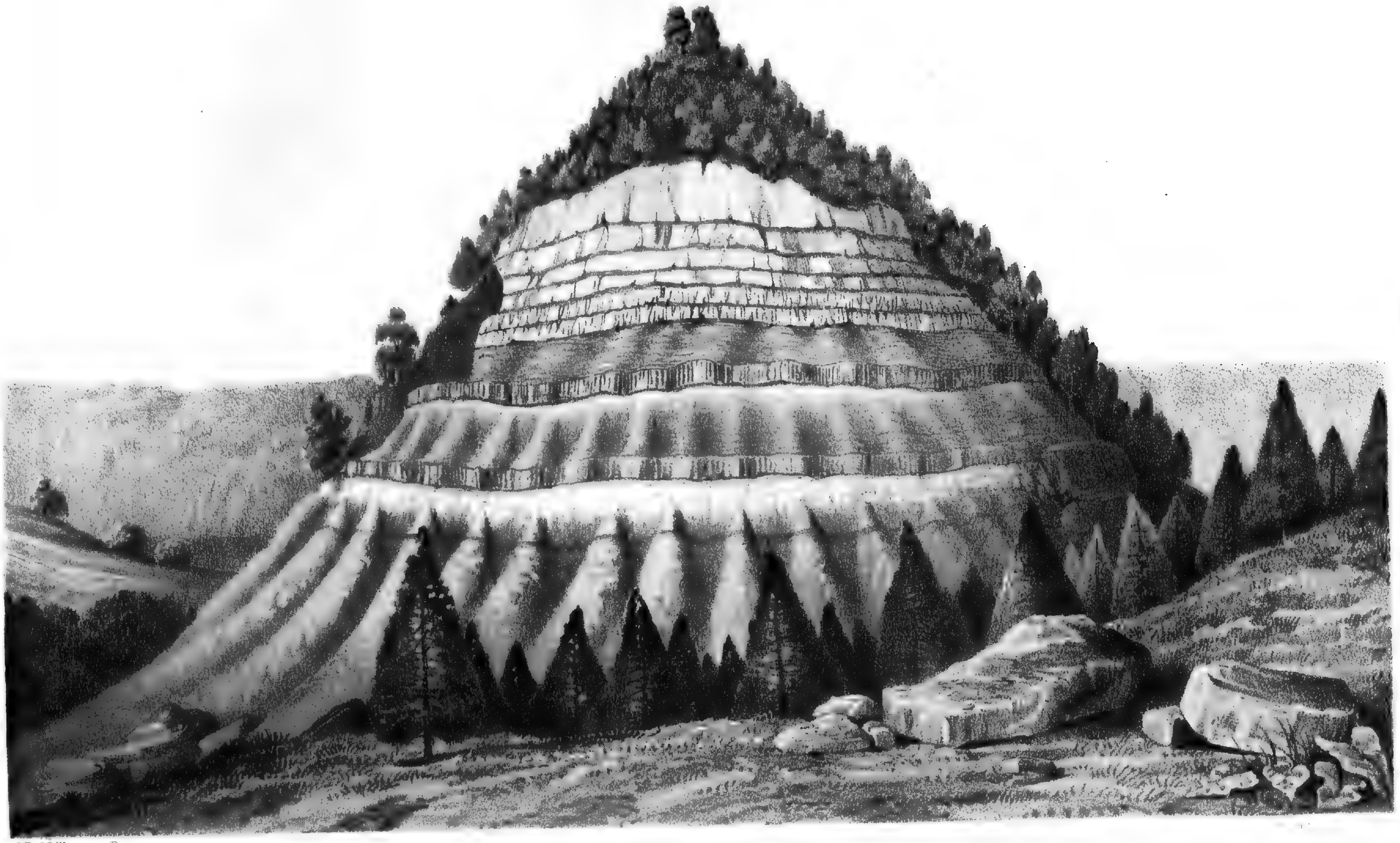
At Camp No. 46, which was at the foot of the Llano, the following section was noted:

10 feet—Limestone resembling Forest marble.
150 feet—{ Red sandy marl. / Violet sandstone. / Red marl.
100 feet—Grey sandstone, sometimes violet.

Mr. Marcou further observes, that the sandstone of Rocky Delaware creek (forming the base of the section) is whitish-grey, with some shales of a rosy hue. A specimen of this sandstone is in the collection, (No. 65,) and is described in Chapter X. It is this sandstone which is regarded as Triassic, and which Mr. Marcou, in his notes, thought was the same as that forming the Antelope hills. (See September 18.)

*Tucumcari Hill.*—On descending from the Llano to the valley of Rocky Delaware creek, the red-colored strata were again encountered, and the trail passed upon them, with occasional exceptions, as far as Hurrah creek, a tributary of the Pecos. The bluffs of the Llano were constantly in view on the south. Beyond Camp 48, the mound called Tucumcari is found, rising to the height of the Llano, but standing apart from it, and completely isolated. This is called Cerro Tucumcari by Captain Marcy,[2] who remarks that it is round and symmetrical, and when seen at a distance, resembles the dome of the capitol at Washington. Simpson also remarks

[1] Shumard in Marcy's Report, pp. 191, 192.
[2] This name appears to have been given to the mound by Gregg. See his work entitled "Commerce of the Prairies."



H B Mollhausen D.

A CONICAL HILL 500 FEET HIGH.

this resemblance, and we are indebted to him for the first observations upon the extent and elevation of the hill. Its circumference at the base was found to be nearly six miles, its height about 700 feet, and the area of the summit about 230 by 370 yards.[1] I do not find any description of the strata of this mound in the notes of Mr. Marcou, but I do not doubt, from the statements of Lieutenant Whipple, that they agree exactly with those of the Llano. This is also indicated by the fact that the slopes of the mound are covered with cedars, exactly as on the northern slopes of the Llano. We have also the section of Pyramid mountain, by Mr. Marcou, which is not far distant, and may be regarded as an exhibition of the mineral character of the Tucumcari and of the Llano.

*Pyramid Mountain.*—The finest and most complete section of the horizontal strata of the bluffs along the route was obtained at this mountain by Mr. Marcou. The point was peculiarly favorable, being one of the isolated mounds, a remnant of the Llano, and exposing the strata on all sides. It is only one of the many mounds dotted over the wide space eroded by the river from the Llano, and called *Plaza Larga* by the Mexicans. This mound was ascended by Mr. Marcou, and others of the party, and we find the following record of the succession of the strata in the notes under date of September 22:

SECTION AT PYRAMID MOUNTAIN.

| | | |
|---|---|---|
| 500 feet | White limestone. | "Jurassic." |
| | Yellow limestone with bluish-grey bed at the bottom. | |
| | Bed containing Ostrea —— [?].[2] | |
| | White sandstone. | |
| | Yellow sandstone. | |
| | White sandstone. | |
| | Grey and green bed in contact with the superior Trias. | "Triassic." |
| | Red and green sandstone. | |
| | White marls with concretions. | |
| | Red and green marls. | |
| | White. | |
| | Red. | |

Mr. Marcou considers that the base of this mound is formed of the beds of the superior Trias, the upper portion being Jurassic. It does not appear to me that the evidences are sufficient to warrant this decision, but the discussion of this subject will be left for a subsequent portion of the report.

A sketch of this mound was carefully taken in colors by Mr. Möllhausen, the tints agreeing as nearly as possible with those presented by the strata. The sketch has been lithographed and is appended. It will serve to convey an idea of the relations of the strata, especially the white and red series, and may be received as an exhibit of the general aspect of the bluffs of the Llano, where the beds are exposed. The section and locality derives great interest from the occurrence of fossils. The bed containing the *Ostrea* is said to be of greyish-blue clay and sub-schistose, and two inches thick. The Ostrea is subsequently called *Ostrea dilatata*, and is again mentioned in the Resumé. This is the fossil called *Gryphæa Tucumcarii* in the collection (No. 133) from Pyramid mountain, and referred to in the Resumé under the same name, it being said to have the greatest analogy with the *Gryphæa dilatata* of the Oxford clay.[3] It probably is a new species or a variety of *Gryphæa Pitcheri*, and a description of it will be found in Chapter IX, under the name *G. Tucumcarii*, originally proposed by Mr. Marcou. See also Plate I.

From these various observations we may conclude that the great plateau, the Llano Estacado, consists of horizontal strata of light-colored white, or greyish-white, and yellowish sandstones, and bluish clays and marls, resting conformably upon beds of red clay, red sandstone, and gypsum, and these, according to Mr. Marcou, are intercalated with greyish or light-colored

[1] Report of the route from Fort Smith to Santa Fé, 1849, p. 14.

[2] The specific name cannot be deciphered in the original. It looks like *Comanche*. W. P. B.

[3] The genus Gryphæa was formerly included with the Ostracea.

sandstones, as on Rocky Delaware creek. It also appears that the light-colored sandstones and calcareous beds constitute the main part of the bluffs, and that the red marls and clay of the gypseous series are at their base and occupy the space between them and the river.

The trail then, after passing the Antelope hills, passed for a time over grey sandstones and their débris, then upon the red clays and sand for several miles, until at Camp 43, on Arroyo Bonito, grey or white sandstones were again found on the banks of the creeks. Beyond this a succession of variegated marls was seen, but gypsum was not found.

At Camp No. 45, on Amari creek, the ascent of the bluffs of the Llano was commenced, and its surface was traversed for a few miles, and then the survey again traversed the red clays of the gypsiferous formation in the valley of the Canadian and its tributaries, until the mounds just described were reached.

*Plaza Larga.*—This place, so called by the Mexicans on account of the wide and fertile valley of the Rio Tucumcari, is at the base of the Tucumcari hills, and about two hundred miles east of the Rio del Norte. Its soil probably consists of the red clays and sand, mingled with the debris of the strata of the Llano; and, according to Mr. Marcou, it is without alluvium, not even of fragments of sandstone or limestone. The border bluffs of the Llano here recede to the south, and Tucumcari hill stands in the centre of the curve. They again extend to the north, and overhang the route beyond Plaza Larga, and near Laguna Colorado, at Camp 50. The road also between Camps 50 and 51 is near the bluffs, but is on the red clay formation. At Camp 51 the wide valley of the Pecos and Hurrah creek is reached, and the bluffs of the Llano again bend southward and disappear. This part of the route is among isolated hills, which are remnants of the once continuous Llano, and now stand as monuments of its destruction, but agree with it in their geological structure.

REMNANT OF A STRATUM OF SANDSTONE NEAR LAGUNA COLORADO.

One of the projecting bluffs passed by the expedition was surmounted by a singular outlier of the rock, poised upon a narrow base. It is an interesting example of weathering and decay,

and is an attractive feature in that monotonous landscape. It is found near Laguna Colorado, Camp 50.

The lake and the bluff margin of the Llano are seen in the back-ground of the sketch.

Lieutenant Simpson gives such an interesting description of the table-mounds, and the country about them, that I quote it from his report: "Following up Tucumcari creek, a fine view, made up of sugar-loaf hills and tableau mounds, and opening vistas, presents itself to your front. The regular stratification of these hills, their party white and red color in horizontal zones, and the whole surface, besprinkled as they are with stinted cedar of a dark-green color, will not fail to be noticed by the traveller as giving them a very beautiful and unique character. The formation of these hills, which are from one hundred to three and four hundred feet high, is at the base a red argillaceous rock, easily frangible; next, proceeding upwards, a zone of sandstone rock, very friable, and of a greenish white color; last, and uppermost, a sandstone rock, of a brownish hue, and rather coarse character. Large fragments of these last mentioned rocks lie scattered on the slope of the hills, and many among them, I noticed, presented evidences of having been subjected to the action of fire. Indeed I think these evidences of igneous action increase as we proceed towards the Rocky mountains, or primary rocks. On all these hills, and in the silt of the streams at their base, are found fossil shells of a species which point to the cretaceous period. This species of fossil was also found on the Independence route, some two hundred miles from Santa Fé, by Mr. A. Randall, of Minnesota, who classes it among the *Inoceramus*, a type of the Cretaceous formation."[1] One of the flat-topped hills is crossed by the trail between Camps 52 and 53. It forms the divide between the bed of Hurrah creek and the Gallinas river, an affluent of the Pecos. The upper strata are said by Mr. Marcou to be nodular, like those of the Llano.

This portion of the route is in the immediate vicinity of the trail of Dr. Wislizenus in 1846 and 1847, and his observations on the geology of that vicinity are interesting. He crossed the Gallinas river about twenty miles north of the line of the survey, and describes the bluffs at that point as consisting "of a dark bluish schistose limestone, with fossils belonging to the Cretaceous formation."[2] He has so marked this part of his trail on his map, and in the description (p. 136) says the limestone on Gallinas creek was dark blue, and contained casts of Inoceramus. Beyond that point, towards the mountains, sandstone of different colors, red, grey, and white, was seen.

*Anton Chico.*—From the river Gallinas the route was upon the gypsum formation to Anton Chico, which is on the same deposites, and is in the valley of the headwaters of the Pecos, surrounded on all sides by the mesa-summits of the horizontal strata of the Llano and its northern extension. Mr. Marcou remarks that, at this point it appears to extend more to the north than south. He also observes of Anton Chico, that it is situated "in a basin of red marl, of Triassic age, with sandy alluvium and diluvium." (Notes, September 28.)

*Cañon Blanco and Cuesta.*—A few miles beyond Anton Chico the bluffs of the Llano approach so closely that the valley becomes very narrow, and the exposure of the red clay becomes very slight. Cuesta is situated at the base of one of these bluffs, on the north side of the Pecos. Mr. Marcou states that the bluffs are 800 feet high at this point, and that they exhibit a beautiful section. The strata which he calls "Trias" form the base, and above them there is a sandy and marly dolomite; white sandstone, with intercalations of greyish-white marly beds succeeds, and sometimes beds of yellow calcareous sandstone, but less than at Pyramid mountain. No beds of *gryphæa* were found at the summit of the cliff.

[1] Simpson's report of the route from Fort Smith to Santa Fé. I place great confidence in this determination by the late Dr. Randall. This gentleman had in his possession many valuable notes, and a collection of specimens made by him during his journey over the country to California. At the time of his assassination he was the President of the California Academy of Natural Sciences, and had done much in aid of science on the western coast. His death will long be deplored by all who are interested in the development of the natural history of the Pacific slope.

[2] Wislizenus's Report, p. 17.

The gorge called *Cañon Blanco* commences nearly west of Cuesta, and is formed by the erosion of the strata of the Llano. Mr. Marcou considered the strata in the bottom of the gorge to be of the age of the upper trias; while the bluffs are of white and yellow sandstone, with some interposed beds of grey marl and a greyish-white nodular limestone. No fossils were seen. He also records that these strata are inclined towards the E.E.S., the heads of the strata being turned towards the mountains. (See notes, September 30.) This is the first observation of a disturbance of the strata of the Llano, but the extent of it, the angle of dip, is not mentioned. The peculiar form of the cañon and the topography show, however, that this dip must be very slight.

Lieutenant Simpson describes this cañon as a "sufficiently wide and smooth defile, the escarpments of which run up on either side in places to at least 1,000 feet." The end of this cañon is at Lagunas, Camp No. 56 of the survey, and No. 55 of Mr. Marcou's notes. This camp is on the summit or swell of the ground which divides the waters of the Pecos from those of the Galisteo, a tributary of the Rio Grande del Norte. At this point the line of survey turns southwestwardly to the entrance of the San Antonio Pass, at the southern end of the Gold mountains, and at the base of the Sandia range. Mr. Marcou's trail diverged from this towards the northwest, along the road to Santa Fé, through the valley of the Galisteo. In this valley, before reaching the village of Galisteo, Mr. Marcou notes the occurrence of upraised white and yellow sandstone, trending north and south, and the strata dipping east and west at angles of from 15° to 60°. Farther onward, at the village of Galisteo, he found a trap dyke, cutting the white sandstone in a direction "30° E.E.N. to 30° W.W.S." The colored strata (the "Triassic") were also upheaved, dipping south-southeast, under angles of 10° to 15°. Volcanic cones and lava streams were afterwards found. These volcanic rocks, the dyke and the volcanoes, are on a basis of granite, forming the lofty mountains east of Santa Fé.

We have thus traced the stratified formations of the plains and prairies to their western boundaries at the foot of the mountains. Their relations to these lines of upheaval and the geology of the mountains will be subsequently considered.

*Alluvial Deposites and Drift or "Diluvium."*—In describing the strata of the section of the route which has been under consideration the superficial deposites or accumulations of pebbles and sand have not been regarded. These accumulations are often mentioned by Mr. Marcou in his notes, and by Dr. Shumard in his observations on the geology of the adjoining tract, on the divide between the Canadian and Red rivers. The deposites will be described under the head of Alluvial and Post Tertiary deposites, in the after part of the report.

# CHAPTER III.

## OBSERVATIONS ON THE GEOLOGY OF THE ROUTE.

### SANTA FÉ, ALBUQUERQUE, AND THE VALLEY OF THE RIO GRANDE DEL NORTE.

General Remarks.—Sandia and santa fé mountains.—View of albuquerque and the sandia mountains.—Carboniferous limestone.—Granite.—Fossils.—Relative positions of the strata.—Coal measures.—Absence of outcrops on the west side of the mountains.—Metamorphic rock.—Granite.—Trap-dykes.—At galisteo and the head-waters of the tuerto.—Resemblance to ruins and walls.—Quartz veins.—Volcanoes and lava, cerritos.—Plains of lava or basalt.—Bluff at san felipe.—Sedimentary deposites of the valley of the rio grande.—Bluffs and horizontal beds.—Resemblance of the strata to those on the canadian.—Cretaceous fossils at poblazon.—Sandstone and selenite.—Probable cretaceous age of the strata in the valley of the rio grande.—Alluvial deposites.—Soil of the valley of the rio grande.—Sand-dunes.—Valley of the puerco.

Although the line of survey did not extend north as far as Santa Fé, this place was visited by Mr. Marcou, and notes were made upon the geology. Some of the most interesting fossils of the collection are from this vicinity—from the Pecos villages at the southern end of the Santa Fé mountains. The geology of this part of the route becomes much more intricate and interesting, as, instead of horizontal strata exposed at most to the depth of a thousand feet, we have the varieties of the intrusive rocks traversed by mineral veins, and flanked by uplifted strata of different ages and lithological characters.

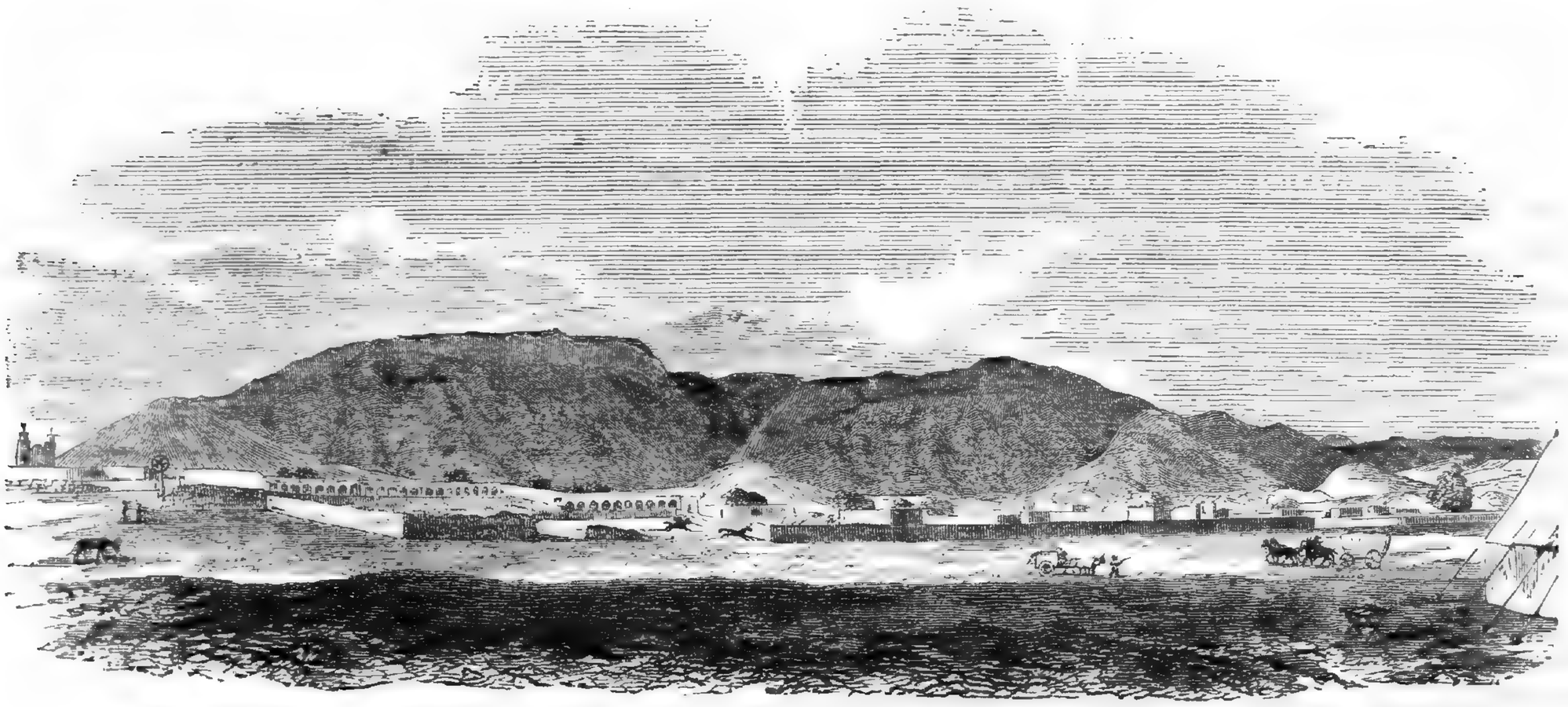
A general description of the wide valley between the two principal ranges of mountains—the Santa Fé and Sandia on one side, and the Sierra Madre on the other—has already been given, (see Chapter I,) and the fact that the Rio Grande occupies a small part of the space, and that its channel is confined to the eastern side of the valley, has been shown. The settlements in that region being chiefly upon this river, are confined to the vicinity of the eastern ranges, the Sandia and Santa Fé, and the geological observations, are, therefore, more numerous and complete around them than on the western side or among the ridges of the Sierra Madre. As the preceding descriptions have extended along the route up to the base of the first mentioned ranges, their geological structure will be first considered.

*Sandia and Santa Fé mountains.*—Previous to the exploration of Lieutenant Whipple, we were aware that the main axis of these mountains was granitic, and that stratified limestones were found in them; but of the age of these strata, and of their relative position to the granite, there appears to have been but little or no reliable evidence. Mr. Marcou's notes, however, and the collection of fossils from the eastern base of the range, leave us no longer in doubt on these points.

These mountains present almost vertical escarpments towards the west, and when seen from Albuquerque or its vicinity, the sky outline appears very regular and straight and is suggestive of the edges of stratified rocks. The annexed sketch was taken by Mr. Campbell, from the Camp beyond Albuquerque, and the peculiar form of the summit of the mountains is distinctly shown.

The examination of the mountains verifies the indications, and we find granite and the associate rocks at the base, and at the summit thick strata of carboniferous limestone dipping eastwardly at angles of 25 or 30 degrees, and so passing under the strata of the Llano which have been described. These limestone strata are associated with shales, which are black, and from

four to six feet thick. Beds of sandstone also occur, and these are rose-colored and very hard. (See notes October 10th.) No coal was found, but its presence further south in the Manzana mountains is mentioned. The following are the fossils noted in these carboniferous rocks: *Productus giganteus* and *punctatus*, *Terebratulæ*, *Spiriferæ*, *Orthocera*, *Zaphrentis*, and *Crinoids*.



ALBUQUERQUE AND THE SANDIA MOUNTAINS.

These observations on the limestone were made on the day of the ascent of the range, but the same strata were seen and notes made upon them at their exposure further south, and along the line of the trail passing eastward from Albuquerque towards San Antonio and San Pedro. After leaving Albuquerque and passing for two miles over alluvial deposites, outcrops of granite were found, three miles wide; and resting on this granite were thick strata of limestone, dipping eastward at an angle of 35 or 40 degrees, the heads of the beds being turned to the west. This is interstratified with thin and black clay shales. *Productus giganteus* and *punctatus* a *Spirifer*, and two *Terebratulæ* and *Polypes*, were found here.

Mr. Campbell informs me that the fossils are very abundant near the trail, and can be readily knocked out of the limestone with a hammer.

This limestone is said to border the trail on the right for a mile or more. The limestone was met with again a short distance beyond San Pedro, and it dips to the east, as before. This is very probably the same outcrop of limestone which contains veins of copper and lead ore, and which is found on the trail between San Pedro and Tuerto. The mines in this limestone were visited by Lieutenant J. W. Abert in 1846, and he obtained from the rock a *Terebrutula*, which is figured in his report.[1]

The next, and perhaps the most interesting locality of this carboniferous limestone, is at the eastern base of the southern end of the Santa Fé range, at the Pecos villages, so well known and celebrated as the former residence of the descendants of the Montezumas, who kept their sacred fire constantly burning until within a few years. At this place—at New and Old Pecos—Mr. Marcou examined the limestone and obtained numerous fossils. These are in the collection, (see Nos. 114 to 122,) and have been examined and described for me by Professor Hall, of Albany. These descriptions, and the figures of new and important species, are given in a subsequent portion of this report. These fossils are all very perfect, and from the number collected, I judge that they are very abundant and easily procured.

Lieutenant Abert mentions the abundance of fragments of hard limestone along the road between Sepullo creek and Vegas, and this renders it probable that the limestone is considerably

[1] Report of a reconnoissance in New Mexico, by Lieutenant J. W. Abert.

developed further to the north; indeed, it probably forms a large part of the eastern flank of the Santa Fé range. It is known to extend for a long distance south, and it flanks the Organ mountains and other ranges on the east of the Rio Grande, these being continuations of the Sandia range.

The outcrop of limestone near Tuerto is directly east of the Sandia or Albuquerque mountain, and south of Gold mountain, an elevated mass of granitic and metamorphic rocks. This granite, and the limestone just south of it, are several miles to the east and north of the northern end of the Sandia range, and these are out of the line of trend of the limestone as it was observed near San Antonio, and on the top of the range by Mr. Marcou. So, also, the limestone on the east side of the Santa Fé range is far east of the line of trend of the Sandia range. If we connect these outcrops together as one line of uplift, we must regard the trend as changing suddenly to the northeast. We, however, find that the trend of the Sandia range, if prolonged across the Rio Grande, reaches to the southern end of a ridge with the same direction, and which appears to be the end of the San Juan mountains. The extension of this uplift of the carboniferous in that direction is thus rendered extremely probable, especially as the ranges further north impinge upon and cross the Rio Grande in a similar manner. It may, however, be found that the Santa Fé, the Gold mountain, and the Sandia outcrop, are parts of one line of flexure or uplift.

It is difficult to understand the exact position of the Carboniferous strata relatively to the granitic rocks of Gold mountain, and in the interval between this uplift and the eastern base of the Sandia range. When Mr. Marcou was travelling at the base of this range he mentions passing from the granite to the outcrop of the limestones, three hundred feet thick, the heads of the beds looking to the west, and the dip being from thirty-five to forty degrees east. A bluff of this limestone was continually on his right hand for one mile as he passed northwards towards San Antonio, where the "Trias" was found. From this we may presume that the road was upon the granite, and indeed this is indicated by the section given, (October 8,) where the wagon-road is shown on the granite. Under date of October 9th he mentions that the inferior Carboniferous extends as far as Tejera village, "where, as the Trias, the coal has been too much compressed and does not appear." There the thickness of the Carboniferous is stated to be two thousand feet. It would thus appear that he crossed the edges of Carboniferous strata which probably consist of sandstones of the coal measures in addition to the limestone, the thickness of the latter having been previously given as three hundred feet. The sandstones are also referred to under date of October 10th. The limestone near the Gold mountain is said to dip east, but for a time I was in much doubt whether it was on the western or eastern side of the granite; but it now appears most probable that it is on the eastern flank, and that it dips away from the mountain precisely as from the granite of the Sandia range.

The occurrence of black shales and strata of sandstone with the limestone, and the fact that Mr. Marcou gives the thickness of the limestone at one point as three hundred feet, and at another locality, but a few miles distant, and in the same line of trend, he found the thickness of the Carboniferous to be two thousand feet, leads me to conclude that the coal measures are developed there. He also states, in his Resumé, that the coal measures do occur there. I have, therefore, represented them upon the map and section.

We would expect to find these stratified rocks, and especially the limestone, coming to the surface on the western slopes of the mountains. They do not, however, appear either at Santa Fé or on the Sandia range. We are, therefore, at a loss to decide how to locate the beds in the interval between the outcrop on the east of the Rio Grande valley and that on the west. Mr. Marcou, in his notes, does not mention the presence of any limestone on the eastern flank of the Sierra Madre, but in his Resumé he distinctly states that it does so occur, and that it is succeeded on the west, or beyond the crest of granite, by another outcrop dipping westward.

The occurrence of this limestone with the easterly dip from the Sierra Madre permits us to conclude that it underlies the whole valley of the Rio Grande, and we should, therefore, find

it outcropping along the western side of the Sandia and Santa Fé mountains. As, however, it does not appear on that side of the mountains near the line explored by the survey, we must conclude that recent sedimentary deposites obscure it from view, or that it has been very much denuded so as not to appear. If we regard the granite as intrusive and as having flowed up in the manner of some trappean intrusions among stratified rocks, it is very probable that the limestone strata on the western side dip under it. The absence of the limestone may be entirely local, and it may be found to outcrop regularly and to dip west a few miles south of the line of exploration.

*Metamorphic rocks.*—It appears from Mr. Marcou's notes that this carboniferous limestone rests immediately upon the granitic and eruptive rocks, without any intervening sandstone or other strata. Neither does he record any evidences of a change or metamorphosis of the beds in consequence of their contact with these rocks. He, however, mentions, under date of October 8th, that the green serpentinoid trap, which is the rock in contact with the limestone strata, contains strata of metamorphic limestone of Devonian age. The position of these rocks is shown by a figure. This serpentinoid trap appears in each of the small sections which Mr. Marcou has drawn in his note-book.

With regard to the mineral characters of this trap, but little can be said beyond the description which I have given of a specimen found in the collection. (See catalogue, No. 41, and the descriptions.) I have there remarked that the specimen greatly resembles a fragment of metamorphosed slate. It has a distinct lamellar structure, and breaks more readily in one direction than in another. It is highly argillaceous, and is interleaved with thin layers of carbonate of lime. It does not appear to contain any great amount of magnesia. These characters favor the belief that it is a metamorphosed calcareous and argillaceous shale.

There is only one specimen of granite from these mountains in the collection, Nos. 1 and 2 of the catalogue. The outcrop from which this specimen was probably taken is said to be three miles in width, and is succeeded by a rose-colored granite, with but little feldspar, and dykes of rosy-white quartz; then follows the serpentinoid trap, with the Carboniferous strata resting upon it. There are no specimens from Gold mount or Santa Fé mountain. The drift or detritus coming from Gold mountain was noted as quartzose and containing crystals of pyroxene, or a similar mineral, about which there appears to have been some doubt. The detritus from the Santa Fé mountain consisted of granite, serpentine, &c.

*Trap-dykes.*—Half way between Tuerto and Galisteo Mr. Marcou found a trap-dyke trending north and south. Further on, in the valley between the Old and New Placer mountains, several dykes were seen, one having a northwesterly and southeasterly direction, and they were all cutting the beds of the formation called "Trias." When at Galisteo another trap-dyke was noted; it is ten feet wide, and traverses the white sandstone in a direction 30° E.E.N. to 30° W.W.S. The beds of the "Trias" were upheaved in the vicinity. (See notes, October 2.)

I learn from A. H. Campbell, esq., the civil engineer of the survey, that there is a fine trap-dyke at the headwaters of the Rio Tuerto, near San Pedro Pass, which is forty feet thick, and trends S. 60° E. magnetic. The dip is 45° S. 20° W. It cuts directly through the red sandstones. The direction of this dyke is so entirely different from that observed by Mr. Marcou, that I cannot but regard it as separate and distinct.

Lieutenant J. W. Abert observed trap-dykes on the banks of Galisteo river north of the Placer, and describes one as follows: "Crossing the creek we entered a little vale, traversed in various directions by walls of trap. At one place we saw a wall that looked at a little distance as if made by human art; it was pierced as if for windows and doors. A stranger, whom we met, insisted that this dyke was one of the vestiges of the '*Indios*,' who lived here long ago. But the Cyclops alone could have worked with such vast materials as these. The planes of the joints and cleavage have formed the mass in fragments, consisting of rhomboidal prisms whose

axes are perpendicular to the cooling surfaces."[1] We see from this description that the dyke was injected into the soft stratified rocks, which have since crumbled away and have left the harder igneous rock standing like a wall. This is often seen in a region where trap-dykes have traversed softer strata. A fine example is cited by Owen, and figures are given of trap-dykes standing out from the surrounding surface, and exhibiting the columnar structure so perfectly that at a distance they appear like great piles of wood. I have often heard of the "stone walls" of this part of New Mexico, and have found it difficult to convince some that they were not in reality works of art.

There are two or three specimens of the rock of these dykes in the collection, (see Nos. 31, 38, and 39,) and they are described in Chapter X. No. 38 is said to form a dyke in the white chalk, and is from the Galisteo river. Whether it is taken from the dyke mentioned in the notes as at Galisteo, is not evident. The rock, however, closely resembles the hard dark-colored trap of the Palisades and Connecticut. The rock of the dyke between Tuerto and Galisteo is very different; it has a grey color, and consists of feldspar and crystals of hornblende. I find in the collection (No. 42) a specimen labelled "*Porphyre en dyke,*" from the volcano of *Cerrito*, near Santa Fé. This dyke is not mentioned in the notes.

In addition to these records of igneous action, we find that the granite and metamorphic rocks of Gold mountain are traversed by numerous veins of quartz, and these are also mentioned by Mr. Marcou as traversing the granite of Sandia mountain, not far west of its junction with the limestone. From all these facts we may conclude that the eastern flank of all these ranges has been subjected to violent igneous disturbances subsequent to the uplift of the Carboniferous limestone, and even as late as the white sandstone strata of the Llano.

*Volcanoes and lava.*—The first volcanic phenomena observed along the line of the survey was at Sieneguilla or Cerrito, a rancho on the Santa Fé river about fifteen miles southwesterly from Santa Fé. At this point Mr. Marcou found several small extinct volcanic cones called *Cerritos*, and overflows of lava which capped the strata along the stream. Specimens of these lavas are in the collection, Nos. 43 and 44, and descriptions of them will be found in Chapter X. We have no knowledge of the elevation or magnitude of these volcanic cones.

The presence of a horizontal plain of basaltic lava on the western side of the river back of San Felipe has been known for a long time, and a plate showing the bluff back of the town is given in the report of Major Emory, and he remarks the presence of basalt crowning the table-lands of the west side of the river.[2] He afterwards observes that these basaltic coverings are characteristic of the valley of New Mexico. From Mr. Marcou's notes I judge that the Rio Grande at this point cuts through the field of basalt, it being found on both sides of the stream. He observes, October 4th: "We see this black lava spread out, and forming the summit of the cliffs on the other side of the river. A broad sheet of basaltic lava was also found spread out over the surface of the table-land between the Rio Grande and the Puerco, and along the route taken by the survey between Camps 61 and 62. This is over thirty miles south of the lava at San Felipe, and is directly west of Isleta."

*Sedimentary deposites of the Valley of the Rio Grande.*—The table-lands of the western border of the Rio Grande attain an elevation above the streams in some places of about 500 feet, and present a bluff, precipitous margin towards the east. Little is yet recorded of the lithological character of the strata composing these table-lands, or *mesas*, as they are there called. The bold bluffs certainly present a fine opportunity to the geologist for obtaining sections.

It is believed that these bluffs reveal very nearly the same composition and arrangement of strata as the bluffs of the Llano.

Mr. Marcou notes the occurrence of Cretaceous strata opposite Alameda. They are sandy and decomposing, and by wearing away expose a layer of red marl below.

[1] J. W. Abert's Report of an Examination of New Mexico, p. 452.
[2] Emory's Report, p. 39.

After passing beyond the Puerco, the stream about fifteen miles west of the Rio Grande, he notes white sandstones and grey clays, and, finally, the red clays of the Trias underlying them. As the Puerco has worn a very regular valley in this table-land, and is bounded by it on both sides, we may conclude that the characteristics of the strata are the same both east and west of it. It would appear from the note, November 11, that the surface of the mesa between Albuquerque and Camp 2 is covered with sand, derived from a sandstone beneath, and at the Puerco a porous, white, and friable limestone is found. Lieutenant J. W. Abert observes in his report on New Mexico, that the mesa or table-land [nearly opposite San Domingo, if I am able rightly to locate the description] is 300 feet in height. This cannot be far from San Felipe, and it is probably this bluff, crowned with basalt, to which he refers.[1] As he descended the river he found that "the lower strata of the rocks resembled the saliferous formations on the Rio Canadian." In crossing over the mesa to the Rio Puerco from the place called Atrisco, opposite Albuquerque, Lieutenant Abert found the surface sandy and barren. At Poblazon, on the banks of the Puerco, where there are ruins, he found a high bluff in one place, presenting an abrupt face of 180 feet, and composed of sandstone. These strata contained fossils, "sharks' teeth, shells, and bones of fish." Professor Bailey, to whom these fossils were referred, made the following observations on them: "The fossils from Poblazon consist of gigantic hippurites; casts from the cells of several species of ammonites; valves of inoceramus identical with a species figured in Fremont's Report, Plate IV, figure 2; casts of small univalves and bivalves too imperfect for determination, and teeth of sharks. These fossils prove that the strata from which they were taken belong to the Cretaceous formation."[2] Figures of some of these forms are given in the report. In extending his march westward, Lieutenant Abert followed the valley of a stream, and the sandstone formations on each side rose to the height of 600 feet. Fragments of carbonate of lime, of ammonites, and of pieces of *Inoceramus*, strewed the ground, and "the little knolls glittered with plates of selenite." This mineral appeared very abundant, and could be seen glittering on the sides of distant mountains.[3] At Moquino, a place due west from Albuquerque and the Sandia mountain, and at the western base of the volcano San Mateo, the surrounding country consists of masses of sandstone, overspread by basaltic lavas.

By these fossils, so fortunately collected by Lieutenant Abert, we are authorized to conclude that the white sandstone of the mesas of that region is of Cretaceous age. Of the thickness of the formation at this point it is of course impossible to decide with our present limited information, but it is probable that all the strata exposed along the Rio Grande and Puerco are Cretaceous.

*Alluvial deposites.*—The eastern bank of the Rio Grande does not appear to be bordered by bluffs, except at a few distant points. For several miles above the mouth of the Santa Fé river both sides of the stream are bordered by bluffs, and the valley is narrow, affording no space for agriculture or settlements. South of the Santa Fé the valley widens, and in places the alluvial formation attains a width of several miles; but it is generally narrow, and the soil poor. It is described as a sandy plain, and only cultivable where well irrigated by canals from the river. According to Major Emory, the valley below Angosturas "opens into a plain, varying from two to six miles in width, generally sufficiently low and level to admit the water of the river to be carried over it for the purposes of irrigation; but the soil is very sandy, and better adapted to Indian corn than to wheat."[4]

Opposite Sandia the river is said to be about 100 yards wide, "and, as usual, sandy, shallow, everywhere fordable, and nowhere navigable, not even for canoes. Vegetation, except on the water-course, is poor, the soil generally sandy and dry."[5] At Albuquerque, where the river

[1] See Abert's Report, 1846–'47, p. 463.
[2] Professor J. W. Bailey, in Abert's Report, New Mxeico, 1846–'47.
[3] Abert's Report.
[4] Emory's Report, p. 39.
[5] Wislizenus's Report, p. 34.

was crossed by Major Emory, its width was about twenty-five yards, and its deepest part just up to the hubs of the wheels. In that vicinity the river deflects slightly to the east, leaving a plain between it and the bluffs on the west side. This plain is sandy, destitute of wood, and has but little grass upon it.

Mr. Marcou observes, under date of October 5, that the valley of the river widens considerably between Alameda and Albuquerque, and consists of sandy alluvium similar to that seen above. Sand-dunes were also found at this point, extending parallel with the valley. When he travelled eastward towards the Pass of San Pedro and the Sandia mountain he crossed the plain of the Rio Grande valley, and notes that for ten miles he travelled on the alluvions of the "Rocky mountains."[1] In this distance he doubtless traversed not only the river alluvion, but the detritus or wash from the granitic rocks of the Sandia range, which forms a broad and gradual slope.

The valleys of the tributaries of the Rio Grande in that region appear to have a similar sandy and arid character. Lieutenant Abert observes of the valley of the Puerco, that it is wide and flat, overgrown with varieties of artemisias and coarse grass, fit only for sheep and goats. The banks of the river are of stiff loam. The country around is very much broken with sand-hills. The valley of Jemez river was also found to be sandy; and this is the character of the banks of the Galisteo.[2]

[1] Meaning probably the Santa Fé mountains and ranges in that vicinity.

[2] Abert's Report on New Mexico.

# CHAPTER IV.

## OBSERVATIONS ON THE GEOLOGY OF THE ROUTE.

### FROM THE RIO GRANDE TO THE COLORADO CHIQUITO.

COAL ALONG THE PUERCO.—LAS LUNAS.—BURNING COAL-BED AT CEBOLLETA.—RED SANDSTONE STRATA.—LAVA.—VOLCANO, SAN MATEO.—BLUE-CLAY AND FOSSILS.—COVERO.—LAVA STREAM.—COULEE.—SMALL CRATER.—GRANITE OF THE SIERRA MADRE.—CARBONIFEROUS.—GNEISS.—LIMESTONE ON THE EAST SIDE AT CAMPBELL'S PASS.—SUMMIT.—CARBONIFEROUS.—VOLCANO AT THE SOUTH.—TABLE-LANDS WEST OF THE SIERRA MADRE.—MOUNDS IN PECULIAR FORMS.—EL MORO OR INSCRIPTION ROCK.—PERFECTION OF OLD INSCRIPTIONS SHOWS THE SLOW WEARING OF THE SANDSTONE.—OJO PESCADO.—LAVA STREAM IN THE VALLEY.—LAVA COVERS THE STREAM.—RUINS AT THE SPRINGS.—COAL.—ZUÑI AND ITS VICINITY.—CLIFFS OF WHITE SANDSTONE.—CURIOUS FORMS RESULTING FROM WEATHERING.—TRADITIONS OF A DELUGE.—FOSSILS.—JACOB'S WELL.—DRIFT OF PEBBLES OF JASPER AND AGATE.—PUERCO OF THE WEST.—FOSSIL TREE.—RED STRATA.—GENERAL VIEW OF THE EXTENT OF THE TABLE-LAND.—CAÑON OF THE COLORADO PROBABLY IN THE PLATEAU.—VALLEY OF THE COLORADO CHIQUITO.—RED CLAY AND GYPSUM.—FOSSIL TREES SILICIFIED.—DRIFT.—BASALTIC BUTTES.

Leaving the low alluvial plain of the Rio Grande, and passing westward, the first change in the geology is presented at the bluff which terminates the mesa lying between the river and the Puerco. The paucity of observations respecting the stratigraphical character of this table-land have already been remarked, and its composition noted as far as possible. Of its Cretaceous age there is scarcely a doubt, both from the evidence presented by the fossils collected by Lieutenant Abert at Poblazon, and those found at Galisteo and in the cañons of the Llano on the other side of the Sandia mountains. The presence of the white porous limestone on the bluff next to the Rio Puerco is additional evidence of the similarity of the strata to those just mentioned. Lieutenant Whipple observed the presence of scoriæ and volcanic hills on the summit of the high table-lands, and a few miles further south a continuous layer of basaltic lava covers the strata and extends from the Rio Grande to the Puerco.

*Coal.*—It appears that coal is found at several points on the Puerco river, and particularly at Las Lunas, where, as Lieutenant Whipple observes, it is used by the dragoon blacksmith. This coal is said by Mr. Marcou to occur in connexion with greyish-blue clays, which also contain fossil trees, and is similar to the clay found at the Galisteo river. It is surmounted by yellow sandstone, and the beds dip to the east at an angle of from 15 to 20 degrees. There are no specimens of this coal in the collection, and I cannot venture to affirm its age, although it most probably is Cretaceous or Tertiary. The nearest coal-bed from which we have received any fossils is at the Raton Pass, where Lieutenant Abert collected leaves of dicotyledonous plants, which were examined by Professor J. W. Bailey, and pronounced of comparatively modern origin. It is much more recent than the carboniferous formation. Coal and jet are also found near Lagunas, and, according to Lieutenant Whipple, an excellent bed of coal crops out at Cebolleta, and there were accounts of a burning bed about forty miles further north. Captain Ker, on visiting this locality, found deep fissures from which smoke was issuing, and which led him to conclude that the combustion proceeded from a coal-bed.[1] Lieutenant Simpson also found coal about forty-five miles further north, under yellowish sandstone.[2]

Before reaching Lagunas, Mr. Marcou notes the occurrence of the red sandstone of the "Trias" underlying the blue and grey clays and light-colored sandstone. This formation was

[1] See Lieutenant Whipple's Report, p. 59.

[2] Simpson's Report on the Navajo country, p. 64.

continuous between Camps 63 and 64, and, indeed, was subsequently found along the valleys of all the streams as far west as the volcano of San Francisco. This formation appears to differ from that under the white or light-colored sandstones on the east side of the mountains, by the absence of the thick beds of red clay or marl. Here, the summit is formed of red argillaceous sandstones. Under this, gypsum occurs, and then red sandstone again. (See notes, November 13.) On the banks of the San José, just below Lagunas, the black front of a stream of lava is found, which appears to have followed the river valley. This, according to Mr. Marcou's observations, is one of the streams of an extinct volcano called San Mateo, and by Lieutenant Simpson, Mount Taylor. It rises about twenty miles north of the line of survey, and has covered the surrounding country with its outpourings of molten rock, which now rests like a black mantle over the horizontal sedimentary strata, and in many places protects them from denudation. According to Lieutenant Simpson, this peak can be seen from Fort Marcy and other places over one hundred miles distant.

Beyond Laguna, the sides of the valley were formed of blue clays, covered by yellowish-grey sandstone; these are surmounted by strata of yellowish-blue clay, containing fossils. In the notes, Mr. Marcou calls these fossils *Gryphæa dilatata*, and scales of saurians. Higher up, a yellowish-grey sandstone is found, containing "*Arca* and *Irsocardia*." The lava proceeding from the volcano, Mount Taylor, covers all these strata. (See notes, November 14.) The occurrence of these fossils at this locality, so near the bed of coal, is very interesting and important, but no specimens are found in the collection.

Beyond Covero, the light-colored sandstone is exposed for a short distance, and is then hid from sight by a covering of black lava. At a point five miles from the village, the trail passed a stream of scoriæ, which was found to be continuous to Camp 65, where it was in connexion with the lavas which come from San Mateo. "The lava and scoriæ are black and porous, with all the conditions of plications and contortions which are found in other countries." (See Mr. Marcou's notes, November 15.) Lieutenant Whipple observes as follows: "The whole length of the valley followed to-day has been threaded by a sinuous stream of lava. It appears as if it had rolled down a viscous semi-fluid mass, had been arrested in its course, hardened, blackened, cracked, and in places broken, so as to allow the little brook to gush out from below, and gurgle along by its side. The lava bed is frequently a hundred yards in width, the cross section being a semi-ellipse, in the centre probably thirty feet high."[1] This peculiar undulating and curved surface, so characteristic of lava streams when partially cooled, was also noticed by Lieutenant Simpson just before entering the valley of San José. At that point there were "hundreds of acres of volcanic rock, a great deal of it exhibiting with marked distinctness the undulations of the wave, in its oscillatory motion."[2]

Between Camps 65 and 66, Mr. Marcou records a great lava stream called the *Couleé;* this is two or three miles wide, and extends to, and beyond, Camp 66. About twenty miles northwest of Camp 65, and on the borders of the San José, there is a crater from which a very considerable stream of lava has descended, and flowed southeast along the valley. It is believed to be continuous to near Camp 65, and to mingle with the streams which have descended Mount Taylor. The position of this crater is shown on the map.[3]

*Sierra Madre—Granite and carboniferous rocks.*—Camp No. 66 was upon the granitic rocks of the Sierra Madre, the second great mountain range crossed by the survey. This granite, according to Mr. Marcou, is coarse-grained, and of a rosy color. There is but one specimen in the collection, No. 6 of the catalogue and description. It is coarse-grained and feldspathic, containing two varieties of this mineral, one white and the other red. A white, silvery mica is also present. This granite appears to have been exposed from Camp No. 66 to No. 67, where it was covered by lava. Mr. Marcou mentions the possibility of his having passed outcrops of car-

[1] Lieutenant Whipple's Report, p. 62.
[2] Simpson's Navajo Report, p. 128.
[3] I am indebted to Mr. Campbell for this information.

boniferous limestone and sandstone before reaching Camp 66. In the Resumé, he is quite positive on this subject, observing that the Trias is replaced by the Carboniferous limestone, which is succeeded by granite, gneiss, &c. Gneiss was seen from Camp No. 67, near the summit, both north and south of the camp. The width of this exposure of granitic rocks is about twelve miles along the route, and this is the distance given by Mr. Marcou in his Resumé. The survey, however, crossed the range at one of its lowest points, where, also, the wide-spread sheets of lava had covered much of the rock from view. There is no doubt that a few miles either north or south the granitic rocks have a much wider exposure, as the mountains rise to a great height, and are composed of hard, rugged rocks. The chain, or the granitic exposure, does not, however, extend many miles north, as Mr. Campbell crossed from the head-waters of the Rio San José to those of the Puerco of the west, several miles northwest of the summit, at Camp 67, without crossing the granite, he being on the red sandstone strata all the way. He saw the granite on the south of his trail, and also noted a bed of limestone, which is probably Carboniferous. This limestone is believed to be on the eastern flank of the mountain, and to dip towards the Rio Grande. It appears from Mr. Marcou's notes that the summit-rock at the pass, at an elevation of 8,000 feet, is of limestone and sandstone, with the strata dipping west. He thought it most probable that these strata were Carboniferous, and so denominates them in the Resumé. Lieutenant Whipple, when describing the characters of the summit or dividing ridge between the ravines on opposite slopes of the mountains, says that the rock is a compact limestone. The presence of the red sandstone is also recorded by Mr. Marcou, and it contains its usual associate, the white gypsum.

On descending from the summit the trail passes a lava stream which appears to have proceeded from the south, where Mr. Marcou saw a high mountain, to all appearance a volcano with two or three secondary cones, the highest of which was estimated at 10,000 feet. This is the third volcanic centre noticed along the route. Mr. Campbell informs me that this stream of lava which was crossed extends for a long distance northward along the base of the Sierra Madre. Before taking leave of the eruptive rocks of this mountain range, it should be remarked that it is apparently the continuation of the ranges at the north called *Sierra de Tunecha* and *Sierra Chusca*, at the western base of which Fort Defiance is located. This place has already become known, at least by name, to mineralogists as a locality from which great quantities of beautiful garnets are obtained. They are probably collected in the beds of streams flowing from the granitic and metamorphic rocks of the mountains.

*Region west of the Sierra Madre.*—The country west of the Sierra Madre presents, in its topographical aspect, a great similarity to that on the east of the Sandia and Santa Fé mountains, except that it is more cut by streams, and is not, on the whole, so arid and forbidding. It is a region of elevated table-lands of nearly horizontal strata, which are cut through in all directions by the streams, leaving here and there isolated mesas of all areas, from a few square feet to many square miles. Lieutenant Simpson, who was one of the earliest explorers of this region, describes the country as consisting of "low mesas, blackened along their crests by outcrops of basalt." At other places the white and red sandstone strata are moulded into fantastic shapes, "some of them looking like steamboats, and others presenting very much the appearance of façades of heavy Egyptian architecture."[1] The singular forms which these strata assume, by the erosion of streams and long exposure to the weather of that peculiar climate, have attracted the attention of every traveller, and resemblances to buildings and steamboats are constantly noted. The isolated columns, with the natural layers of the rock piled one on another with the utmost nicety and regularity, are often mistaken for works of art, and monuments of giant races now lost to the earth and to history.

*El Moro, or Inscription Rock.*—This rock, already made famous by the number and variety of the ancient inscriptions and hieroglyphics which adorn its face, is directly on the line of the survey and about sixteen miles distant from the summit of the Sierra Madre. I present here

[1] Simpson's Navajo Report, p. 118.

Lieutenant Whipple's description of the form of this remarkable rock. Approaching its north-east corner, which is rectangular, the cliffs appear truly vertical and smooth to the height of nearly 200 feet. Here are found the Spanish inscriptions and the Indian hieroglyphics. Upon the eastern face the rock projects somewhat like a bastion. At the reëntering angle there is a semi-cylindrical recess, slightly shelving and as smooth as if a cascade had poured for ages over the top. Below is a spring or pool of water, supplying the camp, but affording barely sufficient for the mules and cattle. The summit of the rock, which is of white sandstone with a yellowish tinge, is broken so as to present at a distance the appearance of turrets like a Moorish castle, from which its Spanish name was derived.[1] Lieutenant Simpson describes the rock as a quadrangular mass of sandstone, of a pearly-whitish aspect, from 200 to 250 feet in height, and strikingly peculiar on account of its massive character, and the Egyptian style of its buttresses and domes.[2] The drawings made by Mr. Kern, and published in Lieutenant Simpson's report, show at once the stratified and horizontal character of the rock. It must be composed of very thick beds of homogeneous sandstone, without coarse pebbles, or many partings of the strata, or alternation with shales. According to Mr. Marcou, the rock is a rose-colored sandstone, the same which is seen along the valley leading from the pass of the Sierra Madre. This rock appears to be a remnant of the wide table-lands, and stands alone, very much like the Tucumcari hill in the valley of the Canadian. Its peculiar vertical bluffs, with the flat, smooth side-faces, result entirely from natural causes—the erosion of the streams and the slow, and indeed almost imperceptible wearing produced by the weather. The inscriptions become exceedingly interesting to the geologist, for the evidence which they afford of the remarkably slow disintegration of this sandstone. This rock, although soft enough to receive the inscriptions with ease, has retained the finest lines of writing which was cut two hundred and fifty years ago. The Indian hieroglyphics, alone, show the effects of long exposure, and how great their age must be when the lapse of two hundred and fifty years does not suffice to dim the clearness of an inscription.

These peculiar and isolated hills, with their level summits and inaccessible vertical sides, are well fitted for the abode of warlike savage tribes, and the former inhabitants have not failed to avail themselves of the advantages which they present. The stone which was used for constructing the buildings, the ruins of which are described by Lieutenant Whipple and others, was probably quarried from the sides of the bluff.

*Ojo Pescado.*—A stream of lava extends across the route a short distance west of Inscription rock, and another is found farther west, and this follows or lies along the bottom of the valley which received and gave it its direction when it was a molten river of rock. Now, it is entirely cold and covered by a soil resulting in part from its decomposition. The expedition followed this grass-covered lava for fourteen miles, until it reached a break where a beautiful spring gushes out and forms a running stream. Here, then, we have the usurpation of a river valley by a river of melted rock which has obliterated all trace of the water for a long distance, but which probably permits its underground flow, with but little or no diminution of its former volume. The spring may be regarded as the reappearance of the stream after its long flow under its rocky covering. Only a short distance below, a second and similar spring and stream was found. Both of these springs were surrounded by ruins which are supposed to be very ancient. They were probably built at those points in order to enjoy the water of the springs. The lava stream was therefore much older than the buildings, as indeed is shown by its soil-covered surface. It appears a very plausible explanation of the desertion of these once extensive settlements, that incursions of lava dried up or covered the water-courses, destroyed agricultural land, and drove the inhabitants away in alarm. It is not improbable that overflows from the volcanoes of that region have taken place within the historic period; but, although the streams, and indeed the great body of the lava, is very recent, the position of the ruins at this

[1] Lieutenant Whipple's Report, p. 64.
[2] Simpson's Navajo Report, p. 120.

and other places shows that the surface of the country was nearly the same as now at the time of their erection.

*Coal.*—The sides of the valley above the lava are, according to Mr. Marcou's notes, of rose-colored micaceous sandstone in beds from 15 to 40 feet thick. At the base of the cliff, however, blackish grey shales occur, containing beds of yellow limestone three feet thick. Several beds of marl are very black and bituminous, and contain seams of coal from six inches to one foot thick. Captain Whipple observes of this coal that the specimens appear good, but the quantity is probably small. A specimen of it is in the collection, (see No. 98 of the catalogue,) and a full description of it is given in Chapter X. The quality of this specimen is not good, it being full of impurities and yielding a large quantity of ash. It more resembles recent coals of the Tertiary formation, than the deposites of the Carboniferous period, but it is not possible to decide upon its age.

Thirty miles north of this locality, and on the road to Fort Defiance, Mr. Campbell found similar dark-colored shales, bituminous, and looking as if coal was in the vicinity. This is, without doubt, the extension of the same deposite, as the whole country is formed alike and the strata are horizontal. It is also most probable that the deposites of coal found by Lieutenant Simpson, east of the Sierra Madre and north of the volcano San Matéo, are of similar age. The beds at Laguna and Las Lunas, and which have already been noticed, (page 36) may also be included. The bed noticed by Simpson is found in a table-mound, and is a horizontal layer between two beds of sandstone. It was also overlaid by gypsum. The other bed, in the *Cañon de la Copa*, is one foot thick, and when broken shows resinous particles.[1]

The lava stream which forms the walls of the spring Ojo Pescado, appears to extend much farther down the valley, and terminates a short distance beyond Camp No. 70. The Pescado river passes under this lava for several miles, and again emerges, to be then known as the *Rio de Zuñi*.

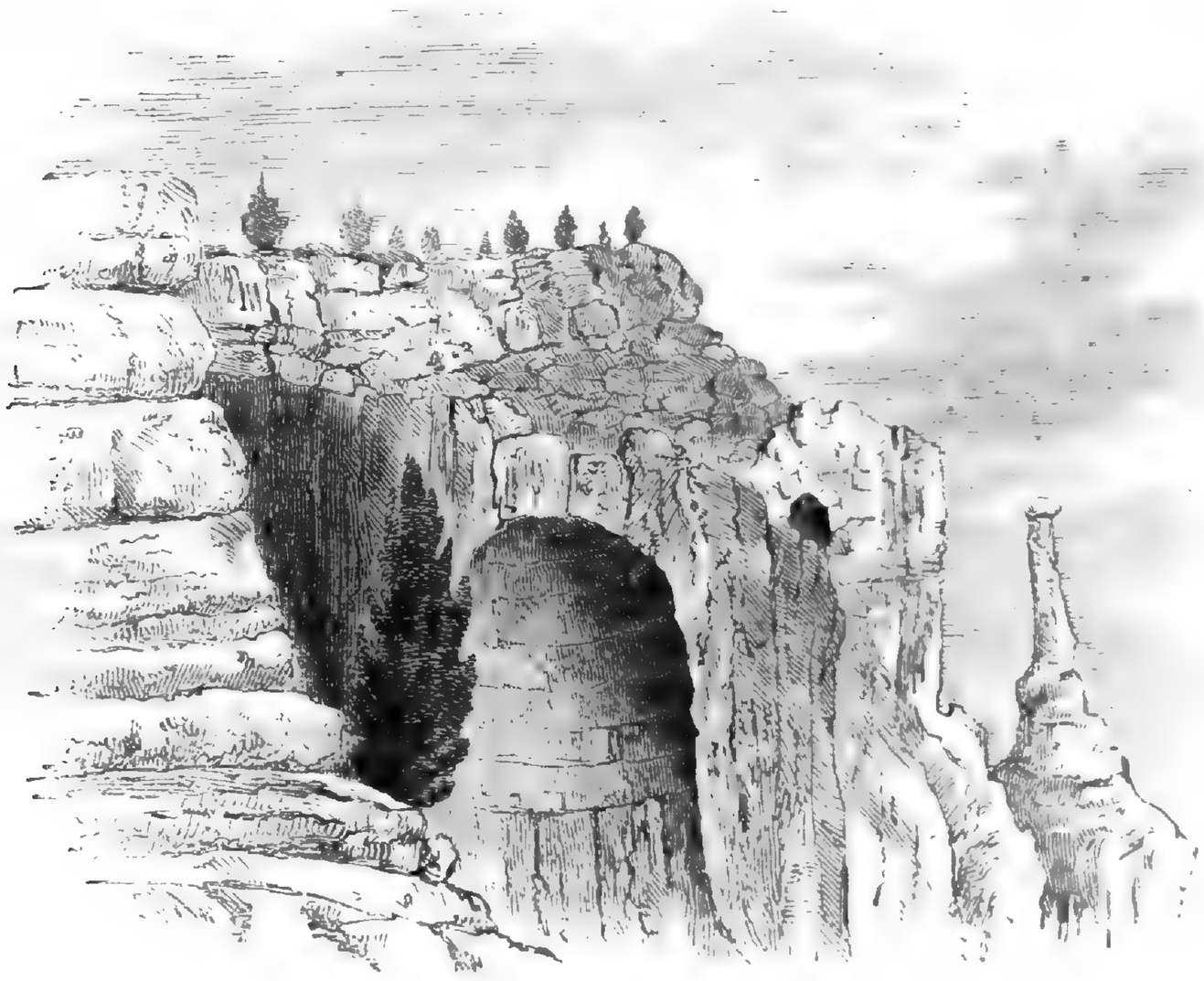
*Zuñi and its vicinity.*—The town of Zuñi, a short distance beyond Camp 70, is upon the borders of Zuñi river, and, according to the observations of Mr. Marcou, is upon the Triassic formation—the reddish clays and sandstones which contain the gypsum. Grey and white sandstones are, however, found, but the bottom of the valley is entirely of rose or wine-colored strata. (Notes, November 25.) The lighter-colored sandstones of Cretaceous or Tertiary age—the Jurassic of Mr. Marcou—have been subjected to considerable erosion at this place, and a wide valley is formed by the union of the smaller valleys of the affluents of the Zuñi river, the cliffs of the white sandstone being removed to some distance from the river on each side. The ruins of Old Zuñi, about five miles southeast from Zuñi, are, however, on the summit of a bluff crowned by these strata. This bluff is said by Captain Whipple to be about 1,000 feet high, and has a broad flat summit a mile wide, covered with thick cedars. It is, in fact, an isolated mesa, limited on all sides by precipitous banks. These banks have been worn into many fantastic shapes by the action of the weather for ages, and here and there arches and columns are seen which seem to be the work of art, so regular and symmetrical are the outlines. The annexed sketch, taken by Captain Whipple from a projecting part of the summit, shows these peculiar forms, and has an additional interest from the fact that the column which stands alone near the main bluff is connected with the traditionary legend of the Zuñians. It is supposed to be the petrified body of one of their tribe who was drowned to appease the Almighty at the time of their flood. Another column is found near, but is not seen in the sketch.[2] Very similar columns are figured by Lieutenant Simpson and by other explorers; indeed, they are very common on the borders of the table-lands west of the Sierra Madre.

The explanation of the origin of these sandstone columns, and of the many other similar shafts found in that region, is very simple. They are formed in the same manner as the

[1] Simpson's Navajo Report, p. 72

[2] This tradition is interesting, and is another form in which the almost universal idea of a deluge is found among heathen nations. The tradition is partly given by Lieutenant Simpson in his report, and more fully by Captain Whipple, p. 67.

table-mounds, by the erosion or cutting of running water, which separates them from the mound or bluff. The degradation or wearing of the sides proceeds more rapidly than the top, so that they become gradually narrowed down to slender shafts, without becoming diminished in height. They are beautiful monuments of the gentle but persistent action of the weather in that climate.



NATURAL PINNACLE AND ARCH, ZUÑI.

The table-lands both north and south of Zuñi are dotted at intervals by remnants of the upper strata, standing alone with flat summits. The yellow and white sandstones appear to be gradually broken away and denuded from this point westward, becoming less continuous and not presenting a thickness so great as farther east.

*Fossils.*—Between Camps No. 71 and 72, Mr. Marcou found some fossil-shells of the genus *Gryphœa*, and the trail rose from the bed of the Zuñi river to the top of the table-lands, where the light-colored sandstones were again met and crossed. This plateau is between the Zuñi and Puerco rivers.

*Jacob's Well.*—At Camp 73 a remarkable well was found. This is described by Captain Whipple as a funnel-shaped depression, about three hundred feet wide at the top, and one hundred and twenty-five feet deep. Water is found at the bottom. It was evidently not the work of art, as there was no vestige of any removed earth around the pit. Several other pits of a similar character were also seen in the vicinity. It is most probable that these depressions are caused by the caving in of the ground over cavities or caverns, caused either by the flow of subterranean streams or the gradual solution of thick beds of gypsum.

Mr. Marcou notes the occurrence in this vicinity of pebbles of red and yellow jasper. This reminds the geologist of the "drift," found on the surface of the Llano and table-like hills on the east of the Rio Grande valley.

*Puerco of the west.*—The Puerco river, like the Zuñi, rises near the western base of the Sierra Madre, and flows in a valley with vertical walls of sandstone strata towards the Colorado Chiquito. After passing Jacob's Well the survey descends from the table-land over the reddish sandstone strata to the bed of the stream. On this slope the alluvial pebbles of agate, jasper, &c., and a fossil tree, were found.

Up to this point the upper or Cretaceous strata have been found to overlie the red sandstone on all the table-lands; but now broad areas are seen, composed of the red strata alone, and

remnants of the upper strata are found only here and there in isolated bluffs. Thus we find the conditions on this side of the Anahuachian chain very similar to those on the east, where the Great Llano breaks off into isolated hills and then disappears altogether. On the western side, the transition is not quite so abrupt; the strata appear to have been denuded more from the surface downward, so as to thin out gradually without leaving long lines of bluffs or escarpments as on the Llano. The general limit of the formation is shown on the map, although there are doubtless many isolated hills of the Cretaceous scattered over the plain and not represented.

*Extent of the table-lands west of the Sierra Madre.*—This is a convenient point from which to take a general view of the broad expanse of the great plain that lies between the Sierra Madre and the mountains, which form the eastern rim of the Great Basin. From the Sierra Madre up to this place, the survey followed the eroded valleys of the streams, and the vision was bounded on both sides by their high and rocky banks, composed not only of the edges of thick horizontal strata, but often capped with the harder and more unyielding solid lava. The observer, as he passes westward from the mountains, is thus placed below the general level of the plateau, which does not become apparent to him unless he stands upon the top of the mesas and can thus cast the eye over the whole. The point already reached in the description is about half way between the Sierra Madre and the high mountains of San Francisco, and here, as we have seen, the upper strata of the plain are denuded and washed away, so that the banks of the streams are not so high, and the country appears more level or gently rolling. From this place the vision is unbounded towards the north, except by the horizon. The plain stretches far away, without any vestige of a mountain range. Indeed, it is the continuation of this plateau which rises upon the flanks of the Park and Wasatch mountains at the far north, and through which the waters of Grand and Green rivers cut their deep cañoned channels. Farther south, these streams unite to form the great Colorado, which is also found traversing this grand plateau. The course of this river is marked by one of the most stupendous valleys of erosion known to geologists. This is the great cañon of which vague accounts have reached us from time to time, and which yet remain to gratify the sight of some future explorer. This great vertical cut through a vast thickness of horizontal strata must of necessity exhibit them under circumstances peculiarly favorable to the geologist, who can there observe their succession and thickness from the top to the bottom. It is believed, by those who are best qualified to judge, that this cañon in some places is not less than two or three thousand feet deep, the sides being vertical. It is, therefore, probable that the edges of the Cretaceous, the underlying red clay and gypsum formation, the coal measures and the carboniferous limestone are exposed to view in a regular succession on the walls of this mighty chasm. Undoubtedly also the summit is crowned with more modern strata, the Tertiary, and then again by the outpourings of lava from the adjoining volcanoes. What a mine of fossils from different chapters of the world's history must be exposed here in readiness for the student! It has been generally supposed that this great cañon was in granitic or eruptive rocks; but this, I think, can scarcely be, although it is undoubtedly true that rocks of this character are exposed at the base of the bluffs. The approximate position of this cañon is shown on Captain Whipple's map.

South of the line of survey the same plain extends until it reaches the Mogoyon mountains, which appear to be its southern and southwestern boundary. According to Mr. Marcou the strata dip away from this range, the heads of the beds being turned towards it. This dip is, however, very slight, seldom or never exceeding ten degrees, as will be seen by Mr. Marcou's notes.

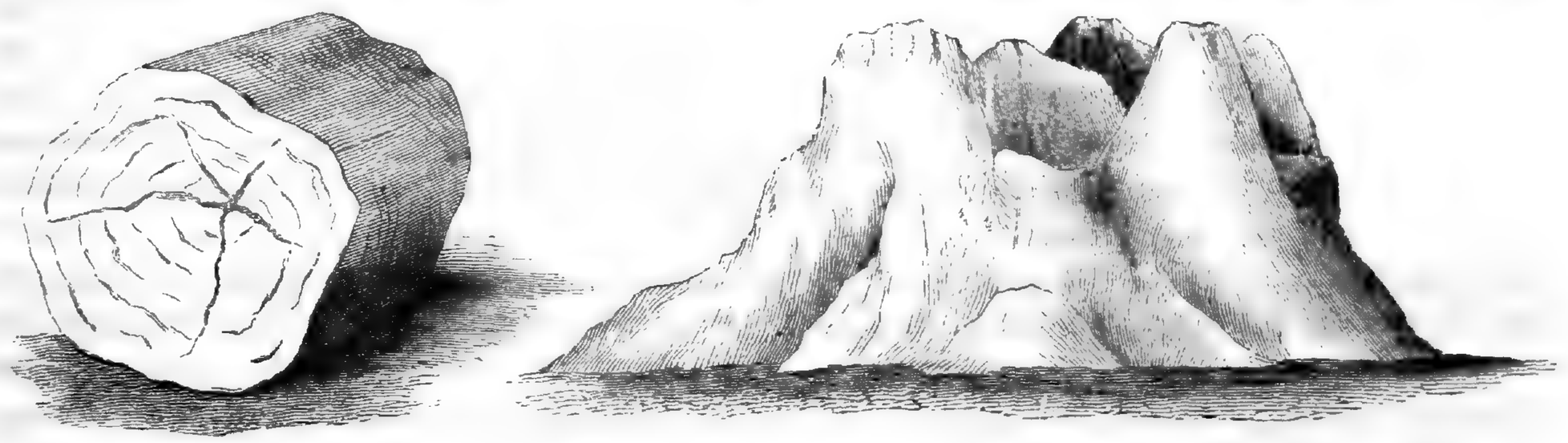
*Valley of the Colorado Chiquito.*—The mineral characters of the strata exposed along the line, in the valley of the Colorado Chiquito, do not appear to differ materially from those already mentioned as characterizing the gypsum formation on the Atlantic slope. Gypsum, however, does not appear to have been found in abundance on this part of the line. The presence of thick beds of white and grey and bluish marls is mentioned by Mr. Marcou, and near Litho-

dendron creek grey and pinkish sandstones were found in beds from three to six feet thick, but even at this locality the red clay predominates. (Notes, December 3.)

*Fossil wood and trees, Lithodendron creek.*—After travelling a short distance down the Puerco, on its northern bank, and crossing several tributary streams, the camp was pitched on the borders of a stream to which Captain Whipple has given the name Lithodendron creek. At this place, according to Captain Whipple, the banks are forty feet in height, and are composed of red sandy marl. In these banks, and on the surface of the ground in the valley of the creek, great numbers of well preserved fossil trees were found. Captain Whipple mentions this deposite as quite a forest, the trunks lying prostrate and buried in marl. One trunk measured ten feet in diameter, and was more than one hundred feet long. Mr. Marcou records the occurrence of these fossils as follows: "Many fossil trees were seen; some of them are four feet in diameter, and are divided into blocks one to two feet long; they are silicified and are brilliantly colored. Some of them contain very clear quartz crystals on the round part of the trunk." (See notes, December 2.) The following figure is from a sketch by Mr. Möllhausen, and represents one of the prostrate trunks.

SILICIFIED TRUNK OF A TREE, LITHODENDRON CREEK.

Captain Whipple gives an interesting figure in his report, which serves to represent the relative size of one of the trees, and a remarkably irregular surface. Captain Whipple, Mr. Möllhausen, and Mr. Campbell are of the opinion that the stumps of these trees are found there; and a sketch, by Mr. Möllhausen, of one of them is here given, together with an enlarged view



SILICIFIED STUMP AND BLOCK.

of one of the broken logs. This regular fracture, directly across the stony trunks, is very peculiar, and was seen in all of the specimens. Mr. Campbell noticed these interesting relics very particularly, and saw, as he thinks, several erect stumps. North of Camp 76 he found the trees lying on the ground, and protruding from the bank at least one hundred feet below the surface of the bluff.

The trees are mostly horizontal, and lying in various directions. One of them was found to be forty feet long, and from three to four feet in diameter. This was merely the main trunk or body of the tree, and no branches were seen; it must therefore have been much larger originally. After these trees are exposed, they seem to lose their solidity, and break up into angular fragments. The trees were most numerous in the valley of the creek, but they were found lying on the surface above it. The outer portions are generally of a darker color than the interior, and frequently rings of various colors, red, yellowish and grey, are found, which give a variegated and pleasing aspect to these interesting remains of a former forest. Simpson, in his journal, gives a description of a large fossil tree, and exhibits its various tints by a colored lithograph

Fragments are also found in the detritus from Leroux's fork and other small streams coming down from the plains at the north. Several specimens of these fossil trees are in the collection, and they exhibit a pleasing variety of color and grain. Some are much more perfectly preserved than others; and the rings of annual growth, the medullary rays, and the cells, are distinctly and beautifully preserved, and can be clearly seen by the naked eye.

One of the specimens, which is very compact, and homogeneous, and as hard as rock-crystal, presents a variety of colors, and resembles a beautiful agate. One side is of a deep carnelian-red color, and the other is nearly transparent and colorless, but has a milky or semi-opaline whiteness, like specimens of calcedony. Intermediate portions of the mass are yellowish, and streaks of red, brown, and yellow are found in almost all parts of it. At first sight, the specimen appeared to be an agate and devoid of structure, but the parallelism of several threads or streaks of dark brown running through one end of the specimen invited a closer examination, and in this the beautiful ligneous fibre was found perfectly preserved; and when a plate was polished, the woody structure was most distinctly shown. In some portions of the specimen, however,—especially in the white and nearly transparent parts—the structure was almost wholly obliterated, and if these parts alone had been collected their vegetable origin would not have been suspected. The variety of color presented by this mass, and the exquisite preservation of the minutest fibre and cell of the former wood in dense glassy silica, and the absence of all open cells or pores, rendered it peculiarly suitable for cutting and polishing, and several ornamental stones cut from it for bracelets, &c., are very beautiful. Another specimen, also very dense and beautifully preserved, shows the effect of pressure and fracture after the silicification was complete, or during its progress. Fragments of the wood are seen separated from each other, and firmly imbedded in dense white silica, which was infiltrated, and is disposed in concentric layers, agate-like in the larger spaces. The polished surface of this specimen is exceedingly beautiful, every pore and fibre of the wood being well preserved, and the angular fragments being set in the white agate base, so as to form a perfect mosaic. Thin slices have been cut by the lapidary from all these specimens, in different directions, so as to permit the structure of the cells and fibres to be studied under the microscope. These slices are ground very thin and are highly polished, so that they readily transmit the light. They have been placed in the hands of Professor Schaeffer, of Washington, for examination and description.

*Drift.*—Beyond this remarkable locality of silicified trees, the ground in many places was found to be strewed with their fragments, and these were mingled with pebbles of agate and jasper, the whole forming a mass of detritus or drift which was occasionally very abundant. Several specimens of these rolled pebbles are in the collection, and consist of compact red and yellowish jaspery rocks, one of them being cut in every direction by a multitude of thin quartz veins, from the thickness of paper to one-eighth of an inch, which form a net-work and enclose the masses of compact red jasper. This stone when polished exhibits the veins distinctly, and yields beautiful ornamental stones. That the mass was thoroughly solidified before it became traversed by the quartz veins, is clearly shown by the sharp angles at the intersection of the fissures and by the numerous faults along some of the veins, showing that they are of different ages. Mr. Marcou also mentions the occurrence in the drift and in the streams of numerous carboniferous fossils, much rolled and worn by attrition. These he supposed to have been transported from the mountains in the south—the Sierra Mogoyon or Sierra Blanca. The strata also, further on, appeared to dip away from this range towards the north.

From Lithodendron creek westward, along the valley of the Colorado Chiquito, the red sandstones and red marls were found on both sides, and the upper or lighter-colored strata entirely disappeared or were present only here and there in isolated mounds far from the trail. Below the point where the stream was crossed, several buttes, supposed to be volcanic or basaltic, were seen on the right bank.

# CHAPTER V.

## OBSERVATIONS ON THE GEOLOGY OF THE ROUTE.

### FROM THE COLORADO CHIQUITO TO SAN PEDRO.

FROM THE COLORADO CHIQUITO TO THE GREAT COLORADO.—MAGNESIAN LIMESTONE.—CAÑON DIABLO IN LIMESTONE.—SIMILAR LIMESTONE AT OTHER PLACES.—GRANITE, OLDER THAN THE MAGNESIAN LIMESTONE.—EXTINCT VOLCANO, CALLED SAN FRANCISCO MOUNTAIN.—LAVA STREAMS.—SECONDARY CONES.—VOLCANIC ASHES.—DIRECTION AND EXTENT OF THE LAVA STREAMS.—SANDSTONE.—BILL WILLIAMS' MOUNTAIN, VOLCANIC.—ITS LAVA STREAMS.—CARBONIFEROUS LIMESTONE.—PICACHO, OF GRANITE.—CARBONIFEROUS LIMESTONE AND FOSSILS.—AZTEC MOUNTAINS.—HORIZONTAL STRATA FORMING A CLIFF.—LAVA.—CYGNUS MOUNTAIN.—AQUARIUS MOUNTAINS.—GNEISS AND METAMORPHIC ROCKS.—TERTIARY STRATA.—TRAP DYKES.—VALLEY OF THE HAWILHAMOOK.—CERBAT MOUNTAINS.—VOLCANIC ROCKS.—COLORADO RIVER.—COLORADO RIVER TO SAN PEDRO.—GRANITIC RANGES.—GREAT BASIN.—SODA LAKE AND MOJAVE RIVER.—NATURE OF THE INCRUSTATION.—SAND-DUNES.—METAMORPHIC ROCKS.—SOIL OF THE SLOPES.—CAJON PASS.—SANDSTONE, PROBABLY TERTIARY.—GRANITE AND METAMORPHIC ROCKS.—TERTIARY STRATA.—FOSSILS.—RECENT ELEVATION.—BITUMEN AND TAR SPRINGS.—TRAP-ROCK.—ALLUVIAL.

#### I. COLORADO CHIQUITO TO THE GREAT COLORADO.

*Magnesian limestone.*—After crossing the Colorado Chiquito and ascending the western bank as far as Camp 86, Mr. Marcou found sub-schistose red sandstone with ripple-marks, and red clay. These were underlaid by a magnesian limestone, or thick dolomite, stratified regularly in beds six inches to one foot in thickness. These strata were conformable with the red sandstones, and, like them, were inclined towards the north, at an angle of ten to fifteen degrees. Some of these limestone beds alternate with the sandstone, and were fossiliferous, but the fossils were very badly preserved. (Notes, December 22.) This limestone was found along the trail continuously for four miles, when it was hid from sight by sheets of lava. A specimen of limestone from the Colorado Chiquito (No. 62) is probably from this locality. A description of it will be found in Chapter X.

This limestone forms a broad mesa or table-land just south of Camps 86 and 87, and this was traversed by Mr. Campbell and Captain Whipple. The former describes the limestone as exactly like that afterwards found further west, and which contained fossils characteristic of the Carboniferous period. The stream or valley called Cañon Diablo is in this rock. The beds dip gently towards the north, and thus do not form any bluff towards the river; but the borders of the Cañon Diablo are precipitous, and the bluffs in some places are one hundred feet high, and entirely of limestone. Captain Whipple describes this cañon, in his report, as a chasm one hundred feet deep, with sides so precipitous that it was impassable. The surface around was nearly level, and the cañon could not be seen until its very brink was reached. From here, westward, the surface of the country appeared nearly level. Similar limestone was seen at Camp 90, just at the southern base of the great volcano. Still further west, a similar limestone formed the sides of the ravine called Parke creek, north of Camp No. 94. These several outcrops of horizontal, or nearly horizontal, limestone strata, at very nearly the same level, indicate that they form one continuous bed; and this is rendered more probable by the similar mineral character of the rock at the different places. It is difficult to decide upon the geological age of this limestone, which is not represented in the collection by fossils, unless we regard the outcrop found near Camp No. 96 as a portion of the same bed. This outcrop is also

called magnesian limestone by Mr. Marcou; but he found in it the fossils characteristic of the mountain limestone or lower Carboniferous.

*Granite.*—Near Camp 90, just at the southern base of the volcano, an outcrop of granitic rock was found. This, according to Mr. Marcou, was "a great mountain of red sienitic rock;" and Captain Whipple states, page 80, that the volcano terminates at the southeast in a gigantic mass of granite. I have, therefore, represented an outcrop of this rock on the map and section. The magnesian limestone was found in horizontal beds a short distance below; hence I infer that the granite is older than it. It is very probable that Mount Kendrick and Mount Sitgreaves, on the west of the volcano, are of granite also, and connected with the first-mentioned outcrop. According to Mr. Campbell, Mount Kendrick is composed of chocolate-colored porphyry. I regret that there are no specimens from these rocks in the collection.

*Extinct volcano, called San Francisco Mountain.*—In the preceding observations on the outcrops of limestone and granite, we passed rapidly from the banks of the Colorado Chiquito to a point several miles west of the great volcano, now extinct. This cone rises north of the line followed by the expedition, and is on the left bank of the Colorado Chiquito. It is unfortunate that this lofty and imposing peak cannot be distinguished by a name which will not lead to endless misapprehension of its position. Nearly all who are not aware of its existence, will, on seeing its name, conceive it to be near the great city of the same name on the Pacific. If the Indian name can be ascertained, it should be adopted. The trail of the expedition passes directly at the southern base of the mountain, over the limestone and granite already described, and in many places over the streams of congealed lava.

The peak is a prominent land-mark to the traveller in passing westward over the plains beyond the Sierra Madre. It was seen by Captain Whipple, for a long distance, and was used as a guiding pillar for the survey. Its elevation was estimated as about 5,000 feet above the plain, or 12,000 feet above the sea. In form or outline it is not remarkably regular, but yet has a general conical shape. The flanks are covered with congealed lava streams, which extend far from its base and cover a wide area of the surrounding plains. The line of survey first reached this lava between Camps 86 and 87, where the limestone was left, and the ascent upon the surface of the lava commenced. From this point onward, until the mountain was passed, the road led over a succession of lava streams or broad beds which covered the underlying strata from view. Before the base of the principal mountain was reached, numerous secondary cones or outlying vents for the lava were found. These were near Camp 87, and, according to Captain Whipple, are beautifully regular in form, and one of them appears to have broken away at one side, permitting a stream of lava to flow from it in a serpentine course. This has hardened in its bed, and now reveals the motions to which it was subjected, almost as distinctly as if it had flowed down but yesterday. This lava is of a black color, and very hard, but in some places is decomposed on the surface so as to form a soil, which appears to be particularly favorable for the growth of the nutritious grama grass. A portion of the lava is cellular and porous, and between Camps 88 and 89 volcanic ashes were found. This was also abundant towards Camp 90, almost directly south of the great cone. Mr. Marcou also records the presence of numerous basaltic dykes and reddish lava. Amygdaloidal trap was found at Leroux's spring, and beyond. The principal flow of lava from this volcano, and its numerous cones, appears to have been towards the east, where it has spread out even to the banks of the Colorado Chiquito at the Cascades, several miles north of the point where it was crossed by the survey. The flow in this direction is in accordance with the present relief of the surface, and shows that at the period of eruption the valley had very nearly its present form.

*Sandstone.*—Mr. Campbell informs me that the limestone south of the volcano is covered in many places by mounds or table-hills of a light-colored sandstone in horizontal beds. This is not described by Mr. Marcou. It may be the continuation of the lower beds seen at the crossing of the Colorado Chiquito.

*Bill Williams' Mountain.*—This peak is probably another extinct volcano of great extent. It

rises about forty miles southwest of San Francisco mountain, and, like it, has poured out immense fields of lava which cover nearly the whole region. The first stream from this crater was crossed at the head-waters of Parke creek, just beyond Camp No. 95, but the most extensive overflow was not found until the survey reached the head-waters of Partridge creek, at Camp 97, the lava being continous from this point to the Picacho, or Camp 99, a distance of twenty miles. The greatest flow from this mountain appears to have been towards the north or northwest. The lava extends north of the trail, and spreads out at the base of an eminence called *Pineveta*, which is probably of stratified rocks.

*Carboniferous limestone.*—The occurrence of limestone containing carboniferous fossils, near Camp No. 95, has already been mentioned. Mr. Marcou found at this locality three or four beds filled with fossils like those at the Pecos villages. He enumerates them in his notes as *Productus reticulatus*, *P. punctatus*, *Spirifer*, *Terebratula*, and *Polypi*. These were very abundant and formed a lumachel. Some fossils from this locality are in the collection, but they are so badly preserved, that their specific characters cannot be determined. It is doubtless the carboniferous limestone. It would appear that this limestone extended for several miles along the trail, and was found beyond Camp 96. It will be seen, on looking at the map, that the limestone called magnesian, along Parke creek, is in close proximity with these outcrops.

After leaving the carboniferous limestone beyond Camp 96, the trail passed over a bed of lava, and then Mr. Marcou found sandstone strata dipping from sixty to eighty degrees, and trending northwesterly. He considered this sandstone to belong to the upper Carboniferous formation. He describes the strata as hard and schistose, harder than the "New Red" sandstone of the prairies. Beyond the sandstone, lava was found, it being the eastern edge of the broad overflow proceeding from Bill Williams' mountain, on the south. This lava covers all the subjacent rocks for twenty miles, except in the ravine of Partridge creek, which cuts through the lava and exposes in many places a greyish-white limestone, probably carboniferous. At Camp 99, which is on the western border of the field of lava, carboniferous sandstone is again found, with beds dipping north.

*Granite.*—A mountain called Picacho was visible a few miles north of Camp 99. This was thought to be granitic by Mr. Marcou; it was also the opinion of Mr. Campbell. The outline of the view on page 85 of Captain Whipple's report, tends to confirm it. One mile southwest of Camp 99, or at Camp 100, outcrops of granite and gneiss were found. This rock trends northwest and southeast, and forms the bottom of the Val de China. This granite was covered by the beds of carboniferous sandstone. Limestone was not noted. I find two specimens of granite in the collection from the Camp near Picacho, Nos. 23 and 36 of the catalogue. The granite is rose-colored, and one specimen contains a light silvery mica in distinct plates; the other has a much finer grain, and is so granular as to resemble sandstone. Two other specimens are from this locality—Nos. 52 and 53—labelled basalt and obsidian. They appear to be transported fragments.

*Carboniferous limestone.*—Seventeen miles southwest of this outcrop of granite, Mr. Marcou notes a table-land formed of carboniferous limestone, at the foot of which the party encamped. The trail continued at the base of this cliff for nine miles. Mr. Marcou mentions seeing crinoids and some species of Productus in the creek. He also mentions an outcrop of carboniferous sandstone before reaching Camp 102.

*Aztec Mountains.*—We have now reached a portion of the line where the geology becomes exceedingly interesting. Since Camp 99, the course of the survey deflected south in order to turn a southern point of the Aztec mountains. These mountains trend northwest and southeast, and have a flat, table-like summit, composed of stratified rocks dipping gently to the east or northeast. These strata present a bold precipitous front towards the southwest, forming in one place the summit of a cliff 1,200 feet high. This cliff, according to Mr. Marcou, in his notes, January 22, is composed of granite from the base to the middle; on this rests a bed of sandstone, then limestone and grey sandstone on the top. The relations of the strata to the underlying

granite, and the general configuration of that region, may be understood by the section given with the translation of Mr. Marcou's notes.

The cliff of limestone which is mentioned between Camps 100 and 102 is probably a continuation of the bed which outcrops on the western face of the mountain. The granite which underlies these stratified rocks was reached in Aztec Pass, just beyond Camp 102. A specimen of this rock from Pueblo creek is an amorphous compact mass, of a reddish color, probably feldspathic. It is marked metamorphic by Mr. Marcou, but its mineral characters are not distinct. Specimens of specular iron ore were also found in this creek, and are described in Chapter X. The outcrop of granite appears to be prolonged towards the southeast, where a range of mountains was seen, which are probably the prolongation of the Aztec range, and which in all probability have a similar geological structure.

After crossing the range at the Aztec Pass, the trail turned north, following the base of the cliff, and at Camp 105 rising upon the bed of sandstone which underlies the carboniferous limestone. Camp 106 was upon the limestone, but, for a short distance between the two camps, the road led over a field of lava. The underlying granite was found beyond Camp 106, and, with a few exceptions, where covered by lava and modern deposites, was the only rock seen as far west as the Aquarius mountains. The nearly horizontal carboniferous strata of the Aztec mountains were found to be continuous north of the trail, and formed the top of Cross mountain, which terminates just north of Camp 109.

*Cygnus Mountain.*—About ten miles south of the part of the route just described we find a range of high peaks about twelve miles long, and which are probably volcanic. This elevation has been called *Cygnus mountain* by Captain Whipple, and is probably the source of the lava streams which are crossed at various points between Camps 105 and 110. The lava probably covers the greater part of the surface lying between the Aztec and Aquarius mountains. Mr. Marcou calls this elevation Whipple mountain. He considers it volcanic, but intermixed with granite.

*Aquarius Mountains.*—This range, of which a physical description has already been given in the first part of this report, consists chiefly of granitic and metamorphic rocks. It has a general parallelism with the Aztec mountains, but is without the overlying carboniferous strata, which impart so much interest to that range. The survey crosses the northern portion of this range along the valley of White Cliff creek, to which the name Cactus Pass has been given. On the eastern side of the pass Mr. Marcou found outcrops of gneiss, overlaid by sandstone and conglomerate, which dipped to the east. The conglomerate appears to be a mixture of volcanic ash and angular fragments of lava. It was thought to be Tertiary by Mr. Marcou. Granite was found beyond, and then beds of sandstone and limestone, also considered Tertiary, were found. These strata were upheaved, and dykes of trap and red porphyry traversing them were found. The trend of these outcrops was north and south. At the summit of the pass Mr. Marcou found a large vein of red sienite trending north and south; afterwards gneiss and quartziferous porphyry, traversed by veins of white quartz. The gneiss is contorted and dips to the west. Granite was again found as far as Camp 112, in the valley of Bill Williams' fork, at the base of the western slope. The granitic rocks of the Aquarius mountains are well represented in the collection. (See the catalogue and descriptions, Nos. 9, 10, 11, 12, 13, 16, 29, and 50.) No. 11 is a specimen of the rock from the summit of the pass; it is composed of coarse crystalline fragments of brilliant red feldspar and white translucent quartz, with a little dark mica. No. 9, from the eastern side of Cactus Pass, is a compact rose-colored granite. The line of survey in following down the valley of Bill Williams' fork, called Big Sandy creek by Mr. Marcou, passed along the western base of the Aquarius mountains for fifty miles. But the range was not crossed again, and few or no additional specimens were collected.

*Valley of the Hawilhamook or Bill Williams' fork.*—In descending the valley of Bill Williams' fork, Mr. Marcou noted drift deposites on each side of the trail, which appeared to extend west as far as the foot of the Cerbat mountains on the opposite side of the river. This drift

was continuous along the valley, and between Camps 113 and 114 was found very thick, containing large pebbles. The next day, Mr. Marcou found its thickness to be 1,000 feet. The presence of this diluvium is again noted at many points along the river down to its junction with the Great Colorado.

*Cerbat Mountains.*—This range is parallel with the Aquarius mountains, and forms the western side of the valley of the Hawilhamook. The rocks are similar to those of the Aquarius mountains. Two or three specimens were found in the collection. One of them, No. 14, is a beautiful flesh-colored granite, containing dark-colored mica. Another, No. 17, is gneissose, and probably metamorphic. A beautiful specimen of fibrous hematite—specular iron—was found in this range. It is a variety called bloodstone by jewellers, and a description of it may be found in Chapter X, No. 91. Some of the lower ridges of this range of mountains were crossed between Camps 115 and 120. Between Camps 115 and 116 these ridges were of granite and gneiss, which were traversed by veins of quartz and feldspar. Between Camps 118 and 119 Mr. Marcou observed granite containing large crystals of white and rose-colored feldspar, also quartziferous red porphyry and dykes of quartz and trap, trending north 70 degrees west. Near Camp 120 an extensive outcrop of trap-rock was found, which, according to Mr. Marcou, formed two great mountains.

*Volcanic rocks, Artillery Peak.*—Opposite Camp 117 a perpendicular cliff, capped with a layer of basaltic lava, was found. This appeared to have flowed from the northeast, and formed a mesa or table-land, which was also seen between Camps 117 and 118. At Camp 119 a high cone was found upon the right. This appeared to be volcanic, and was called Artillery Peak. An interesting figure of it is given on page 103 of Captain Whipple's report. Mr. Marcou observes that this mountain is pointed, and has blackish sides like volcanic lava. It is most probable that the lava proceeded from this point. This mountain, as will be seen by reference to the map, rises at the southern end of the Cerbat range, and from this point the river turns to the west. There is also opposite to this point a considerable break in the Aquarius range, through which the Santa Maria river flows from the northeast. In a direction southeast from Camp 121, an extensive valley or plain was seen. This was bounded on the east by the prolongation of the Aquarius mountains, and on the west by the continuation of a chain parallel with the Cerbat range, but which is intermediate between it and the Colorado river. The end of this range was crossed between Camps 122 and 123, and the pass is called Striped Cañon. Captain Whipple gives the following description of the rocks which are found there: "Soon after starting we entered a chasm cut through a dyke of greenstone, with horizontal veins of granite and white quartz. The vertical section was variegated like jasper. The rock in some places rose in vertical planes to the height of 300 feet. Upon the top it was broken, presenting, sometimes, a fancied resemblance to Gothic architecture."[1]

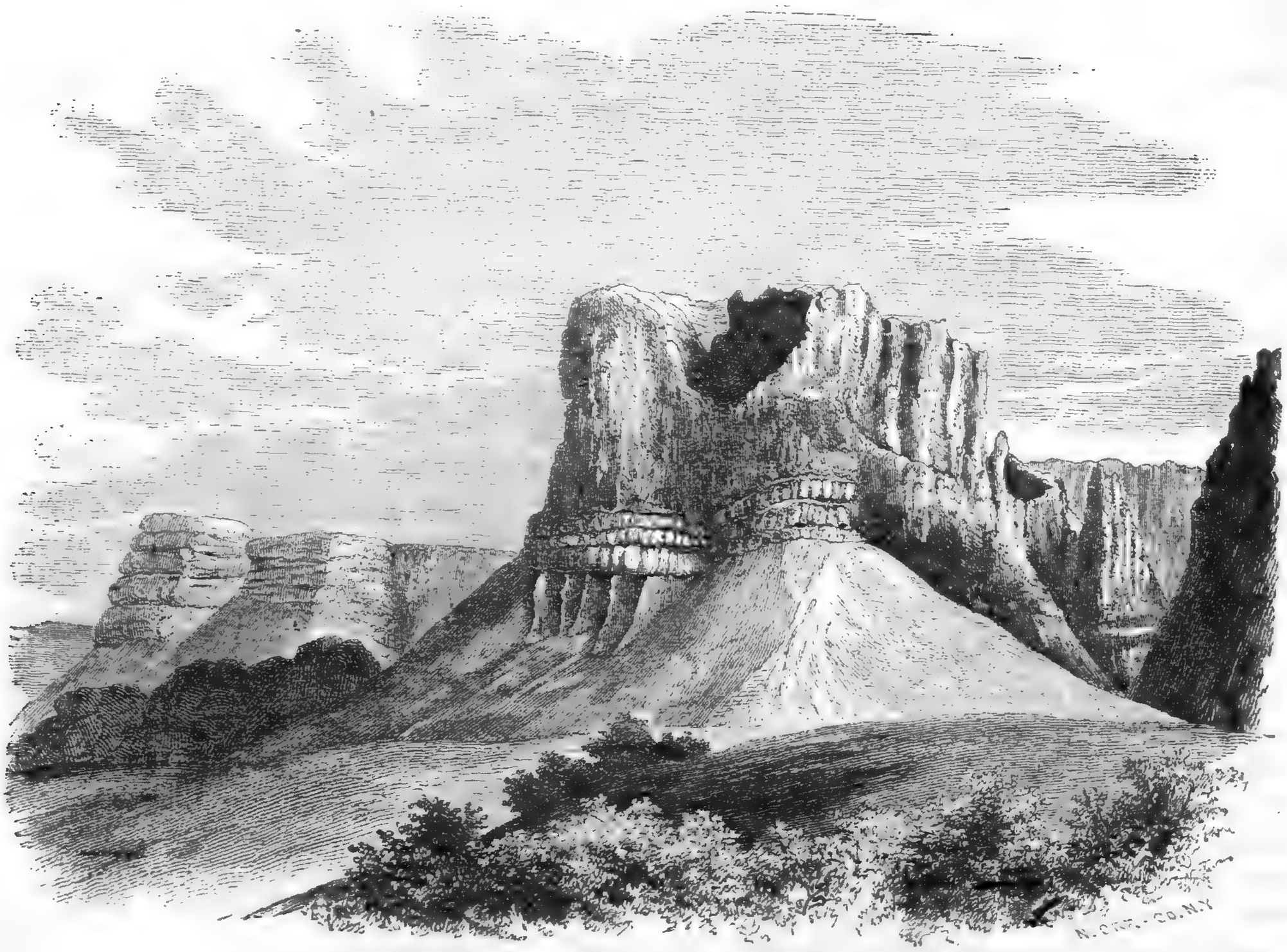
Mr. Marcou states that the rocks are metamorphic and somewhat plicated, but the trend is preserved. He further observes that the rocks are of quartzite, whitened by veins alternating with brown, black, and green mica-schists. (Notes, February 15.) Veins of iron ore were also found in the cañon.

The course of the river in its passage across the Striped Cañon is exceedingly tortuous, but after emerging from the cañon turns to the north and follows the valley of the river leading to the Great Colorado. The trail which follows this valley thus passes northwesterly at the western base of the range just described. In this valley Mr. Marcou observed a great development of drift deposites. Near Camp 124, he notes the occurrence of red pudding-stone and Tertiary red sandstones. These strata are raised up, and Mr. Marcou has recorded the presence of trappean rocks in the vicinity, to which we may refer their uplifted condition.

*Basaltic lava.*—The lower part of the valley of the Hawilhamook is contracted by the presence of thick beds of basalt crowning the summits of the mesas. This rock was first observed near

[1] Report of Captain Whipple, Itinerary, p. 105.

Camp 125, and below Camp 126 the lava formed the summit of perpendicular cliffs on both sides of the river, ranging from two hundred to four hundred feet in height. The base of the cliffs is formed of red argillaceous sandstone, and above it of red conglomerate. The narrowest part of this cañon is about four hundred yards wide. Mr. Marcou also noticed gneiss and talcose schist. A wood engraving representing this cañon is given by Captain Whipple, page 108. According to Mr. Campbell, this lava extends on the south bank of the river as far as the Great Colorado, and even beyond it, on the opposite side, for a long distance. The strata which are thus overlaid by lava are probably identical in age with those of a similar nature seen higher up the river, which Mr. Marcou considered Tertiary.



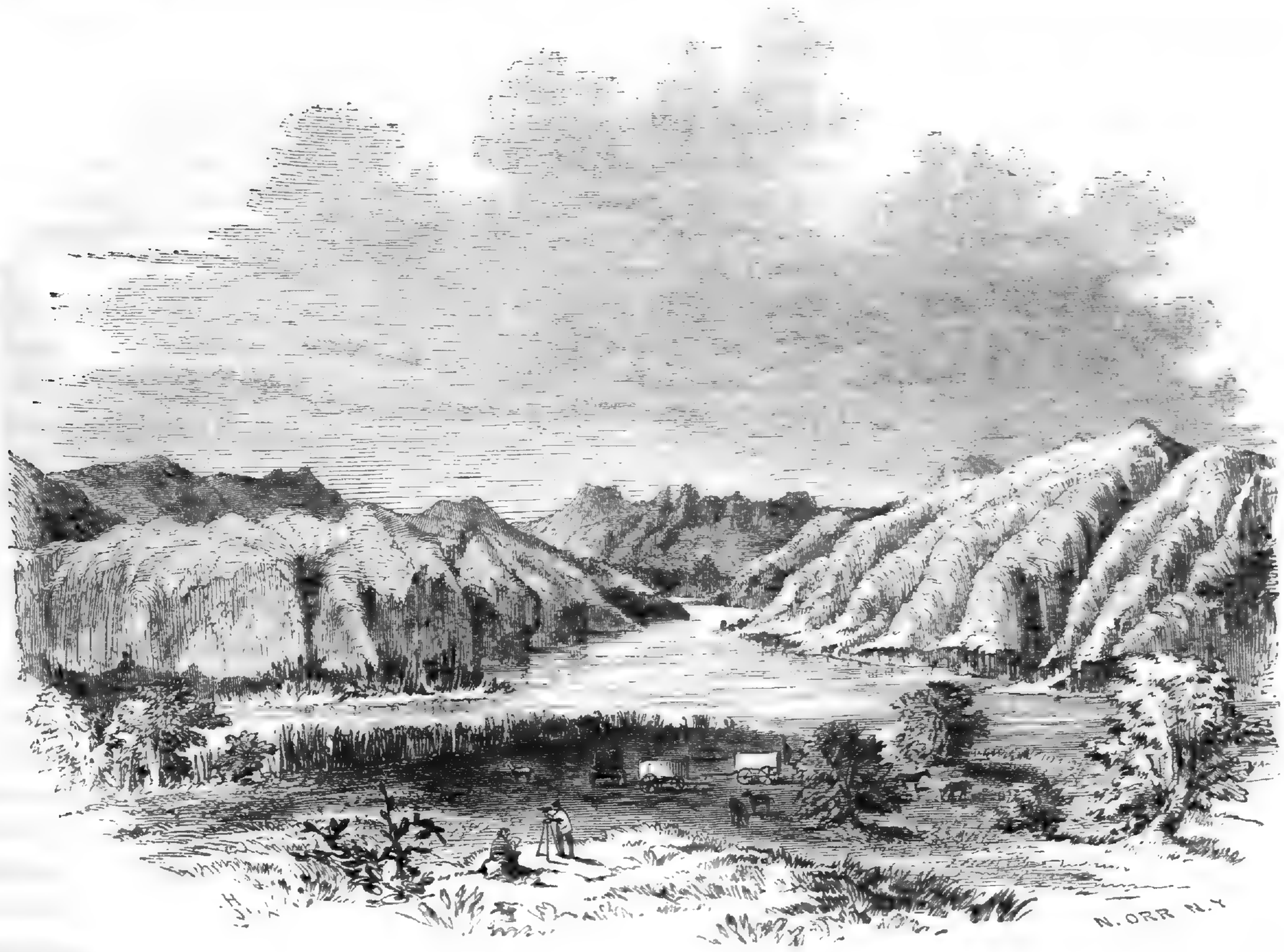
LAVA BLUFFS ON THE HAWILHAMOOK.

The bluffs represented in the above sketch are on the south side of the Hawilhamook, at Camp 126. They rise from eight hundred to one thousand feet above the stream. The base of the bluff consists of strata of red sandstone and conglomerate, but the upper and thickest layer is of basaltic lava. The sketch indicates that this rocky roof, or covering for the softer strata below, is itself liable to rapid decomposition and degradation by the weather.

*Valley of the Colorado river and mouth of the Hawilhamook, or Bill Williams' fork.*—Beyond the narrow cañon in the basalt, the strata of red sandstone and conglomerate are continuous, with occasional interruptions to the mouth of the river. Near this point they were upraised, and dipped westward at an angle of twenty degrees. They occur again between Camps 128 and 129, on the western bank of the Colorado river, where they also dip to the west at the same angle. Mr. Marcou also mentions vast hills of drift. This is very probably detritus from the surrounding mountains.

The valley of the Colorado is narrow, and hemmed in on both sides by rugged granitic mountains, which are parallel with the Aquarius and Cerbat ranges. The prevailing trend is north

30 to 45 degrees west, and the ranges appear much broken into ridges. It is most probable that the range on the east of the stream is a prolongation of the range through which the Hawilhamook flows at the place called Striped Cañon. As the survey followed the valley of the river, the rocks composing these mountains were not very extensively examined, but the granite composing them was seen at several projecting spurs which reach to the river, and were crossed. On one of these points Mr. Marcou mentions the occurrence of red porphyry and gneiss, and at another place porphyry, trap-rock, gneiss and granite, and serpentinoid granite, or protogine, were found between Camps 129 and 130. At the base of the mountains, strata of red sandstone and conglomerate were found in connexion with basaltic and amygdaloidal trap. These are much uplifted and metamorphosed near Camp 129. Beyond Camp 131 similar strata were found. These strata were believed by Marcou to be Tertiary, and probably are similar to those found along the valley and at the mouth of the Hawilhamook.




BANKS OF THE HAWILHAMOOK.

The above sketch was taken about six miles above the mouth of the stream, and serves to show the rugged and desolate appearance of its rocky banks. In engraving the sketch, the peculiar characteristics of the different rock formations were lost, and the whole seem formed alike.

## II. COLORADO RIVER TO SAN PEDRO.

In turning west from the valley of the Colorado, the ascent of the range of mountains bounding it on the west was commenced. These have a peculiarly rugged outline, and Mr. Marcou observes of them that they are extremely abrupt, and have peaks as in the Alps. The same singularly serrated outline, which has the greatest resemblance to the teeth of a saw, is seen in the mountains around the Colorado desert, and on the Colorado north and west of Fort Yuma.

In ascending this range, the dry valley of a stream was followed in a northwest direction, which being the same as the trend of the ridges, the rocks were not fully exposed to view. Mr. Marcou notes of the range that it is four miles wide. Trap and metamorphic conglomerate was observed in crossing, and an extended inclined plain composed chiefly of the debris of the surrounding granitoid rocks. Beyond this range Mr. Marcou notes a second, which, between Camps 136 and 137, was composed of red metamorphic conglomerate, covered by black and shining phonolitic and basaltic trap. A great development of trap-rock was seen in crossing the chain, and beyond it a broad and elevated plateau was found to extend to the base of the third range. This plateau is composed of the debris of erupted rocks, and in several places is covered with a whitish brecciated limestone. This is in horizontal strata, and was considered Tertiary by Mr. Marcou.

The third chain, according to Mr. Marcou's notes, is five or six miles wide, and is composed of a very hard hornblendic granite, and of a whitish dioritic rock. Amphibolic granite was noted on the eastern base. A specimen from this range is in the collection, (No. 54;) it may be called a quartz porphyry. This range is separated from another—the fourth—by an inclined plain, as before, which was composed of the debris of granite. The fourth range appeared to be composed, at the base, of a hornblendic granite, similar to that in the third. In crossing it, or from Camp 140 to 141, quartziferous granite was found to outcrop for twelve miles, and was succeeded by a large exposure of trap and greenstone. Mr. Marcou also records the presence of a great body of drift, forming a bank eight hundred feet thick. This consisted of sand and large blocks but little rolled. I judge that this accumulation is similar to those found around the bases of the mountains of the Great Basin, especially on those forming its southern boundary. In crossing the range Mr. Marcou saw seven or eight cones, of a red color, about ten miles northward, and he believed them to be volcanic. This fourth ridge, or range, bordered the valley of the Mojave on the east. The Soda lake, into which the Mojave sometimes flows, is directly at its western base. We have thus crossed, in our descriptions, from the Colorado river to the Great Basin, within which the Soda lake is found.

Although in the descriptions four distinct ranges of mountains have been mentioned, they may, for the purposes of geology, be considered as forming one great chain of a composite character. The rocks in each are similar, and they are connected by the same formations, underneath the superficial covering of tertiary and post-tertiary sedimentary accumulations, which fill the valleys and flank all the ridges. If this slight covering of earth and of local detritus and debris were subjected to a powerful denuding current for a short time, they would all be removed, and expose a continuous but rugged granite surface, traversed, of course, as we have already seen, by numerous dykes and veins of intrusive rocks—trap, porphyry, and the like. Having myself explored the rocks along the Mojave and of the southern end of the Great Basin between the Mojave and the Sierra Nevada, I am enabled to be more positive and general in the description of this region. From all the information I can obtain, both from Captain Whipple and Mr. Campbell, I conclude that the system of parallel ranges, the geological structure of which has been given in a general way, corresponds very nearly with the ranges found throughout the Great Basin, and which have generally received the title of *Lost Mountains*, from the fact that they do not extend continuously for very great distances, but may be avoided by a slight detour either north or south. This structure is exceedingly interesting not only to the civil engineer who seeks practicable grades, but to the geologist who reads the former existence of stratified formations, now plicated and folded in great waves, and traversed by intrusive masses of granite.

This broken character of the mountains, together with their sharp, ragged outlines, render the scenery of that region highly peculiar.

The effect is heightened by the purity of the air and the deep coloring which distant mountains assume and change each hour in the day. The absence of vegetation, the nakedness of the

rocks, and the prevailing sandy-brown color of the whole surface, afford a strange contrast to the green fields and forests which clothe the rocks and soil in the Atlantic States.

VALLEY OF THE MOJAVE.

## THE GREAT BASIN.

The valley of the Soda lake, reached by the survey on the 8th of March, Camp 142, is within the limits of the Great Basin. It receives the last flowing water of the Mojave river, now celebrated among the explorers of the country from the different opinions which have been held in respect to its course and continuous flow to the Colorado. It was a problem which has only recently been solved by the survey of Lieutenant Williamson, who was commissioned to make a special exploration beyond his direct line of survey for this purpose. This officer reports that the valley of the Mojave is continuous to the dry lake called Soda lake, and which is surrounded by mountains through which there is no outlet for a stream to the valley of the Colorado. It was thus shown that the Mojave is not a tributary of the Colorado, but a river without a connexion with the sea, and sinking in the dry sands of the Basin. Under the supposition that the Mojave was a tributary of the Colorado, the southern limits of the Great Basin were considered to be further north than was at first supposed, and a dividing ridge extending like a wall from east to west, near the parallel of 38°, found a place upon the maps. The establishment, by actual survey, of the fact that the Mojave did not communicate with the Colorado, at once restored the former boundaries of the Basin.

The Soda lake is probably the lowest point in the whole extent of the Basin, and is much below its general surface. Its altitude, as determined by the survey, is 1,116 feet, while the general elevation of surface in the southern part of the Basin is not less than 3,000 feet. The level but dry expanse of this "lake" was whitened by a thick incrustation of soluble salts.

On digging a few inches below the surface, an abundance of water was found. This was

saturated with salt, and Captain Whipple states that it was highly alkaline and effervesced freely with acids. This salt and carbonate of soda is doubtless derived from surrounding strata of Tertiary age.

*Moving sand—Sand-dunes.*—Extensive fiel of dry sand, drifted by the winds, were encountered on the western side of the fourth range, or mountains bordering the Soda lake on the east. Captain Whipple states that the surface of this sand was compact and hard—so hard that the train passed easily and rapidly over it. "In the midst of this barren plain were low, isolated ridges of rocky hills, upon the northwest sides of which sand was piled nearly to the tops, showing the direction of the prevailing winds."[1]

Mr. Marcou records the presence of sand on the opposite side of the Soda lake, and says that it rose upon the mountains on each side. Sand-dunes were afterwards found on approaching the Mormon trail.

*Mountains between the Soda lake and the Mormon trail.*—The eastern boundary of the Soda lake is a range of mountains which Mr. Marcou notes as the the fifth chain. At the base of these mountains, metamorphic rocks, porphyroid greenstone, and quartz veins were observed. These rocks appear to constitute the mass of the range. A deposite of "drift" from eight hundred to one thousand feet in thickness was also observed. In this the pebbles were small, and were intermingled with sand, forming a conglomerate. (See notes, March 10.) Between Camps 146 and 147 metamorphic rocks and roseate porphyry were seen, and similar rocks were continuous to Camp 148. Mica schists and trap-rock were found along the river, near the point where the Mormon road diverges. At this place, or on the right bank of the stream, I myself observed the rocks carefully and found them to consist of highly laminated gneiss, succeeded on the west by compact granite, traversed in different directions by many large veins composed of feldspar and quartz. The gneissoid rock is evidently metamorphic, and the planes of stratification are nearly vertical.

*Mojave river to the Cajon Pass.*—On leaving the Mojave river the line of the survey followed a long, gently ascending slope for about twenty-one miles, to the summit of the Bernardino Sierra. Near the river, bluffs of horizontal strata of clay and sand are seen. These are probably of Tertiary age, and they are overlaid by the more recent deposites which form the slope. This detritus or wash from the surrounding hills is composed of gravel and fine sand and clay. The gravel and sand are not rounded and siliceous as in the beds of streams, but are angular, and result from the gradual disintegration of the surrounding granitic mountains. A great portion of it is, therefore, feldspar, and from its decomposition a soil is formed, rich in the mineral ingredients required by vegetation. In ascending this slope a manifest change is observed in the soil. It becomes much more coarse, and frequently fragments of rocks of considerable size are seen, while on the lower portions fine sand and gravel only are visible. This difference in the state of division of the ingredients of the soil is to be attributed to the same causes which have produced the slope—the transportation of the debris of the mountains by streams, which rise in the high ravines and pour out upon the lower ground at the base, depositing the heavier rocks and detritus on the upper portions of the slope where the current is the most rapid and forcible, and carrying the finer portions to a greater distance.

*Cajon Pass, in the Bernardino Sierra.*—In ascending from the Mojave river to the Cajon Pass the road is upon the gravelly materials of the slope up to the very summit, which is itself composed of the rudely stratified materials flanking the mountains. At this point these materials form a bluff above five hundred feet high, which faces the south, or the Pacific slope of the mountains. No granitic rocks appear within more than half a mile of the crest of the pass where it is crossed by the road. On descending the bluff by a steep and winding road, outcrops of a coarse-grained feldspathic sandstone are found with the strata strongly inclined, and lower down the pass the strata rise into hills and present fine exposures. The inclination is about

[1] Captain Whipple's Report, p. 123.

forty-five degrees, and appears to be from the granitic rocks forming the high ridges on the west side of the pass. The materials forming these strata appear to have been derived from the abrasion of granitic and metamorphic rocks, many large fragments of them being found in some of the beds. All the strata have a light pink or flesh-red color, which appears to be caused by the pink feldspar. The weather has fashioned these outcrops into sharply-pointed pinnacles, and in other places worn holes and openings through the beds, so that a little soil or earth has found a lodgment, and serves to support shrubbery and vines. No fossils were found in these strata; they were evidently deposited in water much affected by currents. Their aspect is very modern, and they are probably Tertiary.[1]

*Granitic and metamorphic rocks.*—Although the granitic rocks do not appear at the summit, they rise in high ridges on each side of the valley of the pass. In the higher ridges they are generally very compact, and yet give evidences of being to a great extent metamorphic. Large blocks of a white crystalline limestone were found in the bed of the creek, but no outcrops were seen. These fragments exhibit bands and lines of deposition, and show the metamorphic character of the parent mass.

In the lower parts of the pass the rocks approach nearer on each side, and the sandstone strata disappear. The stream flows down over the outcrops of granite, gneiss and similar rocks, in a narrow rugged channel. At the base of the mountains, talcose and micaceous slates occur, similar to those in the pass of San Francisquito, further west.

*Slope to the Pacific.*—From the base of the mountains the survey follows a long and gentle descent to the Pacific over formations of comparatively modern origin. The surface is formed of post-tertiary accumulations overlying tertiary strata. These strata appear in hills not far from Los Angeles, and are mainly composed of white clay or marls and sand. Several outcrops along the road to the mission of San Fernando are white and chalk-like, and appear to have been quarried into under the supposition that they were limestone. The rock is compact and very light, but is not calcareous, being chiefly white clay and silex. In the San Fernando hills I obtained tertiary fossils of the genera *Ostrea*, *Pecten* and *Turritella*.

*San Pedro.*—I had an opportunity of examining a section of some of the strata of the slope, at the vertical bluff facing the bay of San Pedro. At that place the beds are formed of ferruginous sandstone and argillaceous sandstone, and thick layers of bluish and grey, and sometimes greenish clay. No fossils were found in these strata. They differ lithologically from those exposed in the pass of San Fernando, but they are probably Tertiary. At another point along the bay south of the landing, more modern accumulations are exposed in bluffs about 30 feet high, they being the margins of a plain or terrace. Near the summit of the bluffs there is a layer of fossil-shells in a fine state of preservation, and very abundant. The following species were obtained there by the writer in 1853: *Saxicava abrupta*, *Petricola Pedroana*, *Schizothœrus Nutalli*, *Tapes diversum*, *Penitella spelœum*, *Fissurella crenulata*, Sowerby, *Nassa interstriata*, *N. Pedroana*, *Strephona Pedroana*, *Littorina Pedroana*, and *Buccinum interstriatum*. With the exception of one, these were all described and named by Mr. T. A. Conrad.[2] These fossils show that the formation is littoral; and this is also shown by the position in which they are found, they being mingled together and surrounded by fragments of broken shells. Below the fossils the bank is chiefly beach-sand. The lower molar of an extinct elephant was also found in the bank, not far from this locality of fossils. It appears to differ from the teeth of *Elephas primigenius*, in the greater distance between the plates, and in their smaller number.

*Bitumen and "Tar springs."*—The broad slope on which Los Angeles is built is dotted in several places by black lakes or pools of semi-fluid bitumen, which rises up from the strata below. These are known as *tar springs*, and the inhabitants make use of the bitumen for covering

[1] These strata are more particularly described in the author's report on the geology of the route surveyed in California, by Lieutenant R. S. Williamson, U. S. Topographical Engineers.

[2] See Description of the Fossils and Shells collected in California by W. P. Blake, Appendix to Preliminary Geological Report: Washington, 1855. See also the report in 4to.

their nearly flat roofs, and for making pavements. In a ravine near one of the springs I found the exposed edges of bituminous shales, they being brownish-black, and in some places the bitumen was visible.

*Intrusive trappean rocks.*—On the road from San Bernardino to Los Angeles, and not far from Cahuenga rancho, there are several hills of moderate elevation, not over 100 or 150 feet, and one of them is composed of a hard trappean rock. It may form a part of a range of hills believed to extend nearly northwest and southeast, between the valley of San Bernardino and the sea.

*Alluvial valleys.*—The whole slope, from the mountains to the ocean, may be said to be fertile and susceptible of cultivation wherever water can be obtained. The valleys of the streams are, however, peculiarly favorable for cultivation, and the bottom lands can hardly be surpassed for their fertility.

# CHAPTER VI.

## GENERAL DESCRIPTION OF THE GEOLOGICAL FORMATIONS.

## GRANITIC, METAMORPHIC, DEVONIAN, AND CARBONIFEROUS.

General remarks.—Granitic and metamorphic rocks predominate west of the Aztec mountains.—Red or pink granite predominates.—Principal places at which metamorphic rocks have been identified.—Their probable age.—Azoic.—Silurian.—Carboniferous.—Relative ages of the granitic chains.—Anterior to and later than the carboniferous.—Tertiary or post tertiary.—Ranges of the same age not coincident in direction.—Devonian, uncertainty of its existence.—Carboniferous.—Of the Sandia and Santa Fé mountains.—General extent along the line.—Lithological characters.—Thickness of the strata.—Fossils.—Sandstone and coal measures.—Lithological characters.—View near Fort Coffee.—Overhanging strata at Sugar-loaf mountain.—Ferruginous sandstone.—Thickness of the coal measures.—Diminish towards the west.—Fossils.—Coal.—General observations on the carboniferous formation.—Disturbances of the formation.—Denudation.—Limestone of Cañon Diablo.—Metamorphic limestone of the Cajon and Tejon, probably carboniferous.

### GRANITIC AND METAMORPHIC.

In a rapid reconnoissance of any region in a direct line, it is impossible to bestow that attention upon the phenomena presented by the disturbed and metamorphosed rocks which their obscured condition demands. The mineral characters and relations of unchanged horizontal strata are ever present to the view along the valleys and ravines; but the folded and crumpled remnants of older strata can only be seen at intervals, and present an endless variety of conditions and appearances, serving to confuse and perplex even the observer who has time at his command. It is not, therefore, possible to assign the dividing lines between the truly erupted granitic rocks and those which simulate them, but are in reality of sedimentary origin. We can only state that here and there the metamorphosed stata are found, but their connexion cannot yet be shown. Neither can the granitic rocks be separated into their several varieties, nor the different intrusions be shown. It is therefore necessary to group all these rocks under one head as above, and to represent them by one tint on the map. The presence of metamorphic strata has, however, been indicated at several points on the section.

The rocks of this group predominate on the western portion of the line. The region where the mountains are most numerous and abrupt is also, as is usual, the region of the greatest granitic exposure. West of the Aztec mountains nothing but these rocks and the more modern sedimentary formations are visible. On the central and eastern portions of the line, and indeed for nearly four-fifths of its entire length, but few exposures of the granitic and metamorphic rocks are found. The area of these outcrops is also comparatively limited. The granite foundations over this broad area, from the Mississippi to longitude 112°, are nearly covered from view by thick strata of Palæozoic and Secondary age. The outcrops of granite are found only in narrow lines, peering here and there above the broad and level plateau. The principal lines, however, constitute the great crest or water-shed between the two oceans. They are the most elevated portions of the country, and consist of the Sierra Madre, Santa Fé mountains, and Sandia mountains. A subordinate line, and one with an entirely different direction, is found in the Witchita mountains and the outcrops between them and Little Rock. These lines of elevation are the only exposures of granitic rock found on the line between the Mississippi and the volcano of San Francisco.

Although there are many specimens of the granitic rocks in the collection, the material is not sufficient to authorize a comparison between the rocks of the different ranges. From some sections, especially the region of the Colorado and the Hawilhamook or Bill Williams' fork, the specimens are quite numerous, and undoubtedly present a very fair view of the general mineral constitution of the ranges; but the representation from other localities is obviously not full and complete. As a description of each of the specimens will be found in a subsequent portion of this report, it is not necessary to repeat them here; but a few general observations will suffice.

The most notable feature in the collection is the predominant red or rose-color of the specimens of granite, few or none of them being white or light-grey. This reddish color is chiefly due to the pink feldspar, which is an almost constant ingredient. In several of the specimens a whitish feldspar or albite is mingled with the red, but the color of the latter predominates. The specimens contrast strongly with the collection which I made on the Sierra Nevada and the Bernardino Sierra, where the white albitic or grey granites and metamorphic rocks abound; but they much resemble the granites of the southern part of the Great Basin and those along the Mojave river. The absence of specimens of compact grey sienitic rocks is also worthy of note. But one specimen of distinct and well-characterized sienite is found in the series. This is No. 25, from the Colorado river below the Mojave villages. The hornblende in this specimen is the most conspicuous, and gives a greenish color to the mass. Another specimen, composed of red feldspar and green hornblende, was found in the collection, but it was without a label. Two specimens labelled sienite were not found to contain any hornblende.

The presence of metamorphic rocks at many places along the route is very clearly shown by the specimens. Their occurrence at other places is, however, mentioned in the descriptions; and the collections must not be considered as a just representation of their position or mineral characters. Some of the most interesting localities, where the rocks are without much doubt metamorphic, may be enumerated as follows: At Little Rock schistose and slaty rocks crop out in nearly vertical strata, and are much contorted and traversed by quartz veins. The carboniferous strata rest horizontally upon their edges. In the Sandia mountains a compact green rock is found underlying the carboniferous limestone, which, from the specimen in the collection, I judge to be a metamorphosed clay slate. Mr. Marcou appears to regard these rocks next below the Carboniferous, as metamorphosed Devonian strata. The auriferous rocks of Gold mountain are in all probability metamorphic, but we as yet know little of their nature, the only information accessible being the statements of Lieutenant Abert and Dr. Wislizenus—the first that the ore occurs in limestone, and the second in sienite and greenstone. Gold is, however, now regarded as a good indication of the Silurian age of the rocks in which it occurs, and it has been remarked "*that it is a Silurian fossil.*" It is not, however, confined to the metamorphic rocks of Silurian age, being certainly found in veins among erupted granitic and trappean rocks, and doubtless occurs whenever the mineral conditions of rocks are favorable, irrespective of their age. There is little doubt that the metamorphic rocks occur extensively in the Santa Fé mountains, for a wide ridge of slates breaking up into sharp angular pieces is mentioned by Lieutenant Abert as occurring between Taos and Santa Fé.

Contorted gneiss occurs in the Aquarius mountains, the beds dipping to the west; and similar rocks occur on the opposite side of the stream in the Cerbat range. The presence of many veins of quartz and feldspar among the rocks of these mountains is also mentioned by Mr. Marcou. Iron ores were also found, and there are several varieties in the collection, but all of them are specular iron or the anhydrous sesquioxide. Metamorphic rocks were also found near the mouth of the river at its junction with the Great Colorado. It is most probable that a great part of the Pai-ute range is composed of metamorphic rocks. They occur without doubt along the Mojave, outcropping near the Spanish trail, in nearly vertical layers. They rise above the surface with a serrated outline, and rest upon a compact feldspathic granite, which is much fissured and traversed by feldspathic veins. A full description of these rocks has already been given.

In the Bernardino Sierra the phenomena of metamorphism are well displayed, or rather the

effects are clearly visible. The rocks of the upper parts of the chain at the Cajon being very compact, and yet in most places showing lines of structure or lamination, while the debris of white limestone, traversed with blue bands or lines of stratification, not quite obliterated, show the former sedimentary origin of the whole. In the lower or southern part of the pass, slates are found similar to those of the pass of San Francisquito, further west, where gold has been obtained.[1]

It is not possible, with our present limited information respecting these different localities of metamorphic rock, to form any conclusion with respect to their age. It is in all probability in most cases Silurian, or older than the Carboniferous. This is certainly true of all the localities east of the Aquarius mountains, for up to that point the carboniferous strata are present in a non-metamorphic state. The formations do not in any place appear to be like the broad metamorphic outcrops on the western base of the Sierra Nevada. They do not appear to consist of such vast masses of argillaceous and talcose slates, but are more compact, and gneissose. That the Azoic rocks occur is very probable, and the abundance of iron ores among Aquarius and Cerbat mountains would incline us to this opinion. Little value, however, can be attached to the indications of age presented by the occurrence of the metals. The abrupt termination of the carboniferous strata in horizontal strata at the Aztec mountains is not readily explained; but it is most probable that beyond that point it has become metamorphosed, if, indeed, it ever existed. The limestone found in the Bernardino Sierra may be of this age. A limestone is also found in the Tejon Pass, in the Sierra Nevada, further west, and is there associated with beds of quartz rock or metamorphosed sandstone.[2] The two localities are very probably similar in age.

*Relative ages of the several chains.*—We may form some general conclusions with regard to the relative age of several of the granitic ranges, but cannot yet determine how recent many of the erupted granitic masses may be. The horizontal carboniferous strata of the Aztec mountains at once point out the fact that we here have one of the most ancient granitic uplifts. The whole granite foundation, from the Aztec and Aquarius ranges eastward, probably as far as the Colorado Chiquito, is older than either the Sierra Nevada, Bernardino Sierra, or the ranges along the Rio Grande, the southern equivalent of the Rocky mountains. These granitic rocks of the Aztec mountains had received their form and position previous to the deposition of the carboniferous limestone, while the Sierra Madre and Santa Fé mountains have been upraised since the carboniferous limestones and sandstones were deposited. We find the two latter ranges with the carboniferous strata flanking them, and dipping at angles of 30° and 35°. It was the opinion of Mr. Marcou that the Santa Fé mountains and Sierra Madre were later in origin than the beds of red clay and gypsum, and the overlying white sandstones, which he regarded as Triassic and Jurassic, and it was his belief that these formations were uplifted by the intrusion of the two ranges. We have, however, seen that the strata of the gypsum formation and the Cretaceous are not disturbed to any great extent, but rest horizontally in the valley between the two ranges. Further observations on this subject are presented with the general observations on these two formations.

*Witchita Mountains.*—The carboniferous strata in the vicinity of the Witchita mountains, and along the line of granitic outcrops, extending east, or a few degrees north of east from them, are more or less uplifted and disturbed, as if the granite ridges had been upraised since their deposition. This line of dislocation would thus appear to be near the age of that of the Santa Fé mountains. The metamorphic schists of Little Rock are, however, capped by the horizontal beds of carboniferous sandstone, showing the uplift of that portion at least to be anterior.

*Ranges along the Colorado.*—It is not possible to determine the relative ages of these chains. Mr. Marcou records the presence of thick strata of tertiary rocks, upheaved and metamorphosed; but it is not certain that their disturbance was produced by granitic movements. It is more

[1] For a description of these rocks see the author's Geological Report on the route surveyed in California by Lieut. R. S. Williamson. (Inedited.)

[2] See as above.

probable that the eruptions of trap and porphyry which abound there have produced the result. Along the Mojave river horizontal tertiary strata are found resting in the basins of the granitic rocks; and this is also the case in the Pai-ute mountains.

The extensive outcrops of sandstone which we find at the summit of the Bernardino Sierra, at the Cajon Pass, have a modern aspect, but are without fossils. They are probably of Tertiary age, and are strongly upheaved. They may be regarded as evidence of granitic intrusions since their deposition, but it is by no means clear that the whole chain of granitic ridges has an origin so modern. We find tertiary strata resting undisturbed at the western and northern base of the chain, and it may be found that portions of the thick bank of horizontally stratified materials at the summit, and which form the upper edge of the long slope of the Mojave, are Tertiary. The uplifted sandstone which is found further west, and which is like that in the pass, also testifies to the violent dislocations and movements in that chain during or since the Tertiary era, provided it be proved that the sandstone is referable to this period. The localities of uplifted sandstone which have been referred to, are by no means the only ones which are found in that chain and near the point of its intersection with the Sierra Nevada. In the pass of San Francisquito, in Williamson's Pass, and at the Cañada de las Uvas, there are extensive outcrops, but some of them may be directly referred to the action of vast dykes of compact porphyry or greenstone. On the eastern side of the Sierra Nevada, at the Cañada de las Uvas, there are disturbed sandstone strata containing fossil plants, which show their Tertiary or Post-Tertiary age. These strata are strongly upheaved and dislocated, and are found in the valleys of the granitic rocks of the chain; but on the western base of the mountains there are extensive horizontal undisturbed deposites, 1,500 feet thick or more, from which great numbers of Miocene fossils were procured. This is not the only locality of Miocene fossils in undisturbed strata at the base of the Sierra Nevada. Mr. Marcou, however, states in his Resumé, that the Sierra Nevada was raised at the end of either the Miocene or Pliocene periods, meaning the dislocation of strata of those periods, or upheaval of the chain, independent of the uplift of the "Coast Range," which he states was raised at the end of the Eocene epoch.[1]

In conclusion, it may be observed that much elaborate investigation is yet necessary before this subject of the relative ages of the numerous and extended mountain chains west of the Mississippi can be satisfactorily discussed. The general conclusions to which we have arrived show, however, that chains which differ greatly in age are nearly coincident in direction, and that others which are probably synchronous, are diverging. The general northwest and southeast trend of the ranges west of the Rio Grande, and the more nearly east and west direction of the Bernardino Sierra, are worthy of note. Should it be proved that the Sierra Mogoyon is a continuous chain, its direction nearly conforms to that of the last mentioned chain. The parallelism and overlapping character of the ranges west of the Aztec mountains may be regarded as evidence of their stratified origin and subsequent plication.

## DEVONIAN.

There is much reason to doubt whether the formations equivalent to those of the Devonian or Old Red Sandstone period are found along the line of the survey. They are mentioned by Mr. Marcou at only two points—at the Sandia mountains, and again at the western termination of the carboniferous rocks in the Aztec mountains. At the latter place there was probably the most reason to suspect its presence, but no fossils or other indication than the position of the strata beneath the carboniferous limestone served to identify them as the equivalent of the Devonian. In crossing the Albuquerque mountains—the Sandia range—the carboniferous limestone was found to be separated from contact with the granite by a mass of "serpentinoid trap containing strata of metamorphic limestone of Devonian age." (Notes, October 5.) This serpentinoid trap, as will be seen by referring to the description of the collection, appears like

[1] See page 48 of Captain Whipple's Report, in 8vo., Ho. Doc. 129, and in the reprint of the Resumé in the Appendix to this Report.

a metamorphosed clay-slate, which it most probably is. There are no further observations on these metamorphic strata except the statement that the trap immediately adjoins the carboniferous limestone.

Further west, at the cliff of carboniferous rocks, the carboniferous limestone was found to be resting on a band of red sandstone, the thickness of which is not stated. The relative positions are shown in the small section given with Mr. Marcou's notes, January 22. At the point where this sandstone was first seen, it was six hundred feet above the trail, in the face of a bluff twelve hundred feet high. It was reached beyond this in the course of the survey, and was under foot. There are no observations on its thickness or mineral characters. As there does not appear to be any good evidence of the Devonian age of this layer of sandstone, and as it occurs at only one place, and even there in a comparatively unimportant extent, it has not received a separate coloring on the map and section, but is included with the carboniferous limestone.

## CARBONIFEROUS.

Before the expedition of Lieutenant Whipple, our knowledge of the position and mineral characters of the carboniferous formation along the line of the thirty-fifth parallel was very slight, and did not equal the extent of our information respecting these rocks further north along a region less known to civilization.

The existence of thick beds of limestone in the mountains along the Rio Grande was early made known, but no collections of the included fossils were made and brought in. Dr. Wislizenus reported them as Silurian, and mentions the strata as occurring at several points along his route southward along the valley of the Rio Grande. Lieutenant Abert, who visited one of the mines in the Gold mountains, found it to be in limestone, and procured a Terebratula from the rock which he has figured in his report.[1]

At the north, the collections made by Colonel Frémont and Captain Stansbury had demonstrated the existence of the carboniferous limestone as far west as the shores and islands of Great Salt lake.

The collections made by Mr. Marcou when with Lieutenant Whipple, leave us no longer in doubt with respect to the age of the limestones of the Santa Fé and Albuquerque or Sandia mountains, their Carboniferous age is clearly established, and the formation is also shown to extend westward of those ranges as far as the Aztec mountains, in longitude 113°. The rock at each of these localities is charged with the fossils characteristic of the carboniferous or mountain limestone, and it is associated with thick beds of sandstone and shales, corresponding to the coal-measures of other districts. The formation was also observed at other localities, as has been shown in the chapter on the geology of the route; and as a particular description of the observations at each locality is there presented, it is only necessary here to compare these observations, and to present some of the general conclusions which may be drawn from them.

*Carboniferous limestone.*—The general descriptions have already shown the occurrence of the carboniferous limestone at the following places along the line: At Delaware mountain, Santa Fé and Albuquerque mountains, Sierra Madre, and west of San Francisco volcano, in the Aztec range.

*Lithological characters.*—The several outcrops of limestone differ somewhat in color and general appearance; but this difference is chiefly found between the rock of Delaware mountain and those further west, which more nearly agree in their color and general aspect, judging from the descriptions and the fossils. The only specimen brought in is from Delaware mountain, (No. 59 of the catalogue and description,) and presents a very light-grey or yellowish-grey color, different from the bluish-grey tint of the fossils from the Pecos villages, and west of San Francisco volcano.

The limestone of the Albuquerque mountains, according to Mr. Marcou's notes, is greyish-

[1] Report of an Examination in New Mexico.

blue, and sometimes black. It is very compact, and breaks with a conchoidal fracture. Some of the strata are very thin, and are intercalated with black clay-shales. It is reported that a short distance further south it contains beds of bituminous coal. At another point, where the mountains were ascended, the limestone was greyish-white, or blackish. At the outcrop on the summit of the Sierra Madre, the limestone was found to be bluish-grey; and further west, beyond the Colorado Chiquito, the limestone of Cañon Diablo is of a similar color, or rather more white and yellowish, as I am assured by Mr. Campbell. At Camp 97, the rock is said to contain siliceous kidney-shaped masses, which have been baked to a rose-color by the hot melted lava. The other and most western outcrops in the Aztec range probably have the same bluish-grey color, as this is the color of the fossils, and I do not find any observations on the color of the beds at that place. The fossils are, however, lighter-colored than those from the Pecos villages.

The strata at nearly all the localities appear to alternate with thin beds of shale or sandstone. At Delaware mount the limestone alternates with sandstone, and at Albuquerque mountains with thin and black clay shales, at one place from four to six feet thick. Beds of very hard and rose-colored sandstone were also found—one of them being composed of coarse rolled grains. The limestone of the Sierra Madre was also found to alternate with beds of roseate sandstone. The rock of Cañon Diablo is hard and compact, and is filled with small pits, leaving sharp and hard angles. Kidney-shaped masses of black silex were found in the limestone beds of the Sandia mountains; and similar nodules occur in the strata near Camp 96, where they have become discolored by the heat of the lava.

*Thickness of the strata.*—Mr. Marcou estimates the thickness of the limestone, and included beds of sandstone, at Delaware mountain, as from five to six hundred feet, and near Camp A, in the cañon of San Antonio, (Sandia mountains,) at three hundred feet; but he again estimates the thickness of the Carboniferous, probably including the sandstones and shales above the limestone, at two thousand feet. There are no notes upon the thickness of the strata at the summit of the Sierra Madre, nor is the thickness of the limestone at the cliff in the Aztec range mentioned, but the combined thickness of the whole formation is represented as about six hundred feet. It is undoubtedly the fact that the beds become thinner towards the west. The strata of Cañon Diablo, according to Mr. Campbell, are from three feet to eight or ten in thickness, and the cañon has a depth of 125 feet, and is wholly in the limestone.

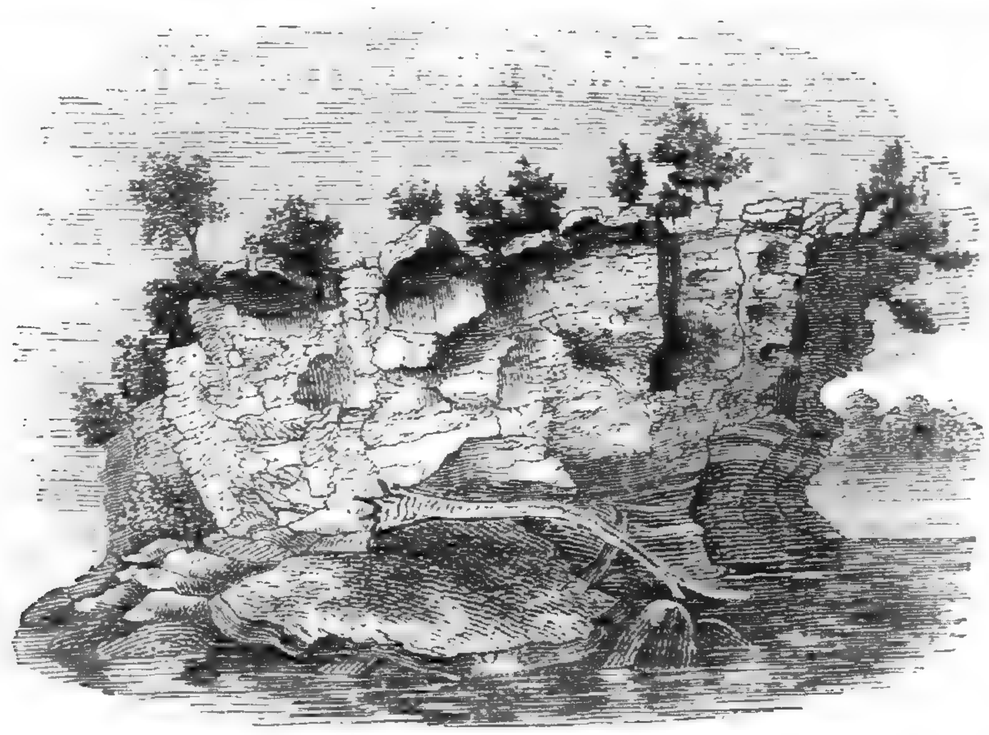
*Fossils.*—The limestone contains a great abundance of fossils at the Pecos villages, and in the cañon of San Antonio. They are also numerous west of the volcano of San Francisco, but are not so well preserved. At Delaware mountain the rock is charged with the stems of encrinites, which are crystalline carbonate of lime, while the surrounding rock is granular. Mr. Marcou mentions finding *Terebratulæ* and *Polypi* at this place, and an *Orthis* is found in the collection—No. 124 of the catalogue and description. The greater part of the fossils in the collection are from the Pecos villages, Santa Fé mountains. They were all submitted to Professor Hall for his examination, and the descriptions of them will be found in Chapter IX. They consist of the following species: *Productus semireticulatus, P. pustulosus, Terebratula subtilata, T. roissyi, T. millipunctata, Spirifer musebachanus, S. pilosus.* Encrinites also occur, and a Cyathophyllum, which is too obscure to be determined. The fossils from the outcrops west of San Francisco mountain are not well preserved; indeed their specific characters are so obscured that they cannot be determined. One of the specimens is a very large *Productus*, and is probably a variety of *P. semireticulatus.* Others are fragments of coral, which are too much mutilated to be recognised. In the notes, January 9, Mr. Marcou states that he found at this place three or four beds filled with fossils, the same as at Sandia mountain and the Pecos villages. He enumerates *Productus semireticulatus* and *P. punctatus, Spiriferæ, Terebratulæ,* and *Polypi,* and says they are very abundant and form a lumachelle. Mr. Campbell informs me that the fossils at this place and at the Sandia mountain in the cañon of San Antonio are very abundant, and that at the latter locality they are found along the roadside, and may be readily knocked out of the

rock with a hammer. Of the fossils from Pecos, which have been described and figured, two are new: *Spirifer pilosus*, Pl. II, Fig. —, and *Terebratula millipunctata*, Pl. II, Fig. —. Both these and the other important species have been most beautifully and accurately drawn for me by Mr. F. B. Meek, whose labors in geology and palæontology are well known to American geologists.

The occurrence of *Productus semireticulatus* at this new locality in the centre of the country is very interesting, inasmuch as this is one of the most widely distributed carboniferous fossils known, it having been found in various parts of Europe, in Asia, South America, and Australia. It was also found near Fort Laramie by Captain Stansbury. *Terebratula roissyi* is another fossil which has a wide distribution.

*Carboniferous sandstone and coal-measures.*—At nearly all the points where the carboniferous limestone is exposed, it is overlaid by thick strata of sandstone and shales in conformable stratification. These strata were found most developed, and reaching their greatest thickness and extent, at the eastern end of the line. The hills and ranges seen in passing up the Arkansas are all formed of this group of rocks. According to Dr. Shumard, the sandstone is the prevailing rock between Fort Smith and Fort Belknap, and, during the exploration of the Red river by Captain Marcy it was found in extensive outcrops.

*Lithological characters.*—The observations which Mr. Marcou makes in his notes upon the mineral character of this group along the line are not numerous or full, nor are the different outcrops represented in the collection by specimens. It appears, however, that the prevailing color of these rocks is grey, or yellowish-grey, and that they are formed, at least along the Arkansas, of thick beds of compact sandstone, alternating in some places with clay shales, which are sometimes blackened by bituminous matter, or contain distinct beds of coal. According to Dr. G. C. Shumard, who has carefully examined the strata near the line in Arkansas and southwesterly to and beyond Fort Belknap, the sandstone is often highly charged with iron, and varies in color from a light grey to a dark brown. It is found in heavy massive beds made up of coarse quartzose grains, and is intercalated with finer-grained sandstone, which is sometimes beautifully ripple-marked. "It corresponds in its lithological features with that forming the Ozark range of mountains."[1] Mr. Marcou states that the beds of sandstone at the mouth of the Poteau river are associated with beds of marly shales, which are blackish in the lower portions. The stratification is very distinct, but the sandstone decomposes where exposed to the air, and is friable; it is also so much filled with fissures that it is not easily

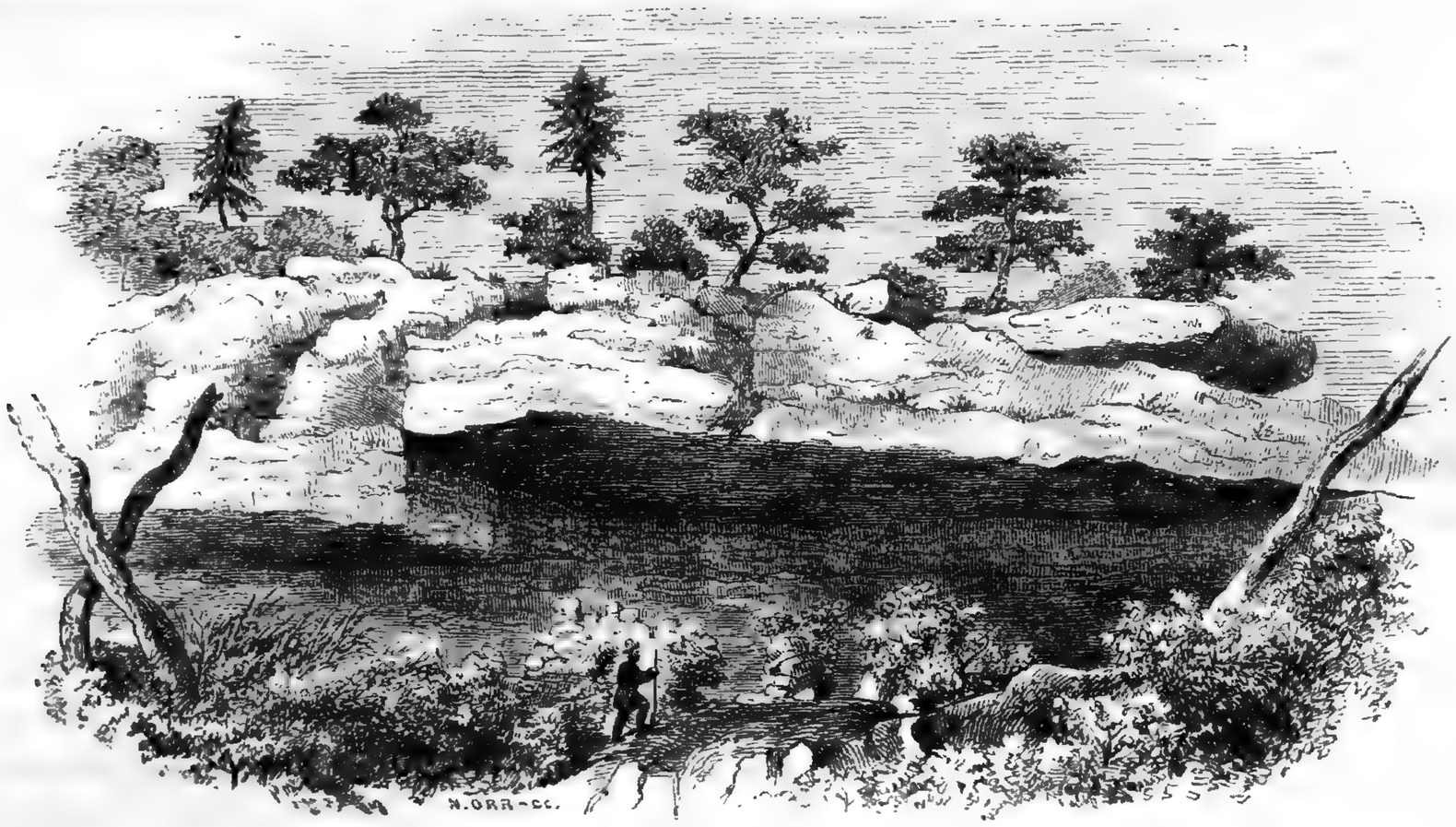


BLUFF OF CARBONIFEROUS SANDSTONE AND SHALE.

worked. Twelve miles south of that point a bed of bituminous coal is found. (Notes, June 19.) At another place, he mentions that the sandstone at the mouth of the river is highly fossiliferous, and a bed of fifteen or twenty inches thick is yellowish-grey, and contains bituminous black spots and nodules of oxyd of iron. It is also ripple-marked.

[1] Shumard. Marcy's Report, Red river, p. 180.

This little sketch of the point of rocks jutting out into the river near Fort Coffee shows in a very distinct manner the contact of a body of sandstone with shales below, and the irregular decomposition of the sandstone by weathering. The sketch on page 14, taken near the same point, also shows the character of the stratification very clearly. Sugar-loaf mountain probably presents one of the best vertical sections of the strata to be found in that vicinity. It is at least one of the thickest remnants of strata which have been much worn down and removed by denudation. Mr. Marcou considered it to be entirely formed of the coal-measures, and states that several beds of coal have been found at its base and in the middle. Beds of sandstone occur from five to twelve feet thick, and alternate with schistose marls of a blackish-grey color, presenting traces of coal, and sometimes containing thin beds of limestone. An idea of the character of some of the beds of sandstone may be obtained from the annexed sketch, taken near the summit, by Mr. Möllhausen:



OVERHANGING LEDGE OF CARBONIFEROUS SANDSTONE—SUGAR-LOAF MOUNTAIN.

It shows that the sandstone is compact and homogeneous, and capable of resisting the weather very well.

Between Camps Nos. 4 and 5, about thirty miles west of Fort Smith, the sandstone is associated with blackish grey schists, and a portion of the sandstone was very ferruginous, and pyrites was disseminated in it. A spring was found there, charged with iron and sulphur. Between Camps Nos. 5 and 6, the sandstone was found of a red color in the interior, it being stained by the oxide of iron. Schists were also found containing concretions. From this point westward to Delaware mountain the sandstone beds were often highly ferruginous, and were intercalated with blackish shales.

I do not find any definite information concerning the lithological characters of the coal-measures or sandstones of the outcrop on the eastern slope of the Sandia mountains. Mr. Marcou gives the thickness of the mountain limestone as 300 feet, and the whole thickness of the carboniferous as 2,000. There is thus a thickness of 1,700 feet of either shales or sandstones, or probably of both. In his Resumé he mentions shales or schists only, and it would appear that they prevail to the exclusion of the beds of sandstone.

At the time the Sierra Madre was crossed, it was very cold, and no observations on the mineral characters of the sandstone were made. Mr. Marcou was doubtful whether he saw it on the eastern side, and on the west no mention is made of any beds except those intercalated with the limestone.

The sandstones beyond Camp 96 were much broken up, and they have a red color. They are

schistose, and yet very hard—harder than the red sandstone of the gypsum formation. The sandstone of the cliff at the Aztec range is red in some places, and again is grey, but it is very hard. Mr. Campbell considers it a light-colored sandstone, and it is possible that the light-colored grey sandstones which he observed south of San Francisco mountain are of the same age. In these, he remarks a resemblance to the light-colored or white and grey sandstones of the table-lands about Zuñi and of the Llano Estucado.

*Thickness of the strata.*—The rocks we have been considering reach their greatest development along the eastern portion of the line, in the State of Arkansas, and within a few miles of its western borders. The greatest thickness stated is 2,000 feet—the height of Sugar-loaf mountain, where the strata are horizontal. This, however, is merely, as I understand, the height of the mountain above the general level of the country immediately around; and, as the base of the strata or the carboniferous limestone is not exposed at that point, the true thickness of the formation is not yet ascertained. The Sans Bois mountains are estimated to be from 2,000 to 2,500 feet high, and are probably composed entirely of carboniferous sandstones and shales. Petit Jean mountain has a height of about 950 feet above the river. The outcrop of the coal-measures at the Sandia mountain must be, as we have seen above, about 1,700 feet thick; for, out of a combined thickness of 2,000 feet, the limestone occupies 300. Much further west, at the Aztec mountains, the whole series, including the limestone and an underlying bed of sandstone, is only about 600 feet thick. The rocks have undoubtedly been greatly denuded; yet it is certain that the thickness of the formation diminishes towards the west.

*Fossils.*—Very few fossils were found in the sandstone strata, and most of them are referable to the lower division of the group, or to the period of the limestone. Ten miles up Little river, near Delaware mountain, Mr. Marcou cites the presence of fossils—*Productus, Crinoids* and *Bellerophon*, and bivalves—in the sandstone. Similar fossils were found in the creek at Camp No. 17. Very few fossil coal-plants were seen, and none were found or collected at the coal-beds. Between Camps 12 and 13 the road lay among hills of carboniferous sandstone, and five or six fragments of the stalks of *Sigilaria* were procured. A fine specimen is in the collection, and is the only fossil from the coal-measures, if we except specimens 100 and 101—a Lepidodendron—from Camp 47, Arroyo Truxillo. At Choctaw Agency, rolled fragments of carboniferous sandstone were found in a brook, containing Polypi and imprints of Productus; also the imprints of Sigillaria and of Equisetum.

*Coal.*—It appears that the outcrops of bituminous shales are quite abundant, and that coal is found at many places along the Arkansas, but generally in thin beds, only in a few instances thick enough to be economically worked. The usual coal-plants, with the exception of the specimens of Sigillaria, were not found; but this is not singular, as none of the beds were opened and explored. The most important of these localities of coal are enumerated in Chapter VIII, under the head of Coal. No coal was found in the Santa Fé mountains; but the shales were very dark; and Mr. Marcou ascertained that workable beds were found in the Manzanna mountains at the south, they being a continuation of the same chain. It is, however, by no means certain that this deposite is in the carboniferous formation; it may be much more modern; and the probability is strengthened by the fact that, at about the same distance north of the line, the coal deposite of the Raton Pass is found, and was at first considered as the true coal, but afterwards was shown to be much more recent, impressions of leaves of dicotyledonous plants having been obtained there.

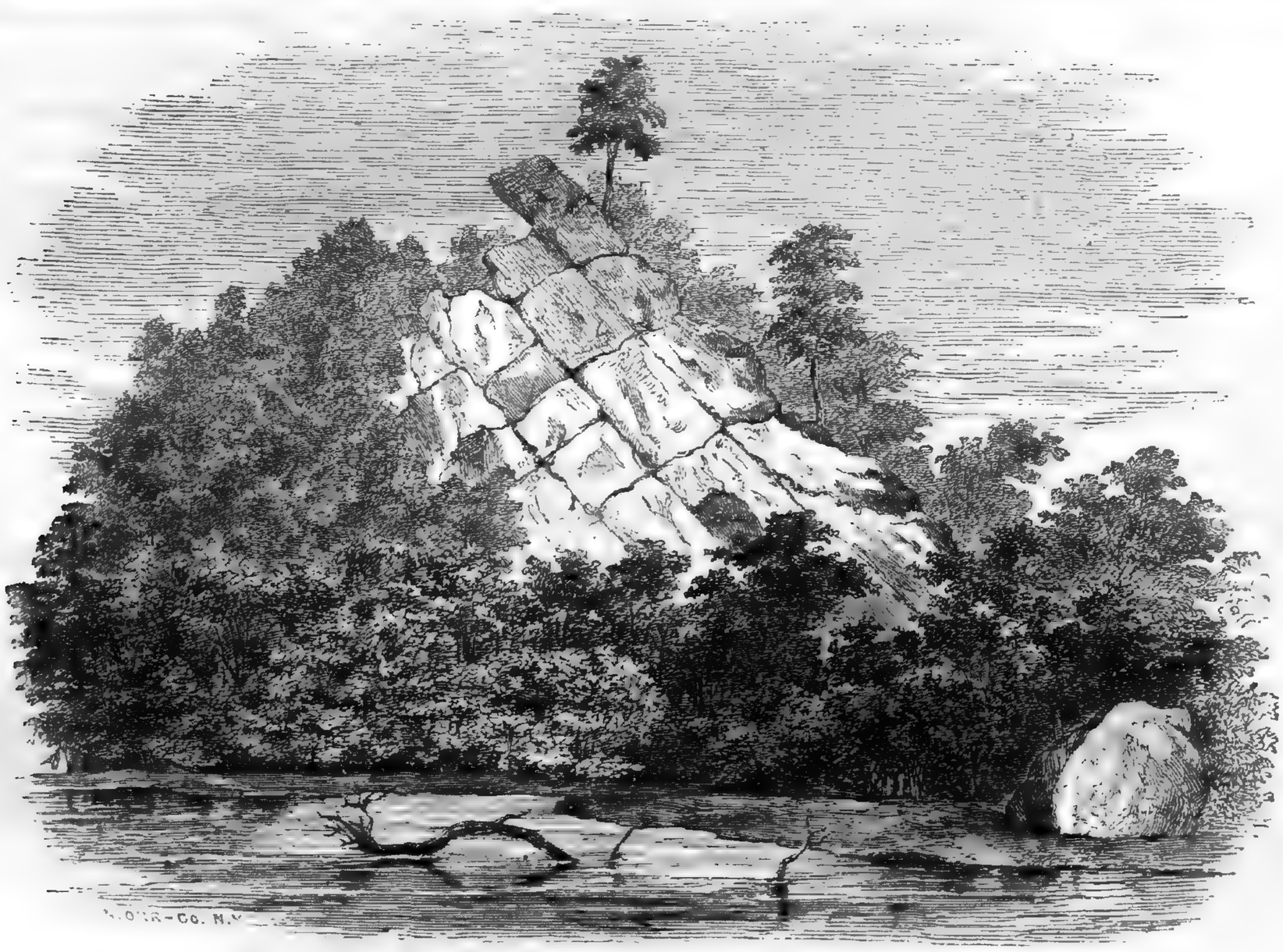
It is possible that the coal found at Ojo Pescado, in the dark-colored bituminous shales, is true Carboniferous, but it is very doubtful. Neither coal nor bituminous shales appear to have been found west of this locality. Even the few observations which we have, force us to conclude that the coal beds decrease in thickness towards the west; and, indeed, that they probably totally disappear west of the Sandia mountains.

GENERAL OBSERVATIONS ON THE CARBONIFEROUS FORMATION.

The Carboniferous may be regarded as the geological horizon for the line, as indeed it is for the whole wide region west of the Mississippi river and the Anahuachian chain. It lies at the basis of all the non-metamorphic sedimentary strata, and is found at convenient points for geological reference along the entire line.

*Disturbances to which the formation has been subjected.*—If we cast our eyes upon the geological map and section, it is at once apparent that the principal orographic features of the continent have been produced since the Carboniferous era. There is also a region which appears to have remained in a state of comparative quiescence since it was submerged by a carboniferous sea. This region is that of the Aztec mountains, and eastwardly from them, towards the volcano of San Francisco. The lines of the principal disturbance and uplift are those of the central chains—the Sierra Madre and the Santa Fé and Albuquerque mountains. Along these lines the carboniferous limestone and associate sandstones or shales are upraised at angles of thirty to forty degrees, and dip away from the central line of granitic rock. At the Albuquerque mountains the mountain limestone was even found at the height of 12,000 feet, forming the summit of the range. The general direction of these lines of uplift of the strata is nearly north and south, conforming to the direction of the ranges. The Sierra Madre, however, diverges towards the west, and its direction may be regarded as north 20° west.

Another line of disturbance is found in the chain of slight elevations commencing at the Witchita mountains and extending in a direction a few degrees north of east to the Arkansas river. Along this line the strata are not raised to a very great height, but the trends of all the ridges and valleys in the carboniferous limestone and sandstone appear to be nearly coincident



DARDANELLE ROCK.

with it. Delaware mountain, which is one of this system, is uplifted, and the direction, according to Mr. Marcou, is N.N.E. and S.S.W. This is a greater deflection to the north than is indicated by the topography of the vicinity. It is possible that there is a line of uplift in a northeast and southwest direction, and that the main granitic axis, extending from the Washita

river east to the Hot Springs and thence to Little Rock, is an older dislocation. The horizontal position of the carboniferous strata on the edges of vertical and contorted metamorphic schist at Little Rock, favors this belief; and yet the long lines of ridges of carboniferous sandstone, extending on the south bank of the river, parallel with this line of igneous and metamorphic strata, show extensive disturbances, and render it more probable that the elevation of Delaware mountain pertains to the same system. At Mammelle mountain, according to Mr. Featherstonhaugh, the strata are well exposed and stand at an angle of 75°, and in some places they were vertical. Dardanelle rock, of which a sketch is here given, is formed of highly inclined strata, the inclination being at least 45°.

Mr. Marcou, however, does not record any inclination so great as these. Between Camps 8 and 9, the dip was found to be from 20 to 30 degrees, and on Gaines' creek it was only 15 degrees, and at several other points it ranged from 10 to 15 degrees. A cause for these slight uplifts may be found in the trap-dykes which Mr. Marcou states are found to traverse the formation in that region.

Near the outcrop of granite at the Caddo village, or not far from Fort Arbuckle, Dr. G. C. Shumard found the limestone to be elevated at an angle of 30 degrees, and at another locality, further west, he found outcrops of sandstone dipping at an angle of 40 degrees.[1] The outcrop of limestone is nearly south of Delaware mountain, and it is probably a part of the same uplift.

The extent of the inclination of the strata at the summit of the Sierra Madre is not expressed in degrees; it is merely noted that the inclination is very strong towards the west. West of San Francisco mountain, at Camp 96, the sandstone strata were found to stand at angles of 60 or 80 degrees, the general direction of the heads of the beds being W.W.N. (Notes, January 10.) It is probable that this is a local rupture of the strata, for they appear to have been found horizontal before reaching the next camp. The strata forming the bluff at the Aztec mountains are not perfectly horizontal, but have a slight dip towards the north. (Notes, January 19.)

The strata being completely hid from our view by more modern deposites of great thickness, between the several points of outcrop just enumerated, it is not possible for us to affirm positively regarding the position or amount of disturbance of these portions; but we are warranted in believing that the beds are much undulated, and perhaps in many places come nearly to view above the more recent deposites. The carboniferous limestone, and the sandstones above it, dip under the beds of the gypsum formation at Delaware mountain, to appear again six hundred and fifty miles further west on the side of the Albuquerque mountains. The depth to which the limestone extends below the surface at any intermediate point cannot be given; but the strata probably do not form one great curve, but rest in a succession of wave-like flexures, at about the same distance from the surface. In representing these portions of the strata on the section, the lines are drawn more evenly and regular than it is probable a close conformity to nature would permit. The uncertainty which attends their position is, however, acknowledged by the broken or dotted line between those portions of the strata which are below the line of vision. No outcrop of the limestone and sandstone being found on the western side of the Albuquerque mountains, we are led to conclude that the edges of the strata are covered from view by the more recent deposites. It is also doubtful whether they rise to the surface on the eastern slope of the Sierra Madre, Mr. Marcou not being positive that they were passed by him. Mr. Campbell, however, having found outcrops of limestone further north dipping to the east, it becomes most probable that Mr. Marcou's supposition was correct. I, however, have not brought the strata to the surface on the section, but have represented them as underlying the whole valley, their edges being concealed on each side by the deposites of the gypsum formation or the Cretaceous.

*Denudation.*—It is very evident that the carboniferous strata have been subjected to powerful denudation, it being sufficiently attested by such remnants of the strata as Sugar-loaf mountain,

1 Marcy's Report, pp. 193 and 195.

which, as is well expressed by Mr. Marcou, stands as a column in witness of the immense denudations to which that part of the country has been submitted. We have an erosion at that place amounting to 2,000 feet in depth, and the mountain is almost the only relic of that elevation in that region. The long valleys between the the Poteau, Sans Bois, and other ranges along the Canadian, are probably for the most part produced by denudation. The denudation at Delaware mountain, by which nearly all the carboniferous sandstone has been removed, is also worthy of remark. The elevated outcrops of the Albuquerque mountains probably have not suffered very greatly by denudation from currents; the slow disintegrating action of snows and the atmosphere have been the principal agents in producing their degradation. But it is by no means certain that extensive denudations have not taken place further west, and that the strata of the Aztec mountains, and under the now wide-spread lavas of San Francisco volcano, have not been swept by powerful currents. The bold escarpment presented by the strata towards the west, and their sudden and entire disappearance beyond, indicate the most extensive and powerful denudation. In estimating the probable amount of denudation of the strata at the extreme west, we must not lose sight of the fact, that the whole series appears to diminish in thickness as we proceed westward. This is first indicated in a marked manner by the outcrop at Albuquerque mountains, where the thickness, even estimating it at 2,000 feet, is much less than the thickness of the upper portions of the group along the Canadian river.

*Limestone and strata along the Colorado Chiquito.*—It will be seen by reference to the general description of the series of red strata containing the gypsum, that there is much probability that a portion at least of these strata, especially those along the Colorado Chiquito, are in reality portions of the carboniferous group. The red color is due entirely to a change in the constituents of the beds, or to infiltration, and is not any evidence of a different age, although a strong contrast may be presented with other strata of unquestionable carboniferous age. The conformity of the strata also appears more perfect along the Colorado Chiquito than at any other point. The limestone of Cañon Diablo, which was met after crossing the Colorado Chiquito, was regarded by Mr. Marcou as the equivalent of the magnesian limestone of the Trias, and he thought he saw fossil *Belemnites*, a *Nautilas*, and a *Pteroceras* in it. He states that it occurs in beds from six inches to one foot in thickness, and dips to the north under angles of from ten to fifteen degrees, conformably with the other strata, "the New Red." Strata of limestone were also found alternating with the red sandstone. Mr. Campbell afterwards saw this limestone greatly developed in the sides of the Cañon Diablo, and states that its appearance is similar to that near Camp 96, which Mr. Marcou at first called magnesian limestone, evidently regarding it as equivalent to that along the Colorado Chiquito, but which he afterwards found to contain abundance of the fossils characteristic of the mountain limestone. It will thus be seen, that it is not possible to draw the dividing line between the carboniferous group and that which has been described under the title of gypsum formation. I have referred the limestone of Cañon Diablo to the Carboniferous, and in the section have represented the red clay and gypsum series as resting directly upon it. If it shall be proved by further exploration that this limestone is in reality a portion of the lower carboniferous series, a large part of the strata now classed under the name of Gypsum formation must be referred to the Carboniferous. As the age of these strata is so doubtful, little attention has been given to the phenomena which they present in the preceding descriptions. Similar uncertainty rests upon the age of the sandstone which Mr. Campbell saw in detached mounds on the limestone around San Francisco volcano.

The probable carboniferous age of the metamorphic limestone found beyond the Aztec mountains has already been adverted to. It is most probable that the outcrops in the Cajon Pass, and those in the Cañada de las Uvas, and in the Tejon, are of this period.

# CHAPTER VII.

## GENERAL DESCRIPTION OF THE GEOLOGICAL FORMATIONS.

## GYPSUM FORMATION—CRETACEOUS, TERTIARY AND VOLCANIC.

GYPSUM FORMATION SUPPOSED TO BE TRIAS BY MR. MARCOU.—ABSENCE OF FOSSILS.—CALLED GYPSUM FORMATION BY PROFESSOR HITCHCOCK.—EXTENT AND BOUNDARIES OF THE FORMATION.—LITHOLOGICAL CHARACTERS.—SECTION AT PYRAMID MOUNTAIN.—GYPSUM.—EXTENT AND LOCALITY OF THE DEPOSITES.—MOST ABUNDANT EAST OF THE MOUNTAINS.—DOLOMITE EAST AND WEST OF THE MOUNTAINS.—THICKNESS OF THE GYPSUM FORMATION.—DISTURBANCES OF THE STRATA.—UPLIFTS NEAR SAN ANTONIO DUE TO TRAP DYKES.—EXTENDS IN NEARLY UNBROKEN STRATA FROM THE EAST TO THE WEST SIDE OF THE MOUNTAINS.—PROBABLE AGE OF THE FORMATION AND ITS REPORTED SYNCHRONISM WITH THE TRIAS OF EUROPE.—CRETACEOUS FORMATION.—POINTS AT WHICH IT IS IDENTIFIED BY FOSSILS.—CRETACEOUS AGE OF THE LLANO ESTACADO.—OF THE PLATEAUX WEST OF THE SIERRA MADRE.—EXTENT OF THE CRETACEOUS ALONG THE ROUTE.—MINERAL CHARACTERS.—THICKNESS.—DISLOCATIONS.—MOUNTAIN RANGES OLDER THAN THE CRETACEOUS.—SUBMERGED IN PART BY THE CRETACEOUS SEA.—REPORTED JURASSIC AGE OF THE LLANO.—TERTIARY.—POST-TERTIARY.—ALLUVIAL.

## GYPSUM FORMATION.

### RED SANDSTONE AND CLAY CONTAINING GYPSUM.

The descriptions of the geology along the route have shown that for a great part of the distance a remarkable series of strata of red sandstone, red marls and clays, containing an abundance of gypsum, were found in all the valleys of erosion. These strata were considered by Mr. Marcou as the equivalents of the Triassic formation of Europe, and he records his observations under that name in his notes, and describes the series in his preliminary report, or Resumé, as the Trias or New Red sandstone, and forms the whole group into three divisions corresponding to the divisions adopted by European geologists.

As no fossils have been found in the strata, and as the line of separation between them and the underlying Carboniferous, and the Cretaceous above, has not yet been traced satisfactorily and does not appear to be well defined, I do not attempt to assign their age, but adopt for them the name *Gypsum formation* for purposes of description until further examinations shall determine to what geological period they can, with propriety, be referred. This name was proposed by President Hitchcock for similar strata, an extension of the same series of deposites, found along the Red river by Captain Marcy, in his exploration of 1852. No fossils having been found, he was not able to determine the age of the formation; and as it was characterized by an abundance of gypsum, the above name was adopted for those portions of the strata which contained it in abundance, and the term Red Clay formation for those where the red marls and clays were predominant. In the following descriptions the term Gypsum Formation will refer to all the red strata of sandstone and marl containing gypsum, which are above the rocks containing fossils of carboniferous age, and below those in which cretaceous fossils abound. It is therefore possible that a portion of each of these two formations may be included in the descriptions.

*Extent and boundaries of the formation.*—The strata of red sandstone and clay were first met on the western side of Delaware mountain, or about two hundred miles west of Fort Smith. They continue along the valley of the Canadian and False Washita westward to the Albuquerque mountains, where the carboniferous rocks rise through them, and form the crest of the mountains. The strata do not appear to rise high up the slope of the mountains, or as high as

the Carboniferous, but are confined to their base; and it appears, from the descriptions, that they extend through the valleys or breaks in the ridges into the valley of the Rio Grande. In this valley they are well known, and are exposed along the valleys made by the streams. They also appear on the western side of the valley, high up on the sides of the Sierra Madre, being found near the summit of the Zuñi Pass, (*Camino del Obispo*,) at an elevation of over 7,500 feet, and farther north the strata are continuous from one side of the range to the other along the road to Fort Defiance, through Campbell's Pass. From the western flank of the chain they spread out and underlie the broad table-lands and mesas towards the Colorado, forming the sides and beds of all the tributaries to the Colorado Chiquito, which is itself, in the formation nearly to its mouth in the Great Colorado. The most western exposure along the route appears to be at the base of the great volcano—San Francisco mountain—where the red strata are succeeded by a thickly-bedded limestone, which is referred, with some doubt, to the lower Carboniferous. The formation is exposed in nearly every river-bed and cañon from Delaware mountain to the foot of the volcano, a distance of about 950 miles, and over one half of the entire route. The highest point at which it is known to occur is that already mentioned. With regard to its northern extension little is yet known; but on the south it has been traced along the Red river by Captain Marcy, and near the parallel of 32° by Captain Pope, where it extends along the Colorado of Texas to its sources in the Llano Estacado. It is also found along the Pecos river and Delaware creek.

*Lithological characters.*—The eastern portions of the formation along the Canadian and False Washita rivers probably present a greater variety in the texture, color, and mineral composition of the strata, than any other part. It is this portion of the formation which contains the thickest and most interesting beds of gypsum, and the observations on the lithological characters along this part of the line are more numerous than upon any other. It appears, from the notes and descriptions, that red is not the only color which the strata present. There are grey gandstones and limestones, beds of white, grey, and rose-colored gypsum, and different shades of blue and red. Thus blue shales, or blue clays, were the portions of the formation first seen a short distance beyond Delaware mountain. Grey sandstone is of frequent occurrence, alternating with the red; and at Denudation mountain, beds of white siliceous limestone are found at the upper part, and are the hardest portions, while below, strata of red sandstone predominate, and are separated by beds of red shale, which split up into thin leaves. The color of the marls and clays was frequently observed to be like that of the dregs of wine—"*lie de vin;*" they were found near Camp No. 21, and between Camps 22 and 23, and again west of the Sierra Madre, near Zuñi. At Camp No. 19 the clays were red and blue, and were rather hard, and associated with a brecciated sandstone. Fragments of dolomite were also seen. Beyond there, white clay was found above gypsum, and a bed of very hard sandstone, coarse-grained and feldspathic. The red or wine-colored clays near Camp 22 were overlaid by a sandy, red, brecciated limestone, passing into a reddish-grey sandstone.

The soft marls were observed, in many instances, to pass into sandstone by becoming more sandy, as near Camp 23, where saliferous marls were found to become so sandy that a true red sandstone with an alternation of grey was formed. Marls were again observed to pass into fine red sandstone and into red siliceous limestone between Camps 24 and 25. Near Camp 29 the strata of red sandstone were nearly 150 feet thick, and at Camp 30 the following section was obtained in the bank:

| | |
|---|---|
| Argillaceous dolomite | 6 feet. |
| White gypsum | 25 " |
| Sandstone and argillaceous shales and red clay | 10 " |

The red sandstone and red clay appear to predominate at all the localities of gypsum, but near Camp 42, green and red saliferous marls occur, and cliffs of white sandstone, a little rose-colored, are found along the creeks. Along Rio Bonito this sandstone was found to contain calcareous concretions and beds of white limestone. At Arroyo Amarillo, (Yellow creek,) some

beds of sandy marl, instead of being red and green, are greenish-yellow, and somewhat dolomitic. Beyond this point, red sandy marls with some green and yellow bands, were constantly found. (Notes, September 15 and 16.) The sandstone of Rocky Delaware creek, according to the notes, is whitish-grey, with some shales of a rosy hue. The specimen in the collection No. 65 is a grey, friable, calcareous sandstone, which crumbles away under the fingers. It resembles recent or Tertiary sandstones. A thickness of 150 feet of red and greyish marls above this sandstone is also noted. They have green tints. Beds of shaly sandstones, of a rose and red color, are also found. It is possible that these strata belong to the overlying cretaceous deposites of the Llano. Mr. Marcou is of the opinion that the greyish-white sandstone is Triassic, and by no means Cretaceous. (Notes, September 18.) In a section of 500 feet in depth, from the level of the surface of the Llano downward, the following succession of deposites were found, the upper ones belonging to the Cretaceous and not to the Gypsum formation:

SECTION AT PYRAMID MOUNTAIN.

| | | |
|---|---|---|
| 500 feet. | White limestone. | "Jurassic." |
| | Yellow limestone with bluish-grey bed at the bottom. | |
| | Bed containing Ostrea [——?] | |
| | White sandstone. | |
| | Yellow sandstone. | |
| | White sandstone. | |
| | Grey and green bed in contact with the superior Trias. | |
| | Red and green sandstone. | |
| | White marls with [concretions?] | "Triassic." |
| | Red and green marls. | |
| | White. | |
| | Red. | |

Mr. Marcou places the dividing line between the Trias and the formations above at the base of the lower bed of white sandstone, in contact with a thin bed of grey and green earth or sandstone. He also states that the red clay predominates, and has green and white bands, while the red is sometimes wine-colored, and much resembles the Keuper of Brissot. The only indication of the line of separation between these formations appears in this case to be the color, for no fossils were found. At Anton Chico red marls occur, and appear to predominate from this place west to the mountains, forming the bottoms of the cañons.

West of the Sierra Madre the reddish sandstone and clay was found in the beds of the brooks. Near Camp 75 crystals of gypsum were found in the clays and red sandstone; and a short distance beyond, a sandy red clay, sometimes brownish-red at the base, was abundant, and many fossil trees were seen. Between Camps 76 and 77 the great number of fossil trees already described was found. Here the sandstone was grey in color, or pinkish, very hard, and thickly bedded—the layers being from three to six feet thick. The red clays are, however, said to predominate, and a little whitish-grey clay was seen. This was regarded as the middle part of the Trias by Mr. Marcou. (Notes, December 3.) Red, blue, and grey clays, supposed to belong to the inferior Trias, were subsequently found, and along the Colorado Chiquito red sandstone and marl, with white marls below them, were the prevailing rocks.

There are several specimens in the collection, labelled Triassic by Mr. Marcou, and they are described in Chapter X. The localities from which they were obtained have been described in the preceding descriptions. They are all from the Atlantic slope, none being found from the red strata in the valley of the Rio Grande or west of the Sierra Madre. They are all soft and friable—the clays and marls having, to all appearance, been so soft when collected, that they were moulded like wet clay. In hardness they do not compare with the specimens from the Gypsum formation brought in by Captain Pope, United States Topographical Engineers, from the route near the thirty-second parallel.[1] It is, however, very probable that the strata are not

[1] For a description of these specimens, see the writer's report on the Geology of the route near the 32d parallel: Pacific Railroad Exploraion and Surveys.

fully represented, as indeed we know they are not, when we compare the descriptions with the collection.

We have thus seen that strata of various colors are found intercalated, and that the red marls and sandstones predominate. It also appears that the red color is most common or striking along the valley of the Canadian before the bluffs of the Llano are reached, and again on the western limits of the formation along the Colorado Chiquito.

*Gypsum.*—In the preceding description of the sandstones and marls of the formation, an account of the various beds of gypsum was purposely avoided, in order that they might be more directly compared. Many specimens of this mineral are in the collection, and are particularly described in Chapter X; and further details respecting the quantity of the mineral, and its uses in the arts, will be found in Chapter VIII. The part of the route near which it appears to occur in the greatest abundance is along the valley of the False Washita, about northeast from the Witchita mountains. Most of the specimens are from Gypsum and Comet creeks, and the vicinity of Camp 30.

At this point a bed twenty-five feet thick was found, and it has already been mentioned, and its association with the red sandstone and shales given. Between Camps 33 and 34, beds from one to twenty feet thick were found above strata of magnesian limestone, the bed at Camp 30 being below. These beds of gypsum are described as white, and traversed with rose-colored and grey veins; and the bed at Camp 30 is amorphous and white. Near Camp 41, beds from six inches to one foot in thickness are found; and beyond this point to the valley of the Rio Grande, very little gypsum appears to have been seen. One specimen in the collection is from San Antonio, the village at the eastern base of the Sandia mountains. There are no specimens in the collection from any point west of this locality, nor are there many observations on the gypsum. It does not appear to have been abundant beyond the valley of the Rio Grande, where we know that it occurs, and is used in considerable quantities as a substitute for glass. Its presence in the red sandstone and marl near the summit of the pass, in the Sierra Madre, is mentioned, but the thickness or extent of the bed, if indeed it forms one, is not given. (See notes, November 18.) It occurs in nodules between Camps 71 and 72, and near Camp 75 in crystals, distributed in the red marl and sandstone. It was also seen at the crossing of the Colorado Chiquito in thick kidney-shaped masses in the red sandstone.

Although an enormous amount of gypsum is exposed along the route, the deposites do not equal in their extent and quantity those found by Captain Pope along the Pecos river and Delaware creek, on the route near the 32d parallel. There, according to Captain Pope, the beds are fifty feet thick, and form bluffs, which are full of caverns.[1]

We must be careful to avoid the impression that the gypsum beds are continuous throughout the formation, or that they retain their thickness for great distances. The facts show that the thick beds are confined to a small portion of the route. Although we find the red sandstones on both sides of the mountains bordering the valley of the Rio Grande, and the strata appear to be geologically equivalent, there is a great difference between the different portions in respect to the amount of gypsum, and the form in which it occurs. It predominates on the Atlantic slope of the mountains, and is most abundant a few miles east of the last outliers of the table-land of the Llano Estacado, in the vicinity of Gypsum and Comet creeks, and near the cretaceous deposites of Camp 31. The term Gypsum formation thus applies more appropriately to the eastern than to the western portions of this wide-spread deposite of red marls, clays, and sandstones.

*Dolomite.*—Magnesian limestone or dolomite appears to form an important part of the formation, and is closely associated with the gypsum. The bed of dolomite which overlies the gypsum at Camp 30 is argillaceous, cavernous, and of a reddish color. A similar rock was again observed between Camps 32 and 33. Between Camps 40 and 41 a bank of dolo-

[1] Report of Captain Pope, United States Topographical Engineers; also, report on the Geology of the route: U. S. Pacific Railroad Exploration and Surveys. Washington: 1856.

mite is noted as three or four feet high and cavernous, with rose-colored beds, as at Salins. (See notes, September 11.) The red clays occur above and below this dolomite. In ascending the bluffs of the Llano Estacado, between Camps 41 and 42, strata of dolomite from three to five feet thick were found, and at Camp 42 it was very abundant. A sandy dolomite is noted as present in the face of the bluffs near Cuesta; and I find a large specimen of compact dolomite in the collection (No. 61) taken from San Antonio, southwest of Cuesta, but which does not appear to be mentioned in the descriptions. This rock is bituminous, and may pertain to the Lower Carboniferous. The dolomites do not appear to have been found in the valley of the Rio Grande, nor in any quantity west of the Sierra Madre, until the base of the volcano of San Francisco was reached. We may, perhaps, except the beds of yellowish limestone associated with the bituminous shales at Ojo Pescado, but which are very probably of carboniferous age. The strata of magnesian limestone beyond the Colorado Chiquito are mentioned in the general description of the carboniferous formation, and their probable carboniferous age is noted. According to Mr. Marcou, they occur in concordant stratification with the strata of the "New Red" sandstone with which they alternate, and attain a thickness of six inches to one foot. This description must refer to other strata than those seen along Cañon Diablo, which were very much thicker, forming the walls of the ravine, one hundred feet deep, but which were conformable with the red strata. It is very probable that the upper beds are interstratified with sandstone. A specimen in the collection from the Colorado Chiquito, and probably taken from this locality, much resembles the specimen from San Antonio. The collection contains many specimens of the magnesian limestones, and they are all described in Chapter X. (See Nos. 60, 61, 62, 63, and 64.) With the exception of the specimen from near Camp 30, they are all hard and compact, and of light grey or buff color.

*Thickness of the formation.*—In a formation of this character—one evidently resulting from the metamorphosis or change of strata, entirely different in color and mineral ingredients, and which we cannot separate exactly from formations either above or below—it is of course not possible to state definitely the thickness, or to give an average thickness for the whole series of beds as a distinct formation. The thickness of the red strata appears to be the greatest on the eastern slope of the Albuquerque mountains, under the Llano Estacado, and perhaps near the point where the gypsum is most abundant. There is, however, no valley of erosion in these horizontal strata deep enough to expose all the beds, nor is there at any point an uplift which brings them all into view; the thickness, therefore, must remain unknown. The same observation will apply to the strata west of the Sierra Madre and in the valley of the Rio Grande; there are no erosions of a depth sufficient to develop the whole thickness of the formation down to strata of undoubted Carboniferous age. The exposures at any point appear to have never shown a greater thickness than two or three hundred feet, the thickness of the white sandstones and chalky limestones of the Llano being subtracted from the depths of the valleys. Mr. Marcou, however, in his notes, states that the Trias has a thickness of four or five thousand feet, (October 9;) and again, that the thickness of the variegated marls, or the superior part of the American Trias, is considerable—not less than three hundred feet above the gypsum. In the Resumé, he states that the lower division of the "Trias" attains a thickness of two to three thousand feet, the middle of about fifteen hundred, and the upper of fifteen hundred; making for the whole a thickness of five to six thousand feet.[1] It is probable that these are estimates based upon the apparent thickness of the beds as they were passed successively in ascending the valley of the Washita and Canadian, and in descending from the Sierra Madre west along the valley of the Colorado Chiquito.

It is certainly very important to determine as nearly as possible the thickness of these strata; but this does not appear possible, as neither the upper nor lower limits can yet be determined.

*Disturbances of the strata.*—The strata were generally found to be horizontal, or nearly so, being conformable with the cretaceous strata of the Llano Estacado. The first observation on

[1] Resumé, &c. Report of Lieutenant A. W. Whipple, 8vo., House Doc. 129, pages 42 and 43.

the position of the strata is found in the notes under date of August 22, when they were observed to be horizontal or nearly so. This was between Camps No. 21 and No. 22. The next day, beyond Camp 22, the strata were observed to dip southwest at an angle of from five to ten degrees. At Camp 28 the strata were inclined at an angle of ten degrees towards the south, the trend being east and west. Beyond Camp 28 the strata were horizontal. This was in the vicinity of Rock Mary and other natural mounds formed by the denudation of horizontal strata. The great beds of gypsum at and near Camp 30 were horizontal ; but near Camp 31 a bed of gypsum dipped towards the north at an angle of ten degrees. From this place to the vicinity of Cañon Blanco (Camp 54) the strata appear to be horizontal ; but in the cañon they, together with the upper strata—the Jurassic, according to Mr. Marcou—are inclined towards the southeast, and the heads of the beds are turned towards the mountains. Beyond this, and on the next day, a line of hills was passed, in which the strata were uplifted and dipped each way under various angles, from fifteen to sixty degrees. The disturbance was so great that portions of the upper strata, the yellow sandstone, had slid upon the marls of the formation, and in some places were overturned. (October 1.) The explorations of the next day developed the existence of dykes of trap, one being found ten feet wide, cutting the strata in a direction "30° E.E.N. to 30° W.W.S." Beyond this the beds of the "Trias" are said to be upheaved, and generally inclined to the south-southeast, under angles of ten or fifteen degrees. A short distance beyond Camp 57, on the Santa Fé river, Mr. Marcou saw, in the north, elevated horizontal beds of "New Red," capped with a layer of basaltic lava. This locality is almost south of Santa Fé, and beyond the Santa Fé mountains. At San Antonio, on the eastern side of the Sandia or Albuquerque mountains, the strata dipped towards the east, the angle of inclination varying from twenty to forty-five degrees. A few miles northeast of this place trap dykes were found traversing the "Trias" in several directions, as has been already described.

In the valley between the Sierra Madre and the Santa Fé and Albuquerque mountains, a short distance beyond the Puerco, beds of greyish-blue clays and yellow sandstone dip to the east at angles of ten or twenty degrees. Near Sheep's spring Mr. Marcou saw the clays and the red sandstone of the "Trias" rising underneath similar strata and dipping to the east at a low angle. This inclination is shown in a small sectional representation accompanying the notes, November 13. The formation, however, on this part of the line appears to be generally horizontal, or nearly so. Near Camp 67, on the east side of the summit of the pass in the Sierra Madre leading to Zuñi, there are, according to Mr. Marcou, very well developed red Triassic sandstones, dipping S.S.E. Beyond the mountains, and in the valley of Zuñi, the "Trias" inclines towards the east, at an angle of from ten to fifteen degrees. North of this place, and in the line of trend of the Sierra Madre, the red strata are, according to Mr. Campbell's statements, strongly uplifted, and dip eastward and westwardly. The edges of the strata may be seen about Fort Defiance in high bluffs. This is a region where trap dykes abound, a large one being found near the fort.

At many points west of those last mentioned, the beds of the gypsum formation were found to be upraised at slight angles dipping east, west, or north, but these angles in no instance were greater than ten degrees. Mr. Marcou refers the disturbances to three lines of dislocation. The dip along the Colorado Chiquito is from eight to ten degrees northward, and the strata were, to all appearance, dipping away from the Sierra Mogoyon, where the plateau seemed to end, the surface being gently ascending in that direction.

We thus find that the line of greatest disturbance or inclination of the strata of the formation is on the eastern side of the Albuquerque and Gold mountains, where it reaches forty and sixty degrees. The inclination at other points seldom is as great as fifteen degrees. The principal disturbance appears to be confined to one line, and this a line of erupted trappean rocks in the form of dykes, whose presence is a sufficient explanation for the dislocations of the strata. So, also, at Fort Defiance, where the uplifts are great, we find trap dykes, which are conspicuous features in the scenery of the region. The flexures along the Washita and the Canadian,

although very slight, may be referred to erupted rocks in the granitic region of the Witchita mountains.

We may for the most part regard the strata as horizontal, and undisturbed by the uplift of either of the great granitic ranges, which are more recent than the Carboniferous. We may conclude from the notes, and the observations of others, and from the topographical indications, that the formation extends continuously in nearly horizontal beds from one side of the central chain of mountains to the other, occupying the wide depressions, or passes, between the ranges. It occurs, according to Mr. Marcou, along the valley of the Galisteo river, and a short distance north of Camp 56, (Galisteo.) This place is directly in the line of the Santa Fé mountains, and between their south end and the north end of the Gold mountains. The white sandstone and calcareous strata of the Llano are also found to extend through this break in the mountains, and are cut by a trap dyke four hundred yards north of Camp 56. (See notes, October 2.) Mr. Marcou also records passing from Camp D (probably at Galisteo) to Camp E, or the Pecos village, through "cañons in the Trias, as far as old Pecos, the top of the cañons being of Jurassic sandstone." From this I conclude that the "Trias" and the "Jurassic" were horizontal at the east base of the Santa Fé mountain, and this conclusion is in accordance with the topography, as given by Abert and Peck, in their map of 1846–7. I have been thus particular to present the evidences of continuity of these deposites from one side of the mountains to the other, as Mr. Marcou represents them in his Resumé, as upraised or dislocated by the "Rocky mountains," the dislocation of which, he states, took place at the end of the Jurassic period.[1]

Having thus shown that the gypsum formation extends from one side of the mountains to the other, undisturbed or dislocated only by local intrusions of trap, we may conclude that the principal uplifts of the central chain took place before its deposition, and that a grand continental elevation of over seven thousand feet has taken place since that time.

### REMARKS ON THE PROBABLE AGE OF THE FORMATION, AND A CONSIDERATION OF ITS REPORTED SYNCHRONISM WITH THE TRIAS OF EUROPE.

In a formation of this character, where the upper and lower limits have not been clearly traced throughout, and where the peculiar conditions which give it a name may occur in strata of an entirely different age, either above or below, and which is also without internal fossil evidences, we cannot properly speak of it as distinct, or assign it a place in the geological series, as one group with an age isolated by time from those above and below. The peculiar mineral conditions which distinguish the strata, and which have served to group them for the purposes of description, are the result of causes acting since they were deposited, producing appearances entirely different from those which characterized them at the time of their deposition, and acting alike on all the formations, either Carboniferous, Triassic, or Cretaceous, without regard to their age or separation by time. We cannot, therefore, discuss the age of the strata described under the name *Gypsum formation*, as if they constituted one separate geological group. We cannot, however, lose sight of the possibility that in these deposites so characterized, and differing so much from the known carboniferous and cretaceous strata, we may have the equivalents of formations which occupy the same relative position in other regions. But the observations which have been made do not get justify the establishment of bounding lines, and consequently, as we have seen, no determinations of the thickness can be made. It is true that for a considerable distance in the valleys cutting the Llano Estacado, there is a distinct line formed by the junction of the white sandstones and limestones above with the red strata below, but at many points the strata are all light-colored, and the only distinguishing difference—that of color—is wanting.

These opinions are, however, very different from those presented by Mr. Marcou in his notes and Resumé. He recognises a distinct and well-characterized formation, which he considers as the equivalent in age of the Trias of European geologists. He gives its whole thickness as four

[1] Resumé. Report of Lieutenant A. W. Whipple, H. Doc. 129, p. 46.

or five thousand feet, and separates it provisionally into three divisions: the first, or lower, corresponding to the *Bunter-sandstein*, or *Grès bigarrés;* the second, or middle, to the *Muschelkalk;* and the third, or upper, to the *Keuper* or *Marnes irisees.*[1]

Mr. Marcou's conclusions upon the age of the formation, and the correspondence with the groups into which the European formation is divided, appear to rest almost entirely upon the mineral characters of the strata. The only distinct fossils found were silicified trunks of trees, one of which was thought to "very much resemble the *Pinites fleurotii* of Dr. Mougeot." As no specimen of this tree is in the collection, I have not had an opportunity to examine it; but even if it were proved to be identical with *P. fleurotii,* I cannot agree with Mr. Marcou in his

[1] For the convenience of the general reader, I append a short description of the Trias of Europe with its divisions, and of the Permian formation as developed in Russia.

In England and France, we find between the strata of the coal formation and those of the Lias a great series of red sandstones and shales, to which the name New Red Sandstone was first given, in order to distinguish between it and similar rocks which are found below the coal, and are known as the Old Red Sandstones. The name Poikilitic was afterwards proposed, this name having reference to the variegated colors of the strata. After the fossil remains of the series had been more fully investigated, it was found desirable to form two divisions, and these were called Upper New Red and Lower New Red. The first is now generally known as the Trias; while the second, or Lower New Red, is called Permian.

The name Trias was adopted by German writers, because the Upper New Red Sandstone could be separated into three principal subdivisions, which were called the "*Keuper,*" the "*Muschelkalk,*" and the "*Bunter-sandstein.*" The same subdivisions are known among French geologists as the "*Marnes irisees,*" the "*Calcaire coquillier,*" and the "*Grès bigarré.*" These subdivisions, with their respective terms in German and French, are clearly shown in the annexed table, taken from Lyell's Geology.*

| | | SYNONYMS. | |
|---|---|---|---|
| | | *German.* | *French.* |
| Trias, or Upper New Red Sandstone. | *a.* Saliferous and gypseus shales and sandstones. | Keuper. | Marnes irisees. |
| | *b.* (Wanting in England.) | Muschelkalk. | Muschelkalk, ou calcaire coquillier. |
| | *c.* Sandstone and quartzose conglomerate. | Bunter-sandstein. | Grès bigarré. |

In England, the upper division of the Trias consists chiefly of fine red clays and thinly bedded sandstones, interstratified with beds of gypsum, and containing rock-salt. This division has nearly the same characters in Germany, consisting of variegated marls, with gypsum and sandstone. Fossils have been found in it, such as teeth of placoid fish, and remains of reptiles, including the *Labyrinthodon.* The fossil plants are generically analogous to those of the Lias and Oolite, and consist of ferns, equisetaceous plants, cycads, and conifers, with a few doubtful monocotyledons. In France, the *Keuper,* or *Marnes irisees,* have a very variable composition, and consist of beds of limestone, more or less clayey, and of strata of wine-colored clay, sometimes greenish and bluish. These strata and colors are much intermingled, and give the highly variegated color to the division—the character upon which its name is based.

The great deposites of rock-salt of Cheshire county, England, are found in connexion with the gypsum and marls of the Keuper.

The middle division of the Trias—the *Muschelkalk,* or *Calcaire coquillier*—is not found in England, but is developed in Germany and France, where it consists of a fossiliferous magnesian limestone, and beds of marl. The following description of this division as it occurs in France, is translated from Beudant:† "The *Calcaire conchylieu* commences by alternating at its base with the *Grès bigarré,* while in its upper portions it passes into the *Marnes irisées,* which overlie it. The limestone is generally compact, greyish, green, or yellow. The upper portions are often magnesian, and frequently earthy. It gradually shades into the marls of the *Marnes irisées,* (Keuper,) among which some beds of limestone, either pure or magnesian, are again found. It often presents siliceous pebbles of considerable size, and contains a large quantity of shells."

The *Bunter-sandstein,* or *Grès bigarré,* consists of sandstones, alternating with thin beds of dolomite and beds of clay. According to Beudant, the sandstone is quartzose, fine-grained, and generally of a red color; portions of it are white, blue and green, which produces the mixture (*bigarrure*) of colors to which it owes its name. In England, this lower division of the Trias is found developed in Cheshire and Lancashire counties. It consists of red and green shales, and red sandstones, and contains much soft white quartzose sandstone, in which the trunks of silicified trees have been found. These were of coniferous wood, and showed rings of annual growth.‡ Impressions of the feet of animals have also been found.

The Trias, as developed in England and on the continent, is of variable thickness. In the salt region of Cheshire, the total thickness is said to be at least 1,700 feet ⁋ The upper group of the Keuper attains a thickness of 700 feet.

According to Messrs. Murchison and Strickland,‖ this upper division is about 600 feet thick in Worcestershire and Warwickshire. In Wirtemburg, the Keuper is 1,000 feet thick.¶ The Muschelkalk of the middle division is not found in England, but its

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* Elements, 5th edition, p. 335.

† Beudant Geologie, p. 211.

‡ Lyell, Elements of Geology, 5th edition, p. 339.

⁋ Phillips, p. 266.

‖ Geol. Trans., second series, Vol. V, p. 318.

¶ Lyell, Elements of Geology, 5th edition, p. 335.

statement "that it establishes a connexion between the New Red of France and that of America."

The collection contains a specimen from Camp 47, labelled "Upper Trias," which is a silicified fragment of the trunk of a *Lepidodendron*.

Great value appears to have been placed in the indications of age presented by the deposite of gypsum—this mineral being considered characteristic of the New Red or Triassic formations. The divisions of the formation are so arranged by Mr. Marcou that the gypsum deposites are included in the middle group. He regards them as establishing a connexion with the gypseous strata of Nova Scotia, at Windsor and Plaister Cove, and at Prince Edward Island, also with the strata of New Jersey.[1] These deposites at Windsor and Plaister Cove have been shown by Mr. Dawson[2] to be in the carboniferous formation, where they are closely associated with the characteristic fossils of that period, such as *Productus Lyelli*, *Terebratula elongata*, *Fenestella membranacea*, *Spiriferi*, *Orthoceras*, and *Connularia*.

Gypsum is found in the carboniferous formation, not only in Nova Scotia, but in Iowa and in Virginia. In Iowa it occurs along the bank of the Des Moines in beds twenty-five feet thick, resting on pink shales.[3] It also occurs in large quantities in other formations in different parts of the world, and it is by no means characteristic of the New Red sandstone or Trias alone.

equivalent, consisting of laminated sandstone, called water-stone, is 400 feet thick in Cheshire. The English representative of the "Bunter," or lower division, reaches a thickness of over 600 feet in the same locality, and in the Hartz mountains is over 1,000 feet thick. The total thickness of the Trias, as developed in England and on the continent, may be considered as nearly 2,000 feet.

The characteristics of the lower or second great division of the New Red Sandstone, called Permian, or magnesian limestone also claims our attention in this place.

*Permian.*—The careful study of the rocks of the New Red Sandstone developed the fact, that the lower portion of the group contained fossils, which were connected in a measure with those of the carboniferous era, and which were entirely different from those of the Trias. This fact was first brought prominently forward by Sir Roderick Murchison and his associates, who proposed for the division the name *Permian*,* "derived from the ancient kingdom of Permia, Russia, within and around which the necessary evidences have been obtained."† The formations to which this name has been given attain an enormous development in Russia. According to the authorities just cited, the "deposites repose upon carboniferous strata throughout more than two-thirds, of a basin, which has a circumference of not less than 4,000 English miles."‡ These deposites are of very varied mineral aspect, and consist of grits, sandstones, marls, conglomerates, and limestone, sometimes enclosing great masses of gypsum and rock-salt. They are also much impregnated with copper, and occasionally with sulphur.§ The general characters of the strata have also been summed up by Sir R. Murchison, in his recent work, Siluria. This description, coming from such distinguished authority, and from one who has so ably investigated the formation, I cannot but quote in full:

"Occupying the enormous area before mentioned, the Permian deposites of Russia are flanked and underlaid on the west, east, and north by upper members of the carboniferous rocks, but with little or no coal. These Permian strata of Russia seldom exhibit a mineral succession similar to that of rocks of the same age in Western Europe; and in different tracts of the vast region explored, they exhibit, as explained in the preceding quotation, many variations in their contents and relations. In some places, as on the river Kama, near the Volga, cupriferous red grits, with plants, underlie the chief limestones, to which succeed marls; but along the eastern limits of the system, as flanked by the Ural mountains, gypseous limestones form the base, followed by the red copper grits, sands, marls, and pebble beds, which extend on all sides around the city of Perm. On the whole, indeed, whether we appealed to the sections on the banks of the great Dwina, above Archangel, or to the western flank of the Ural mountains, or to the banks of the Lower Volga, near Kazan, localities removed from each other by vast distances, we found that limestones, often interstratified with much gypsum, prevailed towards the base of the Russian deposites."‖

[1] Mr. Marcou also connects this formation, or its lowest group, with the "red sandstone that forms more than half the contour of Lake Superior." (See Resumé.) It is hardly necessary to state that Messrs. Foster and Whitney, D. D. Owen, and Sir Wm. Logan and his corps, have severally examined this sandstone with care, and consider it to be the equivalent of the Potsdam sandstone of New York. Its Triassic age is not admitted.

[2] Acadian Geology, p. 219.

[3] Report of a Geological Survey of Iowa, Wisconsin, and Minnesota, by Dr. D. D. Owen: Philadelphia, 1852; p. 126.

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* We are indebted for this elegant and comprehensive name to Sir R. Murchison, with whom it originated in 1841, as appears by the following note, taken from the foot of page 291 of Siluria: "The term was first proposed in a letter addressed by myself, at Moscow, to the venerable and accomplished Russian palæontologist, Dr. Fischer, October, 1841. See Brown and Leonhardt Journal, an. 1841, and Phil. Mag., Vol. XIX, p. 417.

† Russia and the Ural Mountains: Murchison De Verneuil and Von Keyserling, Vol. I, p. 138.

‡ Ibid., Vol. 1, p. 220.

§ Russia and the Ural Mountains, Vol. I, p. 138.

‖ Siluria, pp. 294, 295.

Thus we find it in quantities in the Tertiary strata of Tuscany, where the large quantities of beautiful alabaster used for ornamental purposes are obtained. The vast deposites in the Andes of South America are associated with red sandstone and calcareous shales, and are believed to be in the lower cretaceous group.

Gypsum is a common mineral in the soft and horizonal Tertiary strata of California, and is frequently found with red shales. It occurs at Ocoya creek in the Miocene, and along the entrance to the mountains from the desert in the red shales and sandstones of Carrizo creek, on the summit of which a thick bed of Miocene Tertiary fossils rests in a conformable position.[1]

It is thus seen that gypsum beds are by no means characteristic of the Triassic strata alone, but that it is a widely diffused mineral, being found from the upper Tertiary down to the Lower Carboniferous. In fact we may expect to find it in any formation where the mineral conditions are favorable, and which have been subjected to decomposition and change either from the nature of the included minerals, or by the percolation of acid waters from above or below. The gypsum is by no means to be regarded as laid down at the time of the deposition of the strata, but is a more modern formation, the result of decomposition and recomposition of the materials present in the strata, or supplied from without.

We also find that the strata which the formation was thought to resemble, the gypseous strata of Windsor, Nova Scotia, and Plaister Cove, are not Triassic, but Carboniferous. This evidence, therefore, so far as it can be considered such, denotes a carboniferous age for the formation.

The occurrence of salt and saliferous clays also appears to be regarded as evidence of the Triassic age of the formation. This mineral, like the gypsum, is found in many formations of different ages, being obtained in quantities in the Carboniferous and in the Cretaceous and Tertiary. Its occurrence is by no means to be regarded as evidence of the Triassic age of the strata.

Another point of resemblance to the Triassic formation is found in the beds of dolomite or magnesian limestone; but at the point where this rock is best developed, according to the descriptions, along the Colorado Chiquito, it appears to be conformable with the carboniferous limestone, and is not separated from it by any great thickness of strata. In the absence of fossils, we cannot draw the line, and determine whether these magnesian limestones do not in fact belong to the Carboniferous. Their position favors this conclusion, the carboniferous limestone being the nearest rock identified by fossils.

One of the strongest evidences of the presence of Triassic strata is found in the great thickness of the formation, if Mr. Marcou has not been misled regarding it. If the red gypseous strata attain a thickness of 6,000 feet, we may, with much reason, look for strata intermediate in age between the Carboniferous and the Cretaceous. But after a careful consideration of the whole matter, I am compelled to differ from the conclusion to which Mr. Marcou has arrived, and cannot regard the Triassic age of the formation as established. Triassic strata may be there, but their presence and their divisions are yet to be determined by fossils.

The peculiar characteristics of the formation, as described, and its position relatively to the Carboniferous, suggest the possible Permian age of a portion, at least, of the strata. The resemblance of the lithological characters and position to the Permian deposites of Russia, as described by Sir R. J. Murchison, cannot fail to be noticed; and yet, being without fossils, we are not authorized to determine upon the age. We can only say, that the strata lie between known cretaceous beds above and carboniferous below. They may be in part cretaceous, as they most probably are—in part carboniferous, or may possibly contain representatives of all the Secondary group below the Cretaceous.

[1] I have already presented most of these facts, which show the distribution of gypsum in various formations and the impossibility of relying upon it as an evidence of the geological age of any series of strata, in the Report on the Geology of the route near the thirty-second parallel, explored by Brevet Captain Pope, U. S. Topographical Engineers. See Pacific Railroad Exploration and Surveys.

CRETACEOUS.

The route followed by the expedition having been, for a long distance west of Little Rock, in the valley of the Arkansas and Canadian rivers, and along the broad belt of carboniferous strata extending southwesterly into Texas, no deposites, which could be recognised as cretaceous, were seen until Camp 31, on the False Washita, was reached. It is, however, well known that the cretaceous formation is well developed around Fort Washita, a point nearly south of Delaware mountain, and it probably extends nearly parallel with the route, but south of the carboniferous hills, nearly to Little Rock, where it disappears beneath more modern strata, and is again exposed on the east side of the Mississippi, in the States of Mississippi and Tennessee.

The now well-known cretaceous fossil, *Gryphæa Pitcherii*, was originally obtained from the Kimichi Plains, south of the route between Little Rock and Fort Smith. The same species, according to Mr. Marcou, was obtained on the route at Camp 31, on the False Washita, together with fragments of Ostrea and *Pecten quinque costatus*. Specimens of the gryphæa are in the collection, (see catalogue and description, and Plate I, fig. —;) but there are no specimens of the other fossils. The next point which is identified as cretaceous by the fossils is in the valley of the Canadian, at Pyramid mountain, one of the remnants of the plateau of the Llano. Here Mr. Marcou obtained a gryphæa, which he at first considered a new species, and called it *G. Tucumcarii*. He, however, does not regard it as a cretaceous fossil, but as Jurassic. North of this place, in the valley of the Arkansas, numerous specimens of *Inoceramus* were obtained from similar positions in the bluff borders of the plateau, by Dr. Scheil, who accompanied Captain Gunnison, and they were also found there several years ago, by Dr. A. Randall. Lieutenant Simpson also mentions the occurrence of similar fossils in the vicinity of the Tucumcari hills, or Plaza Larga.[1] Dr. Wislizenus found casts of *Inoceramus* in the schistose limestone of the bluffs of Gallinas creek, and describes the strata as Cretaceous.[2] Mr. Marcou also saw imperfect fossils from the bluffs near Camp 46, which led him to conclude the Llano to be Cretaceous. (Notes, September 18th.) Passing further west, cretaceous fossils were obtained by Mr. Marcou about three miles north of Galisteo, in sandy clay and sandstone. (See notes, October 10th.) Mr. Marcou mentions a tooth and vertebra of a Saurian and an *Ostrea*, also *Inoceramus* or *Plicatulus*. Specimens of sandstone from this place, containing fragments of fossils, are in the collection. (See No. 126 of the catalogue.) This locality is between the south point of Santa Fe mountain and Gold mountain, nearly at the summit of the pass in the mountains, and on the borders of Rio Galisteo, one of the tributaries of the Rio Grande. The same deposite is mentioned in the Resumé, and is there referred to the age of the white chalk. I also find in the collection a specimen, No. 131, labelled as taken from a point near Las Lunas, between the Rio Grande and the Puerco; also, a specimen labelled *Terrain Crétacé*, from a point between Galisteo and Gold mountain. Mr. Marcou also mentions, in his notes of November 28th, the occurrence of rolled or worn specimens of *Gryphæa*, which appeared to be Jurassic. This was beyond Zuñi, west of the Sierra Madre. The collection does not contain any of these last-mentioned specimens.

Most, if not all, of these cretaceous fossils were procured from the edges of the horizontal strata which compose the extensive table-lands along the route, and they indicate to us the cretaceous age of the Llano Estacado. Further evidence of this is found in the collection made by Captain John Pope, on the Llano, further south, near the parallel of 32°. He procured specimens of *Gryphæa* in the bluffs of the Llano at the Big Springs of the Colorado, and also on the surface, near the sand-hills, and these fossils, together with the specimens of the strata and other evidences, led me to describe the Llano as Cretaceous, in the report on the geology of that

[1] See Simpson's Report, and Chapter II of this Report.

[2] See Wislizenus' Report, page 17, and Chapter II of this Report.

route.[1] The Llano is doubtless continuous southeasterly from these localities to the vicinity of Austin and San Antonio, where it forms bluffs filled with cretaceous fossils already described by Ferdinand Roemer. There is thus little doubt that the strata of the Llano Estacado and the other plateaux along the route, resting upon the gypsum formation, are of cretaceous age, surmounted, perhaps, in places by more recent deposites.

Although the strata of the plateau beyond the Sierra Madre were not identified by fossils, if we except the rolled specimens of Gryphæa, we are led to regard them as of the age of the Llano, they being similar in their mineral characters, and probably connected with the cretaceous deposites of the valley of the Rio Grande, through Campbell's Pass. The altitude of the plateau and the underlying red strata containing gypsum, as on the east side of the mountains, leave little doubt of their contemporaneous origin; moreover, cretaceous fossils have been found in the northwestern parts of this extended area of horizontal strata.[2]

As the strata which bear the fossils are conformable with the red marls, clays and sandstones below, which are without fossils, and consequently of undetermined age, and as there is no well-marked line of separation between them, we cannot decide upon the thickness which the Cretaceous attains. It may include the gypseous strata, or at least the upper part of the series. But as this gypsum formation is separately described, the present descriptions will refer only to the lighter-colored strata which overlie it, and which form the upper part of the plateau of the Llano. The extent of these strata will be best seen on the map and section, where they are colored green, and thus separated from the red, which indicates the gypsum formation below. The Cretaceous is made coincident with the bluff margins of the Llano, and other plateaux, and thus may be said to extend along the route from the vicinity of the meridian of 101° to 110°. It also appears in isolated patches or remnants of the table-lands, forming mounds or columns, as at Camp 31 and Antelope hills, and other points east of the bluff margin of the Llano.

As the lithological characters of these strata have already been presented in detail in the descriptions of the geology along the route, they need not be repeated here. The strata are principally white or grey, and highly calcareous, and are sometimes intercalated, as at Pyramid mountain, with grey or blue marl or clay. There are few or no specimens in the collection, but the descriptions lead one to conclude that the strata are very uniform in their appearance along the route. The specimens which Captain Pope collected on the Llano, further south, are chiefly light-colored, whitish, or grey calcareous sandstone, and a buff or yellowish limestone, earthy and amorphous.

The light-colored strata of the Llano do not appear, from the descriptions, to attain a thickness of over 500 or 600 feet at any point, and generally the red strata are described as extending half-way, or more, up the bluffs, which are from 300 to 600 feet high; and this leads to the conclusion that the white strata are generally less than 300 feet thick, but they have been observed in some localities to form nearly the entire bluffs, from top to bottom. The section of Pyramid mountain, given in Chapter II, shows the relation between the red and the white strata at that place, and presents the line of division, not in the centre, but nearly two-thirds of the distance up from the base. No observations regarding the thickness of each series of beds are given by Mr. Marcou, but the whole is stated to be 500 feet. The thickness of the white strata, doubtless, varies in different places, the red color of the strata being produced by decompositions since the original deposition, and, of course, not being confined to particular beds, but extending higher or lower according to circumstances.

The extensive and nearly level plateaux which these strata form, sufficiently show their horizontal position. There are few dislocations or disturbances, and the strata are rarely inclined at angles greater than ten or fifteen degrees. Local uplifts are found among the mountains near Albuquerque and Santa Fé, where there are intrusions of trap, forming dykes; but there

[1] Report on the Geology of the route near the 32d parallel, by W. P. Blake, 4to: Washington, 1855.

[2] See observations on the Geology of the route surveyed by Captain Gunnison, by Dr. Jas. Scheil.

is no good evidence of the uplift of the strata by the mass of the mountains. So, also, at and near Fort Defiance there are great dykes of trap, and, according to Mr. Campbell, the strata are much uplifted and disturbed. Mr. Marcou also records a prevailing dip of ten or fifteen degrees towards the north, in the red strata, along the Colorado Chiquito, to which the upper and white sandstone strata probably conform.

The fact that the strata are nearly or quite continuous from one side of the Anahuachian chain to the other, through the passes, and that they are nearly horizontal around the base of the mountains, shows that the uplift took place before the cretaceous period, and that the mountains were nearly or quite submerged beneath a cretaceous sea. The higher peaks and ranges may have risen above the waters, and formed a chain of islands, trending nearly north and south. We are thus led to refer the uplift of the chain, at least in the vicinity of the route, to the Secondary period, or between the close of the Carboniferous and the first deposition of the Cretaceous and Gypsum formation.[1]

*Reported Jurassic age of the Llano.*—The formations of the Llano and table-lands west of the mountains now described as Cretaceous, are not considered so by Mr. Marcou. In his Resumé, and later publications, he states that they are Jurassic, and they have been so colored by him on maps recently issued. The fossils which are mentioned in the Resumé in support of the Jurassic age of the strata, are as follows: "A *Gryphæa* which has the greatest analogy with the *Gryphæa dilatata* of the Oxford clay of England and France, and which I call, provisionally, *G. Tucumcarii*, and a very large *Ostrea*, having much resemblance to the *Ostrea Marshii* of the inferior oolite of Europe. I found, also, *trigonia*, and a species of *cardinia*."[2] In the later publications by Mr. Marcou the *G. Tucumcarii* is stated to be identical with *G. dilatata*, and the *Ostrea* with *O. Marshii*. These fossils have also been figured by Mr. Marcou. Specimens of the *Gryphæa* are in the collection, but the other fossils do not appear. The only evidence, therefore, of the Jurassic formation, according to Mr. Marcou, which is before me in the collection, is the single species of Gryphæa, which may or may not be identical with *G. dilatata*. It certainly has very considerable resemblance to that fossil, judging from figures; but, even if specifically identical, it cannot be regarded as establishing the presence of Jurassic strata where it was found. The value of the evidence which the fossil presents, if, indeed, it can be regarded as furnishing any, is much lessened by the fact that the cretaceous formations of the Southwest are characterized by the number and variety of the species of *Gryphæa* which they contain. Species are found with many variations at different localities, and specimens which very clearly resemble the *G. Tucumcarii* are abundant in the undoubted cretaceous deposites of New Jersey and Alabama. It is such a variable fossil, and the same species appears under such different aspects, according to age and locality, that it certainly is not safe to regard the doubtful species, *G. Tucumcarii*, as evidence of the Jurassic age of the stratum from which it was taken. It should rather be regarded as showing its cretaceous age. After a careful consideration of this subject, I am compelled to differ from Mr. Marcou in respect to the presence of the Jurassic formation. Its presence has not been satisfactorily shown by the fossils, and all other observations lead to the conclusion that the strata of the Llano are Cretaceous.

## TERTIARY FORMATIONS.

The geological collection furnishes little or no evidence of the presence of Tertiary formations along the line of the survey. There are no fossils which can be referred with certainty to this period, nor are there many rock specimens which have the aspect of such recent deposites. We may, however, except some of the specimens coming from the Llano Estacado, some of them much resembling Tertiary sandstones and marls. As, however, we cannot determine the age

[1] See, also, a paper, by the author, read before the American Association for the Advancement of Science, August, 1856; Albany meeting.

[2] Resumé. Report of Lieutenant A. W. Whipple, 8vo., Chap. VI, p. 44. See, also, Appendix.

of a rock by its lithological characters, the resemblance cannot be regarded as good evidence of their Tertiary age. The mineral characters are, nevertheless, of great importance as an indication of the age, and it is presumed that Mr. Marcou was chiefly guided by them in assigning the age to the sandstone strata found on the route at and beyond Cactus Pass.

We do not find in the notes made by Mr. Marcou any reference to Tertiary formations along the route until after the expedition had passed beyond San Francisco volcano. The Post Tertiary or Quaternary deposites are of course excepted—frequent mention of them being made.

It would appear from the observations of Mr. Featherstonhaugh that Tertiary strata are developed at Little Rock and in its vicinity. He cites the occurrence of fossils of the genera *Ostrea*, *Turritella*, *Calyptrea*, and *Cerithium*, in a calcareous matrix on the south bank of the river. The same deposite is said to occur a few miles further west, where it is so calcareous that it was used to make lime.[1] This is the only record I can find respecting Tertiary deposites at that point. If Mr. Featherstonhaugh is correct in referring this deposite to the Tertiary, it is doubtless the fact that extensive areas of the surface and portions of the bottoms of the extended valleys or depressions in the carboniferous strata in that region are covered by strata of this formation.

The strata of brecciated sandstone and calcareous conglomerate found outcropping near Camps 16, 17, 18, and 19, are very probably Tertiary, but no fossils were found.

There is much reason to believe that the cretaceous strata of the Llano are surmounted by Tertiary deposites over a part of the plain. This is indicated by the second line of bluffs, or second step, seen from the valley of the Canadian. Dr. Shumard also, who examined the Llano at the sources of the Red river, found a layer of rounded gravel and pebbles upon the top, which he denominates *drift*, and which at some places was found to be about 100 feet thick. Fragments of agate and carnelian, and of silicified wood, appear to abound in this deposite. The same pebbly bed appears to be found west of the Sierra Madre on the table-lands of Zuñi and its vicinity. These are, in all probability, Tertiary or Post Tertiary deposites; but as they are not characterized by fossils, and as their extent is not known, I have not indicated them on the map.

In ascending Cactus Pass, strata of sand and a coarse limestone were found outcropping in connexion with dykes of trap and porphyry. The strata inclined strongly towards the west, the trend being north and south. These are said to be Tertiary by Mr. Marcou. (Notes, January 31.) Tertiary deposites, according to the notes, were again met along the valley of Hawilhamook, near Camp 121. At that place intrusions of trap rock have raised up strata of sandstone and conglomerate of a red color. They were very friable, and have a reddish-yellow color, differing from the color of the older red sandstone. (Notes, February 13.) Similar strata were observed between Camps 122 and 123, and again between Camps 125 and 126. This formation appears to have extended along the valley of the stream down to the Colorado. It was again found along the Colorado, and between Camps 127 and 128 the strata were uplifted at an angle of 20°. The mountains which border the river beyond Camp 128 are composed of Tertiary red sandstones and conglomerates, metamorphosed and traversed by basaltic trap and amygdaloid. (Notes, February 22.) This red sandstone and conglomerate was afterwards found associated with white and chalky clay.

Beyond the Colorado, towards the Mojave river, metamorphic conglomerate was found in ascending the mountains. (Notes, March 2d and 3d.) A whitish limestone, brecciated and in horizontal strata, was found on the 4th, between Camps 137 and 138. This was at an elevation of about 4,500 feet.

Horizontal strata of white and bluish clay and grey sandstone, very friable, are found along the Mojave river in high banks near the point where the Mormon road leaves the stream to ascend to the Cajon Pass. Similar strata, but more deeply eroded, are found lower down the stream. They are doubtless Tertiary.

[1] Featherstonhaugh's Report, p. 60.

*Sandstone of the Cajon Pass.*—A description of the sandstone which outcrops at angles of 20 to 45 degrees in the upper portions of this pass, has already been given. It is probably of Tertiary age. The Tertiary strata forming the slope from the mountains to the coast, have also been described. (See Chapter V.) The strata supposed to be Tertiary are thus seen to be principally developed over the western portion of the line—the portion west of the last exposure of the carboniferous limestone. This observation is made under the supposition that Tertiary strata are not found to surmount the Llano or the other table-lands on either side of the mountains. We have also seen that little knowledge of the lithological characters of the formation, its thickness and extent, has been obtained. The strata along the Colorado and its principal tributary, the Hawilhamook, appear to be very similar or constant in their character, being chiefly formed of red sandstone and conglomerate. It is very probable that these beds are the equivalents of the deposites I examined on the eastern side of the mountains at the head of the California gulf, where a thick bed containing *Ostrea*, *Anomia* and *Pectens* was found.

## POST TERTIARY.

The formations included under this head are those of recent origin, the alluvial deposites of the rivers and the banks of detritus or wash which surround the mountains and fill the valleys of the Great Basin. These deposites are so local in their character, and differ so greatly according to their locality, that they cannot be included in one general description. It is not, therefore, necessary to repeat the observations already made upon the alluvium of the Mississippi, nor many other notices of the recent deposites along the route.

Mr. Marcou, in his notes, makes frequent mention of the alluvial and "diluvial" deposites he met in each day's travel. These superficial accumulations appear, in some cases, to be abundant, and merit attention. A description of the deposites between Delaware mountain and the Antelope hills will be found in Chapter II; but I present here notices of the most interesting deposites recorded between Antelope hills and the Sandia and Albuquerque mountains. Immediately after passing the Antelope hills, Mr. Marcou found several rolled masses of volcanic scoria of the size of the fist and head. Sand, with some alluvial pebbles, was found beyond, as far as Camp 36. This same deposite appears to have extended beyond Camp 36, for on the following day we find the presence of sand and alluvial pebbles of quartz noted. Between Camps 37 and 38 "diluvium, from the size of a hazel-nut to that of the fist, with some masses as large as the head," was seen. Those masses were, however, of white sandstone and limestone, which probably came from the strata in the vicinity. Between Camps 38 and 39 the diluvium is said to have been abundant, the pebbles being as "large as a gourd." Again, near Camp 40 the diluvium is said to have consisted of beds of sand and sandstone, containing the pebbles of the diluvium of the "Rocky mountains." Two or three miles before reaching Camp 41 a great number of hillocks of sandy diluvium were encountered. Between Camps 43 and 44 we find it noted that the diluvium of the Rocky mountains is abundant and thick on all the plateaux. After reaching the bluffs of the Llano or their vicinity, the alluvium appears to have been much less abundant, and its absence is several times noted. It was not found again until the valley of the Galinas was reached, where a "diluvium" of granite and trap rock was abundant, and it also forms hills between the Galinas river and the Pecos.

At a point near Red river and nearly south from the Antelope hills, Dr. Shumard found large quantities of "drift," composed principally of quartz and mica-schist; on Red river, sandstone strata were overlaid by "drift" forty feet thick. Again near the outcrop of the upraised sandstones, near Suydam creek, the surface was thickly covered with drift. From this point drift is constantly noted along the trail westward towards the bluffs of the Llano. It will be observed, by consulting Captain Marcy's map, that this region is directly south of and near the valley of the Canadian. At one place the drift contained agate, chalcedony, and fossil-wood. Dr. Shumard's observations on the Llano differ greatly from those of Mr. Marcou, made at a

point further west. Dr. Shumard, as has already been stated, found the summit of the Llano, or the stratum immediately underneath the soil, to be composed of "drift." This is mentioned several times wherever sections of the bluffs were made.[1] The hills around the base of the Llano appear to have been partly composed of or capped with drift, containing agates, chalcedony, &c. On the 22d of June the occurrence in the drift of fossil-wood, agate, jasper, and a few water-worn fossil-shells of the genus Ostrea, is recorded. Similar pebbles were found on the 25th.[2]

These deposites evidently are connected with those noted by Mr. Marcou, who, it will be remembered, noted the same minerals and fossil-shells near Camp 31, east of the Antelope hills.

These descriptions of the drift and alluvium, as it is called, will exactly apply to the extensive layers of pebbles and fossil-wood which are found to surmount the plains of the Colorado and Sonora deserts. There almost endless varieties of agates, jaspers, carnelians, and porphyries may be picked up, and these beautiful pebbles are mingled with no less beautiful specimens of silicified wood, with its internal structure perfectly preserved. This pebbly layer is derived from a thick bed of conglomerate, which rests horizontally upon sandstones, believed to be of Tertiary age. The same drift is found at another point, spread out over a thick bed of Tertiary fossils. I am much inclined to regard this drift of the Llano and the adjoining region as similar in age and in origin to that along the Colorado and Gila rivers. If, however, it be identical in these respects, it does not show that the strata upon which it is spread are of the same or of Tertiary age.

Accumulations of pebbles, similar to these, were also found on the surface of the plateau west of the Sierra Madre, and it was there mingled with a larger quantity of fossil-wood.

*Alluvial deposites of the valley of the Rio Grande.*—The characters of the valley of the Rio Grande and the Puerco have already been presented at some length. All the descriptions unite in asserting the sandy and generally sterile character of the soil, although it is much cultivated and with considerable success. Sand-dunes appear to be common on the uncultivated parts of the valley, and are noted by Major Emory and others. They show the sandy, arid nature of the soil and the prevalence of high winds.

*Alluvial or bottom-land of the Colorado.*—Mr. Marcou describes the alluvium of the Colorado as black and fine, being without pebbles. In color it therefore differs very greatly from the silt which is transported by the stream; which is a brick red, and is so abundant as to render the water almost opaque. Its turbid and highly colored condition is retained even to its mouth; and below Fort Yuma it deposites thick layers of its light-colored red mud in all the shallow and quiet bays along the shore. The bottom-land at this place also differs in color from the stream. The earth has a bluish-grey or ash color when dry, and is quite dark when moistened, and is very fertile. With regard to the fertility and agricultural availability of the bottom-land along the route, the best evidence is found in the large crops of maize and wheat, and vegetables, which are raised by the Indians. It will be seen by reference to Capt. Whipple's report that they were willing to dispose of large quantities of grain for a few trifles and blankets. If Indians, with their rude implements and indolent habits, can provide themselves with such a superabundance of food, what may not be expected to result from enlightened agriculture?

According to Capt. Whipple, these bottom-lands are very extensive in some places, as in the valley of the Mojaves, having a breadth of several miles. The lands are undoubtedly favorable to the growth of tobacco, cotton, and many other productions of the South.

*Detritus or wash of the Great Basin, and other localities.*—In the region of the Great Basin, where there is an endless number of isolated mountains and ridges, entirely bare of vegetation, and thus subject to rapid disintegration by the action of snow and water, there is a very great accumulation of loose gravelly materials around all the elevations. These materials being chiefly derived from the rocks they surround, partake of their character and composition. The

[1] See Marcy's Red River Report, pp. 190, 191.

[2] Ibid.

[3] See the writer's Report on the Geology of the route explored in California by Lieutenant Williamson. (Inedited.)

rocks being principally granite, containing much feldspar, the surface around is generally strewed with little angular fragments of this mineral; and thus, although it may have the appearance of a mere surface of gravel, it has all the elements of a fertile soil, except the vegetable mould, which would soon accumulate if the climate or supply of moisture favored the growth of vegetation. We have already seen that in the formation of the slopes the coarser and heavier materials are not transported far down, but remain on the upper portions near the sides of the mountains, while the finest materials are carried far down. In some cases, where the supply of water is great, and forms ponds or lakes in the valleys, the finest parts of the soil, held in suspension by the water, are deposited there, so that a horizontal layer of clay is left when the water evaporates. In this way the *Playas* are formed. These deposites contain too much clay, and become too firmly impacted, to be of any service for cultivation; moreover, the climatic conditions are not favorable. The slopes, however, in favorable situations, have all the qualities of soil necessary for abundant crops of the cereals, and would become exceedingly verdant and luxuriant with vegetation if water could be artificially supplied.

*Valley of the Mojave.*—There is much fertile land on the banks of this stream, which sustains a vigorous growth of grass and willows. The river-bed is very sandy, and large areas of the bottom-land, which are subject to overflow, are covered with the sand. The fertile and desirable land forms but a thread-like strip along the river, when we compare it with the broad and semi-desert surface of the Great Basin which surrounds it.

*Valleys of San Bernardino and Los Angeles.*—The valley of San Bernardino lies at the southern or western base of the Bernardino sierra, and is entered by the road from the Cajon Pass. It is not possible, within the limits of this brief notice, to do justice to its extreme fertility and the salubrity of the climate. The bottom-land, along the streams, is well adapted to all kinds of crops, and the higher portions, or the surface of the main slope from the mountains, could undoubtedly be successfully cultivated, if it was supplied with water by irrigation. The Mormons, now occupying this valley, are covering it with neat dwellings and well-tilled fields, and the evidences of substantial prosperity abound. The generally fertile character of all the valleys, and of the whole slope from the mountains to the Pacific, is well known, and the productions are a sufficient evidence of the depth and richness of the soil and the favorable climate. The soil of the slope may be regarded as formed of the wash from the mountains, together with the débris of Tertiary strata and the remnants of ancient beach accumulations, formed previous to the comparatively recent elevation of that coast. The river-bottoms are of much finer materials, and often contain more sand than is desirable for cultivation.

## VOLCANIC.

Volcanoes, or the evidences of their former activity, appear to have been almost constantly in view from the valley of the Rio Grande to the Mojave river, in California. Indeed, if we glance at the map, the line of the survey appears characterized by volcanoes and their outpourings. This, however, is probably more apparent than real, as an exploration further south would probably reveal a similar number of volcanic vents. The principal cones or volcanoes, as they succeed from east to west, may be enumerated as follows:

| *Name.* | *Position.* |
|---|---|
| Cerritos | south of Santa Fé. |
| San Matéo | west of Santa Fé. |
| ——— ———? | south and west of *Camino del Obispo.* |
| San Francisco | |
| Bill Williams' | |
| ——— ———? | High peak, N.W. of Bill Williams' mountain. |
| Cygnus mountain | west of Aztec Pass. |
| Artillery peak | Cerbat mountains. |
| Cones | east of Soda lake. |
| Small crater | near the Mojave. |

In addition to these there are many streams of basaltic lava covering broad areas, and which cannot be directly traced to either of the above enumerated sources. Among them the vertical walls of lava near the mouth of the Hawilhamook, on the Colorado and between the Colorado and the Mojave, may be mentioned. The most important of these localities are the mountains called San Matéo, San Francisco, Bill Williams', and Cygnus mountain. Observations on these volcanoes have already been made in the chapters devoted to the description of the geology of the route, and some general remarks only need to be added.

The outpourings of lava from San Matéo and San Francisco appear to have proceeded from a number of side cones or vents much below the principal crater. At San Matéo there is a cone or crater several miles west and a little north, directly on the east border of the branch of the San José river, which heads in Campbell's Pass. This crater, although much lower than San Matéo, and hardly visible a few miles distant, furnished a stream of lava which coursed down the valley of the river until it mingled with the streams from the great cone, and perhaps extended beyond them to Covero and Laguna. This crater may perhaps be regarded as entirely distinct from San Matéo, as it is about twenty miles distant from the peak. The eastern flank of San Francisco volcano appears to be sprinkled with cones of various sizes, from which lava has poured out and flowed down the slope to the east. These cones were seen all along the route from a short distance west of the Colorado Chiquito to the base of the principal péak. Beyond the peak no cones appear to have been seen—they are confined to the eastern and southern slope of the mountain. Mr. Marcou mentions seeing some basaltic buttes on the east bank of the river. These are in the line of prolongation from the principal crater eastward through the lesser vents. Secondary cones do not appear to have been found around Bill Williams' or Cygnus mountain.

The probable volcanic character of the high conical mountain seen in the southeast, after crossing the Sierra Madre, was indicated by a lava stream which had flowed from that direction and which extended across the line of survey. Mr. Marcou estimated its elevation to be ten thousand feet. The high peak called Lantern or Abajo mountain, seen far to the northwest of San Francisco and Bill Williams' mountain, is supposed to be volcanic from its isolation and conical shape. It is probably beyond the great Colorado, and in the broad plains southwest of the lower extremity of the Wasatch range.

The source of the broad areas of lava cut through by the Colorado and Hawilhamook, near the mouth of the latter, is not known; but it is probably in the mountains further south. The horizontal layers of lava near Camp 137 are on the same line of trend, although far northward, and their source is probably north of the route.

The cones seen at the north of the line when near the Soda lake, and a small crater found by Lieutenant Williamscn west of the Mojave, show that the volcanic forces have acted in the Great Basin, although not with the power and effect which is exhibited east of the Colorado. No volcanoes or lava are found in the Bernardino Sierra, and we may thus consider the region of volcanoes to commence at the west, in the Pai-Ute range, between the Mojave and the Colorado. It is, however, important to observe, that volcanic phenomena are abundantly presented in the Sierra Nevada, north of the parallel of 36°—broad fields of basaltic lava being found at the western base of these mountains, along the head-waters of the San Joaquin, Merced, Stanislaus, and Mokelumne.[1]

On the east, it is worthy of note that the broad Atlantic slope appears to be without any volcanoes, the first volcanic cones found being on the western side of the Santa Fé mountains. A great contrast is thus presented between the plains on the east and those on the west of the mountains, which are probably of the same age, and which we would naturally expect to be similarly covered by volcanoes. The region of greatest volcanic activity in former times thus appears to have been between the mountains along the Rio Grande and those on the Colorado. The peaks

[1] See the author's Report on the Geology of the route in California surveyed, in 1853, by Lieutenant R. S. Williamson.

seen both south and north of the line, and the volcano found as far south as the great bend of the Hawilhamook, together with the volcanoes and craters found on other lines of survey, both south and north, show that the volcanic vents are not distributed along an east and west line, but that they are probably found in long lines coincident with the trends of the principal chains of mountains.

*Age of the volcanoes.*—It is probable that all these volcanoes are more recent than the Tertiary. We are aware that the cones and the lava of San Matéo and San Francisco overspread the strata of the plains, which are supposed to be synchronous in their origin with those on the east of the Anahuachian chain. That these are overspread with Tertiary deposites is extremely probable, although we are without any evidence presented by fossils. We have, however, seen that in many places the lava-streams have coursed down the valleys of the streams—the very rivers having been displaced by the molten flood. This shows the comparatively modern activity of some of these vents, and yet we are without any record or tradition of their action.

I regret that it has not been possible to give the specimens of lava a full chemical examination, or to compare them with specimens from Europe. Some important and interesting observations upon them will be found in the letter from Baron Von Humboldt, addressed to Captain Whipple, and published in Part I of his Report.

# CHAPTER VIII.

## COAL, BUILDING-STONES, GYPSUM, METALS, AND ORES.

COAL MOST ABUNDANT ON THE EASTERN PART OF THE LINE.—COAL ALONG THE ARKANSAS AND CANADIAN RIVERS.—IN PETIT JEAN AND SUGAR-LOAF MOUNTAINS.—ALBUQUERQUE OR SANDIA MOUNTAINS.—AT OJO PESCADO.—CAÑON DE CHACO.—AT BELLINGHAM BAY.—VANCOUVER'S ISLAND.—COWLITZ COAL.—BITUMEN OF LOS ANGELES.—BUILDING-STONE.—GRANITE AND GNEISS.—LIMESTONE AND SANDSTONE.—THEIR DISTRIBUTION OVER THE ROUTE.—GYPSUM, ITS APPLICATIONS IN THE ARTS.—USED FOR WINDOW-LIGHTS.—GOLD.—OLD AND NEW PLACERS.—RESEMBLANCE OF THE DEPOSITES TO THOSE OF CALIFORNIA.—"DRY DIGGINGS."—NEW MEXICAN METHODS OF MINING AND WASHING.—YIELD OF THE PLACERS.—ABSENCE OF WATER.—USE OF SNOW-WATER.—QUALITY OF THE GOLD.—RIGHTS IN THE PLACERS.—MINING LAWS.—QUARTZ VEINS.—MINES.—GOLD IN THE GREAT BASIN AND BERNARDINO SIERRA.—ARMAGOSA MINE.—SAN FRANCISQUITO PLACER.—COPPER, LEAD, AND SILVER.—IRON.—SALT.

### COAL.

The principal and almost the only coal deposites along the route are found on the eastern portion of the line, bordering the valley of the Arkansas and Canadian rivers. The other localities either do not offer the coal in beds of sufficient thickness to be profitably worked, or the quality is greatly inferior.

*Coal along the Arkansas and Canadian.*—Beds of coal are numerous along the Arkansas and its tributaries, but there is not yet any very definite and specific information concerning their thickness and extent, or the quality of the coal. Dr. Geo. C. Shumard states, that numerous workable seams of coal have been discovered in Washington county, and that it exists in almost inexhaustible quantities throughout the county of Sebastian, where "the seams vary in thickness from a few inches to seven feet, and lie in such a manner that they can be wrought easily."[1]

The first mention of the coal by Mr. Marcou, in his notes, was on his arrival at the Petit Jean mountain, where, on the right bank, one or two ranges of high hills containing beds of coal were found. Twelve miles south of Fort Smith, Mr. Marcou notes a bed of bituminous coal twelve feet thick, containing traces of oxide of iron. Other beds, from two to twelve feet thick, are found in the adjoining counties further south. Sugar-loaf mountain, which is thirty miles south of Fort Smith, contains coal at its base and in the middle. (See notes, June 19.) At the plantation of Mr. Ring, Camp 1 to 2, a well had been dug forty feet deep, and a bed of coal three feet thick passed through. Coal-beds are noted near Camp 7, and Lieutenant Whipple states that a blacksmith living at that place uses the coal of the vicinity in his forge.

These facts, and the extent and character of the carboniferous strata along the Canadian, show us that the eastern part of the route, from Little Rock to Delaware mountain, traverses an extensive coal region. It may safely be assumed, that coal can be conveniently obtained at almost any point along that section of the line.

*Albuquerque Mountains.*—The next point at which coal, or its indications, was found is in the Sandia or Albuquerque mountains. Here blackish shales were found without coal, but it was reported that coal could be obtained at Manzana, several miles north. It is somewhat doubtful whether this coal, if obtained there, is of the same age as the bituminous shales of the Sandia mountain; it may be more modern. The deposites of coal at the Raton Pass are at the north

[1] Shumard, in Marcy's Red River Report, p. 180.

of the line, and on the eastern flank of the Santa Fé mountains, being in the line with the uplift of the Sandia range; from this circumstance they would naturally be regarded as of carboniferous age, and yet we find by the evidence of fossil plants that the coal is much more modern. This fact was established by the fossils brought in by Lieutenant J. W. Abert, which were submitted to Professor J. W. Bailey.[1] Very little is yet known respecting the extent and value of this deposite of coal.

*Ojo Pescado.*—The deposite of coal at Ojo Pescado is about forty miles west of the pass in the Sierra Madre, and near the ruined Pueblo of Zuñi. It occurs, according to the description of Mr. Marcou, in layers from six inches to one foot in thickness, intercalated with bituminous shales. It is overlaid by thick beds of sandstone, and the whole is nearly horizontal, the upper strata dipping westward at an angle of about ten degrees. The only specimen of coal in the collection, No. 98 of the catalogue, is from this locality. A description of this sample is given in detail in Chapter X.

It very much resembles the Tertiary brown coals, or lignites, found on the western coasts, but is not so compact or of a quality at all comparable to the best coal of Puget's sound. The streak or powder is dark brown, and on the flat cleavage surfaces some impressions of vegetation may be seen. The coal gives off a strong odor of bitumen when it is heated, and it burns with a white flame and little smoke until the flame ceases, when the smoke is white and like that from wood. The quantity of ash which it leaves, together with the large quantity of impurities contained in the mass, lead me to conclude that the coal is of little or no value for furnaces. The thinness of the beds is such, also, that it cannot be profitably obtained. It is not impossible, however, that thicker beds occur, and that the specimen does not exhibit the best part of the deposite. The deposites of coal along the Puerco, and particularly at Las Lunas, have been described. At the latter place it is used by the blacksmith. Coal also occurs at Ciboleta, and Lieutenant Simpson mentions the occurrence of bituminous coal near the parallel of 36°, in or near the *Cañon de Chaco*, almost due north of *Sierra de San Mateo*, or Mount Taylor. It appears in the side of a table-mound interstratified horizontally between sandstone strata. Gypsum, intercalated with argillaceous shales, was found overlying it.[2]

It is very probable that all these deposites of coal are of one era, and yet the indications presented by the position and lithological association of the coal at Ojo Pescado are such as favor the belief in its carboniferous age. The quality of the coal at all of these localities is probably inferior, and its quantity is not very great.

From the thin bed of coal at Ojo Pescado westward to the end of the line at San Pedro, there does not appear to have been any indication of coal. It is not found in connexion with the carboniferous strata, and has either been denuded and washed away, or it was never formed over those regions. This is probably the fact, for the rocks themselves show a decreasing thickness towards the west, and the shales do not appear. There is little reason to expect to find valuable deposites of coal, near the line, west of Delaware mountain.

*Coal of Puget's sound, Bellingham bay.*—The accessibility of the vast deposites of coal along the shores of Puget's sound to San Pedro, renders them a proper subject for consideration in this place. It is most probable that the Pacific coast will be largely supplied with this coal at a price which will lead to its use in preference to that from the Atlantic States, which, by reason of distance, must ever continue to bear a high price on the Pacific. Cargoes of the coal have already been mined and sent to San Francisco, where it is used with great satisfaction by families and for burning in grates. It very much resembles the ordinary bituminous coal of the West, being in large brilliant black masses, which break up readily, with curved surfaces, but generally cleaving into tabular blocks in the direction of the layers. It burns freely, and leaves a fine white ash, which is probably more abundant than in the coal of carboniferous age. The coal was once tried on the United States Coast Survey steamer, the Active, during a trip

[1] Report of an Examination of New Mexico, p. 547, and two plates.

[2] Simpson's Report, p. 73.

to Puget's sound. It burned with much flame—so much that the flames often poured out of the top of the chimney for ten or twenty feet. This shows how highly the coal is charged with bitumen and volatile ingredients, and indicates its value for making gas. It was thought that the coal produced a large quantity of slag and cinder, and the fires required raking every twenty minutes. This is a general complaint from those who use the coal in furnaces with a strong draught, and it is doubtless true that the amount of ash is large, and that it is readily fused together. A peculiar form of furnace may obviate the difficulties which arise from this peculiarity of the coal. This is important, as in other respects the coal is apparently equal to any. I have already given all the facts which could be obtained regarding the geological association and occurrence of this coal in my Preliminary Geological Report.[1] It is in all probability of Tertiary age, and I am inclined to regard the strata as belonging to the same series as the sandstone and shales of San Francisco.

*Vancouver's Island coal.*—The coal of Vancouver's island is probably similar to that from Bellingham bay, and was also tested on board of the steamer Active. The locality is about eight or twelve hours' run by steamer from Bellingham bay, at the port called Nanaimo. I saw this coal in use on the steamer, and found that it produced a large quantity of very fluid slag, which ran down in streams from the grate-bars.

*Cowlitz coal.*—Another large deposite of coal has been known for several years in California, and is now being explored by a company of gentlemen in San Francisco. It is found near the coast, on the navigable waters of the Cowlitz river, and is reported to be equal to the Bellingham bay coal. It is much nearer San Francisco and San Pedro, and has that advantage over the Puget sound mines. A specimen of this coal was brought home by the Exploring Expedition, and was analyzed at the Yale College laboratory by Professor Benjamin Silliman, jr., with the following result:

| | |
|---|---|
| Carbon | 45.56 |
| Volatile ingredients | 52.08 |
| Ashes | 2.36 |

It burned with much smoke.[2]

*Bitumen, or asphalt, of Los Angeles.*—The bitumen of the vicinity of Los Angeles will doubtless at some future day become extensively used for the manufacture of gas, and for various purposes in the arts. In the moderate climate of the Pacific coast it cannot but become an important article for the construction of pavements, cisterns, &c. It is already used for forming roofs, being spread out in quantities on nearly flat surfaces, and softening by the heat of the sun so as to make a water-tight covering.

## BUILDING-STONE.

Granite, or gneiss, suitable for ordinary railroad constructions, can be obtained in the Bernardino Sierra, along the Mojave and the Colorado, along the valley of the Hawilhamook, or Bill Williams' fork, and in Cactus Pass. Granite also forms, according to the descriptions, a comparatively isolated outcrop at the southern base of the San Francisco volcano. From the last-mentioned point, eastward to the Sierra Madre, it cannot be obtained except by transportation. It can be procured in the Sierra Madre, and again at the Sandia and Santa Fé mountains. East of the Sandia mountains it cannot be had along the line, if we except the Witchita mountains, which rise several miles south, but which could be resorted to for stone if required.

*Limestone and sandstone.*—Portions of the route between the granitic outcrops are supplied with building materials in the sedimentary rocks of carboniferous or later age. Thus, between Cactus Pass and the granite at San Francisco volcano, there are numerous exposures of lime-

[1] Preliminary Geological Report, accompanying the report of Lieutenant R. S. Williamson, U. S. Topographical Engineers. H. Doc. 129, p. 72.

[2] Report on the Geology of the Exploring Expedition, by James D. Dana, p. 658.

stone favorably situated for furnishing blocks suitable for purposes of construction. The broad region between San Francisco mountain and the Sierra Madre, although far from granite, is supplied with sandstone, and the western end with magnesian limestone, in layers, which may be found thick enough for building purposes. The sandstones and marls of the gypsum formation are not suitable for building, but the grey or yellow sandstone in the vicinity of Zuñi will probably be found suitable for abutments and bridges. . Carboniferous limestone could probably be obtained in the Sierra Madre. The limestone found in such thick beds in Cañon Diablo would also become available for building, and we may conclude that it is not only an excellent material, but easily worked.

From Fort Smith to Albuquerque, it is probable that the carboniferous limestone, especially at the extremes, would be the best and most accessible building-stone. The sandstone, if conveniently located, would also be valuable. The sandstone of the cretaceous and gypseous strata is probably too friable to be made use of over this part of the route, although there are doubtless many places where firm blocks can be quarried from the table-hills or borders of the Llano.

The valley of the Rio Grande can be supplied with stone from the limestone or granite of the Sandia range, and it is probable that the sandstone along the ravines and valleys west of the Puerco is sufficiently firm and enduring for use.

There is an abundance of building material along the western part of the route in the numerous granitic ranges, the only parts of the whole line that are not well supplied being the two great table-lands on the east and west of the Rio Grande. These table-lands are, however, bordered on each side by outcrops of carboniferous strata, limestone and sandstone, which can be transported each way towards the centre of the plateaux if required.

## GYPSUM.

This mineral occurs abundantly along a great part of the route. It is found in thin transparent plates, in large opaque masses, or with a fine grain and translucency like alabaster, and in red masses with a plumose structure. It forms, in many places, extensive sheets or thin seams in the rocks, and at others thick imbedded masses, constituting a very considerable portion of the strata. Specimens of the several varieties mentioned above are found in the collection, and are registered in the catalogue from Nos. 70 to 82, inclusive. Descriptions will also be found of the most interesting masses in Chapter X; and the principal deposites, with their association and mineral characters, have already been described in the preceding chapters. A few observations only upon the uses of the mineral in the arts will be added here.

I have already presented observations at length upon gypsum, its uses, and its origin, in the report on the geology of the 32d parallel, and the following remarks are in part extracted from that report:

The applications of gypsum in the arts, both in its raw state and prepared, or ground into plaster, are multiplied and various. The uses of alabaster are well known. Large quantities are worked into ornamental objects—vases, statuettes, &c.—in the establishments of France and other places in Europe. The fibrous variety, or satin spar, is sometimes used for making ornaments and beads, called *Roman pearls*. But by far the most important applications of gypsum in the arts are those of plaster of Paris. In this state it is used for moulds, casts, statues, as a cement, for plastering walls, and for ornaments on ceilings. The crude, unburnt gypsum, when powdered, is largely used in agriculture as a fertilizer. Enormous quantities of this substance are thus annually consumed in the United States. It is brought from the quarries of Nova Scotia, and finds its way, by rivers, canals, and railroads, to nearly all parts of the country. It is even taken in quantities from the seaboard, by railway, far into the interior, to the broad fields of northern Virginia, situated on the New Red sandstone. Some idea of the extent to which this substance is used in agriculture may be obtained from a knowledge of the amount taken from the quarries of Nova Scotia and New Brunswick, and exported to the United States,

in 1851. This, according to Mr. Andrews, was 40,592 tons, and valued at $28,145. And in the year 1850, the quantity quarried reached the enormous amount of 79,795 tons. According to Dawson, the quantity quarried in Hants and Colchester districts, in 1851, was 78,903 tons, having a value of £10,000 at the ports of shipment; the greater part of which is exported to the United States for agricultural purposes.

It is thus seen that there is an immense and inexhaustible supply of this valuable mineral in convenient proximity to all parts of the Atlantic coast of the United States. It is readily quarried at little cost, and can be loaded directly into vessels without land transportation. This is sufficient to show that the deposites along the route cannot become valuable as a source of gypsum for export. The expense of quarrying in horizontal beds is greater than in vertical ones, where they are exposed in bluffs; and the distance of the deposites from seaports will confine the use of the gypsum to its immediate vicinity.

It is an interesting fact that selenite was well known to the ancients, who, according to Pliny, made bee-hives out of it, in order to see the bees at work within. According to Dr. Hitchcock, it was used by the wealthy in palaces for windows, under the name of *Phengites*, and "has the curious property of enabling a person within the house to see all that passes abroad, while those abroad cannot see what passes within. Hence Nero employed it in his palace."

From information which I have received from Mr. Campbell, it appears that the transparent plates—the selenite—is found in abundance between the Sierra Madre and the Rio Grande, and it is extensively collected and used for window-lights. It is in use at Covero, and is carried to Zuñi for the same purpose. From this fact, and the description given by Gregg, I judge that the selenite occurs in large and beautifully clear masses. According to Gregg, it is known by the natives under the name of *Yeso;* and he states that it is found in foliated blocks composed of laminæ, which are easily separated with a knife into sheets from the thickness of paper to that of window-glass, and almost as transparent as the latter. It is used to a great extent in the ranchos and villages for window-lights; for which, indeed, it is a tolerable substitute."[1] According to Wislizenus, extensive layers of this selenite exist in the mountains near Algodones, on the Rio del Norte, and in the neighborhood of the Salinas. The mineral appears also to be used as a substitute for lime in whitewashing. It is first calcined, and then mixed with water, and applied to the walls of dwellings and churches.[2]

## GOLD.

The principal locality at which gold in any quantity is known to occur on or near the route surveyed is near Santa Fé, in and around the Gold mountains. In that region there are two localities where the gold is most abundant. These are known as Old Placer and New Placer. The former has been known and worked since 1828. It is about twenty-seven miles south of Santa Fé, and appears to be on the northern and western slopes of the Gold mountains, and to extend for several miles southward.[3] Dr. Wislizenus, who visited the placers in 1846, makes the following observations on them, and the extent of the gold-bearing region:

"Gold seems to be found to a large extent in all the mountains near Santa Fé; south of it, in a distance of about one hundred miles, as far as Gran Quivrira; and north, for about one hundred and twenty miles, up to the river Sangre de Cristo. Throughout this whole region gold-dust has been abundantly found by the poorer classes of Mexicans, who occupy themselves

[1] Commerce of the Prairies, Vol. I, p. 177.

[2] J. W. Abert, U. S. Topographical Engineers. Report of an Examination of New Mexico, p. 509.

[3] The following account of the discovery of the gold is given by Gregg, (Commerce of the Prairies, Vol. i, p. 167.) In 1828 a *Sonoreño* who was in the habit of herding his mules in that vicinity, being one day in pursuit of some that had strayed into the mountains, happened to pick up a stone which he soon identified as being of the same class that was to be ound in the gold regions of Sonora. Upon a little further examination he detected sundry particles of gold, which did not fail to occasion some degree of excitement in the country. The mine appears to have been incorporated as *El Real de Dolores*, but is now generally known under the name *El Placer*

with the washing of this metal out of the mountain streams. At present the old and the new placer, near Santa Fé, have attracted most attention; and not only gold-washes, but some gold mines, too, are worked there. They are, so far as my knowledge extends, the only gold mines worked now in New Mexico."[1]

I do not find any other estimate of the extent of this auriferous region. The estimate given, it will be perceived, is not very definite, and the average breadth of the placers is not given.

It appears that the gold is found here, not only in drift of gravel and sand, but occurs also in quartz veins which traverse the underlying rocks. At the time of the visit of Dr. Wislizenus, and subsequently, when Lieutenant Abert passed over that region, both of these sources of gold were worked. From the descriptions given, it seems that the placer-gold occurs there very much as in California. It is found not only along the streams, but above them, as in the "dry-diggings," resting on a bed-rock of granite, and covered by thick deposites of earth, stones, &c., as in California. On Lieutenant Abert's arrival at the village of Old Placer he gives the following description: "All along in the bottom of the stream, and in the heart of the town, you see holes scooped out by the gold diggers." Again, at another point, he saw holes dug in the sides of a hill of sand by the miners, and says that these mountains of sand were based on masses of granite.[2] One quarter of a mile beyond this place, and up the ravine, there was another little town, and the road on both sides was "full of holes, and sometimes deep wells that had been sunk in search of the precious metal." At a little mining town near Tuerto the houses were found among "huge mounds of earth thrown out from the wells, so that the village looked like a village of gigantic prairie dogs." "Nearly all the people there were at their wells, and were drawing up loose bags of sand by means of windlasses. Around little pools men, women, and children were grouped, intently poring over these bags of loose sand, washing the earth in wooden platters or great horns."[3]

Dr. Wislizenus gives a similar description of a town in the new placer, which, I presume, is the same which has just been referred to. The Doctor states: "The gold in New Placer is, also, got in two ways, by washing and mining. The principal place for gold washing is about one mile northwest from the town, at the foot of a naked granitic mountain, the so-called 'Bonanza.'[4] The whole place is excavated with pits, from whose depths they dig the same yellow auriferous ground as in Old Placer, and they wash it also in the same way." The method of obtaining the gold at the old placer, at the time of the visit of Dr. Wislizenus, was by washing in the old-fashioned *batea*.[5] "The poorer class of Mexicans are generally occupied with those gold washers in the creek; and they divide, for that purpose, the creek with the water among themselves in lots, which often call forth as many claims and contests as the finest building-lots in our cities." "As the gold is apparently carried here by the waters of the creek from higher auriferous regions, the gain from these washes is different according to the season. The most gold is found in and after the rainy season, and it diminishes with the falling of the water. Occasionally they discover a larger piece of gold in the sand; but generally the gold is so divided that a whole day's work will amount, on an average, to not more than a quarter or half a dollar. Every evening they sell their small gains to the shopkeepers and take provisions or goods in exchange, or receive cash for it at the rate of sixteen dollars per ounce." "This is the most common, but the least profitable way of gold-washing. It may be practised on all the water-courses in those mountains, provided that there is sufficient water to wash with." * * "The second place where I saw the process of gold washing was on a high piece of ground not far from a creek. They had opened here a great many pits to the depth of from fifty to sixty

[1] Memoir of a Tour to Northern New Mexico: Washington, 1848; p. 24.

[2] J. W. Abert's Report of an Examination of New Mexico, p. 449.

[3] J. W. Abert. Examination of New Mexico, p. 451.

[4] Memoir of a Tour to Northern Mexico, p. 31.

[5] *Batea:* a wide and shallow wooden bowl, into which the aurifereous earth is placed, with water, and shaken until the coarse gravel and earth are removed, leaving the gold in the centre mixed with the heavy sand.

feet, and raised the ground, a sandy earth mixed with iron ochre, to the surface, where it was washed for gold in the same way, in bateas."

From the preceding extracts and descriptions, the experienced placer-miner of California will at once conclude that both kinds of gold deposites—the river and the hill or dry-diggings—are found in that region. The rudeness and inadequacy of the means for washing this auriferous earth are also very apparent, and there can be little or no doubt that the new methods of washing placer deposites in California would, if applied in New Mexico, develop great riches even in those parts of the placers already washed in such an imperfect manner. The introduction of water by canals and aqueducts, and the adoption of the "hydraulic method" of washing, would doubtless reveal ten ounces of gold where one only could be obtained before, and with no more labor and less time.

According to Gregg, the quantity of gold taken from these placers and mines, between the years 1832 and 1835, could not have amounted to less than from sixty thousand to eighty thousand dollars per annum. Since that time, however, there has been a considerable falling off, the yield for some seasons being only thirty thousand or forty thousand dollars. Mr. Gregg, however, estimated the aggregate yield, since the first discovery, at more than half a million of dollars.[1] This estimate was made in 1844, and the mining has not been vigorously prosecuted since that time. Mr. Gregg also observes that "only a very small portion of the gold region has as yet been dug, and experience shows that the dust is about as likely to be found in one part of it as another."

The principal difficulty in working these placers has been the absence of sufficient water. The miners do not appear to have constructed a single ditch or canal to the dry-diggings, but rely upon the winter snow for their supply. They were in the habit of collecting the snow in a vat, and then melting it with heated stones. Of course, with such a limited supply of water but little gold could be obtained, and it did not even permit of the use of anything but hand implements, such as the pan or *batea* for washing.

It appears that the gold from the new placer was generally considered inferior to that from the old. In order to determine this, Dr. Wislizenus took some of the wash-gold and subjected it to analysis, and gives the following result:

| | |
|---|---|
| Native gold | 92.5 |
| Silver | 3.5 |
| Iron and silex | 4. |
| | 100.0 |

This exhibits but a small portion of silver, and it is probable that it was not all separated from the gold, or possibly by "native gold" the natural alloy is meant. It is probable that the difference between the gold of the two placers is very slight, if indeed there be any. Gregg, in his work, states "that the gold is of very fine quality, and that it produced at the United States mint an average of $19 70 to the troy ounce after melting, or about $19 30 gross. It was at first bought by the traders at the rate of $15 per ounce; but in consequence of the competition which was afterwards excited by the dealers, its price was raised for a short time above its maximum at the mint, although it has since settled down at about $17 30 per ounce troy."[2]

The gold region was for the most part, as in California, a kind of common property, although the government often interfered, and secured a considerable share of the most profitable workings. Dr. Wislizenus makes the following observations on the laws governing the mines at the time of his visit: "Though the law in New Mexico was generally very liberal in granting lots for mining, the instability of Mexican laws, and their arbitrary administration, have neutralized and annihilated it." "When a New Mexican wants to work a gold or other mine not

[1] Gregg's Commerce of the Prairies, Vol. i, p. 167.
[2] Ibid., p. 168.

yet occupied by another, he has to apply to the nearest alcalde, (justice of the peace of the district,) who, according to the means and intended work of the individual, allows him a smaller or larger tract of land, measured only in front, and reaching in depth as far as the owner pleases to go. The price of the land is trifling; but if the owner does not work a certain portion of the mine every year, it falls back to the government." "Foreigners were, in consequence of the eternal revolutions and new law codes in Mexico, sometimes excluded, sometimes allowed to participate in this privilege." "By taking a Mexican as partner, they obviated the law; but the most dangerous enemy was generally the avaricious Mexican government itself. Often, when a foreigner had opened a profitable mine, these trustees of justice interfered for some reason or other, and ejected the owner of his property. Several instances of such proceedings are known. If we add to these causes the isolated situation of New Mexico, the thin population, the want of good mechanics and real miners, the hostilities and depredations of the Indians, it will not astonish us at all that, notwithstanding the great mineral resources of the country, so few mines are worked at present."[1]

*Quartz veins.*—There is one specimen of "auriferous quartz" from the new placer in the collection, (No. 93 of the catalogue.) On examination, as will be seen from the description in another place, no gold could be detected by the eye, but the rock was cellular, and stained with oxide of iron, proceeding from the decomposition of pyrites. I do not find any description of the vein from which this was procured in Mr. Marcou's notes. He, however, mentions the occurrence of copper ores, which are probably auriferous, but from the specimens in the collection I judge that they are from another vein. The direction of the new placer is also given in the notes as east 30° north; but whether this refers to the direction of the auriferous valley or to the auriferous veins, is rather uncertain.

Quartz veins, bearing gold, are, however, mentioned and described by both Abert and Wislizenus, and also by Gregg. The former visited a mine somewhere in the old placer, north of Tuerto, and found the gold to be in a quartzose rock in particles visible to the naked eye. This auriferous quartz was first broken into fragments, and then crushed by a rude mill or *arastra*.[2] Lieut. Abert also visited another mine further south. This he calls a copper mine, and specimens of the ore were seen about the entrance. By pounding up some of this, however, between two stones, and washing, particles of gold and silver were visible. The vein is said to be in compact limestone. The sides of the passages of the mine were very irregular, and cut into deep rounded fissures which were called pockets, and in which the richest ores were said to occur. Lead ore and carbonate of lime were also seen at this place. At another mine—one belonging to Mr. Campbell—the ore was composed of a very porous and vesicular rock, which was easily crushed. The vein is reported to be nearly horizontal, and trends a little north of west, (N. 80° W.,)[3] and traverses compact limestone. The sides of the mine are full of pockets. Mr. Campbell informed Lieutenant Abert that the ore near the surface was the richest, and that the yield in gold diminished on going to a great depth, so that it hardly paid the expenses. This is probably due to improper treatment of the ore. That found near the surface being partly decomposed, yields up the gold more readily and with less care than the undecomposed portions from a greater depth. This conforms to the universal experience with veins of auriferous pyrites, the decayed parts of the vein being the most profitable. With regard to the working of these mines, Lieutenant Abert observes: "These mines are much more extensively worked than those of Real Viejo; and, notwithstanding the scarcity of water, I have been told by several persons that not less than two thousand people congregate here in the winter season

[1] Wislizenus' Memoir of a Tour to Northern Mexico, p. 32.

[2] A peculiar mill for grinding ores, used principally in Spain, South America, and Mexico, and formed by attaching heavy slabs of rock by chains to the ends of long beams projecting from an upright spindle, which being made to revolve, drags the slabs around in a circular pit or trough lined with iron or stone, into which the ore is thrown, with water and quicksilver.

[3] This direction is given in a corrected copy of Lieutenant Abert's Report. It is printed N. 50° W.

when they can get water from the snows. These workers spend the greater part of their time under ground, living on *atolé*, a dilute kind of corn mush; sometimes coming forth to the light of day, when they wish to sell the product of their labor."[1] Mr. Campbell stated that he had obtained from his wells one piece worth seven hundred dollars, and at another time a piece worth nine hundred. Whether these were taken from the veins or from the placer deposites is uncertain, but I judge that they were taken from the latter.

Dr. Wislizenus mentions two gold mines which he says are similar, and I presume are the same that were visited by Lieutenant Abert, and just described. Mr. Campbell's mine is said to be one and a half mile southwest from the town, near the top of a high mountain to which a rough and steep road leads, accessible only to pack-mules. "The gold is found, as in old placer, in sienite and greenstone; it runs horizontally from east to west; the gangue is iron ochre and crystallized quartz. The vein was from eight to ten feet wide, and was explored for a length of twenty feet, and to a depth of ten feet."[2]

As Lieutenant Abert describes the last vein he examined as nearly horizontal, and also states its direction to be nearly east and west, I am led to conclude that the descriptions refer to the same locality described by Dr. Wislizenus. It is difficult to understand what is intended by the statement that the vein has an east and west direction, when it is also said to be nearly horizontal, and thus has, most probably, an extension in all directions. If it were not for the occurrence of pyrites and carbonate of lime, the associates of gold in veins, and the direct statements that the vein is in the solid rocks, we might conclude that the openings followed a layer of auriferous drift on the bed-rock. Lieutenant Abert states that the rock is limestone, while Dr. Wislizenus describes it as greenstone and sienite. It is therefore probable that all these rocks are found together; and we already know that the mines are near the junction of the limestone with the granitic rocks.

*Cerbat and Aquarius Mountains.*—It does not appear from the notes or collection, nor from any published reports, that gold is found in these mountains, or in the region included between the Colorado river and Hawilhamook, or Bill Williams' fork. The metamorphic character of the rocks, however, and their wide extent, lead me to conclude that gold will in all probability be found there in considerable quantities. The subject is worthy of the attention of explorers when passing over that region.

*Gold in the Great Basin and Bernardino Sierra.*—After quitting the Gold mountains, the precious metal was not found again along the route. It, however, occurs at a point near the Mormon road, not many miles beyond the Soda lake, in the Great Basin. The locality is known as the Armagosa mine, and it was noticed in my Preliminary Geological Report. It is exceedingly interesting not only for the peculiar association of the gold, but as the only known vein bearing this metal which has yet been discovered in the Great Basin. This vein was opened upon and worked for a time by a company organized in California, and a considerable quantity of rich ore was raised; but the distance of the locality from settlements, and the difficulty and expense attending the transportation of supplies, caused the enterprise to be abandoned. The many specimens of the rock, charged with small plates and filaments of gold, that were obtained at the mine, and which are to be seen in Los Angeles and other places in California, testify to the richness and value of the locality; and it is desirable that the vein should receive more attention. The specimens which I have obtained from there show that carbonate of lime forms a considerable part of the gangue; the filaments of gold, some of them as large as a common-sized knitting-needle, are seen to penetrate this mineral, and to be imbedded in it so as to protrude on two sides of rhombohedrons, obtained by cleavage. The occurrence of this gold in place in the rocks of the Basin, so far east of the great auriferous region of the Sierra Nevada, has a significance of no small importance. It indicates the presence of veins throughout that vast and as yet almost unexplored region. We may look not only for rich veins, but for

[1] Abert. Report of an Examination of New Mexico, p. 452.

[2] Wislizenus' Memoir, p. 32.

extensive and rich placers, which only require abundance of water and the facilities which would be afforded by a railroad to become sources of national wealth. The exploration of the Armagosa veins and of the surrounding country, not only for veins, but for placers, is exceedingly desirable.

*Placers and veins of San Francisquito and the vicinity.*—Gold has been obtained for several years past in the lower portions of the mountains north and northwest of Los Angeles. It occurs in veins and in placer deposites; but the explorations have hitherto failed to develop riches comparable in quantity to those of the placers of the Sierra Nevada. The talcose and auriferous slates are found in extended ridges along the lower part of the Pass of San Francisquito, and it is probably from these that the gold is derived. Similar rocks occur, also, at the base of the mountains where they are crossed by the Cajon Pass; and it is probable that gold can be obtained there by washing in the beds of the streams. Mr. Marcou states that he saw rocks in the pass precisely similar to those found between Rough-and-Ready, Grass Valley, and Nevada City, which contain veins of auriferous quartz.[1] To me the rocks of the lower portions of the pass appeared to be chiefly metamorphic, while those bearing the quartz veins at Grass Valley and vicinity were evidently in great part of erupted greenstone. The specimens which Mr. Marcou notes as coming from the Cajon Pass were most probably brought through there from the Armagosa mines in the Great Basin.

## SILVER, LEAD, AND COPPER.

These metals, or their ores, do not appear to have been met with in any quantity along the route. The only specimens in the collection are of copper ore from Placer mountain, and are probably from the mine noticed under the head of "Gold." The ore is noticed in the description of the collection (No. 92.) It is chiefly silicate and carbonate of copper disseminated in a gangue of a beautiful light-colored garnet, which is both massive and crystalline, fine crystals being found on the interior of small cavities. The copper ore mentioned by Lieut. Abert is, according to his observations, associated with carbonate of lime. These specimens are, therefore, most probably from another locality.

According to Wislizenus, copper occurs at many places in that region, and he cites the following as localities: Las Tejeras Jemez, Abiquiu, and Guadelupita de Mora. He, however, knew of only one locality that was worked—that south of the placers [2]

*Vein in the Great Basin.*—A vein of copper ore, with a width of several feet, occurs on the northern side of the Bernardino Sierra, not far from the entrance to Williamson's Pass. It is about seven and a half miles east of Johnson's river, so named on Lieutenant Williamson's map. The rock which bounds the vein on each side is gneiss or mica-slate, trending nearly N. 75° E., and the dip of the rocks and vein is nearly vertical. The outcrop, showing dark-green stains of the carbonate of copper, varies from twenty to thirty feet in width. The vein-stone is chiefly quartz. A large amount of oxide of iron filling the cavities shows the former presence of a very considerable amount of sulphuret of iron, now entirely decomposed.[3] Copper ore also occurs in the pass, (Williamson's Pass,) a few miles below the summit.

The occurrence of silver with the gold obtained by crushing and washing the copper ores of the mine in or near the new placer is mentioned by Lieutenant Abert. It is possible that brilliant white particles of mundic may have been mistaken for the metal; but it would not be strange to find the silver there, as we are informed of the presence of veins of lead ore, one of its most common associates. I do not find any full account or description of this lead mine. According to Lieutenant Abert, the vein is in the limestone, and he gives a figure of a *Terebratula*, a fossil common in the carboniferous limestone which he obtained in the mine.

The carboniferous limestone appears to be peculiarly favorable to the occurrence of lead ores and silver. Rich veins are found in the Organ mountains, about 200 miles south of the route,

[1] Resumé, p. 48. [2] Wislizenus. Memoir of a Tour through Northern Mexico, p. 24.

[3] A notice of this vein was given in the author's Preliminary Geological Report, p. 74, and will appear with further details in the final Report.

on the southern extension of the Santa Fé and Sandia mountains. Specimens of the ores brought in by Captain Pope from his survey along the 32d parallel of latitude are very rich, and consist of massive sulphuret of lead, galena, and large masses of carbonate of lead. The former contains about forty-eight troy ounces of silver to the ton of ore.[1] It is probable that the mountains around Santa Fé and Albuquerque, and also the Sierra Madre on the west, contain many valuable veins of argentiferous lead which have never been discovered. Wislizenus states that several rich silver mines were worked in Spanish times at Avo, at Corrillos, and in the Nambe mountains.[2] Lieut. Abert, when at the village of Manzana, obtained specimens of silver ores which were taken from mines in the adjoining mountains.[3] The extensive silver mines of Mexico are doubtless in the more highly metamorphosed limestone of the same age with that at Santa Fé and along the flanks of the mountains bordering the Rio Grande.

In passing down the valley of the Hawilhamook, or Bill Williams' fork, Mr. Marcou observed several veins of argentiferous galena, (see notes,) and this led him to believe that silver was abundant in those mountains.

### IRON.

There are several specimens of iron ores in the collection, and it is an interesting fact that they are all of the specular or hematite species, although they present very different appearances. All of the specimens are described in the description of the collection. One is a beautifully fibrous variety, and its size indicates that very large masses may be obtained at the parent source. Nearly all the specimens appear to have been boulders or loose masses, as Mr. Marcou does not give any description of veins or beds.

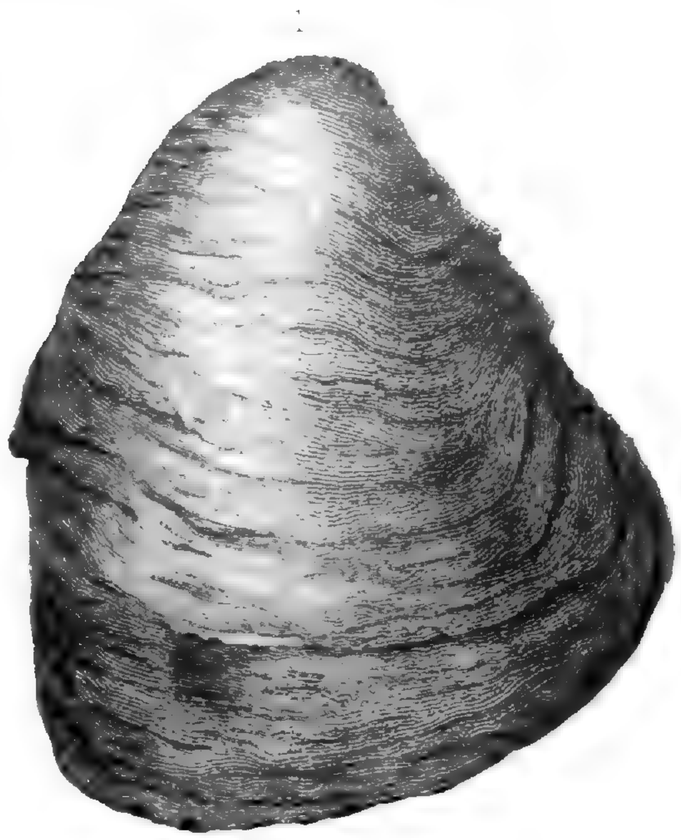
Magnetic iron ore occurs in considerable quantity in the pass next west of the Cajon, (Williamson's Pass,) where I found large quantities in the bed of a stream coming in from the east, mingled with the detritus from the surrounding mountains.

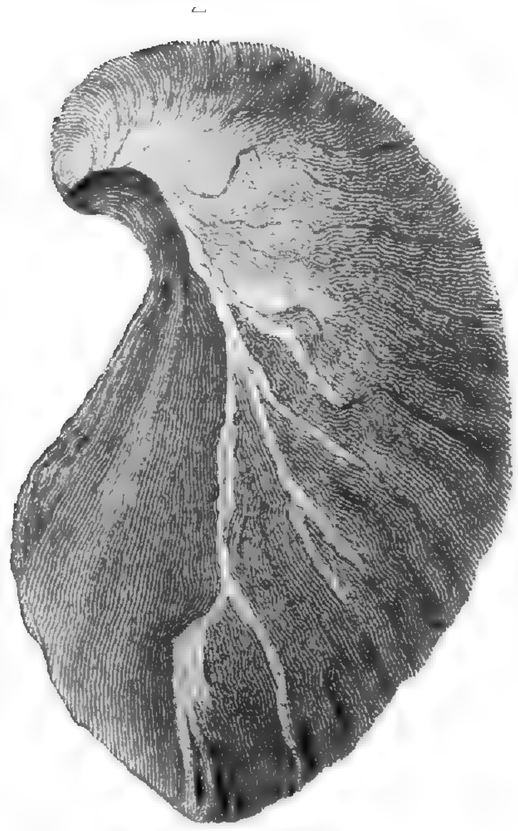
### SALT.

The inhabitants of the valley of the Rio Grande have long been accustomed to resort to several salt lakes, or *Salinas*, on the east side of the mountains, for their supply of salt. These lakes are about fifty miles east by south from Albuquerque, and one hundred miles south of Santa Fé. They are on the high table-lands which extend from the mountains to the Pecos, and which are most probably formed by Tertiary strata in that region. The lakes are capable of furnishing an almost unlimited quantity of good salt, and the whole adjoining country is supplied from them. I find an interesting account of these lakes given by Gregg. "The largest of these Salinas is five or six miles in circumference. The best time to collect the salt is during the dry season, when the lakes contain but little water; but even when flooded, salt may be scooped up from the bottom, where it is deposited in immense beds, in many places of unknown depth, and when dried resembles the common alum-salt. The best, however, which is of superior quality, rises as a scum upon the water. A great many years ago, a firm causeway was thrown up through the middle of the principal lake, upon which the *carretas* and mules are driven, and loaded with salt still dripping with water. The Salinas are public property, and the people resort to them several times a year, in caravans, for protection against the savages of the desert in which they are situated. Although this salt costs nothing but the labor of carrying it away, the dangers from the Indians, and the privations experienced in an expedition to the *Salinas*, are such, that it is seldom sold in the capital for less than a dollar per bushel. On the same great plain, still a hundred miles further south, there is another *Salina*, of the same character.[4]

According to Mr. Marcou, the red marls or clay, near Camp No. 41, are saliferous, and holes were found filled with very brackish and magnesian water, which was insupportable to the taste. Salt was also found in small quantities at several other points. The bed of the dry lake—the Soda lake—at the sink of the Mojave, was covered with a saline incrustation, already described.

[1] See report on the Geology of the route near the 32d parallel, p. 37, Pacific R. R. Explorations and Surveys, &c.
[2] Memoir of a Tour to Northern Mexico, p. 24.
[3] Report of an Examination of New Mexico, p. 487.
[4] Commerce of the Prairies, Vol. i, p. 176.





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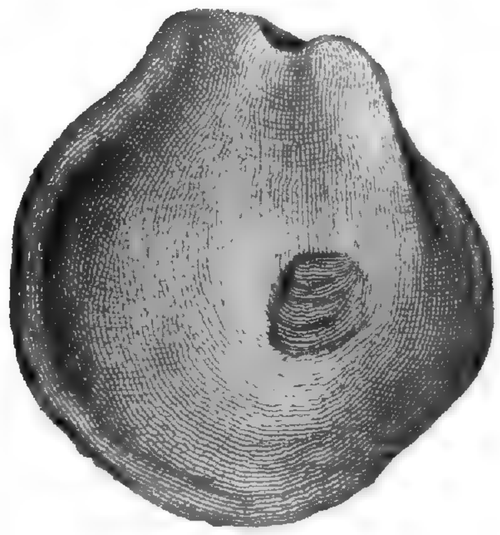

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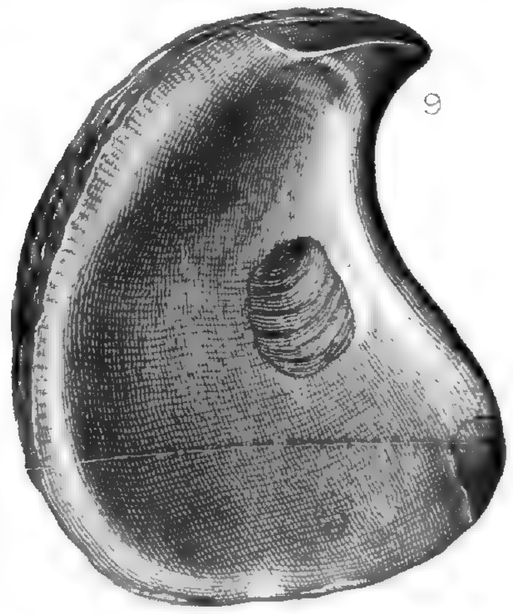

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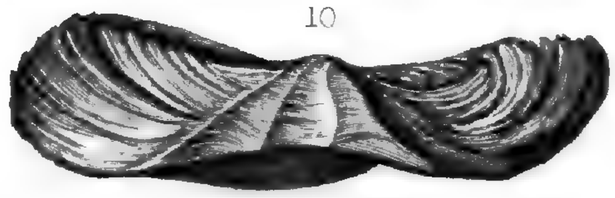

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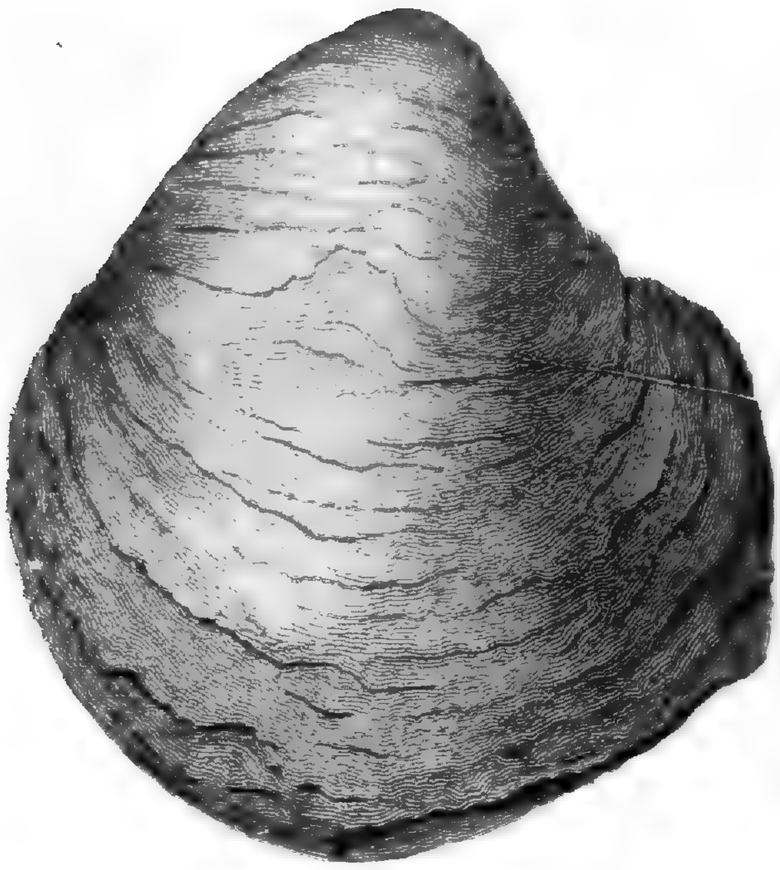

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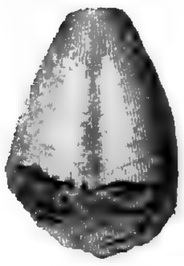
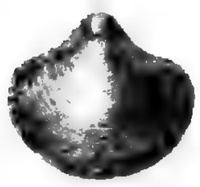
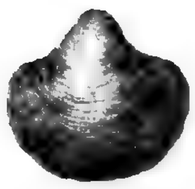
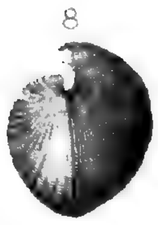
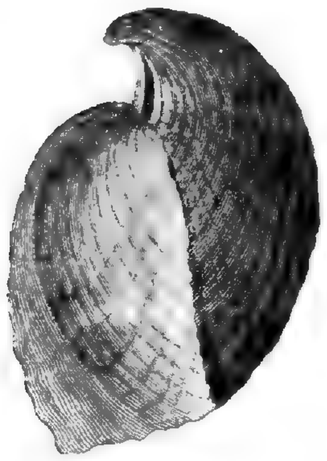
FIGS. 1-6 GRYPHÆA PITCHERI - FIGS 7.10 G. PITCHERI VAR. NAVIA. — FIG. 11. OSTREA CONGESTA.

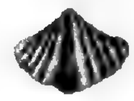


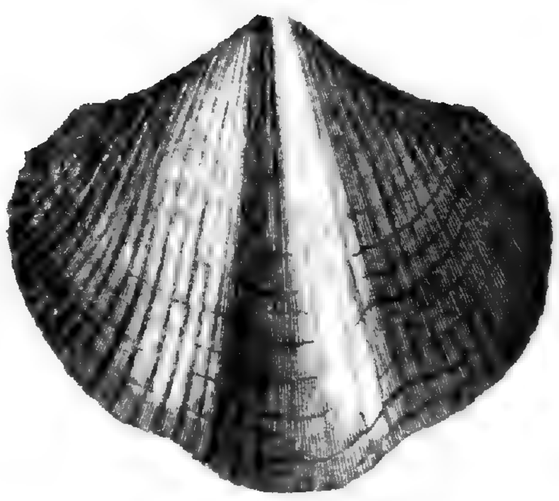


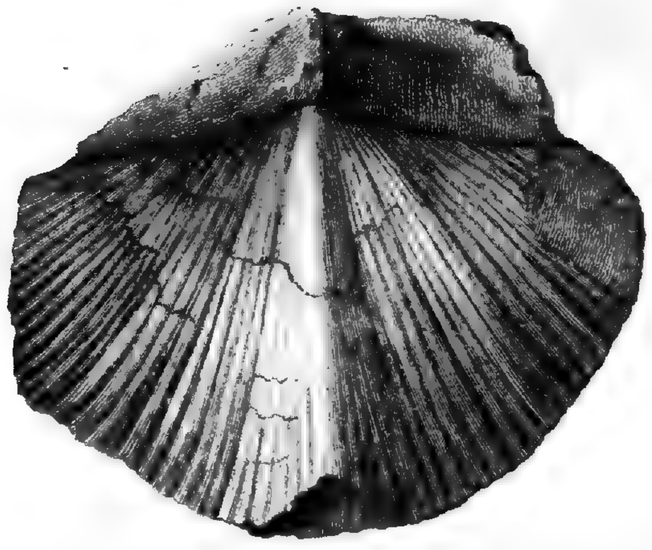












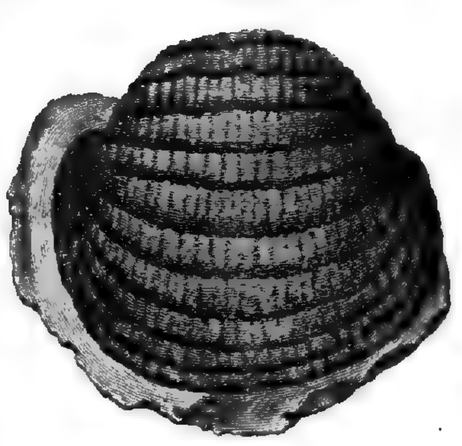


FIG. 1. TEREBRATULA ? SUBUMBONATA. — 2, 3, 4, 5. T. SUBTILITA. — FIG^S 6, 8. SPIRIFER LINEATUS. — FIG^S 9, 10, 11. SP. CAMERATUS. FIG. 12. S. MACRONOTUS. — FIG. 13. S. SEMIPETUNIATUS. — FIG. 14, 15. P. ROGERSI.

# CHAPTER IX.

## DESCRIPTIONS AND NOTICES OF THE FOSSILS COLLECTED UPON THE ROUTE.

BY PROFESSOR JAMES HALL.

The fossils of this collection were submitted to me by Mr. W. P. Blake, in July, 1855. They consist of cretaceous and carboniferous species, most of them previously described and well known. A considerable number of specimens were not sufficiently perfect to be identified and described in detail, though they were clearly of the age of the formations designated above. At the time of my examination, two of the carboniferous species were undescribed; since then, however, one of them has been described by Dr. Shumard, in the Geological Report of the State of Missouri.

The following list embraces those which have been recognized, with the single new species.

LIST OF FOSSILS DESCRIBED AND FIGURED.

GRYPHÆA PITCHERI. Plate I, figures 1–6.
GRYPHÆA PITCHERI, var. NAVIA. Plate I, figures 7–10.
OSTREA CONGESTA. Plate I, figure 11.
TEREBRATULA MILLEPUNCTATA. Plate II, figures 1 and 2.
TEREBRATULA SUBTILITUS. Plate II, figures 3, 4, and 5.
SPIRIFER LINEATUS. Plate II, figures 6, 7, and 8.
SPIRIFER KENTUCKENSIS. Plate II, figures 10 and 11.
SPIRIFER CAMERATUS. Plate II, figures 9, 12, and 13.
PRODUCTUS ROGERSI. Plate II, figures 14 and 15.
PRODUCTUS SEMIRETICULATUS. Plate II, figures 16 and 17.

### CRETACEOUS SPECIES.

**GRYPHÆA,** *Lamarck.* GRYPHÆA PITCHERI.—Plate I, figs. 1–6.

GRYPHÆA PITCHERI, *Morton*, Synopsis of the Organic Remains of the Cretaceous Group of the United States, 1834, page 55, plate XV, fig. 9.
GRYPHÆA TUCUMCARII, *Marcou*, Resumé of a Geological Reconnoissance, &c.
GRYPHÆA DILATATA, var. TUCUMCARII, *Marcou*, Bulletin de la Soc. Geol. de France. Tome XII, Mai, 1855, plate XXI, figs. 1, 2, 3.

Shell subovate, more or less thickened, expanded, distinctly lobed; lower valve very convex, gibbous in the middle; beak more or less strongly incurved; umbo large and prominent; upper valve thick, subconvex anteriorly, concave in the middle; postero-ventral margin sinuate and elevated in a line corresponding to the depression in the opposite valve; surface strongly lamellose, with sometimes a few impressed radiating lines near the centre.

This shell presents much variation in specimens from different localities, and even in those from the same locality. In well marked specimens the larger valve is very distinctly lobed by a broad, undefined depression, extending from the posterior side of the back to the postero-ventral margin. It is sometimes simply convex, often gibbous and extremely arcuate, with the beak strongly incurved. In the simply convex specimens, the inner side of the beak often presents but a slight incurvation, while the exterior is still strongly arcuate. The surface exhibits, more or less distinctly, an imbricate-lamellose structure. The upper valve is often abruptly elevated in front, flat or concave in the middle, with the surface strongly imbricate-lamellose,

particularly towards the margins, and sometimes with radiating striæ in the centre. The sinuosity and elevation in the postero-ventral margin corresponds to the depression in the opposite valve, and in small specimens is often not conspicuous. In young shells, the surface of the lower valve is not unfrequently costate-imbricate.

This shell, in some of its varieties, resembles *G. vesicularis*, and the upper valve might be mistaken for that species; the strongly incurved beak and the more direct sinus of the larger valve are distinctive characters.

It has clearly the typical form and characters of the species, as will be seen by referring to Dr. Morton's figure of a small individual. Numerous specimens from different localities have been examined, and the characters are sufficiently constant in all to leave no doubt of the specific identity. The specimens figured by Dr. Roëmer in his Kreide von Texas, as *G. Pitcheri*, may be an extreme variety of that species, but we have not yet seen specimens showing satisfactorily the gradation from one to the other. The specimens upon which Mr. Marcou proposed the new species, are evidently much larger and finer ones than were possessed by Dr. Morton when he wrote his description and gave the figure of this species. The original of his figure and description, however, is still preserved in the cabinet of the Philadelphia Academy of Natural Sciences.

*Locality*.—Brought by Mr. Marcou from Pyramid Mountain, Plaza Larga, Camp 50.

GRYPHÆA PITCHERI, var. NAVIA.—Plate I, figs. 7–10.

GRYPHÆA PITCHERI, *Roëmer*, Kreide von Texas, page 73, plate IX, fig. 1.

Shell elongate, narrow-subovate; lower valve longitudinal, somewhat trilobate; a distinct depression extending from the posterior side of the beak to the base of the shell; anterior side flattened or slightly depressed; middle gibbous and extremely arcuate; beak abruptly incurved, laterally compressed, and turned to the posterior side; hinge line short; upper valve unknown.

Specimens of this form are very abundant, judging from the collections made in the west. The general aspect of the shell is that of *G. Pitcheri*, but it is much narrower, more elongated, and more trilobate than the typical forms of that species. The larger valves are usually very thick, and often distorted from this cause. The extreme incurvation of the beak is most conspicuous on the exterior; and though the thickening of the shell sometimes obliterates this character upon the inner side, it is, nevertheless, a characteristic feature. This form is the one usually referred to *G. Pitcheri*, and in its extreme character is well represented in the figures of Dr. Roëmer, cited above. Like the preceding, in its young state it is sub-costate-imbricate on the larger valve; but this character disappears with age, and the lamellose structure becomes very conspicuous sometimes on the ridges, rising into squamose node-like elevations.

*Locality*.—False Washita, Camp 31. The same has likewise been brought from numerous other localities in the west.

**OSTREA**, *Linneus*. OSTREA CONGESTA.—Plate I, fig. 11.

OSTREA CONGESTA, *Conrad*, Nicollet's Report, page 167. Washington, 1843.

"Shell elongated, upper valve flat, lower valve ventricose, irregular; the umbo truncated by a mark of adhesion."

In the young specimens, when not distorted by pressure, the form is obliquely ovate, with a sharp triangular beak curving to the left, and a small well-defined area, the shell adhering by the entire outer surface; the margins are abruptly inflected, so as to become vertical to the plane of the adhering surface and continue to grow in that direction, the inner side crenulated at the junction of the upper valve. In older specimens the form is distorted by the pressure of contiguous individuals, and the beak truncated by adhesion, and finally becomes obsolete; the entire valve often assumes a somewhat semi-cylindrical or tubular form.

The shell is extremely abundant, and in its stages of growth presents all the variable characters of form observed in other species which live in closely aggregated masses.

This species is usually found in thin, more or less continuous, layers, adhering to the surface of calcareous laminæ, which are largely composed of fibrous calcareous matter, similar to the outer part of the shell of Inoceramus, mingled with fragments of other shells. Sometimes laminæ of this fibrous calcareous mass, several inches square, are entirely covered with this oyster adhering to one side. In other instances the fibrous laminæ fill interstices between the shells, and radiate from different centres, as if having filled the space subsequent to the growth of the shells.

*Locality.*—Brought by Mr. Marcou from three miles north of Galisteo; from the cretaceous marls on the Missouri by J. N. Nicollet; and by Mr. Meek and Dr. Hayden from the lower beds of the cretaceous rocks on the Missouri river, twenty-six miles above the mouth of l'Eau qui Court.

## CARBONIFEROUS SPECIES.

**TEREBRATULA,** *Shwyd.* TEREBRATULA MILLEPUNCTATA, n. sp.—Plate II, figs. 1, 2.

Shell elongate; curved from beak to base, dorsal (ventral) valve, with a broad mesial depression, extending the entire length of the shell, obtusely subangular at the sides, which project beyond the margin of the opposite valve; ventral (dorsal) valve varying from flat to extremely convex or gibbous along the line from beak to base; surface minutely but conspicuously punctate.

The specimen in the collection is imperfect, the beak of the larger valve being broken off. The smaller valve is slightly concave, in a longitudinal direction, and somewhat semi-cylindrical.

Other specimens from Topeka, in Kansas, are extremely gibbous on the middle of the smaller valve; while the larger valve is extremely arcuate, and the beak abruptly incurved with a perforation above the apex. The Topeka specimens are less elongate than the one here described.

*Locality.*—Pecos village (New Mexico) associated with *T. subtilita*, and *Spirifer cameratus*, and *S. lineatus.*

TEREBRATULA SUBTILITA.—Plate II, figs. 3, 4, 5.

TEREBRATULA SUBTILITA, *Hall;* Stansbury's Report, page 409, plate IV, figs. 1 and 2.

Gibbous, obovoid, valves nearly equally convex; beak of dorsal valve elevated, incurved, and perforated at the apex; a mesial depression commencing just below the centre and extending to the front, which is produced and elevated, filling a broad sinus in the ventral valve; surface marked by strong concentric lines of growth, with faint, almost imperceptible, radiating striæ.

There are a large number of specimens of young and full grown individuals, exhibiting a great variety of form. In many instances the mesial depression is not fully developed until the individual is more than half grown; but sometimes it is well exhibited in the young shell. Several of the specimens show a narrow, sharply impressed line along the mesial depression from the beak to the base of the dorsal valve.

*Locality.*—Pecos village, near Santa Fé, New Mexico, where it occurs in abundance, associated with *Productus* and *Spirifer cameratus.*

It was also found on the Missouri river, near Weston; and is known in numerous localities in the west.

**SPIRIFER,** *Sowerby.* SPIRIFER LINEATUS.—Plate II, figs 6, 7, 8.

ANOMITES LINEATUS, *Martin.*

SPIRIFER LINEATUS, *De Koninck, De Verneuil,* and other authors.

Shell inflated subglobose; sometimes transverse and subelliptic; dorsal valve scarcely more convex than the ventral valve; mesial line marked by a scarcely perceptible impressed line which sometimes becomes developed in a shallow sinus in front; umbo prominent, beak incurved, area short, extremities rounded; surface marked by fine concentric laminæ which are crossed by longitudinal striæ.

These shells vary from elliptical or depressed globose to rotund and inflated forms. The area is often inconspicuous, and the beaks of the two valves are nearly equally prominent. The surface of the specimens is in general somewhat exfoliated, and presents a striato-punctate appearance. Sometimes the concentric and radiating striæ are nearly equal in strength; and the punctæ or bases of the small tubular spines are scarcely perceptible. In better preserved specimens the fimbriated character is conspicuous.

The form and essential characters possessed by these specimens leave no doubt of their identity with the European species to which they are referred.

*Locality.*—Pecos village, New Mexico, associated with the preceding species. This species is common in the carboniferous limestone of Europe.

SPIRIFER KENTUCKENSIS.—Plate II, figs 10, 11.

SPIRIFER KENTUCKENSIS, *Shumard*, Geological Report of Missouri, 1855, page 203.
SPIRIFER OCTOPLICATUS, *Hall*, Stansbury's Report, 1852, plate IV, fig 4.

Shell subtrigonal or semicircular, more or less elongate, gibbous, with from four to six plications on each side of the mesial sinus, plications rounded, beaks remote; beak of the dorsal valve very prominent and slightly incurved; area large; surface marked by closely imbricating concentric striæ, which are studded with minute granulations.

Specimens of this species from different localities show some variations; those from Weston, in Missouri, being more gibbose, with the plications less angular than those from Pecos village.*

Dr. Shumard says of this species, that it has from "six to nine plaits on each side of the mesial sinus." I have not been able to see specimens with more than six plications on each side; though it is not improbable that this character may undergo much variation with age.

This species resembles the *Spirifer octoplicatus* of Sowerby, to which I formerly referred it with doubt. It bears some relation to *Sp. crispus*, Dalman, but is less pointed at the extremities, the plications are less angular, and the concentric laminæ less abruptly arched; while the minute granulations of the present species are represented by the short striæ in that one.

*Locality.*—Pecos village, associated with *Spirifer cameratus* and *Terebratula subtilita*. It occurs in the same connection at Weston, Missouri, and at other localities.

SPIRIFER CAMERATUS.—Plate II, figs 9, 12, 13.

SPIRIFER CAMERATUS, *Morton*, 1836, American Journal of Science, vol. 29, p. 150, plate II, fig 3.
SPIRIFER MEUSEBACHANUS, *Roëmer*, Texas, p. 420, 1849; Kreide von Texas, 1852, p. 88, plate XI, fig 7.
SPIRIFER TRIPLICATUS, *Hall*, Stansbury's Report, 1852, p. 410, plate IV, fig 5.

Shell large inflated, transverse, subtrigonal or semicircular; scarcely alate; plications numerous, rounded or subangular, disposed in fasciculi; dorsal valve with the sinus of moderate depth, becoming very broad at the base, and marked by longitudinal plications; beak acute and strongly incurved; area moderately large, sublinear extending to the extremities of the hinge line, and vertically striated; ventral valve with the mesial elevation distinct, marked by longitudinal plications.

The form of this shell varies in some degree in specimens from different localities. It is in general somewhat inflated, and varies from trigonal to semicircular, depending on the prominence of the lower margin of the shell. The umbo is often very gibbous, and the beak abruptly incurved, but in this character there are some variations. The mesial sinus is subangular above, and becomes broader and gently curved towards the base. The longitudinal striæ are

* When these collections were first submitted to me in July, 1855, I suggested the name of *Spirifer pilosus* for this species; and it having once been in print, though not published under this name, I here make the explanation. The publication of Dr. Shumard's name in December, 1855, has consequently precedence over the one proposed by me.

disposed in fascicles, and in some specimens pretty uniformly of three plications in each; others are irregular. The mesial elevation is often marked by two fascicles of three plications each, even when the remaining plications are irregularly disposed.

A comparison of specimens from different localities shows that the one described by me in Captain Stansbury's report under the name of *Sp. triplicatus* is identical with specimens from New Mexico which correspond with the figures given by Dr. Roëmer of *Sp. meusebachanus*. Specimens from a limestone in the coal measures of Greentown, Ohio, are more extended laterally, and more nearly semicircular than the southwestern specimens; and they likewise present some slight differences in the strength and disposition of the plications, but are clearly identical species.

*Locality.*—Occurs abundantly at the Pecos villages near Santa Fé, New Mexico; where it is associated with the preceding and following species.

This species has perhaps a wider geographical distribution than any one of this genus yet known upon the continent. Dr. Roëmer cites the species from the San Saba valley, Texas, twenty miles below the old Spanish forts. It occurs likewise in considerable numbers at Greentown, Ohio, where the writer collected it in 1841. It is known in northern Illinois and as far north as Nebraska, and there can be little doubt but it will be found in limestone of the same age in the region of the Great Salt Lake.

**PRODUCTUS,** *Sowerby.* PRODUCTUS SEMIRETICULATUS.—Plate II, figs. 16, 17.

ANOMITES SEMIRETICULATUS, *Martin,* 1809.

PRODUCTUS SEMIRETICULATUS, P. MARTINI, P. ANTIQUATUS, &c., of authors. For synonomy and references see De Koninck, Monograph of Productus and Chonetes, page 83.

Dorsal valve gibbous, subquadrate, beak recurved, umbo prominent; a sinus more or less deep extends from near the beak, and becomes deeper and more expanded upon the middle of the shell; hinge line equal to the greatest width of the shell; surface marked by longitudinal rounded ribs which are more or less regular (often irrregular) in size, increasing in number chiefly on the sides of the shell; these are crossed on the upper half of the shell by concentric elevated lines which are nearly of the same size as the longitudinal ribs; surface tuberculous at the decussating of the two sets of lines.

The specimens in the collection do not preserve the ventral valve, and they are otherwise imperfect; but their close resemblance to the figures of De Koninck, as well as identity with what are regarded as authentic specimens of this species, leave no hesitation in thus referring them.

The specimens are all strongly marked on the upper half of the shell by decussating lines; and in some the longitudinal ribs exhibit the bases of spines, and in a single specimen the bases of spines are preserved at the junction of the ears with the body of the shell.

This is a very characteristic carboniferous species, being widely distributed both in Europe and America. According to Mr. De Verneuil, this species occurs in the United States at Harrisville, Bagdad, and Cuyahoga, Ohio; near Louisville, Kentucky; near St. Louis, Missouri, and at Fort Leavenworth; in Indiana and Illinois, in Alabama and Tennessee, and at Blossburgh, Pennsylvania.

The three first-named localities are in the Chemung group; and some of the others are in the carboniferous limestones below the coal, while others are in the coal measures, or upper carboniferous limestone, showing a remarkable vertical range. The specimens under consideration are from the coal measures, or upper carboniferous limestone. We know this species also from Fort Laramie, and it has been brought in various collections from the extreme western and southwestern extension of the carboniferous formation in the United States and Mexico.

*Locality.*—From the Pecos villages.

PRODUCTUS ROGERSI.—Plate II, figs. 14, 15.

PRODUCTUS ROGERSI, *Norwood* and *Pratten*, in Journal Acad. Nat. Scien., Philadelphia, Vol. III, 1854, page 9, plate I, fig. 3.

"Shell of medium size, slightly transverse; dorsal valve very high and strongly enrolled on itself; cardinal border equal to about four-fifths of its greatest transverse diameter; beak rather large, and passing beyond the cardinal border; ears but little distinct from the dorsal vault. The anterior part is flattened, and possesses a slight sinus. The surface is covered with ribs, of which twelve may be counted in the space of ten millimetres, at the distance of ten millimetres from the beak. It is also covered in its whole extent with transverse folds. Those nearest the beak are rather small, but after passing the visceral disc they rapidly increase in size to near the middle of the shell, after which they again decrease in size to the margin. The whole anterior portion of the shell seems to have been pretty thickly covered with tubercles, especially between the transverse bands, while a few were distributed over the remainder of the surface."

The dorsal valve is inflated and extremely arcuate; the beak incurved and extending slightly beyond the cardinal line; mesial line flat or subdepressed; surface (in a partially exfoliated condition) marked by interrupted longitudinal ribs and stronger concentric undulations or ridges, which are stronger towards the beak. Where not exfoliated, the longitudinal ribs are interrupted only by the concentric undulations, which, at the crossing, sometimes produce a slight nodulosity. In the exfoliated shell, the longitudinal ribs are often not continuous across the concentric undulations; and they appear as if gradually rising from the surface, and terminating suddenly below, as if forming the base of a spine. In the same specimens there is frequently a row of deep pits between the concentric undulations, with numerous finer punctæ. A single specimen shows the prominent round bases of a few spines upon the front and central parts of the shell. The ventral valve is strongly marked upon its upper part by nearly equal longitudinal and concentric ridges, the latter becoming fainter below the curvature of the shell; surface of the ventral valve nodulose at the crossing of the two sets of ridges.

The figures of Messrs. Norwood and Pratten are not unlike some European figures of *P. pustulosus*, but these gentlemen compare the shell with *P. undatus* as its nearest analogue. Our specimens are unlike DeKoninck's figures of the latter, and more resemble those of the former species.

We have in our collection authentic specimens of this species from Springfield, Illinois, which are clearly identical with the specimens under examination.

*Locality.*—Pecos villages, in the coal measures, or upper carboniferous limestone.

*Imperfect specimens, the specific characters of which are obscure or indeterminable.*

No. 123.—"Polypier du lower carboniferous, Rocky mountains." These specimens contain remains of *Zaphrentis* and *Cyathophyllum*, of carboniferous types.

No. 123½.—"Polypier briozoaire, of the coal measures near to Choctaw agency." This specimen contains remains of *Fenestella*. It appears to be a portion of a transported mass, one of the surfaces being worn smooth.

No. 124. "Delaware Mount, Camp 19." Several specimens from this locality contain a species of *orthis*, but too imperfect to be identified. It is evidently a carboniferous form. A specimen from the same place, No. 59 of catalogue, is a compact, crystalline, buff-colored limestone, containing crinoidal fragments.

No. 125.—"Fossils of the lower carboniferous, Shawneetown." Some specimens marked "Shawneetown" are a fine-grained sandstone, with numerous casts and fragments of crinoids, a species of *Productus*, a *Nucula*, and an impression of *Pleurotomaria sphærulata*.

No. 127.—"Encampment creek, Jurassic inferior." A specimen with this label and marked

also from the "formation of the Llano Estacado," contains casts of small shells, too obscure and imperfect to decide the specific characters, or determine the age of the formation to which they belong. They are imbedded in a compact ferruginous rock.

No. 128. ————————? This specimen has no label; it is a gray or ash-colored carbonate of lime, evidently of organic origin. It consists of innumerable closely arranged fibres or small hexagonal prisms, having a direction transverse to the surface of the slab, and more or less irregularly curved and radiating. The specimen is from one quarter to three quarters of an inch in thickness, and five inches long, somewhat abruptly curved in a transverse direction. The concave side is unequally striated and grooved, evidently from the surface of some body to which it has adhered. The exterior is concentrically undulated, like the surface of a shell, the undulations converging in one direction.

The general structure is similar to that of Chaetetes, and like the coarser fibrous portions of the outer shell of Inoceramus. Professor Tuomey, to whom the specimen has been subsequently shown, pronounces it to be the shell of a large species of Inoceramus, having found similar specimens in Alabama with the hinge attached. The specimen under consideration has all the characters of having these relations; but it is not so easy to account for the occurrence of similar fibrous laminæ of many inches square, having but little thickness, and extending for many inches, and covered with valves of the *Ostrea congesta*.

No. 126.—"Three miles north of Galisteo." The smaller specimens with this label are similar to the preceding, consisting of thinner laminæ, with broad undulations upon the exterior surface, and coarse striæ, or what appear to be impressions of imbricating lamellæ upon the under or concave surface. The fibrous material exhibits lines of successive growth, and is sometimes separable into thinner laminæ. These specimens do not exceed a quarter of an inch in thickness.

No. 126.—"Three miles north of Galisteo." These specimens contain numerous fragments of shells and impressions of the surface of Ammonites, and Inoceramus, but all of them too imperfect to be specifically recognized. Notwithstanding the fine specimens of the fibrous outer shell of Inoceramus described above, no specimens of entire individuals have yet been brought in among these collections.*

Nos. 122 and 129.—"Carboniferous fossils west of San Francisco mountain." These specimens include fragments of two species of Productus of large size. One of these is probably allied to or identical with *Productus semireticulatus*, having the same kind of superficial marking in its longitudinal striæ, crossed by concentric lines near the beak, and not on the body of the shell. Two other specimens, in addition to these characters, have also the broad mesial sinus of that species. Among the specimens from this locality are two of hornstone, containing fragments of coral too obscure to be determined.

With the Productus and Spirifer of the carboniferous formation, we find also several fragments of crinoidal columns belonging to two different species, but too imperfect to be identified; also some fragments of Cyathophyllum in the same condition. They are all from the carboniferous limestone at the Pecos villages.

No. 130.—"Orthoceras près d'Agua Fria, Sierra Madre." This is a portion of the outer chamber of an Orthoceras, too obscure for determination. It is in a greenish argillaceous limestone.

* In the specimens from the Missouri, above the mouth of l'Eau qui Court, already referred to, the *Ostrea congesta* is attached to fibrous laminæ, precisely similar to those described above, except that they are rarely more than a quarter of an inch, and often not more than an eighth of an inch in thickness. These laminæ appear to have been flexible, as they are often bent and folded among the shells; and they exhibit abrupt inequalities, filling the irregular spaces between the shells, and radiating in somewhat hemispheric elevations upon the surface. These laminæ extend in broken pieces often for many yards, and are attached and cemented together by calcareous matter, and covered with almost continuous layers of the Ostrea. Mr. Meek informs me that he has seen similar fragments or laminæ scattered at intervals through the beds of clay succeeding that containing the Ostrea, but without any shells attached. What appears most remarkable in this instance is that no species of Inoceramus is known in the bed which contains the *Ostrea congesta*, at least in the locality where this shell is so abundant, and where the fibrous laminæ occupy so conspicuous a place.

# CHAPTER X.

## DESCRIPTION OF THE COLLECTION.

GRANITIC AND METAMORPHIC ROCKS.—VOLCANIC ROCKS.—TRAP FROM DYKES NEAR GALISTEO.—LAVA FROM SAN FRANCISCO MOUNTAIN.—STRATIFIED ROCKS AND GYPSUM.—LIMESTONE OF DELAWARE MOUNTAIN.—MAGNESIAN LIMESTONE OF THE LLANO ESTACADO.—GYPSUM AND SELENITE.—SANDSTONE FROM THE CAJON PASS.—MISCELLANEOUS SPECIMENS.—ORES AND MINERALS.—COPPER ORE.—GOLD.—IRON ORE.—HEMATITE.—ABSENCE OF MAGNETITE.—COAL.—SIGILLARIA.—LEPIDODENDRON.

### GRANITIC AND METAMORPHIC.

[No. 1 to No. 38.]

Nos. 1 and 2. *Cañon de Tejeras, near Albuquerque.*—These two specimens, as the labels indicate, appear to be from the same locality. They are also alike in their mineral character. The granite may be said to be coarse-grained, and contains a large amount of black or dark green mica, in masses from one-sixteenth to one-quarter of an inch in diameter. I have not detected any hornblende in the specimens.

No. 3. *Pueblo creek.*—This specimen is a compact, fine-grained granite, of a delicate lilac color, modified by the grains of dark-colored mica. It is slightly porphyritic, containing several small isolated crystals of feldspar. The pink or lilac color appears to be due partly to the quartz, which is purplish or amethystine. This rock will furnish excellent building material.

No. 4. *Between Pueblo creek and Turkey creek.*—This specimen is a large mass of amorphous quartz, stained with oxide of iron, and bounded on two sides by implanted crystals of a beautiful white silvery mica. The specimen appears to be a part of a vein which probably traversed a granitic rock. A small cavity in one end of the quartz is cellular, and appears to have been filled with iron pyrites, which has probably produced the stains on the surface of its decomposition. I am informed by Mr. Campbell, who collected this specimen, that it occurs in a granite rock which underlies a thick mass of red sandstone and beds of limestone. These strata are nearly one thousand feet thick, and rest horizontally on the granite. They form the margin of an extensive *mesa* formation, stretching far northward towards the great cañon of the Colorado river. He also states that quartz veins or "ledges" are common in that region, and that the country presents many indications of the presence of gold. The specimen in hand is too compact and hard to be regarded as auriferous, but yet may be a portion of a gold-bearing vein, and the former presence of pyrites is a good indication. The mica crystals in this specimen are interesting for their well-marked crystallization. They have the usual form of Muscovite micas, the regular rhombic prism.

No. 5. *Pueblo creek.*—This specimen, although apparently from the same region as No. 4, and containing a similar silvery mica, differs from it in containing a large portion of feldspar, which, with the quartz, renders it a coarse-grained granite, and it is so labelled by Mr. Marcou. The mica is found at one side of the specimen only, and thus indicates that it formed part of the wall of a vein.

No. 6. *Sierra Madre, Agua Fria.*—This specimen may be considered to be a very coarse-grained granite. It consists chiefly of feldspar, of which mineral there are two varieties; one white, and cleaving with broad, flat faces, and the other flesh-red, and in smaller and less regular masses. Quartz, in coarse grains—some as large as the end of one's thumb—is found with this feldspar. A white silvery mica is also present in small quantity, but is not in defined crys-

tals ; it is interleaved in fragmentary films between the masses of feldspar. No dark mica or any hornblende is visible in the specimen.

No. 7. *Cañon San Antonio.*—In composition this specimen simulates No. 6, but differs from it in its texture, and in the color of the mica, which in this is dark and in larger quantity. It contains both white and flesh-red feldspar in nearly equal quantities, but quartz is almost entirely absent. The minerals are all intimately mingled, and in consequence the mass presents a very even grain. The white feldspar is principally in imperfectly-formed crystals, giving a porphyritic character and appearance to the rock. The predominant color of this rock is pink from the feldspar, and it is well suited to building purposes.

No. 8. *Cañon of San Antonio.*—This rock is similar to No. 7, and appears to have been taken from the same outcrop. It, however, contains a large crystal of white feldspar, and has a distinctly defined linear arrangement of the minerals approaching that of gneiss.

No. 9. *Aquarius mountains, camp before Cactus Pass.*—This is a rose-colored granite, compact and even in its texture, with a good grain, and suitable for building purposes. The feldspar is red or reddish, especially the outer parts of the crystals. The mica is dark-colored, and is not in distinct crystals, but is evenly distributed through the mass.

No. 10. *From the same locality as No.* 9 ; appears similar, but is somewhat lighter in color, and the weathered surface shows the presence of two varieties of feldspar.

No. 11. *Summit of Cactus Pass, Aquarius mountains.*—This specimen consists of coarse crystalline masses of a brilliant red feldspar, and white, translucent quartz. A little dark mica is also seen.

No. 12. *Cactus Pass, Aquarius mountains.*—This specimen corresponds with what is usually called gneiss. It consists of mica and small white feldspathic grains, ranged in parallel layers. The mass has the appearance of a metamorphic rock.

No. 13. *Aquarius mountains.*—A fragment of granite traversed by veins of compact epidote.

No. 14. *Cerbat mountains, Bill Williams' fork.*—This is a beautiful flesh-colored granite. The mica is distributed in detached crystalline grains, and being very dark and compact, resembles hornblende, and gives the rock a strong resemblance to sienite. The quartz of the specimen is amethystine and rose-colored, and the feldspar is reddish, translucent, and in crystalline grains, presenting a porphyritic character.

No. 15. *Bill Williams' fork.*—A coarse-grained sienitic granite. The feldspar is in large reddish imperfectly-formed crystals, and the hornblende is dark-colored but not abundant.

No. 16. *Mouth of Big Sandy creek, (Bill Williams' fork of the Colorado.)*—This specimen is a coarse-grained porphyritic granite, with large imperfect crystals of a rose-colored feldspar. It contains also a lighter-colored variety, in small quantity, and a dark-colored mica.

No. 17. *Cerbat mountains, on Bill Williams' fork.*—This is a dark, reddish-brown rock, in which the mineral characters are not well defined. It is micaceous and contains white grains, which are probably feldspar. This mineral, with the mica, is evidently arranged in parallel layers, and the rock is gneissose, and probably metamorphic.

No. 18. *Near the mouth of the Bill Williams' fork of the Colorado.*—A compact dark-red granite, highly ferruginous, and not presenting an even, clear grain. It has the appearance of a weathered specimen stained by iron. (No. 35 is a similar rock from the same locality.)

No. 19. *Bill Williams' fork of the Colorado.*—A dark-green metamorphic rock, with a quartz vein running parallel with the structural lines of the rock. Grains and threads of similar white opaque quartz are also seen running in parallel lines through other parts of the mass. The green color appears to be due to chlorite, or green mica. The mass emits a strong argillaceous odor when it is moistened by the breath.

No. 20. *Bill Williams' fork, near its mouth.*—This specimen bears a general resemblance to No. 19, but the minerals in this are more distinct, while in the other they are not separately defined. The structural character of this rock is at once apparent, and the mass cleaves more

readily in one direction than in another. It is composed of a succession of layers of hornblende and mica with white quartz and feldspar.

Nos. 21 and 22. *Bill Williams' fork.*—This specimen is peculiar in its appearance, and consists chiefly of irregular masses and fragments of white granular quartz, imbedded in a greenish paste or matrix. One of the specimens contains small, partly decomposed cubes of iron pyrites.

No. 23. *Camp near Picacho.*—A rose-colored granite, containing grains of feldspar of two colors. The mica is light-colored and silvery, and in distinct plates. The texture of the specimen is not even.

No. 24. *Between the Colorado and the Mojave rivers.*—A hard, compact, even-grained, and dark-colored granite. In this rock the feldspar has a slightly reddish color, and is well crystallized; it is very evenly distributed among the other minerals, which are present in nearly equal quantities. The mica is dark, and in distinct crystalline grains. This rock, if abundant, would make beautiful building-stone.

No. 25. *Rio Colorado, below the Mojave villages.*—This specimen is a well-characterized sienite, consisting of feldspar and hornblende—the former in very irregular, amorphous, or granular masses; and the latter well crystallized, and showing the characteristic cleavage of the species on all parts of the specimen. It has a green color, which is also the predominating color of the specimen, it being modified by the grains of white feldspar only. No quartz or mica can be seen in this rock. It is probably erupted, and not metamorphic.

No. 26. *Colorado river, below the Mojave villages.*—This specimen consists of white quartz and feldspar in alternate layers, interleaved with films of mica, thus showing a structural character, and indicating a sedimentary origin, and that it is metamorphic.

No. 27. *Cajon creek.*—A beautiful white, crystalline limestone. This rock is perfectly white, and has a beautiful crystalline grain, which renders the fractured surfaces very brilliant. It is a beautiful marble, and is well suited for buildings. The specimen being labelled Cajon creek, leads me to conclude that it was broken from a rolled or transported fragment, especially as I myself saw blocks of this limestone in the bed of that creek, but was not able to find the source or outcrop from which they were broken. It probably exists in the high ridges on the east of the valley of the pass.

No. 30. *Camp* 52.—This specimen is labelled "*Sulfate de Baryte*," but probably by mistake, since it consists of white feldspar, with its characteristic cleavage. It contains several small masses of translucent quartz, and is from a coarse granite or a granite vein.

No. 31. *Between Tuerto and Galisteo.*—Mr. Marcou has labelled this specimen "Hornblende rock," which it may very properly be called, consisting, as it does, chiefly of black hornblende in small crystals, intermingled with white granules of feldspar and quartz, giving the whole mass a dark grey color. The hornblende appears to be disposed in parallel planes, and a structure is thus given to the rock, and it might be called a hornblende slate.

No. 36. *Near to Picacho.*—This specimen is a reddish and granular granite, of very fine grain, so that it at first resembles sandstone. The feldspar is red, and one or two small, well-formed crystals, of a more glassy and colorless variety, are seen in the specimen. The mica is in small, brilliant scales, and is abundantly disseminated.

No. 37. *Pueblo creek.*—This specimen is an amorphous, compact mass of reddish rock, probably feldspathic. It is marked metamorphic by Mr. Marcou, but it is impossible to determine to what formation it belonged, nor are its characters sufficiently well marked to determine its mineral character without analysis.

## VOLCANIC ROCKS.

[No. 38 to No 59.]

No. 38. *Trap forming a dyke in the White Chalk, Rio Galisteo, New Mexico.*—This specimen presents weathered surfaces on all sides but one, and appears to have been broken from a loose

mass or boulder. It is a compact, dark-colored trap, resembling the ordinary trap-rock of the Palisades along the Hudson river and East and West Rocks, near New Haven.

No. 39. *From between Tuerto and Galisteo.*—According to Mr. Marcou, this rock forms a dyke. Its eruptive character is also clearly indicated by the specimen, it having the peculiar crystalline grain and compact character common to recent intruded rocks. The mass has a pleasing grey color, produced by the intermingling of white semi-crystalline granules of feldspar with brilliant needle-shaped crystals of black hornblende. The rock may with propriety be called *diorite*, this name having been proposed for volcanic rocks in which hornblende is abundant, and mingled with feldspar.

No. 40. *Village of Sineguilla, near Santa Fé.*—This specimen, like the preceding, is characterized by the presence of distinct crystals of black hornblende; but it differs from the first in the nature of the base through which the hornblende is distributed. In this specimen it is compact and nearly homogeneous, being without the granular or crystalline character of No. 39. The color of the base is a bluish-grey, and the disseminated crystals of hornblende give the specimen the appearance and character of a porphyry. There is a general parallelism between the hornblende crystals of the rock.

No. 41. *Cañon de Tejeras, near Albuquerque.*—This specimen much resembles a fragment of metamorphored slate, having a distinct lamellar structure, and cleaving more readily in one direction than in others. It consists of alternate layers of compact, dark-green argillaceous rock, with thin films of carbonate of lime. It is labelled *Trap serpentineuse* by Mr. Marcou; but, although of a green color, does not closely resemble serpentine. The rock at a short distance resembles ordinary trap or greenstone.

No. 42. *Volcano of Cerrito, near Santa Fé, in a dyke.*—This specimen is compact, and represents a uniform grey color, but is without any black hornblende crystals or other dark mineral. It has the appearance of a specimen that has been long exposed to the action of the atmosphere; and, although there are surfaces of fresh fracture, they are dotted here and there by brown stains, which, on examination, are found to be produced by the decomposition of a ferruginous mineral, the powder of which is strongly attracted and lifted by a magnet. The mass is also full of small irregular cavities, some of which appear to have once been occupied by a mineral which has dissolved away. Crystals of white glassy feldspar are disseminated, and the rock may be called a *feldspar porphyry*.

No. 43. *Volcano of Cineguilla, near Santa Fé.*—This is compact and fine-grained, but not very hard rock, of a faint lilac color, consisting of numerous disseminated imperfectly-formed crystals of white feldspar and distinct and well-formed crystals of hornblende.

No. 44. *Cañon of Sineguilla, near Santa Fé.*—This specimen has the appearance and character of a recent lava. It is hard, and like some trappean rocks in color; breaks with curved surfaces and sharp edges; is amygdaloidal, having numerous air-cells; somewhat elongated, or almond-shaped. These are hollow, and many are lined with a thin white crust of a zeolitic mineral, its surface being drusy with brilliant but microscopic crystals, so that the species cannot be determined. Other cavities are lined with a greenish-yellow crust, enveloping a siliceous nucleus.

No. 45. *From near the Pueblo de Zuñi.*—This specimen is ticketed by Mr. Marcou as basaltic lava, from the end of the lava stream near the Pueblo of Zuñi. It resembles the preceding specimen in its color and general characters, but is not so compact, being filled with small, irregular cavities, which render it more porous. It also contains large air-cells, or amygdaloidal cavities, but which are not lined with minerals. The mass is filled with small vitreous grains of a smoky tint, which are nearly or quite as hard as quartz. They may, however, be crumbled to a white powder under strong pressure by a hard steel-point; and in this respect, and in a peculiar metallic lustre which they present in certain positions, they differ from that mineral, and leave me in doubt as to their true nature. They may be olivine; but the grains being so so small and obscure, it is impossible to examine them with satisfaction.

No. 46. *Leroux's spring.*—This is a porphyitic lava, crystals of glassy feldspar being disseminated in a compact dark base. Distinct crystals of black hornblende are abundant. The specimen is very small, and much weathered.

No. 47. *From a lava stream near Leroux's spring.*—According to Mr. Marcou this specimen is from a stream of basaltic lava from San Francisco mountain. It very much resembles No. 45, having a similar color, composition, and aggregation. In this specimen the vitreous grains are more distinct, larger, and better characterized. The color is olive-green; they are easily pulverized, and are infusible before the blow-pipe. They are distinct from quartz, and are probably olivine.

The weathered surface of this rock has a rusty brown color, but the discoloration is only on the surface, or below it for an eighth of an inch; the rock is slightly bleached.

No. 48. *Volcano of San Francisco mountain.*—This is a light amygdaloidal lava, full of elongated air-cells, from the size of a pin's head and smaller to half an inch in length. These cells are very smooth on the interior, and are of a lighter color than the surrounding portions. The cells are all elongated and flattened in one direction, showing the mass to have been in a state of tension when in a fluid or pasty condition. The outside or weathered surface has a reddish color. The color of the rock is an ash-grey with a faint shade of green.

No. 49. *San Francisco mountain.*—This is a fine specimen of volcanic scoria, or porous slag. It is an irregular porous mass, very light, and apparently formed by the dripping of the froth and scum from the surface of fluid lava. The outer surface is smooth, and presents several shades of color—black, purple, drab, and grey. It resembles scoriaceous specimens from the crater of Kilauea and other volcanoes.

No. 50. *Aquarius mountains.*—This is a beautiful porphyry. The feldspar is in distinct, well-formed glassy crystals, from one-eighth to three-eighths of an inch long. The base is compact, and of a light purple or rose-color.

No. 51. *From the base of San Francisco mountain, near the Colorado Chiquito.*—This specimen is a beautiful amygdaloidal lava, with the cavities very similar in their size and form. They are lined with a white zeolitic crust, without crystals, and in such small quantity that the species cannot be readily determined. The base of the rock is dark, compact, and hard, and presents a pleasing contrast with the white cells. I find in this rock olive-green grains similar to those which were found in Nos. 45 and 47; and, in addition, some which are red, and more nearly resemble garnet than olivine. On trial before the blow-pipe, however, they are found to be infusible; and, as the other characters are exactly those of the green variety, I am led to regard them as identical.

No. 52. *Near the Picacho.*—This specimen appears to have been a loose boulder, as rounded and water-worn surfaces are found on the specimen. It is an exceedingly hard and compact black rock, breaking with a conchoidal fracture, very brittle, and without any trace of crystallization. The weathered surface is deeply wrinkled, and marked with little pits, looking as if it had been soft and undergone slight contraction when cooling. In this peculiarity it resembles many of the similar black basaltic pebbles found by me along the Colorado and Gila rivers, and on the desert, near Carrizo creek, California.

No. 53. *Camp near Picacho.*—This rock is similar to No. 52, and differs only in being more compact and vitreous, being not unlike obsidian. Mr. Marcou has ticketed this "*Basalte obsidienne.*" It contains one or two isolated, transparent, and colorless vitreous grains, which resemble quartz, but are softer and more easily crumbled. This specimen, like the preceding, appears to have been taken from a transported mass.

No. 54. *Third chain beyond the Colorado.*—This is a small specimen, and much altered by weathering. It consists of a light-colored feldspathic base, porphyritic, and containing isolated grains of quartz. It may be called a quartz porphyry.

No. 55. *Mojave river.*—This is a beautiful green-stone porphyry, the base being a compact, dark green trappean rock, bearing isolated crystals of a white or light yellow mineral, having

the hardness of feldspar, but without distinct cleavage. They do not exceed one-eighth of an inch in length, and are sparsely distributed.

No. 56. *Mojave river.*—A compact brownish-red rock, filled with small and thin crystals of glassy feldspar, forming a porphyry. This character is not, however, evident, without close inspection and the aid of a glass. Small grains of quartz are also distributed, and several minute crystals of brown mica were observed. The feldspar crystals appear to be distributed in parallel planes throughout the rock.

No. 57. *Mesa, near Gila river.*—A fragment of volcanic scoria or cinder, full of large cavities, and very porous. It is black, and one of the surfaces has a green glaze, and is quite smooth. The curves and folds which it presents show its former plastic condition. This specimen was probably taken from a transported mass, and was obtained by Lieutenant A. W. Whipple when on the boundary survey, and given to Mr. Marcou.

No. 58. *Rough and Ready.*—This is a compact, hard trap or greenstone, apparently magnesian, and breaking with a brilliant crystalline surface, showing cleavages of imperfect feldspar crystals. This is from the auriferous region of Grass valley—Rough and Ready being a mining locality near that town.

## STRATIFIED ROCKS AND GYPSUM.

[No. 59 to No. 88.]

No. 59. *Delaware mountain.*—This is a light-drab or yellowish limestone, charged with small cylindrical stems of encrinites, which are seen most distinctly on the weathered surfaces. These fossils are crystalline, while the surrounding rock is amorphous. Mr. Marcou considers this rock as belonging to the mountain or lower carboniferous limestone.

No. 60. *From the foot of the Llano Estacado.*—This limestone specimen has a curious appearance, being full of small cavities, and resembling a mass of slag from a furnace. The interior surface of the cavities is very irregular, and is as smooth as if glazed by heat. It is, however, completely infusible, and its peculiar vesicular condition must be due to aqueous action. Its color is a peculiar drab or ash-grey, not easily described. There are no traces of fossils or of stratification.

No. 61. *San Antonio.*—This is the largest and heaviest specimen of limestone in the collection. It has a dark bluish-grey color; is hard and compact, with a fine, even grain. It is very tough, and if it can be obtained in large blocks, will be valuable for building purposes. There are no traces of fossils in the specimen, which appears to have been part of a stratum an inch and a half thick. This rock when heated emits a slight bituminous odor, but it is not perceptible when the mass is struck by the hammer. If a solution of this rock be freed from lime, and then treated with phosphate of soda, a very abundant precipitate of magnesia is at once obtained. It may be regarded as highly magnesian.

No. 62. *Colorado Chiquito.*—This specimen greatly resembles that last described, and has a similar grain and color. It has apparently been more exposed to the weather, and has a lighter color. The mass breaks with curved surfaces.

No. 63. *Shady creek, Camp No.* 42.—This specimen is a light-drab colored limestone, saccharoidal, fine-grained, and compact. It is a hard, firm rock, and is suitable for building. One of the weathered surfaces shows indications of fossils, but they are not sufficiently distinct to be recognised.

No. 64. *Camp No.* 30, *near the mounds.*—This is a red, porous limestone. Its red color is distinct, and like that given by per-oxide of iron. The mass is so porous and full of small cavities, that it resembles a sponge, and on one of the surfaces, which is weather-worn, the little cavities are well exposed, and are so regular and even in their size, and so closely arranged, that it gives the specimen an organized appearance, and suggests a coralline origin.

No. 65. *Camp No.* 46, *at the foot of the Llano Estacado.*—Mr. Marcou has labelled this speci-

men "Sandstone of the upper Trias." It is a grey, friable, calcareous sandstone, crumbling away under the fingers. It effervesces violently with chlorohydric acid, and in addition to the siliceous grains, has a considerable amount of white mica disseminated in planes parallel to the stratification. It much resembles recent or Tertiary sandstone. The broad and tabular surface of the specimen is marked with parts of hieroglyphic characters cut by the Indians.

No. 66. *Shady river, Camp No.* 42.—Variegated marl, red and clay colored. It emits a strong argillaceous odor when breathed upon, and effervesces with acids. This is from the *Trias*, according to Mr. Marcou.

No. 67. *Between Delaware mountain and Beavertown.*—This specimen is labelled by Mr. Marcou "Red and white clays of the Trias." The mass was evidently soft and plastic when collected, and in its color resembles No. 66, just described. It is very fine, and consists chiefly of clay and carbonate of lime. It effervesces freely with acids.

No. 68. *Antelope Hills, Camp No.* 36.—This is a white sandstone, with a dark-grey weathered surface. The specimen presents a remarkable resemblance to several of the sandstone specimens collected by Captain Pope near the 32d parallel. The grains are siliceous, white and yellow, and are cemented by a large quantity of amorphous white carbonate of lime; in fact the grains seem rather to be imbedded in a paste of carbonate of lime. It most resembles No. 29 of Captain Pope's collection, found on the surface of the Llano, forty miles east of the Rio Pecos. The evidences presented by the fossils collected by Captain Pope led to the conclusion that the sandstone of the Llano was Cretaceous, and I am inclined to refer this specimen to that age. Mr. Marcou considers it as from the upper Trias.

No. 69. *Between Camps No.* 31 *and No.* 32.—This specimen consists almost wholly of per-oxide of iron, or Limonite, and is apparently the result of infiltration of a solution of iron among the strata of the formation in which it occurs. Its stratified character is evident on inspection, and it appears to have resulted from the decomposition of a layer of small bivalve shells, casts of which are visible, but they are so obscure that the species cannot be recognised.

No. 70. *From the foot of the Llano Estacado, probably at Gypsum creek.*—This specimen is one of a series of beautiful masses of red and white gypsum. This is a dark-red mass, a part of it amorphous or granular, and somewhat porous, and the remainder crystalline, cleaving with irregular radial surfaces. Its dark-red color—like that of well-burned bricks—appears to be due to the presence of a large quantity of per-oxide of iron, which is so abundant and uncombined on one side of the specimen that it rubs off upon the fingers and label, giving the characteristic color of rouge, or red ochre. Mr. Marcou considers this specimen to be from the middle division of the Trias. (*Trias moyen.*)

No. 71. *Gypsum creek.*—Red crystalline gypsum. A fine large specimen, with the crystalline plates arranged in radial or plumose groups slightly curved, and each plate being only about one-eighth or three-sixteenths of an inch broad, and from one to three inches long. Their brilliant surfaces inclined in different directions, together with the peculiar deep-red color, render the specimen very interesting. Small plates of clear crystalline gypsum (selenite) are seen in several places imbedded in and among the red plates. The red portions do not cleave as readily as clear, colorless selenite, and are more brittle. A thin plate held to the light is translucent, and transparent in places, and the coloring matter, which is per-oxide of iron, does not appear to be evenly distributed. It is a mechanical mixture, and has probably influenced the crystallization.

No. 72. ——————?.—A mass of red and white gypsum in small irregular crystalline plates, about one-quarter to one-half of an inch broad, confusedly mingled together. The predominant color of the mass is red, and it probably came from the same locality as the preceding, or near it, but there is no label attached to the specimen.

No. 73. *Canadian river.*—A fragment of colorless crystalline gypsum, selenite, perfectly transparent and very beautiful. At one end there is a slight depression, partly filled with very perfect and clear rhombohedrons of dolomite, (carbonate of lime and magnesia.) These crys-

tals have curved surfaces, and some of them are pearly, and resemble the pearl spar found with the gypsum of Lockport, New York.

No. 74. *Comet creek.*—A fine specimen of white, amorphous gypsum, very compact and solid. The mass appears to have formed part of a layer one and a half inches thick, as it has a stratified character, and has two broad, flat surfaces parallel with the layers, and stained as if they had been in contact with grey or blue marl, or clay. Mr. Marcou marks this specimen as from the Middle Trias, ("*Trias moyen.*")

No. 75. *Comete creek.*—White saccharoidal gypsum, amorphous. It is slightly stained with red. From the "*Trias moyen,*" according to Mr. Marcou.

No. 76. *Prairie near Gypsum creek.*—White fibrous or plumose gypsum. This is apparently part of a layer about two inches thick, and it has in the middle a divisional seam from which part of the fibres radiate, and which contains a thin layer of greenish shale.

No. 77. *Gypsum creek.*—Opaque, amorphous gypsum, with a grey or reddish white color and fine grain. One side of the specimen is composed of greenish grey shale or clay, which is traversed by irregular seams or veins of gypsum, that are connected with the principal mass. It appears to have been imbedded in the blue clay, both faces of the specimen being covered with it.

No. 78. ————— ?—This specimen is without a label. It consists of compact amorphous gypsum of a flesh-red color, and containing patches of blue shale, as in the preceding. It is probably from the same locality.

No. 79. *Grande prairie, Camp No.* 30.—A white amorphous gypsum, stained with red veins. The mass is slightly porous or cellular, and somewhat resembles No. 75.

No. 80. *Camp* 30.—This is similar to No. 79, and is probably from the same bed.

No. 81. *Camp* 30.—A plate of selenite, surrounded by amorphous gypsum veined with red. It is probably from the same bed as the preceding.

No. 82. *San Antonio.*—A white granular gypsum, with a pleasing crystalline grain resembling some fine-grained marbles. It is white, solid, and compact. This is from the "Trias," according to Mr. Marcou.

No. 83. *Cajon Pass,* (from the Great Basin to San Bernardino.)—White or reddish white sandstone, composed chiefly of feldspar and quartz, with some mica. It has resulted from the abrasion of granite and the allied rocks. Its red color is due to the presence of a large amount of pink feldspar. The specimen is interesting, as almost the only one in Mr. Marcou's collection, which he has labelled as from the Tertiary or Quaternary formations. It is also interesting from the fact that the cementing material—carbonate of lime—is beautifully crystallized, so that the whole surface of the specimen is covered with brilliant reflecting surfaces, seen only when it is held in certain positions. Viewed in some directions the crystalline character of the specimen is invisible, or would not be suspected. This crystallization of the mass enveloping the grains of sand is like that of the Fontainebleau sandstone.

No. 84. *Camp before Cactus Pass.*—Mr. Marcou considers this specimen as *Quaternary*, and observes, on the label, that it was covered with the lava of a volcano. It is a conglomerate of rolled masses of pumice-stone and small pebbles and sand, the cementing material being apparently fine volcanic ash, or the fine dust from the abrasion of the pumice. I have found similar agglomerations under the basaltic lava near Fort Miller, on the San Joaquin, and in the Tertiary or Quaternary deposites of Ocoya creek, California.

No. 85. "*Little stones, of which the ants build their mounds, west of the Sierra Madre.*"—These little grains or pebbles are very uniform in size, and are, nearly all of them, over one-eighth of an inch in diameter. Transparent grains of quartz are very numerous, some of them retaining a part of the planes of crystallization. The remainder of the grains consist chiefly of carnelian, chalcedony, and hard volcanic rocks. Fragments of granite are also numerous. These grains are entirely free from sand or dust, and are remarkable for their uniform size and beauty.

No. 86. *Between Zuñi and the Colorado Chiquito.*—Several beautiful pebbles of agate and jasper, of different colors, accompanied by specimens of silicified wood. One of the pebbles has a deep red color, and is traversed by seams and veins of white quartz. Many of these intersect each other in different directions, and produce small faults, one part of the mass being slipped by the other. This pebble is susceptible of taking a high polish, and plates cut from it by the lapidary show the veins beautifully.

No. 87. *Pinal Lleno, Gila river*, 1851.—This is a small stalactite, obtained on the Gila river by Lieutenant Whipple, in 1851.

Five or six specimens of sandstone, gypsum, and limestone are without labels, and I have not entered or described them. They do not present anything of interest, and one or two appear to be fragmentary duplicates.

## ORES AND MINERALS.

No. 88. *Third cañon when descending Bill Williams' fork.*—There are several specimens under this number, consisting of rolled or water-worn masses of an epidotic rock, traversed by veins of specular iron-ore or *Hematite.* These veins vary in width from one-quarter to three-quarters of an inch, and one of the masses, an inch and a half long, consists entirely of the ore, and has been worn until as round as a pebble. The ore is the micaceous variety, and a fractured surface presents a brilliant appearance. The scales are radial and plumose, and grouped in rosettes. The characteristic red streak and powder is obtained when the mineral is scratched or powdered. This ore is composed of iron and oxygen, containing, in 100 parts, iron 70, oxygen 30. It is a sesqui-oxide, and crystallizes in rhombohedrons. It is known under a variety of names—as hematite, specular iron, iron glance, per-oxide of iron, oligiste iron, &c. It occurs chiefly in the granitic or crystalline rocks. The finest crystallizations are brought from the island of Elba. The Iron mountain and Pilot Knob, of Missouri, are formed of the same ore. The specimens in the collection being transported fragments, the exact locality of the parent mass or vein is not known, but it is probably not far from the point where the specimens were picked up.

No. 89. *Near Picacho mountain.*—This is a small crystalline nodule of the same ore as last described, (No. 88,) but this exhibits the planes of the rhombohedron without any modification. It is formed of a multitude of crystals, and their points extend outward on all sides. Its composition is the same as No. 88—iron 70, oxygen 30.

No. 90. *Pueblo creek.*—Grains of massive specular iron disseminated in granite. The ore, however, forms a very considerable part of the mass, and is very friable. It much resembles magnetic iron ore, but gives the hematitic streak.

No. 91. *Cerbat mountains, Bill Williams' fork.*—This is a beautiful specimen of fibrous hematite, with long silky fibres extending from several points or centres. The mass is about three inches long and one broad, and is pure and free from gangue. The burnishers called bloodstones, used by jewellers and workers in gold and silver, are made of this variety of hematite, and the specimen in the collection would be suitable for those uses.

No. 92. *Copper ore—New Placer mount, near San Pedro, New Mexico.*—There are several specimens of copper ore under this number. The gangue appears to be chiefly massive garnet, becoming crystalline on the walls of cavities. These crystals are small, but very perfect and brilliant. They are rhombic dodecahedrons, with all the edges truncated. Green carbonate of copper coats these crystals, and is disseminated through the mass of the specimen. Blue carbonate is also present in some of the fissures, and thin crusts of the silicate are also found.

No. 93. *New Placer, San Pedro, New Mexico.*—These specimens are fragments of a quartz vein, and are cellular, porous, and contain cavities lined with crystals. No pyrites or gold can be detected by the eye or magnifying glass, but a considerable amount of hydrous peroxide of iron (brown hematite) is present. This is probably derived from the gradual decomposition of pyrites, which was very probably auriferous. Mr. Marcou has ticketed the specimen as from

an auriferous vein, but I have not made any examination of the specimen for gold by crushing and washing or by chemical tests.

No. 94. *Canada Hill, near Nevada City.*—A fragment of ferruginous quartz, stained by the decomposition of pyrites, and containing minute grains of gold. The auriferous quartz of Canada hill is well known in Nevada as a rich source of gold. There are numerous other quartz veins, or "leads," in that vicinity, but they are not represented in the collection; this specimen being the only one of auriferous quartz that I find from California.

No. 95. *Pueblo creek.*—This, according to the label of Mr. Marcou, is "*fer argentifere? en filon*" (vein of argentiferous iron.) It is a small mass of quartz, evidently a part of a vein which appears to have had the character of a true fissure vein, the quartz having the comb-like structure so well known in the mining regions of Cornwall. The metalliferous portion is implanted among the ends of the compressed quartz crystals, in a layer transverse to them, and a second parallel layer is seen, about one quarter of an inch distant, in the body of the quartz, but which was at one time on the inner wall or face of the fissure. It thus appears that there have been two successive depositions of the ore, a layer of quartz having taken place in the interval. That the inner layer of ore now imbedded in the quartz was once upon its surface is shown conclusively by the fact that it presents a zigzag line, the angles exactly conforming to the angles and terminations of quartz crystals.

A freshly-fractured surface of the small layer of ore presents a mass of rosettes of beautiful red color, formed by an aggregation of small plates. They are soft, and easily crushed by the point of a knife to a red powder resembling that of hematite. It does not give off fumes before the blow-pipe, and is infusible. A solution in nitric acid does not give any reaction for silver with hydrochloric acid. The fragment heated by the blow-pipe becomes magnetic, and a reaction for iron is obtained from the nitric acid solution. The mineral is probably hematite.

No. 96. *From two miles north of Cactus Pass, Aquarius mountains.*—This specimen consists of quartz, with some feldspar, bearing thin seams and irregular veins of a dark mineral, with a metallic lustre. This, on being scratched, gives a dark blood-red streak, like hematite. It is infusible before the blow-pipe in the outer flame, but in the inner it fuses to a black magnetic globule. It is, therefore, in all probability, hematite, and similar in composition to the specimens previously described.

These specimens of peroxide of iron present very different appearances, and, to an ordinary observer, would seem to be entirely different in their chemical characters. Hematite is a common product of volcanic action, and is found abundantly in the lavas of Vesuvius. It is interesting to note the number of the specimens from different localities, brought in by Mr. Marcou, while the magnetic iron ore, which in the Appalachian chain is the most common and abundant crystalline ore, is not represented in the collection.

No. 97. ——— ———. No label. This specimen probably belongs with some of those already described, but has either been displaced, or has not had a label. It is, however, of little consequence, the specimen being chiefly quartz, with some intermingled oxide of iron, and on one side a stain of carbonate of copper. It somewhat resembles the specimens from New Placer, (No. 93.)

### COAL AND FOSSIL VEGETATION.

No. 98. *Bituminous coal, Ojo del Pescado Zuñi.*—Very considerable interest attaches to this specimen, from the fact of its being the only organized representative, with a label, of the formation called Jurassic by Mr. Marcou. He has labelled it as Jurassic—upon what grounds I do not know; for the specimen does not appear to me to present any very decisive evidence of its geological age. It much resembles the Tertiary brown-coals or lignites found on the western coast. The evidence upon which Mr. Marcou bases his opinion of the Jurassic age of this coal, was probably presented by its stratigraphical position. He states, on one of the labels, that t occurs between two thick beds of rose-colored sandstone.

The specimen is a flat mass, about three inches square and one thick. It has a lamellar or stratified structure, and is traversed by cracks parallel with the sides, and which are caused apparently by the shrinking of the mass. The form is not quite square or rectangular, but is distinctly rhombic, and the cracks of the mass divide it up into smaller fragments, with the same angles. The streak or powder is dark-brown, and it makes a brown streak upon paper. On the surfaces of fracture, parallel with the broad surfaces of the specimen, there are distinct impressions of vegetation, but it is not possible to decide upon their character. On careful inspection of the edges of the specimen, several thin layers, of what at first appear to be grains of sand, are seen. These grains are the ends of small prismatic bodies, which are compact and of a drab color. They are striated longitudinally, and break, or cleave, readily in a direction perpendicular to the longer axis of the prism. These bodies are very probably the spines of fishes or echinoderms, but they are so imperfect and minute that their true nature cannot be satisfactorily determined.

When this coal is heated it gives off a strong odor of bitumen, and burns with a white flame, and but little or no smoke, until the flame ceases, when the smoke is white like that from wood. When it is strongly ignited for a long time in the outer flame of the blow-pipe, it leaves a white skeleton residue, nearly as large as the original fragment. The edges of this on being strongly heated fuse to a white glass.

No. 99. *Coal creek, Camp No.* 12.—This is a fine specimen of *Siggillaria*, about nine inches long and four in diameter. The markings of the root are very distinctly preserved on one side, while the opposite is rough and not characteristic.

No. 100. *Camp No.* 47, *Arroyo Truxillo.*—This, according to the label, is fossil wood of the Upper Trias. It is a silicified fragment of the trunk of a *Lepidodendron*—a well known plant of the Carboniferous period. The markings upon the surface are distinct and characteristic.

# CATALOGUE

OF THE

# GEOLOGICAL COLLECTION.*

## I.—ROCKS AND MINERALS.

| No. | Description. | Locality. |
|---|---|---|
| 1 | Granite formant le outre des Rocky mountains | Cañon de Tejeras, near Albuquerque. |
| 2 | Granite formant le outre des Rocky mountains | Cañon de Tejeras, near Albuquerque. |
| 3 | Granite à hornblende | Pueblo creek. |
| 4 | Granite à gros grains | Pueblo creek. |
| 5 | Granite à gros grains | Pueblo creek. |
| 6 | Granite de la Sierra Madre | Agua Frio. |
| 7 | Granite du montagnes rochenses | Cañon de San Antonio, avant Tejeras, N. M. |
| 8 | Granite du montagnes rochenses | Cañon de San Antonio, avant Tejeras, N. M. |
| 9 | Granite rose | Aquarius mountains, camp avant Cactus Pass. |
| 10 | Granite rose formant les montagnes qui courant du nord au Sud. | Aquarius mountains, camp avant Cactus Pass. |
| 11 | Syènite rouge | Sommét de Cactus Pass, Aquarius mount. |
| 12 | Gneiss | Cactus Pass, Aquarius mountains. |
| 13 | Epidote dans le granite | Aquarius mount. |
| 14 | Syènite pyroclase | Cerbat mountains, Bill Williams' fork. |
| 15 | Granite à hornblende | Bill Williams' fork. |
| 16 | Granite à gros grains | Embouchure de Big Sandy, dans Bill Williams' fork. |
| 17 | Metamorphic gneiss | Cerbat mountains, sur le Bill Williams' fork. |
| 18 | Gneiss porphyroide | Près de l'embouchure de Bill Williams' fork, dans le Rio Colorado. |
| 19 | Roche quartzo-serpentineuse, metamorphic | Bill Williams' fork, près de l'embouchure. |
| 20 | Roche quartzo-serpentineuse, metamorphic | Bill Williams' fork, près de l'embouchure. |
| 21 | Quartzite metamorphiques | Bill Williams' fork. |
| 22 | Quartzite metamorphiques | Bill Williams' fork. |
| 23 | Granite. | Camp près du Picacho. |
| 24 | Granite à hornblende | Entre le Rio Colorado et le Mojave rivière. |
| 25 | Hornblende syènite | Rio Colorado au dessous des Mojave villages. |
| 26 | Quartz schistoide | Rio Colorado au dessous au Mojave villages. |
| 27 | Marble blanc en filon | Cajon creek. |
| 28 | Syènite et quartzite | Big Sandy creek. |
| 29 | Granite à gros grains. | Aquarius mount. |
| 30 | Sulfate de baryte | Camp 52. |
| 31 | Hornblende rock en dyke | Entre Tuerto and Galisteo. |
| 32 | Syènite decomposes, en contact avec les veines de quartz aurifere. | Nevada City, California. |
| 33 | No label. (Metamorphic rock.) | |
| 34 | No label. (Syenite.) | |
| 35 | Gneiss porphyroide | Près de l'embouchure de Bill Williams', dans le Rio Colorado. |
| 36 | Metamorphic sandstone, or gneiss. | Près du Picacho. |
| 37 | Roche metamorphique. | Près de Pueblo creek. |
| 38 | Trap en dyke dans le white chalk | Rio Galisteo, N. M. |
| 39 | Dyke de roches hornblendiques | Entre Tuerto Galisteo. |
| 40 | Syènite à hornblende, en filon | Au village de Cineguilla, près de Santa Fé. |
| 41 | Trap serpentinense. | Cañon Tejeras, near Albuquerque. |
| 42 | Porphyre en dyke. | Dans le volcan de Cerrito, près de Santa Fé. |
| 43 | Porphyre. | Dans le volcan de la Cineguilla près de Santa Fé. |
| 44 | Basaltic lava | Cañon de Cineguilla, près de Santa Fé. |
| 45 | Basaltic lava | Fin de la Coulin, près du Pueblo de Zuni. |
| 46 | Roche volcanique | Leroux spring. |

* This list, with but few exceptions, is copied from the labels found with the specimens.

I. ROCKS AND MINERALS—Continued.

| No. | Description. | Locality. |
|---|---|---|
| 47 | Coulé de lava basaltique du San Francisco mount | Près de Leroux spring. |
| 48 | Lava | Du volcan de San Francisco mountain. |
| 49 | Scorie volcanique | Vennant du volcan eteint de la Sierra de San Francisco. |
| 50 | Pophyre rose | Aquarius mountains. |
| 51 | Laves amygdaloides | Au pied du grand volcan de San Francisco mountain, près du Colorado Chiquito. |
| 52 | Basalte | Near the Picacho. |
| 53 | Basalte obsidienne | Camp près du Picacho. |
| 54 | Trachyte porphyroide | Troiseme chaine en quittant le Rio Colorado. |
| 55 | Porphyroid greenstone | Mojave river. |
| 56 | Scorie volcanique | Mesa near Rio Gila (Whipple.) |
| 57 | Porphyre quartzifire | Mojave river. |
| 58 | Trap | Rough and Ready. |
| 59 | Mountain or Lower Carboniferous limestone | Delaware mount. |
| 60 | Dolomie ou magnesian limestone | Au pied du Lano Estacado. |
| 61 | Dolomie ou calcaire magnesien | San Antonio. |
| 62 | Dolomie ou magnesian limestone | Rio Colorada Chiquito. |
| 63 | Dolomie or magnesian limestone, Trias de la Prairie | Shady creek, Camp No. 42. |
| 64 | Dolomie or magnesian limestone au dessus du gypsum ; Trias moyen. | Camp No. 30, près des mound. |
| 65 | Sandstone de l'upper Trias ; gravé par les Indiens des Pueblos. | Camp No. 46, aux pieds du Llano Estacado. |
| 66 | Variagated marls du Trias | Shady river, Camp No. 42. |
| 67 | Argile rouge et blanc du Trias | Entre le Delaware mount et Beavertown. |
| 68 | Grés blanc, grés, friable, de l'upper Trias | Antelope hills, Camp No. 36. |
| 69 | Fer, Au Sommet du New Red Sandstone ou Trias, près du Neocomien. | Entre les Camp No. 31 et No. 32. |
| 70 | Gypsum rouge du Trias moyen | Au pied du Llano Estacado. |
| 71 | Gypsum rouge du Trias moyen | Gypsum creek. |
| 72 | (No label.) | |
| 73 | Gypsum cristallise, Trias moyen | Canadian river. |
| 74 | Gypsum, Trias moyen | Comete creek. |
| 75 | Gypsnm blanc, sacharoide amorphe ; Trias moyen. | Comete creek. |
| 76 | Gypsum blanc de Trias | Prairie près de Gypsnm creek. |
| 77 | Gypsum, Trias moyen | Gypsum creek. |
| 78 | (No label.) | |
| 79 | Gypsum blanc sacharoide de Trias moyen | Grand prairie, Camp No. 30. |
| 80 | Gypsum blanc et veine de rose amorphe sacharoide, Trias moyen. | Camp No. 30. |
| 81 | Gypse cristallisè pur, veine dans le gypse amorphe, Trias. | Camp No. 30. |
| 82 | Gypsum blanc du Trias | San Antonio |
| 83 | Sandstone and conglomerate fourmant le sommet et la mesa de Cajon Pass | Cajon Pass, Sierra Nevada. |
| 84 | Roche Tertiare Poudringue, recouvrent par la lava | Camp 50. |
| 85 | Little stone, dont se servent les fourniers pour batir | West de la Sierra Madre. |
| 86 | Jaspe et agathe, dans le diluvium | Entre Zuni et le Colorado Chiquito. |
| 87 | Stalactite | *Pinal Lléno*, on Rio Gila, 1851. |
| 87½ | Efflorescence, Soda lake | Pied du Rio Mojave. |
| 88 | Specular iron, dans une roche epidotique | Troisiéme cañon, en descendant Bill Williams' fork, Camp 62. |
| 89 | Cristaux de specular iron | Près du Picacho. |
| 90 | Specular iron, dans le granite | Pueblo creek. |
| 91 | Hematite iron | Cerbat mountains, Bill Williams' fork. |
| 92 | Sulphuret and silicate of copper | New Placer mount, near San Pedro, New Mexico. |
| 93 | Filon de quartz aurifère | New Placer, near San Pedro. |
| 94 | Quartz aurifère | De la veine de Canadian Hill, near Nevada City. |
| 95 | Fer argentifere | Pueblo creek. |
| 96 | Veine metallifère | Two miles north of Cactus Pass, Aquarius mountains. |
| 97 | (No label.) | |

II. FOSSIL-WOOD, FOSSILS AND SHELLS.

| | | |
|---|---|---|
| 98 | Bituminous coal, Jurassique | Ojo del Pescado, Zuñi. |
| 99 | Sigillaria, (carboniferous sandstone) | Coal creek, Camp No. 112. |
| 100 | Bois fossile de l'upper Trias | Camp 47, Arroyo Truxillo. |
| 101 | No label, but similar to No. 100, and probably *Lepidodendron*. | |
| 102 | Fossil wood | Colorado Chiquito. |

II. FOSSIL-WOOD, FOSSILS AND SHELLS—Continued.

| No. | Description. | Locality. |
|---|---|---|
| 103 | Bois fossile agatisé, trouvés dans le Trias moyen | Près du Rio Colorado Chiquito. |
| 104 | Bois fossile agatisé, trouvés dans le Trias moyen | Près du Rio Colorado Chiquito. |
| 105 | Bois fossile agatisé, trouvés dans le Trias moyen | Près du Rio Colorado Chiquito. |
| 106 | Jaspe au agathe, dans le diluvium | Entre Zuni et le Colorado Chiquito. |
| 107 | With the preceding | Entre Zuni et le Colorado Chiquito. |
| 108 | With the preceding | Entre Zuni et le Colorado Chiquito. |
| 109 | With the preceding | Entre Zuni et le Colorado Chiquito. |
| 110 | Bois fossile. | Entre le Rio Puerco, et Alamo, New Mexico. |
| 111 | Bois Silicifiés, trouve dans les grés rouge du Trias moyen. | Près d'Antelope Hills. Prairie. |
| 112 | Bois fossile, dans le grés Jurassique | Vis-à-vis de la ville d'Albuquerque. |
| 113 | Bois fossile, dans le Trias | Entre le Rio Colorado Chiquito et le Pueblo de Zuñi. |
| 114 | Fossiles du mountain limestone, (*Productus pustulosus*) | Village de Pecos. |
| 115 | Fossiles du mountain limestone, (*Productus semireticulatus*). | Village de Pecos. |
| 116 | Fossile du mountain limestone, (*Terebratula subtilata*) | Village de Pecos. |
| 117 | Fossile du mountain limestone, (*Terebratula roissyi*) | Village de Pecos. |
| 118 | Fossile du mountain limestone, (*T. millipunctata*, n. s.) | Village de Pecos. |
| 119 | Fossile du mountain limestone, (*Spirifer musebachanus*) | Village de Pecos. |
| 119½ | *Spirifer pilosus*, (n. s.) | Village de Pecos. |
| 120 | Fossiles du mountain limestone, (*Crinoids*) | Village de Pecos. |
| 121 | Fossile du mountain limestone, (*Cyathophyllum*). | Village de Pecos. |
| 122 | Fossiles du carboniferous limestone, (*Productus* ———) | West of San Francisco mountain. |
| 123 | Polypier du Lower Carboniferous. | Rocky mountains. |
| 123½ | Polypier briozoaire du coal measure, (*Fenestella*) | Près de Choctaw agency. |
| 124 | Orthis, mountain or carboniferous limestone | Delaware mount, Camp No. 19. |
| 125 | Fossiles du Lower Carboniferous. | Near Shawneetown. |
| 126 | Empreintes et débris de fossiles: Ammonites, Inoceramus, etc.; white chalk, (several specimens.) | Three miles north of Galisteo. |
| 127 | Formation du Llano Estacado, Jurassique inferieur avec poudringue à la base. (A ferruginous rock with casts of shells; probably Tertiary.) | Encampment creek. |
| 128 | No label. (This resembles Chætetes.) | |
| 129 | Fossiles du Carboniferous limestone. (Coral, but very obscure.) | West de San Francisco mountains. |
| 130 | Orthoceras | Près d'Agua Fria, Sierra Madre. |
| 131 | Fragments d'Ammonite de la craie blanche, dans les grés blanc. | Entre les Rio Grande et Puerco, près de Las Lunas, New Mexico. |
| 132 | Lucina. Terrain Crétacé | Entre Gold mount et Galisteo, New Mexico. |
| 133 | Gryphæa Tucumcarii, Marcou; Argile bleu du Jurassique. | Pyramide mount, Plaza Larga. Camp No. 50. |
| 134 | Gryphæa Pitcheri, Mort.; Calcaire nèocomien. | Camp No. 31, False Witchita. |
| 135 | Piéce d'os fossile. | Trouvé sur le sol du Trias, a l'ouest de Zuni. |
| 136 | Ostrea congesta. | Three miles north of Galisteo, with No. 126. |

| No. | Marks. | Description. | Locality. |
|---|---|---|---|
| 137 | 54 | Unio, 1 valve. | Canadian river. |
| 138 | 55 | Unio | Canadian river. |
| 139 | 56 | Unio | Coal creek. |
| 140 | 57 | Unio | Canadian river. |
| 141 | 58 | Unio, 1 valve. | Canadian river. |
| 142 | 59 | Unio | Gaines' creek, affluent of the Canadian. |
| 143 | 60 | Unio | Gaines' creek, affluent of the Canadian. |
| 144 | 61 | Unio | Gaines' creek, affluent of the Canadian. |
| 145 | 62 | Unio | Gaines' creek, affluent of the Canadian. |
| 146 | 63 | Unio | Gaines' creek, affluent of the Canadian. |
| 147 | 64 | Unio | Gaines' creek, affluent of the Canadian. |
| 148 | 65 | Unio | Gaines' creek, affluent of the Canadian. |
| 149 | 66 | Unio | Gaines' creek, affluent of the Canadian. |
| 150 | 67 | Unio | Gaines' creek, affluent of the Canadian. |
| 151 | 68 | Unio | Gaines' creek, affluent of the Canadian. |
| 152 | 69 | Unio | Gaines' creek, affluent of the Canadian. |
| 153 | 70 | Unio | Pecos river. |
| 154 | 71 | Unio | Pecos river. |
| 155 | 72 | Planorbis and Physa | Little river, near Shawneetown. |

# No. 2.

# RESUMÉ AND FIELD NOTES,

BY

## JULES MARCOU,

GEOLOGIST AND MINING ENGINEER TO THE EXPEDITION;

WITH

A TRANSLATION BY WILLIAM P. BLAKE.

NOTE.—This paper is a copy of Mr. Marcou's field-book, and is an exact transcript of the original rough notes as they were taken while on the road or in camp.

*Itinéraire Géologique du Fort Smith et Napoléon (Arkansas) au Rio Colorado de Californie.*

[Original.]

LITTLE ROCK, ARK.,
*le* 16 *Juin*, 1853.

Les alluvions du Mississippi forment entièrement les bancs de cette rivière depuis Cairo jusqu' à Napoléon. Cette alluvion est noire grisâtre et formée de limon ou dépôt de boue à deux endroits, Highland et Memphis. On voit dessous ce limon un sable jaunâtre et blanchâtre très-fin qui forme les cliffs de la rivière à ces deux points.

En remontant de Napoléon à Little Rock sur la rivière Arkansas, on a la même alluvion limoneuse que sur les bancs du Mississippi, seulement, la couleur est jaune rougeâtre, et dessous se trouve d'épaisses assises de sables jaunâtres, ce qui rend le cours de la rivière très-serpentineuse. On ne voit aucune pierre, même de la grosseur d'une noix, dans tout cette alluvion. Ce n'est qu' à 1 mille au dessous



*Geological Itinerary from Fort Smith and Napoleon (Arkansas) to the River Colorado of California.*

[Translation.]

LITTLE ROCK, ARK.,
*June* 16, 1853.

The alluvial deposites of the Mississippi form both of its banks from Cairo to Napoleon. This alluvium is greyish-black, and consists of slime or mud at two places—Highland and Memphis. We see under this slime a very fine whitish and yellowish sand, which forms the cliffs of the river at these two points.

On going up from Napoleon to Little Rock, upon the Arkansas river, we find the same slimy alluvium as upon the shores of the Mississippi; only its color is reddish-yellow, and under it are found thick beds of yellowish sand, which renders the course of the river very sinuous. No stones are visible, even of the size of a nut, in all this alluvium; and it is only a mile below Little Rock that we meet

de Little Rock que l'on commence à rencontrer une alluvion avec des petits cailloux quartzeux.

À Little Rock on a des roches schisteuses, noires, métamorphiques et contournés, avec un grès et des filons de quartz, ayant une direction E.E.N. à l'O.O.S. Ici commence aussi des rideaux de collines suivant la même direction: ces rideaux ne paraissent pas élevés de plus de 100 pieds. Plus haut que Little Rock, à 2½ milles sur la rive gauche, on a les grès carbonifères en couches peu inclinées et formant des mamelons en ligne, lorsque sur la rive droite, on a des schistes métamorphiques redressés et contournés et dont la hauteur au-dessus de la rivière n'est que 10 à 30 pieds. On voit à trois ou quatre milles de Little Rock sur la rive gauche des grès et calcaíre houiller reposant en stratification discordante sur les schistes métamorphiques. Ce qui fait présumer q'une partie de ces montagnes est antérieure à l'époque des Alleghanies et du carboniferous groupe.

Cinq ou six milles au-dessus de Little Rock le pays devient encore plat, avec des alluvions sableuses; cependant la formation carbonifère inférieure parait former toute la rive gauche. Lorsqu'on arrive à Petit Jean montagnes, on a sur la rive droite une ou deux lignes de hautes collines ayant des couches de houille; ainsi le terrain carbonifère a traversé la rivière.

Après Petit Jean, on a encore quelques collines carbonifères coupées quelque fois par des injections de *trap dike*, sur la rive droite de la rivière; le pays redevient plat et couvert de sable alluvial; ainsi à Dardanelles et jusque près de Ozark city où l'on retrouve les collines de grès et de shistes du lower carboniferous. Les couches de ces collines sont presque horizontales; il n'y a pas de fossiles dedans. Après une douzaine de milles on a de nouveau la plaine alluviale; toujours pas de cailloux dans le sable; à Van Buren on a des collines du lower carboniferous et enfin à Fort Smith on est sur l'alluvion assez épaisse de sable et d'argile rougeâtre.

A la rivière Poteau, sur le côté droit, à 200 ou 300 yards de l'embouchure, á l'endroit du *ferry-boat* on a une cliff de sandstone

with an alluvium containing small quartzose pebbles.

At Little Rock we find black, schistose metamorphic rocks, contorted, and a sandstone and quartz veins having a direction E.E.N. and and W.W.S. Here also commences a range of hills having the same direction, but which do not appear to attain an elevation of over one hundred feet. Two and a half miles above Little Rock, on the left bank, we find carboniferous sandstones in slightly-inclined beds, forming a line of rounded hills; while on the right bank we find metamorphic slates, upraised and contorted, and the height of which above the river is but ten to thirty feet. Three or four miles from Little Rock, on the left bank of the river, we find sandstones and carboniferous limestone resting unconformably upon the metamorphic schists; from which we can presume that a part of these mountains is interior in age to the Alleghanies.

Five or six miles above Little Rock the country becomes flat again, and we find the sandy alluvium, while the lower carboniferous formation appears to form all the left bank. When we arrive at the *Petit Jean* mountain we find, on the right bank, one or two ranges of high hills containing beds of coal; the carboniferous formation has thus crossed the river.

Beyond *Petit Jean* mountain we still find some carboniferous hills, sometimes traversed by injections of trap in the form of dikes. On the right bank of the river the country again becomes flat, and is covered by alluvial sand; so at Dardanelles, and even near Ozark, we find hills of sandstone and schists of the lower carboniferous formation. The strata of these hills are nearly horizontal, and there are no fossils in them. About twelve miles further on we still find the alluvial plain, always having pebbles in the sands. At Van Buren we find hills of lower carboniferous, and finally, at Fort Smith, we stand upon a thick alluvial deposite of sands and reddish clay.

At the river Poteau, upon the right side, and two or three hundred yards from its mouth, at the landing of the ferry-boat, we find a cliff

carbonifère avec des assises de schistes marneux, noirâtres à la partie inférieure. Ces assises sont horizontales très-bien stratifiées, le grès est friable dans les endroits exposés à l'air, et se laisse travailler difficilement à cause du grand nombre de fissures qu' il présente. On ne rencontre pas de fossile. A 12 milles au sud du Fort Smith on a une couche de houille bitumineuse de 12 pieds d'épaisseur, avec des traces de fer oxidé. En allant au nord du côté de Washington county, à 40 milles du Fort Smith, on s'élève successivement par des faibles gradins ——— [?] sur le calcaire carbonifère, ou *mountain limestone*, qui apparait alors avec des *Productus*, *Bellerophon* et *Terebratula*, caractéristique de cette formation ; des assises de coal d'une épaisseur qui varie de 2 à 12 pieds, se trouvent répandues dans plusieurs des comtés avoisinant.

Les Ozarkes étant entierèment carbonifères et de couches horizontales, sont dûs à les dénudations du group carbonifère. Il n'y a que les monts de Little Rock au Hot et Sulf. Springs qui sont disloqués et antérieur au carbonifère. À 30 milles au sud du Fort Smith, il y a une montagne isolée de 2,000 pieds de hauteur, nommeé *Sugar-loaf* et qui est resté comme une colonne, temoin des immenses dénudations auxquels cette partie du pays a éte soumise aux époques tertiares et quaterniares. Cette montagne et formée entièrment du *coal measures*, plusiers couches de coal oût eté trouvées á la base et au milieu de cette montagne ; il y a souvent des assises de grès de 5 à 12 pieds d'épaisseur, alternat avec des marnes schisteux gris noirâtre présentant des traces de charbon et quelques minces assises de calcaires ; les fossiles y sout très-rares, s'il y en a.

À la rivière Poteau, le grès est très-friable, par couches de 15 à 20 pouces, gris jaunâtre avec des taches noires, bitumineuses ; et des nodules d'oxide de fer ; il a aussi des *ripple-marks*.

Le 15 Juillet nous quitons le Camp Wilson, pour traverser la rivière Poteau, et nous nous avancons de 9 miles au Camp No. 2, Ring house. Nous traversons une espèce de marais avec canes cu bambous formé de terrain d'al-

of carboniferous sandstone, with beds of marly shales of a blackish color in the lower portions. These beds are horizontal, and the stratification is distinct. The sandstone is friable in places exposed to the air, and is worked with difficulty on account of the great number of fissures which it presents. No fossils are visible. At twelve miles south of Fort Smith, we have a bed of bituminous coal twelve feet thick, with traces of oxide of iron. On going to the north in the direction of Washington county, forty miles from Fort Smith, we rise insensibly on to slight hills of the carboniferous formation, or mountain limestone, which then is found to contain shells of *Productus*, *Bellerophon*, and *Terebratula*, characteristic of that formation. Beds of coal, of a thickness varying from two to twelve feet, are found spread in several of the adjoining counties.

The Ozarks being entirely carboniferous, and in horizontal strata, are due entirely to the denudation of the carboniferous group. The hills of Little Rock, at the Hot and Sulphur Springs, are the only dislocation anterior to the carboniferous. At thirty miles south of Fort Smith, there is an isolated mountain two thousand feet in height, called Sugar-loaf, and which has remained as a column, in witness of the immense denudations to which that part of the country was submitted in the Tertiary and Quaternary periods. This mountain is formed entirely of the coal-measures, and several beds of coal have been found at its base and in the middle. There are often beds of sandstone, from five to twelve feet in thickness, alternating with schistose marls of a blackish grey color, presenting traces of coal, and some thin beds of limestone. Fossils are very rare, if indeed there are any.

At the river Poteau, the sandstone is highly fossiliferous, with a bed fifteen or twenty inches thick, of a yellowish grey color, and containing bituminous black spots and nodules of oxide of iron ; there are also some ripple-marks.

*July* 15. —We left Camp Wilson and crossed the river Poteau, and we advanced nine miles as far as Camp No. 2, or Camp Ring. We here crossed a marsh overgrown with canes like bamboo, being an alluvial formation over-

luvion couvrant les *coal-measures*. Au ruisseau du Camp Ring on voit du grès et des schistes marneux.

Le 17, je trouve à 1 mile du Camp Ring, précisément au bord du bois de la prairie, un cailloux de quartz de la grosseur du poing, erratique ; c'est le premier *boulder* de cette grosseur que jai trouvé depuis Louisville dans le Kentucky.

19 *Juillet.—Du Camp No.* 1 *au Camp No.* 2, *ou Choctaw agency.*—Nous traversons un pays plat, présentant dans quelques ravins un peu de débris de grès quartzeux très dur, carbonifère, espèce de silex, avec quelque polypiers en empreintes et *Productus* ainsi que l'empreinte d'un *Sigillaria* et d'un *Equisetum*. Ces fossiles sont cependent assez rares, j'en recueille 5 ou 6. On voit aussi des schistes très noirs et bitumineux indiquant la houille. Le puit de M. Ring, qui a 40 pieds de profondeur a traversé une couche de houille de 3 pieds d'épaisseur. Tout ce pays depuis au dessus de Van Buren est complètement sur la houille ou *upper carboniferous*, non erratiques; alluvion sableuse, rougeâtre et jaune recouvrant la surface des roches.

On trouve des fragments de grès très-quartzeux, presque de silex —— [?] avec des *Polypes, Crinoids, Spirifers* provenant des dénudations des couches supérieures ; ces silex sont dans le sable et quelquefois ils forment une brèche ferrugineuse, comme à Choctaw agency, les silex sont souvent très ferrugineux eux mêmes.

26 *Juillet.—Du Camp No.* 2 *au Camp No.* 3.—Nous suivous des praries coupés par des colines de grès houillers avec schistes. Ces grès sont relevés, la direction suivant de O.O.S. à l'E.E. nord, les couches plongeant au sud est sous un angle de 5 ou 6 degrés, pas de fossiles, cailloux de silex ont disparu. Pas d'erratiques ; beaucoup de *ripple-marks* sur les assises de grès.

27 *Juillet.—Du Camp No.* 3 *au Camp No.* 4.—Les mêmes roches que précédement, sans aucun changement. Les ruisseaux sont presque tous secs, ce qui est un caractère prédominant et constant des régions dont le sol est placé sur les *sandstones*. De l'agency au Camp No. 4, on est constamment sur des prairies ou des bosquets de bois ; ces bois sont composés de

lying the coal-measures. At the brook of Camp Ring, we see limestone and marly schists.

*July* 17.—I found precisely at the border of the wood of the prairie an erratic quartz pebble, of the size of one's fist. It is the first boulder of that size which I have found since leaving Louisville, Kentucky.

*July* 19.—*From Camp No.* 1 *to No.* 2, *or Choctaw agency.*—We cross a level country, presenting in some ravines a small amount of débris of quartzose sandstone, very hard, carboniferous, a kind of silex, with some polypiers in imprints ; a *Productus ;* also the imprints of a *Sigillaria* and of *Equisetum*. These fossils are, however, quite rare ; I gathered five or six of them. Schists, very black and bituminous, also occur here, indicating the coal. The well of Mr. Ring, which is forty feet in depth, has crossed a coal-bed three feet in thickness. All this country, from below Van Buren, is completely on coal or upper carboniferous. There is no drift, but a reddish and yellow sandy alluvium covers the surface of the rocks.

We find fragments of a very quartzose sandstone, containing *Polypi, Crinoids*, and *Spiriferæ*, resulting from the denudation of the upper beds. These silicious fragments are found in the sand, and they sometimes form a ferruginous breccia as at Choctaw agency. These fragments are often themselves very ferruginous.

*July* 26.—*From Camp No.* 2 *to Camp No.* 3.—We traverse prairies diversified by hills of carboniferous sandstone, with schists. These sandstones are raised, their trend being from W. W.S. to E.E.N., the beds dipping to the S.E. at an angle of five or six degrees. There are no fossils ; the pebbles of silex have disappeared ; there are no erratics, but many ripple-marks are visible on the beds of sandstone.

*July* 27.—*From Camp No.* 3 *to Camp No.* 4.—The formations continue, as before mentioned, without material change. The brooks are almost all dry, which is a predominating and constant character of the regions of which the soil rests upon the sandstones. From the Agency, at Camp No. 4, we are constantly on prairies or among groves of wood. These

chêne blanc et noir avec du noyer ; végétation forestière pauvre, les vignes très rares.

28 *Juillet.*—Séjour au Camp No. 4.

29 *Juillet.—Du Camp No.* 4 *au Camp No.* 5.—On suit un chemin qui traverse et longe à moitié des collines de 100 à 200 pieds de hauteur. Ces collines sont formées de grès houillier avec des schistes gris noiràtre, indiquant la houille. Plusieurs couches de ce grès commencent à devenir très-ferrugineuses ; quelque morceaux de pyrites sulfureux sont disséminés, mais la plus grande partie est de l'oxide de fer, ainsi la source d'eau où nous établissons le Camp No. 5 est sulphuro-ferrugineuse, avec un goût très marqué.

30 *Juillet.—Du Camp No.* 5 *au Camp No.* 6.—On suit une vallée courant à l'ouest un peu sud, entre deux systèmes de collines de grès, assez élevés, surtout au sud. Pas d'alluvions, mais des sables, avec absence complète de *boulders*. Du *creek* où nous campons, il y a des couches de grès très-ferrugineux se décomposant facilement, brun à la surface exposée à l'air, et rouge oxide à l'intérieur ; on voit aussi des schistes gris noirâtres avec concrétions ; mais pas de fossiles. Couches horizontales.

31 *Juillet.—Du Camp No.* 6 *au No.* 7, *ou Sans Bois creek.*—On continue à suivre la même vallée, coupée de temps à autre pars des *creeks* qui sont à secs, la ligne de montagnes au sud est plus éleveé que celle au nord. Pas d'alluvions avec cailloux ; des grès et schistes, et des couches de houille qui affluent prés du Camp No. 7.

1 *Août.—Du No.* 7 *au No.* 8, *ou Camp Cooper.*—Nous passons de petites collines de grès et schiste houilleux, sans fossiles ; alluvions de sables sans cailloux. Les lignes de montagne au sud et au nord ayant la même direction ; celles du côté du sud sont plus élevées que les jours précédents.

2 *Août.—Du No.* 8 *au No.* 9.—On passe constamment sur les grès carbonifères qui sont très-développés sans fossiles, disloqués dans la direction O.O.S. à E.E. nord, les couches plongeant au sud et sous un angle de 20 à 30 dé-

woods are composed of white and black oak, with butternut trees ; but the vegetation is poor, and the vines very scarce.

*July* 28.—Remained at Camp No. 4.

*July* 29.—*From Camp No.* 4 *to Camp No.* 5.—We followed a road which crosses and passes along about half way up the slope of hills, from 100 to 200 feet in height. These hills are formed of a carboniferous sandstone, with blackish-grey schists, indicating coal. Several beds of these sandstones begin to be very ferruginous, and several masses of pyrites are disseminated, but the greatest part is of oxide of iron ; so the spring of water, where we established the Camp No. 5, is sulphuro-ferruginous, with a very strong taste.

*July* 30.—*From Camp No.* 5 *to Camp No.* 6.—We followed a valley running a little south of west, between two systems of hills of sandstone somewhat elevated, especially towards the south. No alluvium, but sand, completely free from boulders. From the creek in which we camped there are beds of very ferruginous sandstone which readily decompose, with a brown surface where exposed to the air, the interior being colored red by oxide of iron. We also find blackish-grey schists with concretions, but no fossils. The strata are horizontal.

*July* 31.—*From Camp No.* 6 *to Camp No.* 7, *on Sans Bois creek.*—We continue to follow the same valley, cut here and there by creeks, which are dry. The line of the mountains in the south is more elevated than that in the north. No alluvium with pebbles, but sandstones and shales, and coal-beds, which are nearly level near Camp No. 7.

*August* 1.—*Camp No.* 7 *to Camp No.* 8, *or Camp Cooper.*—We passed little hills of carboniferous sandstone and shales without fossils ; also alluvial deposites of sand without pebbles. The lines of mountains in the south and north having the same direction ; those of the south side are more elevated than those of the preceding days.

*August* 2.—*From Camp No.* 8 *to No.* 9.—We passed constantly upon carboniferous sandstones, which are very well developed, but are without fossils ; they are dislocated in a direction W.W.S. to E.E.N., the beds dipping in

grés. Plusieurs gros blocs de ces grès per cent la surface par suite de la décomposition et paraissent comme des *boulders*. Pas d'alluvions, on trouve plusieurs espèces d'*Unio* et d'*Anodonta*, dans le Sans Bois et ses affluents. Gros *Equiseteum giganteum* dans le ruisseau près du camp.

3 *Août*.—Le Docteur traverse la montagne et va jusqu' à la Canadian river; la montagne est des *sandstone* des *coal measures* et des alluvions sabloneux jusqu' à la rivière.

4 *Août*.—*Du No.* 9 *au No.* 10, 17 *milles*.—Toujours sur le *carboniferous limestone*, pas d' alluvions. Vallées avec montagnes au sud et au nord, plus élevées au nord qu' au sud. Même direction qu' auparavant.

5 *Août*.—Sandstone plonge au nord sous un angle de 15° au second ruisseau, (Gaines' creek). Au sommet, au dessus de la plantation, on découvre un plateau qui ferme la vallée longitudinale du Sans Bois. On est élevé à peu près 250 pieds au dessus du Fort Smith. *Carboniferous limestone* toujours. Alluvion sableux avec des cailloux de quartz de la grosseur d' un oeuf.

Camp No. 11, on voit que l'alluvion a changé et de sableuse est devenue sablo-caillouteuse. Je fais une collection de 7 ou 8 species d'*Unio* et *Anodonta* dans Gaines creek, ou South Fork of the Canadian.

6 *Août*.—*Du* 11 *au* 12.—Nons traversons 13 milles de mamelons de *carboniferous sandstones* avec alternations de schistes, alluvion sableuse avec quelques cailloux très-petits de quartz. Beaucoup de lits de sandstone sont très-ferrugineux. Les assises sout disloquées, même direction et inclinaison de 10 à 15 dégrés au nord et au sud ouest.

7 *Août*.—*Du No.* 12 *au No.* 13, 5 *milles*.—Suivant les couches de corboniferous sandstone on trouve 5 ou 6 specimens de tiges de *Sigillaria*, très-caractéristiques des *coal measures*.

the south at an angle of from 20 to 30°. Several large blocks of these sandstones pierce the surface, in consequence of the decomposition of the surrounding portions, and succeed each other like boulders. No alluvial deposites seen. Several species of *Unio* and *Anodonta* were found in the Sans Bois and its affluents; also a large *Equisetum giganteum* in a brook near the camp.

*August* 3.—The Doctor traversed the mountain, and went as far as the Canadian river. The mountain is of sandstone of the coal-measures, and is bordered by a sandy alluvium as far as the river.

*August* 4.—*From Camp No.* 9 *to Camp No.* 10, (17 *miles*.)—We were always on the carboniferous sandstone; there is no alluvium. Valleys and mountains are visible in the south and in the north; but more elevated in the north than in the south. Their direction is the same as before given.

*August* 5.—*From Camp No.* 10 *to No.* 11.—Sandstone dips in the north at an angle of 15° at the second brook, (Gaines' creek.) At the summit, above the plantation, we discover a plateau, which ends the longitudinal valley of the Sans Bois. We are elevated about 250 feet above Fort Smith. Carboniferous sandstone prevails, as before. Sandy alluvions, with pebbles of quartz of the size of an egg.

At *Camp No.* 11 we find that the alluvium has changed, and becomes more pebbly. I made a collection of seven or eight species of *Unio* and *Anodonta* in Gaines' creek, or South fork of the Canadian.

*August* 6.—*From Camp No.* 11 *to Camp No.* 12.—We crossed for thirteen miles small rounded hills of carboniferous sandstone, with alternations of shales, and sandy alluvium with very fine quartz pebbles. Many of the sandstone beds are very ferruginous. The strata are dislocated in the same direction, to the northeast and southwest, and the inclination is from ten to fifteen degrees.

*August* 7.—*From Camp No.* 12 *to No.* 13, (*five miles*.)—We followed the beds of carboniferous sandstone, and found five or six specimens of the stalks of *Sigillaria*, very characteristic of the coal-measures.

8 *Août.—Du No.* 13 *au No.* 14, 9 *milles.*—Sur le grés houiller et les schistes marneux noirs. Il y a une montagne où l'on trouve que les grés sont disloqués. Souvent les grés sont trés-ferrugineux.

9 *Août.—Du No.* 14 *au No.* 15.—A 3 milles du No. 14 on a une montagne de 100 pieds de hauteur à traverser qui est mauvaise pour les wagons. C'est du *carboniferous sandstone* disloqué, inclinaison 60 degrés, plongeant à l'est est sud. A Shawnee village on a de nouveau des alluvions sableuses très-considérables. Nous sommes de nouveau dans la vallée du Canadian river.

10 *Août.*—Carboniferous sandstone 6 milles de Shawnee town, les couches inclinent ouest ouest sud, sous un angle de 15 degrés, argile grisâtre alternant avec le grés.—[?]—Sableuse très-fine, avec qulques cailloux de grés et de dolomie dans le sable alluvial.

11 *Août.—Du No.* 16 *au No.* 17.—Peu après notre départ du camp on trouve une couche de *sandstone* très-bréchiforme, à petits cailloux anguleux blanc argileux et de limestone. Souvent cette brêche est ferrugineuse. Pas de fossiles. À 2 milles en remontant Little river, on a dans le lit de la rivière du sandstone fin et grossier, avec fossiles du Lower Carboniferous, tels que *Bellerophon, Crinoids, Productus* and bivalves. Je trouve les mêmes fossiles dans le creek au Camp No. 17, ainsi nous sommes sortis de la région des *coal measures* pour le lower carboniferous, entre Shawnee valley et Shawnee town.

14 *Août.—Du No.* 17 *au No.* 18.—On passe la plaine pour avoir à sa droite un rideau de petites collines qui séparent du Canadian river les eaux de Red river; ces collines de grès carbonifère ne s'élèvent que de 50 à 70 pieds. On a dans les *creeks* des couches de *sandstone* avec brêche siliceuse et ferrugineuse ou poudingiforme de grès blanc jaunâtre. Pas de fossiles. L'alluvion formée de très-petits cailloux de silex carbonifére avec quantité de sables blancs.

15 *Août.—Du No.* 18 *No* 19 *au.*—On suit

*August* 8.—*From Camp No.* 13 *to Camp No.* 14, (*nine miles.*)—We were upon carboniferous sandstone and black marly shales. We found a mountain where the sandstones were dislocated, and they are often very ferruginous.

*August* 9.—*From Camp No.* 14 *to Camp No.* 15.—At three miles from Camp No. 14, we cross a mountain one hundred feet high, which is very bad for wagons. It is of dislocated carboniferous sandstone, with an inclination of fifteen degrees E.E.S. At Shawnee village we again find very considerable sandy alluvions. We are still in the valley of the Canadian river.

*August* 10.—*From Camp No.* 15 *to Camp No.* 16.—Carboniferous sandstone appears at six miles from Shawnee village; the beds incline W.W.S. at an angle of fifteen degrees; greyish clays alternate with the sandstone. Sandy ——[?] very fine, with some pebbles of sandstone and dolomite, are found in the alluvial sand.

*August* 11.—*From Camp No.* 16 *to No.* 17.—A short time after our departure from the camp we found a bed of brecciated sandstone, containing little angular pebbles of white clay and limestone. This breccia is often ferruginous. There are no fossils. On going two miles up Little river we find in its bed a fine and a coarse sandstone with fossils, of the lower carboniferous, such as *Bellerophon, Crinoids, Productus,* and bivalves. I found the same fossils in the creek at the Camp No. 17, so we left the region of the coal-measures for that of the lower carboniferous, between Shawnee valley and Shawnee village.

*August* 14.—*From Camp No.* 17 *to Camp No.* 18.—We passed the plain and found on our right a range of small hills, which separate between the waters of the Canadian and the Red river. These hills of carboniferous sandstone have a height of from only fifty to seventy feet. We find in the creeks beds of sandstone with silicious and ferruginous breccias or conglomerates of yellowish white sandstone without fossils. The alluvium is formed of small pebbles of carboniferous silex, with a quantity of white sand.

*ugust* 15.—*From Camp No.* 18 *to Camp*

d'abord la plaine avec sandstone et sables, près du pied du Delaware mont on a des calcaires tres développés qui forment presque en entier la montage avec quelques alternations de grès. Les calcs disloqués; ils plongent au nord. Près du Camp No. 19 apparait une *mountain limestone* ou *lower carboniferous;* on trouve dedans des tiges de Crinoids, et au camp je trouve une couche sablo-siliceuse de 4 ou 5 pouces d'épaisseur qui est remplie de *Septaria, Terebratula* et un *Polypier*. Couleur gris blanchâtre, dure, à cassure sub-conchoidale, bien strafiée, se désagrégeant facilement à l'air. L'alluvion est moins sableuse et le lit des torrents est rempli de fragments calcaires de la grosseur d'une noisette à celle de la tête. Direction du Delaware mountain sud sud ouest ou 30° à l'ouest au nord nord est.

16 *Août.—Du No.* 19 *au No.* 20.—On passe constamment des collines de *limestone* et quelque couches de *sandstone* le tout d'une épaisseur de 5 à 600 pieds, avec peu ou pas de fossiles, car je ne puis en voir ; à moitié chemin, on passe prés d'un creek où il y a un poudingue calcaire, espèce de *nagleflüe* formé des débris des roches environnantes. On remarque un *sandstone* carbonifère à grain assez grossier et facilement décomposable ; un creek à 5 milles avant le camp en est rempli exclusivement.

Au Camp No. 19 on a des argiles rouges et bleues assez dures avec sandstone bréchiforme et quelques fragments de dolomie ———— ; [?] qui indiquent que les gypses ne sont pas loin de nous.

17 *Août.—Du No.* 20 *au No.* 21.—On suit une plaine un peu ravinée et où l'on ne voit que de l'argile blanche du supérieur gypsum et une couche de grès, très dure, à grains grossiers, avec feldspath. L'alluvion est formée de cailloux de quartz de la grosseur d'un oeuf de pigeon.

22 *Août.—Du No.* 21 *au No.* 22.—On suit constamment l'argile rouge souvent remaniée de  à 3 pieds à la partie supérieure et alors mêlée de quelques cailloux de quartz roulés, gros comme le poing au-dessous de cet argile

*No.* 19.—We at first followed the plain with sandstone and sands ; then arriving at the foot of Delaware mountain, we find limestones very well developed, of which the mountain is almost wholly formed, with some alternations of sandstone. The limestone is upheaved, and at Camp No. 19, dips towards the north. It appears to be mountain limestone or lower carboniferous ; it contains stalks of *Crinoids*, and at the Camp I found a bed of silicious sand four or five inches in thickness, which is filled with Septaria, *Terebratulæ*, and a *Polyp*. The color of the limestone is whitish-grey ; it is very hard and breaks with a sub-conchoidal fracture ; is very regularly stratified and separates readily where exposed to the air. The alluvium is less sandy, and the beds of the torrents are filled with fragments of limestone, from the size of a nut to that of the head.

The direction of Delaware mountain is S.S. W. (or 30 degrees west) to N.N.E.

*August* 16.—*From Camp No.* 19 *to Camp No.* 20.—We constantly passed limestone hills, with some beds of sandstone, the whole series having a thickness of from 500 to 600 feet, but with few or no fossils, for none were seen. Half-way, we passed near a creek where there is a calcareous conglomerate, a species of *nagleflüe*, formed from the wrecks of the surrounding rocks. We met with a carboniferous sandstone, coarse-grained, and easily decomposed ; a creek five miles distant from our camp is completely filled with this rock.

At the Camp No. 19, we found red and blue clays, pretty hard, with a brecciated sandstone. Some fragments of dolomite ———— ; which indicate that the gypsum formation is not far from us.

*August* 17.—*From Camp No.* 20 *to Camp No.* 21.—We followed a plain traversed by some creeks, and saw only white clays above gypsum, and a bed of very hard sandstone, with coarse grains, and somewhat feldspathic. The alluvium is formed of quartz pebbles of the size of a pigeon's egg.

*August* 22.—*From Camp No.* 21 *to Camp No.* 22.—We constantly followed red clay, often reassorted or washed in the upper portions for two or three feet in depth, and then mixed with some rolled quartz pebbles as large

rouge, couleur de vin un peu sableux, se trouve un schiste sableux, blanc et quelques concrétions blanches dans l'argile rouge. Les couches paraissent horizontales, ou à peu près. La topographie du pays est une prairie ravinée de 30 à 80 pieds par des ruisseaux presque tous á secs et nous suivons le dos d'âne de la ligne de partage des eaux entre Walnut et Canadian et Washita rivers.

23 *Août.—Du No.* 22 *au No.* 23.—On suit les mêmes argiles, sableuses, rouges, couleur de vin au sommet d'un des mamelons, ces argiles rouges sont couronnées par un calcaire sableux, rouge, bréchiform passant à un grès rougeâtre, bien stratifié, les couches plongeant à l'ouest seul, sous un angle de 5 à 10 degrès. Pas d'alluvions. Des efflorescences alumineuses et salifères dans une marne. Au camp ces marnes deviennent tellement sableuses que c'est un veritable grès rouge, avec un grès gris alternant.

24 *Août.—Du No.* 23 *au No.* 24.—On suit constamment l'argile rouge qui est un peu moins sableuse que précedemment, aussi on traverse des ruisseaux qui ont de l'eau courante. Pas d'alluvion.

25 *Août.—Du No.* 24 *au No.* 25.—On voit sans interruption les argiles rouges sableuses, passant dans grès rouges très-fins, et calcaire silicieux rouge. Pas d'alluvion.

26 *Août.—Du No.* 25 *au No.* 26.—Les argiles rouges avec grès de même couleur sont toujours en vue. À moitié chemin on a des alluvions très sableuses avec cailloux de quartz, serpentine, trap, agate, jaspe variant de la grosseur d'une noissette à celle du poing toutes très-roulées, épaisseur de cette alluvion de 1 à 1½ pied. Le sable est blanc; on y trouve deux ou trois fragments de gypse.

27 *Août.—Du No.* 26 *au No.* 27.—On a constamment les marnes rouges, mais on commence de plus à y trouver quelques fragments de gypse, blanc ros tre amorphe, et un peu crystallin, il est sous forme de gâteau ou biscuit. La même alluvion qu' hier.

28 *Août.—Du No.* 27 *au No.* 28—On a

as the fist. Under this red clay, of a wine-color, and somewhat sandy, we find white argillaceous and arenaceous shales, and in the red clay some white concretions. The beds appear to be horizontal, or nearly so. The topography of the country is a prairie, cut by ravines from twenty to eighty feet deep. The courses of brooks now nearly all dry. We followed the water-shed or dividing ridge between the Walnut and Canadian and Washita rivers.

*August* 23.—*From Camp No.* 22 *to Camp No.* 23.—We followed the same red or wine-colored sandy clays. At the summit of one of the small knolls these red clays are crowned by a sandy, red, brecciated limestone, passing into a reddish-grey sandstone, well stratified, and dipping to the southwest at an angle of from five to ten degrees. No alluvial deposites. Some efflorescences of salt and alum were found in the marls. At camp these marls became so sandy that they form a true red sandstone, with an alternation of grey.

*August* 24.—*From Camp No.* 23 *to Camp No.* 24.—We constantly follow the red clay, which is a little less sandy than before. We cross brooks with running water. No alluvium.

*August* 25.—*From Camp No.* 24 *to Camp No.* 25.—We followed without interruption the red and sandy clays, passing into a very fine red sandstone, and into a red silicious limestone. No alluvium.

*August* 26.—*From Camp No.* 25 *to Camp No.* 26.—Red clays, with sandstone of the same color, are always in view. Half-way we find a very sandy alluvium, with pebbles of quartz, serpentine, trap, agate, and jasper, varying from the size of a nut to that of the fist, all of them much rounded and water-worn. The thickness of this alluvium is from one to one and a half feet. The sand is white. We found fragments of gypsum.

*August* 27.—*From Camp No.* 26 *to Camp No.* 27.—We constantly find red marls, but fragments of gypsum make their appearance; they are of a rosy-white color; amorphous and occasionally somewhat crystalline, and having a form like a cake or biscuit. Alluvium the same as yesterday.

*August* 28.—*From Camp No.* 27 *to Camp*

d'abord des marnes rouges qui deviennent de plus en plus sableuses et au Camp 28 on a un grès rouge très fin, se désagrégeant facilement et alors à l'état de sable rouge un peu argilleux. Les couches de grès plongent au sud sous un angle de 10 degrés et la direction est ouest, est.

29 *Août.—Du No.* 28 *au No.* 29, *ou Denudation mountain.*—Nous suivons les mêmes grès argilleux, rouges, très-fins; les assises sont horizontales, on voit de beaux exemples de dénudations par l'eau. Le 1° exemple près de *Spring creek* est formé de 8 ou 10 cônes, ayant 10 pieds de hauteur; dont M. Campbell me donna un dessin. Ensuite à Rock Mary 8 ou 10 grands cônes tronqués, au sommet, ayant de 60 à 100 pieds de hauteur. Les assises en sont horizontales; c'est du grès rouge qui domine, à épaisse stratification; avec les alternations de schistes rouges, plus argilleux, se levant par feuillet, avec deux ou trois couches à la partie supérieure de calcaire siliceux, gris blanchâtre très dur et qui a préservé et formé ces *natural mounds.*

Près de Camp 29, il y a un de ces mounds avec des colonnes de grès, montrant la stratification. Ces grès rouges sont très-épais, près de 150 pieds et je commence à soupçonner que depuis après Delaware mountain, nous sommes dans le New Red au lieu du lower carboniferous. Pas d'alluvium caillouteux; une plaine parfaite.

30 *Août.—Au Camp No.* 30.—Section à l'est du camp, à 20 pas:

| | |
|---|---|
| Dolomie argileuse | 6 pieds. |
| Gypsum | 25 " |
| Grès, schiste argileux et argile rouge | 10 " |

On a d'abord passé pendant 7 miles sur des grès argileux rouges, puis ensuite sur du gypse blanc, qui est superposé au grès. Ce gypse blanc est amorphe avec quelques veinules crystallissées; il y a avec des rubans roses; les couches sont horizontales; le gypse a 25 à 30 pieds d'épaisseur. Dans plusieurs endroits où nous passons le gypse est décomposé et forme des cavernes en zig-zag. L'alluvion est du sable rouge, avec quelques cailloux de quartz. Au camp No. 30 on à des couches d'une dolo-

*No.* 28.—We first find red marls, which become more and more sandy, and at Camp No. 28 we find a very fine red sandstone decomposing readily into a red sand somewhat argillaceous. The sandstone beds dip to the south at an angle of ten degrees, and the trend is east and west.

*August* 29.—*From Camp No.* 28 *to Camp No.* 29, *or Denudation mountain.*—We followed the same very fine, red, argillaceous sandstone. The strata are horizontal, and beautiful exhibitions of denudations by water are seen. The first example near Spring creek is composed of from eight to ten cones, having a height of about ten feet, of which Mr. Campbell made me a drawing. Afterwards, at Rock Mary, we saw eight or ten great cones truncated at the summit, and being from sixty to one hundred feet in elevation. The strata are horizontal, and thick strata of red sandstone predominate with alternations of red shales, more argillaceous and separating in thin leaves. Two or three beds of silicious limestone occur at the upper part, of a whitish grey color, very hard, and which have preserved the lower strata from denudation; forming natural mounds.

Near Camp No. 29, there are similar mounds with columns of sandstone showing stratification. These red sandstones are very thick, nearly one hundred and fifty feet, and I commence to suspect that since leaving Delaware mountain we are on the New Red sandstone instead of the lower carboniferous. No pebbly alluvium; a perfect plain.

*August* 30.—*At Camp No.* 30.—Twenty steps east of the Camp I find the following section in the bank of the creek:

| | |
|---|---|
| Argillaceous dolomite.. | 6 feet. |
| White gypsum | 25 " |
| Sandstone and argillaceous shales and red clay | 10 " |

The latter is at the level of the creek.

We passed for seven miles upon red argillaceous sandstones, and afterwards upon white gypsum, which is superposed upon sandstone. This white gypsum is amorphous, with some crystallized veins and rose-colored belts. The beds are horizontal, and the gypsum is from twenty-five to thirty feet thick. In several places where we passed the gypsum is decom-

mie argileuse, un peu caverneuse, rougeâtre, grise lorsqu' elle est exposée à l'air.

31 *Août*.—Le gypse plonge au nord, sous un angle de 15° près du Camp No. 31. Le gypse apparait en plusieurs endroits, entre les camps 30 et 31 ; mais les grès et argiles rouges dominent ; ainsi à Gypsum creek, Bear creek ; mais à Comète creek le gypse parait plus puissant. Près du Camp No. 31 on a une alluvion caillouteuse de quartz, carbonate of lime, silex, jaspe, gneiss et quelque fragments roulés d'*Ostrea*, crétaceé, provenant de la vallée de Washita d'où l'on peut conclure que nous sommes dans Washita ou Wishita vallée. On voit plus au sud est à 35 milles, les Wishita mountains.

1 *Septembre*.—À 2 miles ouest sud du Camp No. 31, on a au sommet et à moitié quelques fois des collines de grès rouges et argiles rouges, trois ou quartre couches brisées, et ——— [?] disseminées ça et là ; comme des ruines sont formées d'une calcaire lumachelle du Néocomien ; cette lumachelle est formée des débris *d'Ostrea aquila* ou *couloni?* ou une variété car elle est plus petite ; on peut recueillir une quantité de ces Ostrea en bon état de préservation ; je trouve aussi une remplisse de petit *Pecten quinque-costatus* et un débris de *Terebratula*. Avant la lumachelle en contact avec le grès argilleux rouge du Trias, il y à grès calcaire blanc grisâtre, qui passe à un calcaire blanc un peu oolitique ——[?] puis la lumachelle d'*Ostrea;* cette couche de passage a seulement 1 pied d'épaisseur. Les 4 couches de lumachelle ont 2 pieds, à l'exception de ces petits points Néocomien, tout le reste de la marche jusqu'au Camp No. 32, est sur le *New Red sandstone*, argileux, L'alluvion est du sable rouge avec quelques cailloux de quartz et du fer hematite. Dans le *new red*, près du Néocomien, on a une couche calcaire, trés ferrugineuse.

2 *Septembre.—Du No.* 32 *au No.* 33.—On a constamment le grès argilleux rouge, avec

posed and forms zig-zag caverns. The alluvium is red sand with some pebbles of quartz. At Camp 30, we have beds of argillaceous dolomite, somewhat cavernous ; reddish, and when exposed to the air, grey.

*August* 31.—The bed of gypsum dips to the north at an angle of fifteen degrees near Camp 31. The gypsum appears in several places between Camps 30 and 31, but the red sandstone and clays predominate; so, also, at Gypsum and Bear creeks, but at Comet creek the gypsum is more abundant. Near Camp 31, we have an alluvium composed of pebbles of quartz, carbonate of lime, silex, jasper, gneiss, and some rolled fragments of *Ostrea*, cretaceous, coming from the valley of the Washita, whence we can conclude that we are in the valley of the Washita or Witchita. We see further towards the southeast the Witchita mountains.

*September* 1.—*From Camp No.* 31 *to Camp No.* 32.—About two miles southwest of Camp No. 31 we find, at the summit and sometimes half way up the hills, red sandstone and clays in three or four broken beds, with crinoids disseminated here and there as if the ruins were formed of a lumachelle limestone of Neocomien age. This lumachelle is formed by the fragments of *Ostrea aquila* or *couloni*, or a variety, for it is smaller. It is possible to gather a quantity of this Ostrea in a good state of preservation. I found, also, many small shells of *Pecten quinque-costatus* and a débris of *Terebratula*. Before coming to the lumachelle, which is in contact with the red argillaceous sandstone of the Trias, there is a greyish-white calcareous sandstone, which passes to a white limestone slightly oolitic,——[?] then the lumachelle of *Ostrea*. This bed of transition is only one foot thick ; the four beds of lumachelle are two feet. With the exception of these little points *of* Neocomian age, all the rest of the route as far as Camp No. 32 is on the New Red argillaceous sandstone. The alluvion is of red sand, with some pebbles of quartz and some hematite iron-ore. In the New Red, near the Neocomien, we find a very ferruginous bed of limestone.

*September* 2.—*From Camp No.* 32 *to Camp No.* 33.—We constantly find red argillaceous

beaucoup de gypse blanc intercallé, et de la dolomie argileuse rougeâtre. Les ruisseaux sont chargés de substances magnesiennes qui donnet un goût très-prononcé à l'eau. Alluvion comme le jour précédent.

3 *Septembre.—Du No.* 33 *au No.* 31, 21 *milles.*—On suit d'abord des grès et argiles rouges qui deviennent ensuite très-gypseuses ; le gypse est blanc avec quelque veines rose et gris ; les couches ont d'un à 20 pieds ; au dessous se trouve la dolomie argileuse. À moitié chemin entre les deux camps on a une grande quantité de petites collines procédant de dénudations ou de débris de diluvium formé en monticules ; on voit ces monticules dans toutes les directions où l'on regarde. L'alluvion devient ici puissant, et est formé de cailloux plus gros, quartz, granite, de la grosseur d'une gourde, fer erratique, il y a du sable blanc souvent d'une épaisseur de 15 pied, et dur.

On traverse la ligne de partage des eaux de Canadian et Washita et au Camp No. 34, on a un peu de gypse fibreux, cristallisé par des veines de 3 à 4 pouces dans le grès rouge. A 4 milles du Camp No. 33, on trouve les débris d'arbre fossile avec branches à l'etat silicifié ; j'en prends un specimen, il est sur le sol de l'argile rouge.

4 *Septembre.—Du* 34 *au No.* 35, 12 *miles.* On a sur le bord de la rivière Candian les assises de grès rouges, friables très développés avec du gypse blanc, amorphe, et quelque cristaux. Plusieurs monticules avant d'arriver à la rivière sont formés de cailloux d'alluvion, comme le jour précédent. Mais près de la rivière on a seulement du sable blanc et rouge, sans cailloux. Il y a sur la boue sèche du lit de la rivière, des efflorescences de sel et de magnésie. Au Camp No. 35 on a encore du grès rouge, et un peu de gypse blanc au bord du creek. On voit le gypse blanc s'étendant à l'autre côté de la rivière Canadian vers le nord.

6 *Septembre.*—A 4 miles du camp nous passons Antelope Hills, formées de grès friable, blanc grisâtre, incrusté par du carbonate de chaux ; quelques couches supérieures étant entièrement calcaire blanc un peu oolitique ; assises horizontales, stratification distincte en

sandstone, containing intercalations of much white gypsum, and of reddish argillaceous dolomite. The brooks are charged with magnesian substances, which give a very strong taste to the water. Alluvium, as on the preceding day.

*September* 3.—*From Camp No.* 33 *to Camp No.* 34, (21 *miles.*)—We at first followed the sandstones and red clays, which became very gypseous. The gypsum is white, with some rose-colored and grey veins ; the beds are from one to twenty feet thick, and the argillaceous dolomite is found below. Half way between the two camps we find numerous little hills proceeding from the denudation or wrecks of diluvium ; we see little hills in every direction. The alluvium here becomes very thick, and is formed of larger pebbles of quartz and granite, of the size of a gourd. There are also erratic masses of iron ore, and accumulations of white sand, often fifteen feet thick, and hard.

We cross the dividing line of the Canadian and Washita rivers, and at Camp No. 34 we find a little fibrous gypsum, crystallized in little veins, three or four inches thick, in the red sandstone. Four miles from Camp No. 33 we found the débris of a fossil-tree with branches completely silicified. I procured specimens. It is on the red clay.

*September* 4.—*From Camp No.* 34 *to Camp No.* 35, (12 *miles.*)—We find upon the borders of the Canadian river strata of red sandstone, friable, and striped by white amorphous gypsum, with some crystals. Several little hills, before we arrive at the river, are formed of alluvial pebbles, as on the preceding day ; but near the river we have only white and red sand, without pebbles. These are upon the dry mud of the river bed : efflorescences of salt and magnesia. At Camp 35 we still find red sandstone and a little white gypsum at the border of the creek. We see the white gypsum extending on the other side of the Canadian river, towards the north.

*September* 6.—*From Camp No.* 35 *to Camp No.* 36.—Four miles beyond the camp we pass the Antelope Hills, composed of friable sandstone of a dirty greyish-white color, incrusted with carbonate of lime, some of the upper beds being entirely of white limestone, a little ooli-

grand ; décomposition très active, et formant des trous de toutes formes. Pas de fossiles. Je trouve plusieurs cailloux roulés de scorie volcanique de la grosseur du poing et de la tête. Tout le reste du chemin jusqu'au Camp No. 36, est du sable blanc et grisâtre et quelque cailloux d'alluvion.

7 *Septembre.*—Sables blanc grisâtre comme sol, et alluvion avec quelque petits cailloux de quartz. Grès blanc comme à Antelope hills dans les ravins. *Natural mounds* à notre gauche, et sables blancs, sur une surface assez étendue du côté opposé de la Canadian 18¾ miles.

8 *Septembre.—Du No.* 37 *au No.* 38.—On a à droit et à gauche le grès blanc et les alluvions du Rocky mountains. Diluvium de la grosseur d'une noisette à celle du poing avec quelque cailloux de la grosseur de la tête, de grès blanc et calcaire blanc environnant. Nous avons suivi la rivière, mais à notre Camp 38, à droite et à gauche de la Canadian on a le commencement du Llano, espèce de plateau avec quelques montagnes plates isolées comme avant garde. De même que l'Albe du Wirtemburg près de Hendinger et Balenguen.

9 *Septembre.—Du No.* 38 *au No.* 39.—On voit le long des bords du bassin de la rivière, le grès blanc, plus on moins dur blanc ou jaunâtre, horizontal. Diluvium nombreux. Les cailloux de la grosseur d'une gourde deviennent plus mombreux. Scories volcaniques erratiques. Du Camp No. 9 vis-à-vis de la rivière on voit un second gradin de Llano.

10 *Septembre.—Du No.* 39 *au No.* 40.—Même chose que hier ——— [?]; à moitié chemin, il y a un bluff du 30 pieds au-dessus du bassin de la rivière qui est du grès rouge du Trias. Le Llano que nous avons à notre droite se recule de la rivière pour aller à 7 ou 8 miles plus au nord ; mais on l'aperçoit toujours dans le lointain. Près de Camp No. 40 on a dans le diluvium des couches de sable passant à un grès très-friable, renfermant les cailloux de diluvium des Rocky mountains.

tic. The strata are horizontal, and are decomposing rapidly, forming holes or cavities of all shapes ; no fossils were found. I found several rolled masses of volcanic scoriæ of the size of the fist and of the head. The remainder of the road to Camp 36 is of white and greyish sand, with some alluvial pebbles.

*September* 7.—*From Camp No.* 36 *to Camp No.* 37, (18¾ *miles.*)—Greyish-white sand, like soil and alluvium, containing some small quartz pebbles. White sandstone in the ravines, as at the Antelope Hills. Natural mounds at our left, and white sand, upon a somewhat extended surface, on the side opposite the Canadian river.

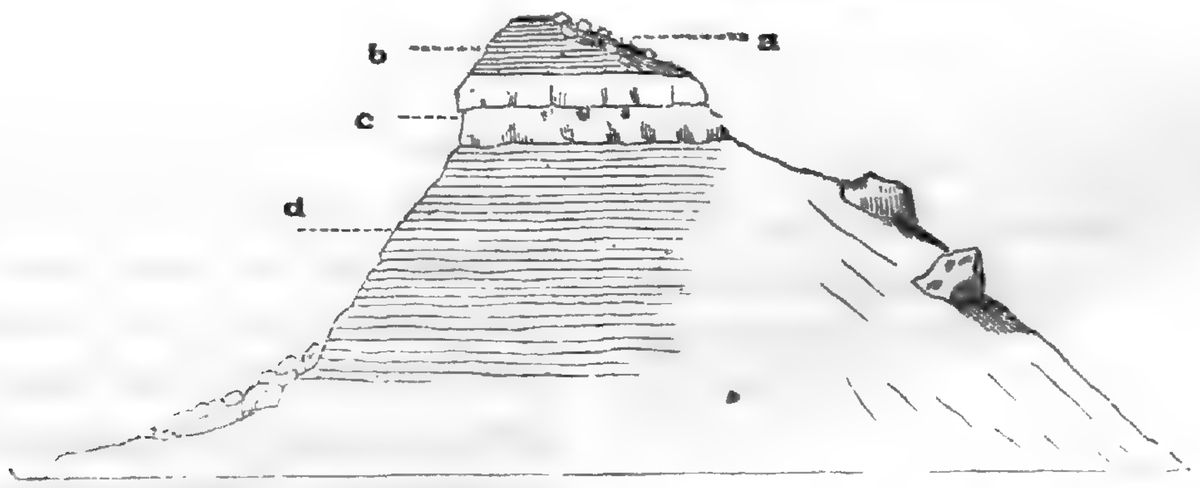
*September* 8.—*From Camp No.* 37 *to Camp No.* 38.—We have white sandstone on the right and left, and the alluvium of the Rocky mountains. Diluvium from the size of a hazelnut to that of the fist, with some masses as large as the head, composed of white sandstone and limestone, is found about us. We have followed the river ; but at our Camp 38, on the right and left of the Canadian, we have the commencement of the Llano, a sort of plateau, with some flat, isolated mountains, as an advanced guard, similar to the "*Alb*" of Wirtemburg, near Hedinger and Balenguen.

*September* 9.—*From Camp No.* 38 *to Camp No.* 39.—We see along the borders of the river white sandstone, more or less hard, white or yellowish, and horizontal. Diluvium abundant ; the pebbles, as large as a gourd, become more numerous, and volcanic scoriæ is also present. From Camp No. 39, opposite the river, we saw a second step or flat summit of the Llano.

*September* 10.—*From Camp No.* 39 *to Camp No.* 40.—We find the rocks the same as yesterday, except———[?]; at about half-way, there is a bluff thirty feet high above the bed of the river, which is of grey sandstone of Triassic age. The Llano, which we have on our right, withdraws from the river and rises seven or eight miles further north, but it is always visible in the distance. Near Camp No. 40, we find in the diluvium beds of sand passing into a very friable sandstone, and containing the pebbles of the diluvium of the Rocky mountains.

1 *Septembre.—Du No.* 40 *au No.* 41.—On ₎ le diluvium R. M. avec des cailloux plus gros et des blocs de dolomie ou mieux calcaire magnésien du Trias environnant. Beaucoup de sables blancs tout le long de la rivière. A droite et à gaùche on voit le New Red sandstone ou Trias, avec quelque veines de gypse et un banc de 3 ou 4 pieds en hauteur de Dolomie blanche, caverneuse ou ——— [?] avec couches rosâtres comme à Salins; des argiles rouges se trouvent au-dessous et au-dessus de ce banc de dolomie. Deux ou 3 milles avant d'arriver au Camp 41, on voit au milieu d'un grand nombre de monticules de diluvium cailloux, et couvert de vegetation, un monticule conique avec une grande quantité de blocs de dolomie; cela provenant du sommet.

*September* 11.—*From Camp No.* 40 *to Camp No.* 41.—We see the diluvium of the Rocky mountains, with larger pebbles and blocks of dolomite or magnesian limestone of the surrounding Trias. Abundance of white sand borders the river on the right and left. We see the New Red sandstone or Trias, with some veins of gypsum and a bank of white dolomite three or four feet high, and cavernous or ——— [?] with rosy-colored beds as at Salins. The red clays are found below and above this bed of dolomite. Two or three miles before reaching Camp No. 41, we see, in the midst of a great number of hillocks of sandy diluvium covered with vegetation, a conical hillock, the sides of which are strewn with a large quantity of blocks of dolomite which have fallen away from the summit.



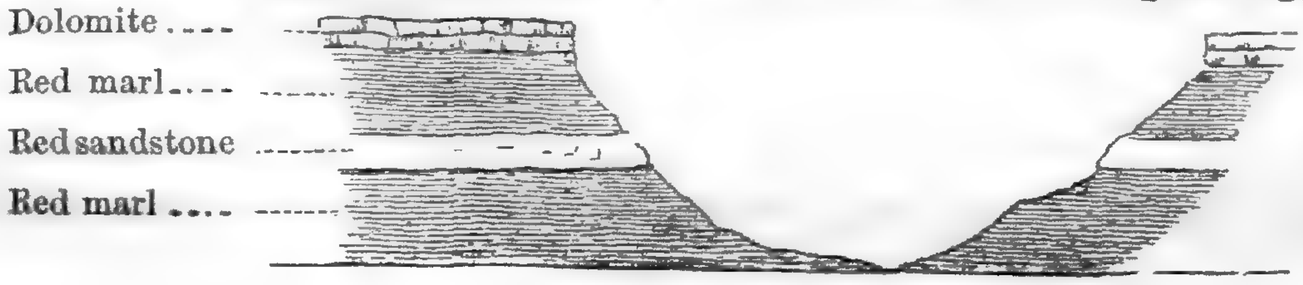

a. Diluvium. b. Red marl. c. Dolomite. d. Red marl.

12 *Septembre.—Du No.* 41 *au No.* 42.—On a à peu de distance du Camp No. 41, dans les bluffs qui dominent la route, des bancs de gypse de ½ à 1 pieds d'épaisseur, et les marnes rouges et un peu vertes en places sont saliféres. Il y a des trous d'eau très saumâtre et magnésienne, insupportable au goût. On monte de la vallée de la Canadian au sommet du Llano, passant à des schistes sableux rouges et épaisses avec de dolomie, 3 on 5 pieds. Diluvium de Rocky mountains nombreux et un peu gros.

*September* 12.—*From Camp No.* 41 *to Camp No.* 42.—At a short distance from Camp No. 41, in the bluffs which overhang the route, are beds of gypsum from one-half to one foot in thickness, and the marls, which are red and in some places green, are saliferous. There are also holes filled with very brackish and magnesian water, which is insupportable to the taste. We ascended from the valley of the Canadian river to the summit of the Llano, and found the beds of red marls turning into red sandy shales, and strata of dolomite from three to five feet thick. The diluvium from the Rocky mountains is abundant and coarse.

13 *Septembre.*—Au No. 42 où nous séjournons on a un bel exemple de dolomie du Trias des prairies avec marnes rouges et vertes et gypse blanc, amorphe.

*September* 13.—At No. 42, where we rested, we found a beautiful exhibition of the dolomite of the Trias of the prairies, with red and green marls and white amorphous gypsum.



14 *Septembre.—Du No.* 42 *au No.* 43.—On a le diluvium des Rocky mountains avec sable blanc, et des cliffs dans les *creeks* de *white sandstone*, un peu rose, avec calcaire blanchâtre. Au Camp No. 43, ou Rio Bonito, on a un grand développement de ce grès, très-friable, rose et blanc avec concrétions calcaires et couches calcaire blanc. Pas de fossiles.

15 *Septembre.*—A 4 miles du Camp No. 43 on à des monticules de marnes sableuses rouges avec une couche des grès rouge en contact avec un grès friable comme à Antelope Hills. A 8 miles on à Amarillo arroyo une dolomie où il y a du sulphate de baryte, au-dessus et au-dessous on a les *sandy red marl.* Des couches de sandy marl, au lieu d'être rouges et vertes sont jaune verdâtre, 15 pieds d'épaisseur et un peu dolomitiques.

L'épaisseur de ces marnes irisés ou partie supérieure du Trias américain est considérable, au moins 300 pieds au-dessus de gypse. Le grès blanc est peu nombreux aujourd'hui. Diluvium des Rocky mountains nombreux et épais sur tout le plateau. Section au Rio Amarillo :

Sables rouges alluviaux.
Diluvium Rocky mountains.
Sandy marl red.

16 *Septembre.—Du No.* 44 *au No.* 45.—On a constamment les *red sandy marl* avec quelque bandes vertes et jaunes. Le diluvium est assez nombreux. A notre gauche on voit dès le matin le Llano Estacado avec une crête blanche qui forme la table de son sommet, 20½ miles.

17 *Septembre.—Du No.* 45 *au No.* 46.—A 8 miles du No. 45 on s'arrête à *Encampment creek*, ou l'on a la coupe suivante qui est la même au pied du Llano.

*White limestone.*
*Calcareous conglomerate.*
Calcaire.
Grès avec nombreuses concrétions calcaire.
*Red sandy marl* de New Red.

Dans le lit du creek on a les *red sandy marls* avec taches vertes, et le diluvium au-dessus à peu près jusqu' à moitié du Barrancas, puis on

*September* 14.—*From Camp No.* 42 *to Camp No.* 43.—We found the Rocky mountain diluvium with white sand, and in the creeks cliffs of white sandstone, a little rose-colored, with whitish limestone. At Camp No. 43, at Rio Bonito, we found a great development of this sandstone; very friable; of a rose or white color, containing calcareous concretions, and some beds of white limestone. No fossils seen.

*September* 15.—*From Camp No.* 43 *to Camp No.* 44.—Four miles from Camp No. 43, we found hillocks of red sandy marls, with a bed of red sandstone, in contact with a friable white sandstone, as at the Antelope Hills. Eight miles from camp, we found at *Arroyo Amarillo* (Yellow creek) a dolomite which contains sulphate of baryta. Above and below, the sandy and red marls occur. Some beds of sandy marl, instead of being red and green, are greenish-yellow, are somewhat dolomitic, and have a thickness of fifteen feet.

The thickness of the variegated marls, or the superior part of the American Trias, is considerable, not less than three hundred feet above the gypsum. White sandstone is not abundant to-day. The diluvium of the Rocky mountains is abundant and thick on all the plateaus. A section at Rio Amarillo gives the following succession of deposites from the surface to the river :

Red alluvial sands.
Diluvium of the Rocky mountains.
Red sandy marl.

*September* 16.—*From Camp No.* 44 *to Camp No.* 45.—We constantly found red sandy marls, with some green and yellow bands; the diluvium is also abundant. At daylight we saw on the left the Llano Estacado, with a white crest forming a table-like summit.

*September* 17.—*From Camp No.* 45 *to Camp No.* 46.—At eight miles from Camp 45 we stopped at Encampment creek, and found the following vertical section, which is the same at the foot of the Llano:

White limestone.
Calcareous conglomerate.
Limestones.
Sandstone with numerous calcareous concretions.
Red sandy marls of the New Red.

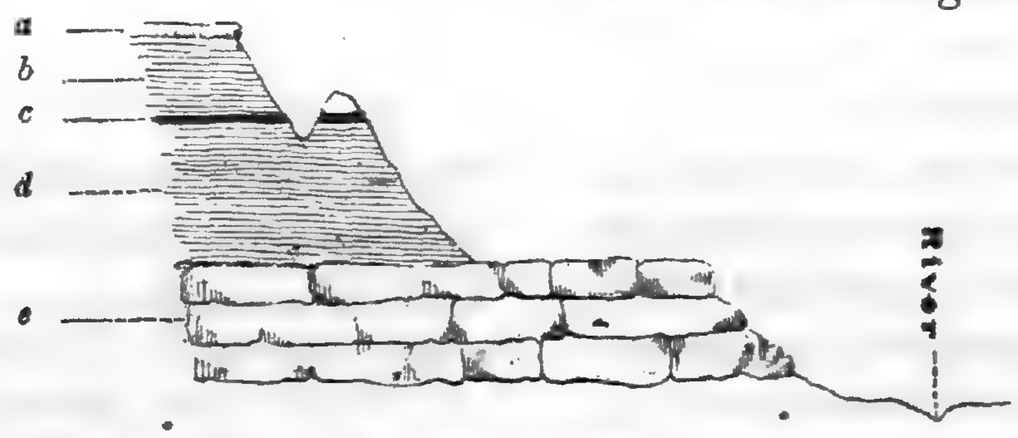
We have, in the bed of the creek, a red sandy marl with green spots, and diluvium, about

à un grès calcaire jaunâtre, avec nombreuses concrétions calcaires de la grosseur d'une noisette ou d'une pomme, à peu près 30 pieds. Puis au-dessus on a une couche de conglomerate très-calcaire, les cailloux sont de silex, quartz, jaspe, gneiss, fer; la pâte calcaire est rose. Dans deux cailloux, l'un est de fer avec beaucoup d'empreintes de petites bivalves indéterminables et deux petites *Turritella*. Je pense que ce morceau de fer vient du carbonifére. Plus un morceau de calcaire jaune rougeâtre, renfermant une lumachelle que je crois être d'*Ostrea Aquila Americana*. Deux pieds au-dessus on a un demi-pied de calcaire blanc, très-compacte, à cassure conchoide avec petites géodes de cristaux de carbonate of lime. Puis suit un calcaire, tantôt un peu grisâtre, le plus souvent très-blanc, friable un peu crayeux, qui tache les doigts et qui vu au-loin ressemble à la craie, 15 à 20 pieds. Au-dessus il n'y a pas de diluvium de même espèce, mais la terre végétale. Je pense que cette Llano formation est crétacé superieur.

18 *Septembre*.—Le Llano Estacado est de la terre, provenant de la décomposition du limestone crétacé; pas d'alluvion d'aucune espèce. Au Camp No. 46, on a la section suivante.

half-way up the hill of Barrancas; then we found, for about thirty feet, a yellowish calcareous sandstone containing numerous calcareous concretions of the size of a hazel-nut or an apple. Still above we found a bed of a very calcareous conglomerate; the pebbles are of silex, quartz, jasper, gneiss, and iron-ore, and the calcareous cement is rose-colored. Of two of these pebbles, one is ferruginous, with many casts and imprints of small undeterminable bivalves and two little *Turritellas;* I think that this ferruginous mass is of carboniferous age. Another mass of limestone, of a reddish yellow color, contains a lumachelle, which I consider to be of *Ostrea aquila Americana*. Two feet above we have a thickness of half a foot of white limestone, very compact, breaking with a conchoidal fracture and containing small geodes of crystals of carbonate of lime. Then follows fifteen or twenty feet of limestone; a little greyish, but mostly very white; it is friable and somewhat chalky, soiling the fingers, and when seen from a distance resembles chalk. Above it there is no diluvium of any kind, but the earth is vegetable mould. I think that this Llano is the superior cretaceous.

*September* 18.—The surface of the Llano Estacado is of earth, proceeding from the decomposition of the cretaceous limestone. No alluvium of any kind. At Camp No. 46, we have the following section:




| | | |
|---|---|---|
| *a*. Limestone resemblant au forêt marbre | 10 | pieds. |
| *b*. Red sandy marl<br>*c*. Sandstone, violet<br>*d*. Red marl | 150 | " |
| *e*. Grey sandstone, quelques fois violet | 100 | " |

Le sandstone du Rocky Delaware creek ou Agua Piedra est grès blanchâtre, quelques assises schisteuses sont rosâtres, dénudation profonde et bizarre, hieroglyphes des *Pueblo Indians*. [Drawings of some of these hieroglyphics accompany this note.]

Au-dessus on a des marnes rouges et grisâtres, avec teintes vertes et quelque assises de grès

| | | |
|---|---|---|
| *a*. Limestone resembling forest marble | 10 | feet. |
| *b*. Red sandy marl<br>*c*. Violet sandstone<br>*d*. Red marl | 150 | " |
| *e*. Gray sandstone, sometimes violet | 100 | " |

The sandstone of the Rocky Delaware creek, or Agua Piedra, is whitish-grey, with some shales of a rosy hue. The denudation is deep and peculiar. Some singular hieroglyphics, made by the Pueblo Indians, were seen here.

Above the sandstone we have one hundred and fifty feet of red and greyish marls, with green tints, and some beds of shaly sandstone

schisteux, rose et rouge, 150 pieds; puis au sommet de la montagne qui est à l'ouest du camp on a un calcaire gris blanchâtre, rougeâtre à cassure lisse et ressemblant au forest-marble du Jura; pas de fossiles. Ce doit être du Crétacé, ou peuts être du Jurassique. Le *sandstone* gris et blanc où se trouve notre camp est du Trias, et tous le *sandstone* précedent depuis Antelope Hills est la même couche, qui n'est nullement crétacée. Pas de diluvium.

19 *Septembre.—Du No.* 46 *au No.* 47.—Partie supérieure du Trias ou New Red entre le Crétacé et le *grey sandstone.* Pas de diluvium; un peu de calcaire crétacé venant de Llano; beaucoup de specimens d'un bois fossile de Trias. Les morceaux trouvés pres de *gypsum creek* sont du Trias et non-erratique comme je le croyais alors.

20 *Septembre.—Du No.* 47 *au No.* 48.—Le même qu 'hier. On trouve dans 3 ou 4 ravins sans eau courante maintenant, près du Camp 48, des *Ostrea aquila* roulés et un *Trigonia;* ce qui prouve que cêtte couche Néocomienne se trouve sur le sommet du Llano, où l'on voit un second gradin.

21 *Septembre.—Du No.* 48 *au No.* 49.—New Red all the way, avec crétacé sur le top du Monte Revulto et Tucumcari.[1]

of a rose and red color. Then at the summit of the mountain, which is at the west of the camp, we have a grey, whitish and reddish limestone, which breaks with a smooth fracture and resembles the forest marble of the Jura. No fossils were seen; it must be Cretaceous or Jurassic. This greyish white sandstone at our camp is of Trias, and all of the preceding sandstone from the Antelope Hills is the same bed, which is by no means cretaceous. No diluvium.

*September* 19.—*From Camp No.* 46 *to Camp No.* 47.—The superior part of the Trias or the New Red is between the cretaceous and the grey sandstone. No diluvium; a little cretaceous limestone coming from the Llano. Many specimens of the fossil-wood of the Trias were found; the pieces found near Gypsum creek are of the Trias, and not erratic, as I then thought.

*September* 20.—*From Camp No.* 47 *to No.* 48.—The same formations as yesterday. We found in three or four dry ravines, near Camp 48, some rolled specimens of *Ostrea aquila,* and a *Trigonia,* which proves that this Neocomien bed is situated on the top of the Llano, where we see a second table or summit.

*September* 21.—*From Camp No.* 48 *to Camp No.* 49.—The New Red is found all the way between these camps, with cretaceous on the top of Mount Revulto and Tucumcari.

*September* 22.—*From Camp No.* 49 *to Camp No.* 50.—At Pyramid mountain we find the following succession of strata:

SECTION AT PYRAMID MOUNTAIN.

| | | |
|---|---|---|
| | White limestone. | "Jurassic." |
| | Yellow limestone, with bluish-grey bed at the bottom. | |
| | Bed containing Ostrea [——?] | |
| | White sandstone. | |
| | Yellow sandstone. | |
| 500 ft. | White sandstone. | |
| | Grey and green bed, in contact with the superior Trias. | |
| | Red and green sandstone. | |
| | White marls with [concretions?] | "Triassic." |
| | Red and green marls. | |
| | White. | |
| | Red. | |

Nous faisons l'ascension et l'exploration de Pyramid Moutain; à 4 milles du Camp No. 48;

We made the ascension and the exploration of Pyramid mountain at a point four miles from

[1] The section of Pyramid Mountain being given in English in the original, it is not duplicated.—W. P. B.

la base et formée des couches superieures du Trias, l'argile rouge dominant, avec bandes vertes et bandes blanches; le rouge étant quelquefois lie de vin, le petit cone à droite est entièrement formé de ce Keuper, qui resemble beaucoup à Brissot. Une couche gris bleu de 1 pied sert de transition et est en contacte avec un grès gris et vert.

En suite on a une enorme couche de grès jaune très fin et dur, 60 pieds de hauteur; c'est coupé perpendiculairement et forme des cliffs non seulement ici, mais tout le long des montagnes que nons voyons hier et aujourd'hui. Au-dessous on a des assises de grès blanc très-fin, très faciles à dégager et qui ont des monticules sableuses au pied des assises; à peu près 25 pieds; puis on a une assise d'argile gris bleu, sub-schisteuse avec *Ostrea*. La couche *d'Ostrea dilatata* est à 6 pouces du banc de *white sandstone*, et a 2 pouces d'épaisseur; les *Ostreæ* sont libres ou unies, et il est très difficile de trouver des specimens avec la valve supérieure et le bord parfait; quelques *Ostrea* sont désséminés un peu plus haut dans la marne, mais elles sont rares. Les argiles à *Ostrea*, ou *True Oxford clay*, ont 30 pieds; puis vient un grès à pâte calcaire, jaune et brillant, très dur, à strata de 5 ou 6 pieds d'épaisseur, qui devient entièrément calcaire microtant jaune, au sommet; enfin sur quelques parties du sommet on a un calcaire silicieux blanc, gris, sans fossiles, analogique à celui d'encampment creek. Toute la plaine de Plaza Larga n'a pas d'alluvions, à peine quelques fragments de calcaire et de grès disséminés sur des monticules, ou dans Tucumcari creek. Toutes les montagnes environnant sont courroneé par ce Jurassique à *Ostrea dilatata*, jusqu'au Camp No. 49, ou cêtte partie supérieure disparait. *Ostrea* Marchii ou ———[?]

23 *Septembre.—Du No.* 50 *au No.* 51.—On a constamment l'upper Trias, argile est gris rouge quelque grès gris à la base; le Llano se voit sur notre gauche jusque vers le Camp 51, où il disparait au sud il est entièrement formé de Trias, le grès blanc et jaune Jurassique est

Camp No. 48. The base of this mountain is formed of the superior beds of the Trias, red clays predominating, with green and white bands, the red being sometimes wine-colored. A small cone on the right is formed entirely of this *Keuper*, which much resembles that of Brissot. A greyish-blue bed, one foot thick, forms the transition to, and is in contact with, a grey and green sandstone. We afterwards found an an enormous bed of very hard and yellow sandstone, sixty feet in height, and cut perpendicularly, forming cliffs not only at this place, but along the whole of the mountains which we saw yesterday and to-day. Above we found beds of very fine white sandstone, which are easily separated, and which have hillocks of sand about twenty-five feet high at their base. We then found a bed of greyish-blue clay, sub-schistose, with *Ostrea*. The bed of *Ostrea dilatata* is six inches from the bank of white sandstone, and is two inches thick. The *Ostreæ* are separate or united; but it is very difficult to find specimens with the superior valve and perfect edges. Some specimens are disseminated a little higher in the marl, but they are rare. These clays with *Ostrea*, or true Oxford clay, have a thickness of thirty feet. Then comes a calcareous sandstone, yellow and shining; very hard, with strata five or six feet in thickness, which become yellow, "*calcaire microtant*," at the summit. Finally, on some parts of the summit we found a greyish-white silicious limestone, without fossils, analogous to that of Encampment creek. All the plain of *Plaza Larga* is without alluvium; there are hardly any fragments of limestone or sandstone disseminated on the hillocks, or in Tucumcari creek.

All the surrounding mountains are crowned with Jurassic strata, with *Ostrea dilatata*, as far as Camp No. 49, where that superior portion disappears. [1]*Ostrea marchii* — — —[?]

*September* 23.—*From Camp No.* 50 *to Camp No.* 51.—We found constantly the upper Trias; the clays and sandstones are red, and sometimes the sandstone is grey at the base. The Llano appears on our left as far as Camp 51, where it disappears towards the south. It is

[1] Mr. Marcou here mentions *Ostrea marchii* in connexion with two or three words which cannot be deciphered.

disparu à moitié chemin. Pas d'alluvion in diluvium.

24 *Septembre.—Du No.* 51 *au No.* 52.—On est constamment sur l'upper Trias. À moitié chemin, à notre droite, on a une montagne conique, large, le sommet est Jurassique, ainsi que celui de plusieurs montagnes que l'on voit plus loin à droite.

26 *Septembre.—Du No.* 52 *au No.* 53.—On a au sommet d'un plateau que l'on treverse à 2 milles du Camp le calcaire blanc grisâtre, à structure noduleuse du Llano; qui doit être Jurassique; en suite on est constamment sur l'upper Trias, grès rouge et argile rouge; dans la vallée du Gallinas river, on trouve, pour la première fois le diluvium des Rocky Mountains un granite rose, quartz blanc et trap noir verdâtre, ce dernier en abondance et gros du poing à la tête três-roulé. Entre Gallinas et Rio Pecos on a plus de diluvium des petites collines, et l'on voit à notre droite de hautes collines à tables, dont le sommet doit être Jurassique, par la couleur des roches. Ce Jurassique parait s'étendre plus au nord qu'au sud de nous.

27 *Septembre.—No.* 53.—Dans le diluvium du Rio Pecos, on a de la dolomie erratique et du gypse, on trouve cela à 5 milles en remontant de puis Anton Chico. Anton Chico est situé dans un bassin du red marl du Trias avec diluvium et alluvion sableux.

28 *Septembre.—Du No.* 53′ *au No.* 54′.—On monte les assises de l'upper Trias 500 pieds, puis on entre sur un plateau où il y a le cañon Blanco, dans le grès blanc Jurassique. À l'ouest des cliffs perpendiculaires de 800 à 1,000 pieds montrant une belle section de l'upper Trias et du lower Jurassique. En montant des deux formations il y a une dolomie marneuse et sableuse. Dans le grès Jurassique blanc, il y a souvent intercallées des assises marneuses d'un grès blanc; quelques couches de grès calcaire jaune, moins qù à Pyramide mont; au sommet du cliff on n'a pas encore la

formed entirely of Trias; the white and yellow Jurassic sandstone disappeared at half-way. No alluvium or diluvium.

*September* 24.—*From Camp No.* 51 *to Camp No.* 52.—We are constantly on the upper Trias. About half way, on our right, we saw a large conical mountain, the summit of which is Jurassic, as well as those of several mountains which are visible further to the right.

*September* 26.—*From Camp No.* 52 *to Camp No.* 53.—At the summit of a plateau which we crossed, two miles from the camp, we found greyish-white limestone with the nodular structure of the Llano, which must be Jurassic. Afterwards we are constantly upon the *upper Trias;* red sandstone and red clays. In the valley of the Gallinas river we find, for the first time, the diluvium of the Rocky mountains, consisting of much rolled masses of a rose-colored granite, white quartz, and greenish-black trap; the latter in abundance, and from the size of the fist to that of the head. Between Gallinas river and the Rio Pecos we find more diluvium, forming little hills, and we see on our right high hills, forming table-lands, the summit of which must be Jurassic, judging from the color of the rocks. This Jurassic appears to extend more to the north than southward from us.

*September* 27.—In the diluvium of Rio Pecos we find some erratic dolomite and gypsum, five miles above Anton Chico. This place is situated in a basin of red marl of Triassic age, with sandy alluvium and diluvium.

*September* 28.—*From Camp No.* 53′ *to Camp No.* 54′.[1]—We ascended the beds of the upper Trias five hundred feet, and again find a plateau where cut by *Cañon Blanco* in the white Jurassic sandstone. At Cuesta, perpendicular cliffs of 800 to 1,000 feet high exhibit a beautiful section of the upper Trias and lower Jurassic. On ascending these formations, there is a sandy and marly dolomite. In the white Jurassic sandstone, there are often intercalations of greyish-white marly beds; sometimes of beds of yellow calcareous sandstone less than at Pyramid mountain. At the

[1] From this point, the numbers of the camps do not agree with those of Lieutenant Whipple's train, which took the arcou travelled towards Santa Fé.

couche à *Gryphœa*. On voit au nord ouest de nous que les assises du Trias et du Jurassique sont relevés et plongent à l'est ; les montagnes rocheuses se voient à 20 on 30 miles. Pas du diluvion sur le plateau et dans le Cañon Blanco ; quelques assizes de calcaire blanc noduleux dans le cañon.

30 *Septembre.—Du No.* 54′ *au No.* 55′.—On suit les gorges du Cañon Blanco, le fond de la gorge est du trias supérieur et les bluffs sont du grès blanc et jaune Jurassique, avec quelques assises de marnes grises interposées et un calcaire blanc grisâtre, noduleux comme aupararant. Pas de fossiles trouvés. Les assises du Trias et Jurassique sont en concordance de stratification et inclinent à l'Est'est Sud; la tête des couches regardant les Rocky mountains. Pas de diluvium; un peu d'alluvions dans le fond du cañon.

1 *Octobre.—Du No.* 55′ *au No.* 56′.—À 2 miles on a un petit cañon qui conduit au Rio Galisteo, et qui est entièrement sur l'upper Trias, avec une traversine de Jurassique ou grès jaune concretionaire. À droite, on suit une ligne de collines disloquées de grès jaune et blanc Jurassique au sommet avec upper red Trias à la base. La direction est nord, sud, les couches plongeant est et ouest sous un angle de 15 à 60 dégrés. Quelques assises de grès jaune ont glissé sur le red marl du Trias et sont renversèes en plusieurs endroits. Dans cette vallée on a un peu de diluvium venant de Gold mountains. C'est une roche quartzeuse avec cristal noir de *pyroxine?* Au village de Galisteo on a des collines de diluvium venant de Santa Fé mountain, il y a granite, quartz, serpentine, etc.

*Du No.* 55′ *au No.* 56′.—Dyke de trap 30° est est nord à 30° O. O. S. coupe le sandstone blanc, 10 pieds de large, à 400 yards nord du Camp No. 56; grès jaune blanc du Jurassique. Les assises du Trias apparaissent ensuite disloquées et inclinent généralement au sud sud est sous un angle de 10 à 15°. Avant d'arriau sommet d un plateau on est sur le diluvium épais, à fragments anguleux, non gros avec

summit of the cliff we do not yet find any beds of *Gryphœa*. We see in the northwest of us that the beds of the Trias and of the Jurassic are upheaved, and dip to the east. The Rocky mountains are seen twenty or thirty miles distant. No alluvium upon the plateau, or in the Cañon Blanco, but some beds of nodular white limestone were seen in the cañon.

*September* 30.—*From Camp No.* 54′ to *Camp No.* 55′.—We followed the gorge of Cañon Blanco. The bottom of the gorge is of upper Trias, and the bluffs are of white and yellow Jurassic sandstone, with some interposed beds of grey marls, and a greyish-white nodular limestone as before. No fossils found. The Triassic and Jurassic strata are conformable, and are inclined towards the E.E.S. The heads of the strata are turned towards the Rocky mountains. No diluvium; a little alluvium in the bottom of the cañon.

*October* 1.—*From Camp No.* 55′ *to Camp No.* 56′.—Four miles from the camp, we found a small cañon in the upper Trias; then a long cañon which led to Rio Galisteo, and which is entirely upon the upper Trias, but crosses a belt of Jurassic, or yellow concretionary sandstone. We followed a line of hills of dislocated white and yellow sandstone of Jurassic age at the summit, with the upper Trias at the base. The direction is north and south, and the strata dip east and west, at an angle of from fifteen to sixty degrees. Some beds of yellow sandstone have slid upon the red marl of the Trias, and are overturned in several places. In that valley we have a little diluvium coming from Gold mountain; it is a quartzose rock with black crystals of pyroxene. In the village of Galisteo, we have hills of diluvium coming from the Santa Fé mountains; there are among it masses of granite, serpentine, &c.

*October* 2.—*From Camp No.* 56′ *to Camp No.* 57′.—At four hundred yards north of Camp No. 56′, a trap-dyke ten feet wide cuts the white sandstone in a direction 30° E.E.N. to 30° W.W.S. These sandstone are yellowish-white and Jurassic.

The beds of the Trias beyond are upheaved, and are generally inclined to the south-southeast under angles of ten to fifteen degrees.

sable. Granite rose à cristaux de hornblende comme au Lac Supérieur. On a au Cerrito où nous campons, les cônes et couches d'anciens volcans ; trachyte et roche pyroxènique, trap. Un poudingue blanchâtre recouvre les trachytes horizontalement le long du creek.

Derrière est la sierra Jumez et la Rio Grande. Les volcans sont au sud de Santa Fé entre Placer et San Domingo et sont nommés Cerritos ainsi que les ranchos où nous campons.

3 *Octobre.—Du* 57′ *au No.* 58′.—A peu de distance du camp on trouve le rio de Santa Fé qui suit une barranca pendant sept ou huit milles; on a des roches pyroxéniques au bord du volcan et le *New Red,* relevé au nord ou horizontal ; avec une immense couche de lava trap, recouvrant le tout et formant le top du barranca. Quelquefois ce trap est basaliforme, et il recouvre aussi le grès Tertiaire qui est au bord du bassin du Rio Grande. On voit dessous une brèche volcanique formée de roches pyroxéniques et autres, roulées des Rocky mountains dessous le trap. Des scories de lava de lapilli rougeâtres trés-légères; de la dolomie. Les côtes des barrancas ont de 250 à 300 pieds d'élévation. Ces montagnes d'hier et de ce matin sont nommées les Cerritos.

4 *Octobre.—Du No.* 58′ *au No.* 59′.—On suit constamment les bords du Rio Grande, avec l'alluvion à cailloux assez gros, pas de blocs erratiques. Près de San Felipe, la gorge se resserre et on a la lave trap qui couronne le sommet de New Red et de grès blanc. De l'autre côte du Rio Grande on voit cette lave noire s'étendant et formant le sommet des cliffs.

5 *Octobre.—Du No.* 59′ *au No.* 60′.—On suit les mêmes alluvions sableuses, de plus, la vallée s'élargit considérablement et entre Alameda et Albuquerque l'on voit de veritables dunes de sable 2 ou 3 en succession dans la direction du sud au north.

8 *Octobre.*—D'Albuquerque au Camp A au-

Before arriving at the summit of the plateau, we stand on a thick diluvium containing angular fragments of small size, and mingled with sand and rose-colored granite, with crystals of hornblende, as at Lake Superior. At the Cerrito, where we encamped, we found the cones and streams of an ancient volcano ; trachyte, pyroxenic rocks, and trap. A whitish conglomerate, in horizontal beds, covers the trachytes along the creek. The Sierra Jemez and the Rio Grande lie beyond these volcanoes ; they are south of Santa Fé, between Placers and San Domingo, and they are called *Cerritos*, as well as the ranchos where we camped.

*October* 3.—*From Camp No.* 57′ *to Camp No.* 58′.—A short distance beyond camp we found the Santa Fé river, which follows a barranca for seven or eight miles. We find volcanic rocks at the borders of the volcano, and in the north elevated beds of New Red, norizontal, with an immense stream of trappean lava covering the whole, and forming the top of the barranca. This trap is sometimes basaltiform, and it also covers the Tertiary sandstone which is at the border of the basin of the Rio Grande. We saw under the trap a volcanic breccia, formed of pyroxenic and other rocks rolled from the Rocky mountains. We saw scoriaceous lava, and a very light reddish lapilli, and some dolomite. The sides of the barrancas are from 250 to 300 feet in elevation. The mountains seen yesterday and this morning are named *Cerritos.*

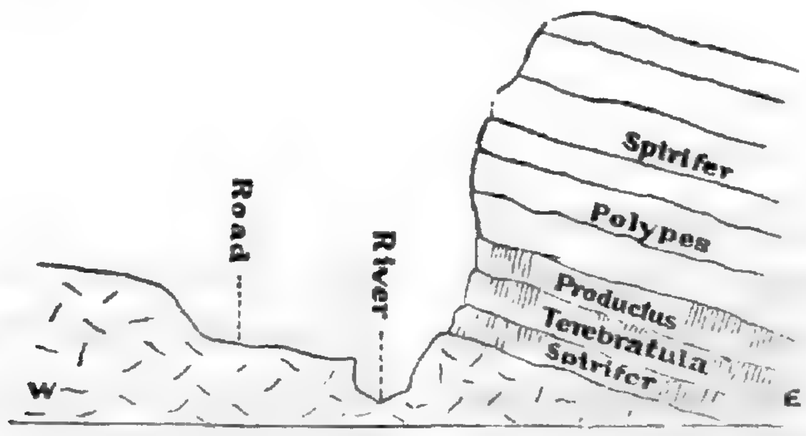
*October* 4.—*From Camp No.* 58′ *to Camp No.* 59′.—We were constantly upon the borders of the Rio Grande. The alluvium is rather coarse, and there are no erratic blocks. Near San Felipe the ravine becomes narrower, and we see the trappean lava which crowns the summit of the New Red and white sandstone. On the other side of the Rio Grande we see this black lava spread out and forming the summit of the cliffs.

*October* 5.—*From Camp No.* 59′ *to Camp No.* 60′.—We followed the same sandy alluvions. The valley widens considerably between Alameda and Albuquerque, and we find true sand-dunes, two or three in succession, in a north and south direction.

*October* 8.—*From Albuquerque to Camp A,*

essous de Tejera. D'abord du Rio Grande allant est on a pour 10 milles d'alluvions du R. M., puis avant d'entrer dans le cañon de San Antonio, on a des masses de granite gris noirâtre, à horneblende et gros cristaux de feldspath blanc quelquefois, jaunâtre les masses de granite ont 3 milles de large, puis après le rancho habité, on a un granite rose, un peu de feldspath, et des dykes de granite blanc rosâtre; enfin un trap serpentineux vert, renfermant des assises calcaires metamorphiques de l'âge Dévonien; et en contact avec cette roche verte, le calcaire de montagne ou *lower carboniferous*. Au Camp A on a la coupe suivante:

*below Tejera.*—On going easterly from the Rio Grande, we travel ten miles on the alluviums of the Rocky mountains; then, before entering the cañon of San Antonio, we found outcrops of blackish-grey granite, with hornblende and large crystals of white feldspar, sometimes yellowish. These exposures of granite are three miles wide. Then, after passing the inhabited ranchos, we have a rose-colored granite, with but little feldspar, and dykes of rosy-white quartz; finally, a green serpentinoid trap, containing strata of metamorphic limestone of Devonian age, and, in contact with this green rock, the Mountain limestone or Lower carboniferous. At Camp A we have the following section:



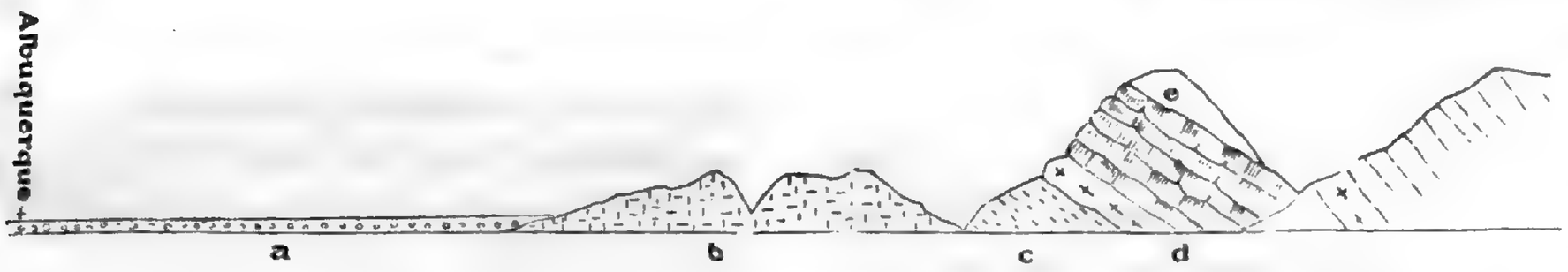

Le trap serpentineux est en contact avec le calcaire du carbonifère inférieur qui plonge à l'Est sous un angle de 35 à 40 dègres, les têtes de couches regardant l'Ouest, et la direction nord sud, un peu nord est de 3 à 5°. Ce calcaire est bleu grisâtre, quelque fois noir, très-compacte, à cassure conchoïde, quelque fois se brisant facilement lorsqù' il contient une lumachelle de fossiles.

Quelques assises d'argile schisteuse, noire, très-mince, sont intercallées. Il y a 3,000 pieds de ce calcaire, plus au sud, on dit qu'il contient des couches de houille grasses. Les fossiles ne sont pas abondants ni bien conservés, jài surtout recueilli les *Productus giganteus* et *punctatus;* un *Spirifer* et deux *Terebratulæ* deux polypes, des masses de tiges d'encrinites formnat marbre —— [?] plusieurs petits *Productus*, le *Cora*. Du Camp à Tejera pour un mille on a constamment, sur notre droite, ce calcaire carbonifère, puis au village on a de nouveau le Trias, avec toutes ses divisions; derrière San Antonio près d'Antonitto, on a le gypse blanc du Trias. Les couches plongent toutes à l'est sous un angle de 20° à 45°.

The serpentinoid trap is in contact with the limestone of the inferior carboniferous, which dips to the east at an angle of from thirty-five to forty degrees, the heads of the beds turning towards the west. The trend is north and south, or from three to five degrees E. of N. This limestone is greyish-blue, sometimes black; very compact, with a conchoidal fracture, and sometimes breaks easily when it contains a lumachelle of fossils. Some strata of very thin and black clay shales are intercalated. This limestone has a thickness of three hundred feet. It is said that a short distance further south it contains beds of bituminous coal. The fossils are not very abundant or well preserved. I gathered principally the *Productus giganteus* and *punctatus*, a *Spirifer*, and two *Terebratulæ* and *Polypi;* fragments of the stalks of encrinites forming marble ——[?]; and many small *Producti*, the species *Cora*. From the camp at Tejera we have constantly on our right, for the distance of a mile, this carboniferous limestone, then in the village we again meet the Trias with all its divisions. Behind San Antonio, near Antonitto, we have white gypsum of the Trias; all the beds dip to the east at angles of from twenty to forty-five degrees.

9 *Octobre.—Du Camp A, Humboldt, au Camp B, Douglas, or Antonitto.*—On a le carbonifère inférieur jusqu'au village de Tejera, où comme le Trias, le *coal* a été trop comprimét n'apparait pas. Le carbonifère a 2,000 peids, le Trias 4 ou 5,000 ; derrière San Antonio, on a le gypse blanc et toute notre route jusqu'au Camp Douglass est sur le Trias. Alluvion seulement des montagnes, sans cailloux striés, on a d'immenses blocs erratiques.

*October* 9.—*From Camp A, Humboldt, to Camp B, Douglas, or Antonitto.*—We have the inferior Carboniferous as far as Tejera village, where, as the Trias, the coal has been too much compressed and does not appear. The carboniferous has a thickness of two thousand feet (2,000,) the Trias four or five thousand (4,000 or 5,000.) Behind San Antonio we find white gypsum, and all our route, as far as Camp Douglas, is on the Trias. Alluvium from the mountains, and without striated pebbles. We have immense erratic blocks.




a. Alluvium. b. Granite. c. Serpentinoid Trap. d Carboniferous. e. Trias.

10 *Octobre.—Camp B ou Douglas.*—Ascension d'Albuquerque mountains 10,000 pieds. Direction N.S. Les couches plongent à l'est sous un angle de 25° à 30°. Le Gold mountain est moins élevé que Albuquerque. Du Camp Douglas, on suit un cañon dans l'upper Trias pour un mille et demi ; puis on commence avec le calcaire gris blanc, noirâtre du carbonifère ; le *coal* ne paraît pas, il a été trop serré ; immédiatement on trouve dans le carbonifère, les *Productus giganteus, punctatus ; Terebratula ; Spirifer ; Orthocera, Zaphrentis,* Crinoids ; *Zaphrentis* très-abondant. Le *coal* se trouve plus au sud dans le Manzana mountain. Quelques assises de schistes noirs, très minces se trouvent entre les assises de calcaire compactes de quartre et six pieds d'épaisseur ; rognons de silex noir dans le calcaire, au sommet le calcaire est un peu marneux, avec silex, comme le calcaire du Fort St. André. Dans le cañon pas de traces de glaciers visibles. La coupe a beaucoup d'analogie avec celles d'hier. Quelques assises de grès rosâtre très dur sont interposées dans le calcaire ; l'un de ces grès est à gros grains roulés. Le calcaire domine de beaucoup.

*October* 10.—We ascended the Albuquerque mountains (*Sandia mountains*) 10,000 feet high. They are surmounted by the limestones of the inferior carboniferous. The direction is N. and S., and the rocks dip to the eastward at an angle of from twenty-five to thirty degrees. Gold mountain is less elevated than Albuquerque mountain. From Camp Douglas we followed for one and a half miles a cañon in the upper Trias ; then we commenced with the greyish-white, blackish limestone of the carboniferous formation ; the coal does not appear—it has been too much compressed. In these carboniferous rocks we found the following fossils: *Productus, giganteus* and *punctatus; Terebratulæ, Spiriferæ, Orthocera, Zaphrentis* and Crinoids ; the *Zaphrentis* was very abundant. Coal is found further to the south, in the Manzana mountains. Several beds of black shales, four to six feet in thickness, and very thinly stratified, are found between the beds of compact limestone. Kidney-shaped masses of black silex are present in the limestone, and at the summit it is a little marly, with silex, like the limestone of Fort St. André. There are no visible traces of glaciers in the cañons. The section is much like that seen yesterday. Some beds of very hard and rose-colored sandstone are interposed in the limestone. One of these beds is of coarse rolled grains. The limestone is the predominating rock.

11 *Octobre.—Du Camp Douglas au Camp Placers.*—East side of Indian spring on trouve des veines de *copper* et peut être de *gold.* Je prends plusieurs specimens à San Pedro. Du camp à San Pedro on est constamment sur le Trias supérieur, peu après San Pedro on traverse encore le calcaire carbonifère, qui plonge à l'est, et est reserré entre le rio de San Pedro et le New Placer, où l'on voit horizontalement le Trias et le Jurassique, le new placer dirigé est 30° nord, est plus ancien que les Rocky mountains. Entre l'old Placer et le New Placer mountain il n'y a pas de formations visibles mais de l'alluvion.

12 *Octobre.*—A moitié chemin entre Tuerto et Galisteo à l'est de gold mountain on passe un dyke de roche pyroxénique? comme à Sineguilla, dirigé nord, south. Du Camp Placer on suit une vallée nord est. entre l'old et New Placer mountains. Les roches sont quartzeuses et feldspathiques. Puis on a le Trias coupé dans plusieurs directions, par des dykes de trap; l'un va est est sud à l'ouest ouest nord; on a ensuite en allant plus à l'est et au nord, le terrain jurassique jaunâtre avec Lucina; grès jaune; argile sableuse grès à la partie inférieure. Ce terrain Jurassique incline à l'est; est horizontale contre une montagne de granite quartzeux qui va du nord est au sud ouest comme le New Placer. Ce qui prouve que ces montagnes sont antérieures aux Rocky mountains. Le Jurassique s'étend nord est sans interruption qu'un peu au rio de Galisteo. A 3 milles nord de Galisteo je trouve dans des argiles sableuses ——[?] comme le grès superliassique des environs de Salins; une dent et vertèbre de Saurien, un *Ostrea* Jurassique —— [?] et une espèce *d'Inoceramus* ou mieux de *Plicatulas.* On voit sur les plaquettes de grès des débris nombreux, ressemblant à des os brisés de poissons ou sauriens. On a ces argiles jusqu'au Camp D. Pas de diluvium; entre Placer et la vieille montagne pres de Galisteo.

13 *Octobre.—Du Camp D au Camp E, à Pecos village.*—Peu après le camp on quitte le terrain Jurassique, et l'on suit jusqu'à old

*October* 11.—*From Camp Douglas to Camp Placer.*—On the east side of Indian springs we found veins of copper ore, perhaps auriferous. I procured several specimens at San Pedro. From the San Pedro camp we are continually upon the superior Trias. A short distance from San Pedro we again cross the carboniferous limestone, which dips to the east and is shut in between the Rio San Pedro and the New Placer, where we also find the Trias and the Jurassic. This New Placer has the direction E. 30 N., and is older than the Rocky mountains. Between the Old Placer and the New Placer mountain there are no formations visible, except the alluvium.

*October* 12.—Half way between Tuerto and Galisteo, on the east side of Gold mountain, we passed a dyke of pyroxenic (?) rock, like that at Sineguilla, with a direction north and south. From Camp Placer we followed the valley towards N.E., between the Old and New Placer mountains. The rocks are quartzose and feldspathic. Then we find the Trias cut in several directions by trap-dykes; one has the direction E.E.S. and W.W.N. On going further to the east and north, we find the yellow deposites of Jurassic age, containing *Lucina;* yellow sandstone and grey sandy clays at the inferior part. This Jurassic formation, inclined towards the east, is horizontal against a mountain of quartzose granite which trends from northeast to southwest, as the New Placer, which proves that these mountains are anterior to the Rocky mountains. The Jurassic extends northeast without interruption, except a little at the Rio Galisteo, three miles north of Galisteo. I found in sandy clays, ———— [?] sandstone, like the super-liassic sandstone of the vicinity of Salins; a tooth and vertebra of a Saurian, a Jurassic *Ostrea,* ———— [?] and a species of *Inoceramus,* or rather of *Plicatulus.* We saw upon the slabs of sandstone numerous fossil fragments resembling broken bones of fishes or saurians. We find these clays as far as Camp D. No diluvium between Placer and the Old mountain near Galisteo.

*October* 13.—*From Camp D to Camp E, at Pecos village.*—A little beyond camp we leave the Jurassic formation, and follow cañons in

Pecos, des cañons dans de Trias; les sommets des cañons étant du grès Jurassique.

14 *Octobre.*—D'old Pecos à Pecos on voit sur la rivie gauche de la rivière les couches du Terrain carbonifère supérieur, et nous campons sur le terrain carbonifère inférieur. Près du pont je trouve une quantité de fossiles, et la couche à *Terebratula biplicata*, à *Productus giganteus* et *punctatus; Spirifer*, *Polypes*, *Crinoids.*

On quitte le terrian, peu après le camp, et le reste du chemin jusqu'au Camp F, est sur le trias; le sommet du cañon près du camp est Jurassique, la partie inférieure étant très ferrugineuse, comme l'oolite ferrugineuse entre le grès blanc et le grès jaune.

15 *Octobre.—Du Camp F ou Camp G, ou Santa Fé.*—Deux miles après avoir quitte le camp, on quitte le Trias pour être jusqu'à Santa Fé sur le granite et autres roches éruptives. Ce granite est rose, et contient beaucoup de feldspath.

16, 17, 18 *Octobre.—Du Camp G au Camp H, ou Galisteo rio.*—On a le diluvium jusqu'à Cineguilla puis là les volcans couronnant et recouvrant le Trias et le Jurassique; dans le vallée du rio Galisteo, on a le Jurassique supérieur avec *Lucina* ou *Cardium* et des dykes de trap courrant nord 30 est.

19 *Octobre.—Du Camp H au Camp I.*—On a le Jurassique, jusqu'au sortir du cañon de Cuesta creek où l'on voit le Trias, au dessous à San Felipe on a du côté de la rivière deux ilots de Jurassique couronnés de lava, le volcan étant derrière San Felipe un peu nord ouest. La lave s'étend de l'autre côté du rio Grande sans interruption tandisque de ce côté on ne l'a plus après San Felipe; les alluvions s'étendent sur les collines de marnes Jurassique entre Cuesta et notre Camp I.

20 *Octobre.—Du Camp I à Albuquerque.*—Vis-à-vis Alameda de l'autre côté du rio Grande, on a le Crétacé sableux décomposant et une petite assise de red marl à découvert; entre Alameda et Albuquerque sur le côté droit de la rivière on a de nouveau des laves volcaniques. Derrière Bernalillo on a dans l'alluvion une argile plastique rouge et jaune,

the Trias as far as old Pecos, the top of the cañons being of Jurassic sandstone.

*October* 14.—We saw on the left bank of the river, between Old Pecos and Pecos, the beds of the superior carboniferous formation, and we encamped upon the inferior carboniferous. Near the bridge I found a quantity of fossils and a bed filled with *Terebratula biplicata*, *Productus giganteus* and *punctatus*, *Spirifer*, *Polypi*, and *Crinoids.*

We leave the formation a short distance beyond camp, and the rest of the way, as far as Camp F, is on the Trias. The summit of the cañon near the camp is Jurassic, and the inferior portion is very ferruginous, like the ferruginous oolite between the white and the yellow sandstone.

*October* 15.—*From Camp F to Camp G, or Santa Fé.*—Two miles beyond camp we left the Trias, and, until near Santa Fé travelled on granite and other eruptive rocks. The granite is rose-colored, and contains abundance of feldspar.

*October* 16, 17, *and* 18.—*From Camp G to Camp H, on Galisteo river.*—We find diluvium near to Cineguilla, then volcanoes covering the Trias and Jurassic rocks. In the valley of the Rio Galisteo we have the superior Jurassic, with *Lucina* or *Cardium*, and some trap-dykes running N. 30° E.

*October* 19.—*From Camp H to Camp I.*—We found the Jurassic as far as the mouth of the cañon of Cuesta creek, where we found the Trias; below, on this side of the river, we find two small islands of Jurassic strata crowned with lava; the volcano being behind San Felipe, a little northwest. The lava extends, without interruption, on the other side of the Rio Grande, while on this side it disappears after passing San Felipe. The alluvium extends on the hills of Jurassic marl, between Cuesta and Camp I.

*October* 20.—*From Camp I to Albuquerque.*—Opposite Alameda, on the other side of the Rio Grande, we have the Cretaceous, sandy and decomposing, and a little layer of red marl is uncovered. Between Alameda and Albuquerque, on the right side of the river, we again find the volcano lavas. Behind Bernalillo we have a red and yellow plastic

dont on se sert pour la poterie. Arrivé á Albuquerque à 3 h. ½ après midi.

21 *Octobre.*—Jusqu'au 10 November resté à Albuquerque, parti le 10 November dans l'après midi, Camp No. 1 à 3 milles d'Albuquerque sur l'alluvion de la rivière. On trouvera le 11, la mesa formée de sables provenant de grès; au sommet du côté de Puerco river, il y a un calcaire poreux, blanc friable avec petits cailloux d'alluvion comme la pâte.

11 *Novembre.—Camp No.* 2′.—On Campe sur le rio Puerco, peu d'eau, facilement par des puits.

12 *Novembre.—Camp No.* 3′.—Peu après le Puerco on a l'argile blanc grisâtre; avec nombreux rognons de fer oxidé; quelque arbres fossiles, au-dessus se trouve le grès jaune, les couches plongent à l'est sous un angle de 15 à 20 degrés. Cette argile est la même qu'au rio Galisteo, et contient la couche de houille à Las Lunas et sur plusieurs autres points du Puerco. Peu d'alluvion et pas gros. Le terrain avec argile grise à la base et grès blanc au sommet les argiles diminuent de puissance et les grès augmentent près du Camp No. 3′ ou Sheep spring. On voit les argiles et surtout grès rouge de Trias qui s'élèvent dessous. L' inclination est généralement à l'est, sous un angle faible. Exemple de l'autre côté du rio de Lagunas et au Camp 3′ on a.

13 *Novembre.—Du Camp* 3′ *au* 4′.—On a sur la droit une table de grès rouge de Trias, environné quelquefois par des grès et argiles grises Jurassiques; il n'y a presque pas d'argile rouge, mais des grès argil'eux rouges au

clay, which is used for making pottery. We arrived at Albuquerque at half-past three p. m.

*October* 21.—We remained at Albuquerque until the 10th of November, and left it in the afternoon, and camped three miles from the town. At this camp we have the alluvium of the river.

*November* 11.—*From Camp* 1′ *to Camp* 2′.—We traversed the *mesa* formed by the sand derived from the sandstone. On the summit, at the side of Rio Puerco, there is a porous limestone, white and friable, with small alluvial pebbles in the paste.

*November* 11.—*Camp No.* 2′ *to Camp No.* 3′, *on the Rio Puerco.*—There is but little water here, but it is easily obtained by wells.

*November* 12.—*Camp No.* 3′ *to Camp No.* 63[1].—A little beyond the Puerco we found greyish-blue clays, with numerous kidney-shaped masses of oxide of iron; some fossil trees; the yellow sandstone is above, the beds dipping to the east at an angle of from 15 to 20 degrees. This clay is similar to that at Rio Galisteo, and contains beds of coal at Las Lunas, and several other points on the Puerco. Alluvium scanty and not coarse. The formation with grey clays at the base and white sandstone at the top is found here. These clays diminish in thickness, and the sandstone increases near Camp No. 3′, or "Sheep spring;" we see the clays, and especially the red sandstone of the Trias, rising underneath. The inclination is generally to the east at a low angle; for example, on the other side of the Rio des Lagunas and Camp 3′, we have the appearance shown in the annexed figure.

*November* 13.—We find on the right a table-land of red stonestone of the Trias, sometimes surrounded by Jurassic sandstones and grey clays; there is hardly any red clay, but red argillaceous sandstones from the summit of

[1] From this point onward, the camps are numbered to correspond with those of the main party.—W. P. B.

sommet du Trias. Puis du gypse blanc et de la dolomie ; et dessus du nouveau grès rouge. A la rivière au dessous de Laguna ; on a la fin d'une conche de lave venant de mont Taylor et qui suit la vallée de la rivière. Deux milles avant d'arriver à Laguna, on retraverse les grès blancs et sableux Jurassiques l'on campe sur cette formation. La lave couvre le tout et a sauté par dessus les cliffs des argiles et des grès Jurassiques.

14 *Novembre.—Du Camp 4′ au No. 5′.*—En quittant Laguna, on suit une vallée assez large. Ce fond et une partie de ses flancs, est formé entièrement par des argiles blauâtres du Jurassique inférieur. Ces argiles sont couronnées par des assises des grès gris jaunâtre. Puis on a de nouveau une assise d'argile gris bleuâtre renfermant de petites *Gryphœa dilatata* et écailles de Sauriens ; c'est l'*Oxford clay ;* et de nouveau des grès gris jaunâtres, assez puissants renferment des *Arca* et *Isocardia.* Le tout sur notre droite et quelquefois sur la gauche est recouvert par la lave du grand volcan Taylor.

15 *Novembre.—Du No. 5′ au 6′.*—En sortant de Covero, on suit une vallée dont le fond est encore des argiles grises Jurassiques qui disparaissent ensuite pour n'avoir plus que des grès jaunes du Jurassique supérieur sur la gauche ; ce Jurassique est constamment recouvert par des laves ; et à cinq milles de Covero on remonte une couche de scorie que l'on suit ensuite jusqu'au Camp No. 6′ ; où elles sont en connexion avec les laves qui viennent du côté du Mont Taylor. Deux milles avant d'arriver au camp ; et au-dessus du camp ces laves sont basaltiformes sur le côté droit. Sur la gauche on n'a que du grès Jurassique : pas de laves. Ces grès au camp plongent un peu 5 ou 6° à l'est ; jusque la, ils sont restés horizontalement sous la lave et les scories sont noires, poreuses avec tous les accidents de plis et de contorsion que l'on rencontre dans les autres pays. La coulée de scorie envoye de 200 à 400 mêtres de dans le fond de la vallée.

16 *Novembre.—Du Camp No. 6′ au No. 7′.*—Nous suivons d'abord jusque'à 3 miles la rive

the Trias ; then some white gypsum and dolomite, and under it the red sandstone again. At the river below the Laguna we find the end of a bed of lava coming from Mount Taylor, and which follows the valley of the river. Two miles before we reach Laguna we recross the Jurassic white sandstone and sands, and we camped on this formation. The lava covers the whole, and has risen over the cliffs of Jurassic clays and sandstones.

*November* 14.—*From Camp No.* 63 *to No.* 64.—On leaving the Laguna we followed a large valley, the bottom and a part of the sides being formed entirely of blue clays of the inferior Jurassic. These clays are crowned by the strata of yellowish-grey sandstone. We then find again a strata of bluish-grey clay, containing small *Gryphœa dilatata* and scales of Saurians ; this is the Oxford clay ; and again, yellowish-grey sandstones, rather thick, containing some *Arca* and *Isocardia.* The whole upon our right, and sometimes upon our left, is covered by the lava of the great volcano Mount Taylor.

*November* 15.—*From Camp No.* 64 *to No.* 65.—On going out from Covero, we follow the valley, the bottom of which is still composed of grey clays, somewhat ferruginous, which afterwards disappears, leaving nothing but yellow sandstones of the superior Jurassic upon the left. This Jurassic is constantly covered by lavas, and at fives miles from Covero we met with a stream of scoria which we afterwards followed as far as Camp No. 65, where it is in connection with the lavas which come from the side of Mount Taylor. Two miles before arriving at the camp, and above it, on the right-hand side, these lavas are basaltiform. On the left we find only Jurassic sandstones and no lava. These sandstones at camp dip slightly (5 or 6 degrees) to the east ; until now, they have been horizontal under the lava.

The lava and scoria are black and porous, with all the conditions of plications and contortions which we find in other countries. The stream of scoria is from 200 to 400 metres wide in the bottom of the valley.

*November* 16.—*From Camp No.* 65 *to No.* 66.—We at first followed, for three miles, the

droite du courant de laves; puis nous traversons la coulée; jusqu'au Camp No. 7′ où nous la quittons pour camper sur le granite rose à gros grains. Sur la droite de notre route, nous avons les grès Jurassiques jaunes et gris, et au-dessous pas de granite, et dans quelque ravines, on voit des grès rouge du Trias. Les couches inclinent à l'est, 10 à 15°; et la direction des têtes de couches et du granite est nord-south, âge des Rocky mountains. Pas de diluvion; pas d'erratiques. Hauteur du Camp 7′ de 7,000 à 8,000 pieds.

17 *Novembre.—Du No.* 7′ *au No.* 8′.—Peut-être hier, 2 miles avant d'arriver au camp et jusque près du camp, ai-je passé des grès et calcaire carbonifères, c'est douteux, le matin nous ne faisons que 8 miles ½, et toujours sur le granite, sur le point de jonction avec la lave; traversant quelque fois des portions de calcaire. A notre Camp No. 8′ on quitte la lave; et l'on est sur le point de partage du volcan, new red et granite. La lave se retrouve autour de nous et spécialement sur notre droite. A 100 yards au nord on a le gneiss fortement relevé au nord est ou nord. Au sud du camp, ce sont des grès rouges du Trias très développés, et plongeant sud sud ouest.

18 *Novembre.—Du No.* 8′ *au No.* 9′.—En partant du camp, on laisse la lave à droite; puis on s'élêve rapidement sur les couches du Trias du sommet; en tournant un peu au sud on traverse du calcaire gris bleuâtre avec quelques couches de grès rosâtre intercalées. Je n'ai pas été capable de trouver des fossiles au nord ouest, et on la laisse sur la droite pour suivre des sables provenant de la décomposition du grès jaune et blanc et rosâtre Jurassique qui forment une cliff table regardant l'Est, et dont *Inscription Rock* fait partie.

right bank of the lava currents; we then traversed the *coulée*, which is two or three miles wide, and then followed along its left bank as far as Camp No. 66, where we left it, and camped on a coarse-grained, rose-colored granite. On the right of our route we have grey and yellow Jurassic sandstones, and above, near the granite, and in some ravines, we saw the red sandstone of the Trias. The beds dip to the east, 10 or 15 degrees, and the direction of the uplifted edges of the beds and of the granite is north and south, being of the age of the Rocky mountains. No diluvium or erratics. The height of Camp No. 66 is from 7,000 to 8,000 feet.

*November* 17.—*From Camp No.* 66 *to No.* 67.—Yesterday, I perhaps passed carboniferous sandstones and limestones, two miles before arriving at camp, and even at camp, but it is doubtful. This morning we made only eight and a half miles, and were always on the granite, or the point of junction with the lava, sometimes crossing portions of the latter. At our Camp No. 67 we left the lava and were upon the point of division between the volcano, the New Red and granite. Lava is again seen about us, and especially upon our right. One hundred yards to the north we found the gneiss much upraised to the northeast or north. South of the camp there are very well developed red Triassic sandstones dipping south-southeast.

*November* 18.—*From Camp No.* 67 *to No.* 68.—On going from camp we leave the lava on the right; then we rise rapidly upon the beds of Trias, with white gypsum near the summit; on turning a little to the south, we crossed some bluish-grey limestone, with some intercalated beds of roseate sandstone. I have not been able to find any fossils, on account of the cold and of the fog. I believe it is of the age of the lower Carboniferous, but it is doubtful. The beds incline strongly to the west, especially the limestones. (Direction of the Sierra de Zuñi northwest and southeast.)

We again descended between the lavas coming from the south and the red sandstones of the Trias. We traversed this great lava field which extends towards the N.N.W., and we leave it upon the right, and follow sands proceeding from the decomposition of the white

Du sommet d'Inscription Rock je vois au sud est, un volcan et deux ou trois cones secondaires ; le grand volcan a 10,000 pieds de hauteur et est isolé.

and yellow and rose-colored Jurassic sandstone, which forms a table-cliff facing the east, and of which Inscription Rock is a part. From the summit of Inscription Rock, I see in the southeast a volcano, and two or three secondary cones. The great volcano is 10,000 feet in height, and is isolated. The following is the section from Camp 67 to Camp 68.

10 *Novembre.—Du No.* 9′ *au No.* 10′, *ou Ojo Pescado springs.*—On traverse la coulée de lave en sortant du camp ; puis une colline de *sandstone* rose et d'argile grisâtre à la base Jurassique. Puis le chemin retraverse de nouveau sur la lave jusqu'aux [ruines ?) ou Camp No. 10, où la coulée de lave paraît terminer. Les cliffs de cañon à droite et à ganche sont couronnés par un grès rose très-fin, vinacé à stratification très-épaisse de 15 à 40 pieds ; et la base des cliffs jusqu'au ¾ est formée d'argiles schisteuses gris noirâtre ; avec intercalation de couches de calcaires jaune de trois pieds d'épaisseur et plusieurs assises de marnes sont si noires, qu'elles deviennent bitumineuses et ont des assises de houille, d'un demi à un pied d'épaisseur. Les assises Jurassiques inclinent à l'ouest sous un angle de 8 à 10 dégrés. Les sommets des cañons sont des Mesas. Pas de diluvium.

20 *Novembre.—Du No.* 10′ *au No.* 11′.—On suit le cañon qui part d'Inscription rock. La lave est beaucoup réduite de dimension ; mais occupe tout le temps le fond du bassin jusqu'au Camp 11 où il se termine à 30 yards plus à l'ouest du Camp 11. On arrive à un resserrement du cañon avant d'arriver dans la vallée de Zuñi proprement dite ; et alors le Jurassique disparait, excepté sur quelques sommets. Le Trias est très-développé, surtout les grès rouges; quelque assises banches et grises sur le sommet ; le fond de la valleé entièrement rose ou rouge lie de vin. Le Trias inclinant à l'est sous un angle de 10 à 15 ; et la valleé de Zuñi est un écaillement longitudinal parallèle

*November* 19.—*From Camp No.* 68 *to Camp No.* 69, *or Ojo Pescado springs.*—We crossed the *coulée* of lava on going out from the camp, then a hill of rose-colored sandstone and grey clay, at the base of the Jurassic ; then the road again crosses the lava near to the [ruins?] or Camp No. 69, where the stream of lava appears to terminate. The cliffs of the cañon on the right and on the left are crowned by a very fine rose-colored, micaceous sandstone, very thickly bedded, from fifteen to forty feet thick ; and the base of the cliffs, or three-fourths of the height, is formed of blackish-grey clay shales, with intercalations of beds of yellow limestone three feet thick ; and several beds of marls are very black and become bituminous, and also contain layers of coal from six inches to one foot in thickness. The Jurassic strata incline to the west under an angle of eight to ten degrees ; the tops of the cañons are plains or *mesas*. No diluvium.

*November* 20.—*From Camp No.* 69 *to Camp No.* 70.—We followed the cañon which commences at Inscription Rock. The lava is much reduced in its dimensions, but occupies all the bottom of the basin as far as Camp No. 70, where it terminates only thirty yards beyond. We reached a contracted part of the cañon before arriving at the valley of Zuñi, properly so called, and then the Jurassic disappears, except upon some summits. The Trias is very well developed, especially the red sandstones ; some grey and white strata towards the summit. The bottom of the valley is entirely rose or wine-colored. This Trias inclines towards the east at an angle of from ten to fifteen de-

à la sierra de Zuñi ; mais qui n'a pas amené au jour le granite.

26 *Novembre.*—Nous partons du Camp No. 11′ pour venir au Camp No. 12′ à 5 miles au-dessous de Zuñi, sur la route du Fort Defiance. Nous avons été tout le temps sur le *New Red sandstone* qui s'étend vers l'Orient et au sud. Au nord le sommet des Plateaux est recouvert par une mince couche jaunâtre Jurassique. Pas de diluvium.

28 *Novembre.*—Nous faisons 11 miles au sud ouest, Camp No. 13′. Nous avons été tout le temps sur le Trias, quelques nodules de gpyse se sont rencontrées. Près du camp il y a des *Gryphœa* roulès, qui me parvaissent Jurassiques ; on s'est élevé peut-être sur le Jurassique.

29 *Novembre.—Du. No.* 13′ *au No.* 14′.—On suit un plateau raviné un peu où l'on ne voit pas les couches, c'est une terre un peu sableuse rosâtre. 20 milles de distance. Á 14 milles on traverse une crête, qui montre les assises de grès et d'argile rouge ; il y a un peu de jaune Jurassique au sommet. Les assises plongent à l'est, et les têtes des couches regardent l'ouest. Inclination très-faible de 8 à 10°. L'eau se trouve au fond d'un entonnoir de 100 pieds de profondeur dans de la terre rougeâtre. Il y a plusieurs autres enfoncements voisins. On commence à voir sur le sol de petits cailloux de jaspe jaune et rouge de la grosseur d'une noisette.

30 *Novembre.—Du. No.* 14′ *au No.* 15′.—8 *milles de distance.—New Red* tout le temps. On est dans une vallée très-large avec une espèce de marais ; au fond c'est de l'argile sableuse, en creusant un puit on a beaucoup d'eau. Au Camp 15 on commence à avoir de l'alluvion avec cailloux de jaspe rouge, jaune, noir, etc., asssz gros, et arbres fossiles siliceux avec couleur, aussi quelques fragments de la grosseur du poing.

1 *Décembre.*—Nous faisons 12 miles à l'ouest toujours sur le Trias supérieur, les assises étant un peu inclinées vers l'ouest et étant la seconde levée de la troisième ligne de grees, and the valley of Zuñi is a longitudinal *ecaillement* parallel with the Sierra de Zuñi, but which has not brought the granite to view.

*November* 26.—*From Camp No.* 70 *to Camp No.* 71.—For five miles below Zuñi, upon the route to Fort Defiance, we pass constantly upon the New Red sandstone, which extends to the west and south. In the north, the top of the plateaus is covered by a thin and yellow bed of Jurassic age. No diluvium.

*November* 28.—*From Camp No.* 71 *to Camp No.* 72, (11 *miles.*)—Between these two camps we have been constantly upon the upper Trias, and met with some nodules of gypsum. Near the camp there are some rolled *Gryphœa*, which appear to me to be Jurassic ; we have risen upon the Jurassic.

*November* 29.—*From Camp No.* 72 *to Camp No.* 73, (20 *miles.*)—We followed a plateau cut by some slight ravines where the strata are not visible ; it is a reddish-colored earth, and somewhat sandy. At fourteen miles from camp, we traverse a crest which shows the strata of sandstone and red clay ; there is a little yellow Jurassic at the summit ; the strata plunge to the east, and the heads of the beds face the west ; the dip is slight, being from eight to ten degrees. Water is found at the bottom of a funnel-shaped hole in the reddish earth one hundred feet in depth. There are also several other sinks or holes in the vicinity. We commence to find on the surface some small pebbles of red and yellow jasper, of the size of a hazel-nut.

*November* 30.—*From Camp No.* 73 *to Camp No.* 74, (8 *miles.*)—We found New Red all the way ; and travelled in a very large valley, where there is a kind of marsh which is of sandy clay at the bottom ; by digging down one foot, we obtained much water. At Camp No. 74, we commenced to have some alluvium, with pebbles of red and yellow and black jasper, pretty large ; and fossil trees, silicified and colored ; also some fragments of the size of the fist.

*December* 1.—*From Camp No.* 74 *to Camp No.* 75.—We travelled twelve miles to the west, always upon the upper Trias ; the strata are a little inclined towards the west, and are

dislocation. Au summet d'un *ridge* on est quelques instants sur le grès jaune Jurassique. Près du Camp No. 16′ on a des cristaux de gypse blanc, répandus dans l'argile et les grès ronges. Plateaux à gradin. Diluvium de jaspe, silex, grains de granite.

2 *Décembre.—Du No.* 16′ *au No.* 17′.—On fait 11 miles au sud sud ouest, tout le temps sur l'*upper* Trias ; les assises plongent au nord nord ouest sous un angle de 5 à 7 degrés. Beaucoup d'argile sableuse rouge quelquefois ronge brun à la base. Beaucoup d'arbres fossiles ; quelques-uns ont 4 pieds de diamêtre et sont divisés par d'un à deux pieds de long, siliciés avec de brillantes couleurs, quelques-uns ont des cristaux de quartz, très-clairs sur le rond de tronc. Grand ravin avec nombreux éboulements, peut-être au sommet d'une hill une roche trapèenne? Sierra Blanca. Great table-land à l'ouest et au nord.

3 *Décembre.—Du No.* 17′ *au No.* 18′.—On descend les assises du Trias, qui continuent à plonger au nord. Notre direction étant ouest sud. On trouve une grande quantité d'arbres fossiles, passé à l'état de jaspes et agates à couleurs très-brillantes, rouges, jaunes, blanches, noires et barriolés. Des arbres presqu'entiers se sont vus aujourd'hui dans le *sandstone*. Ce *sandstone* est dur gris un peu rosâtre ; mais surtout gris blanc ; dur ; à grande stratification, 3 à 6 pieds. Argiles rouges dominant, un peu d'argile grise blanchâtre à concrétions rougeâtres. On est, je pense, dans la partie moyenne de Trias. Pas de Jurassique. Au point où l'on traverse une large rio, il y a dans le *sandstone* des espèce de *Cardinia*, les coquilles sont fracturées et mal conservées ; peut-être que plus tard j'en trouverai de meilleures. Dans le diluvium ou a un mélange de petits cailloux colorés, provenant de ces débris d'arbres silicifiés. Aspect du pays, *table-land ;* allant en s'abaissant du côté du cours du Rio Colorado Chiquito. Quelques buttes ou cones à tables restant dans la plaine au sud de nous.

5 *Décembre.—Du No.* 18′ *au No.* 19′.—On fait 12 miles ouest ouest sud passant la partie inférieure du second soulèvement de la troisième ligne de dislocation. Au summet d'un *ridge* on est quelques instants sur le grès jaune Jurassique. Près du Camp No. 16′ on a des cristaux de gypse blanc, répandus dans l'argile et les grès ronges. Plateaux à gradin. Diluvium de jaspe, silex, grains de granite.

the second uplift of the third line of dislocation. At the summit of a ridge, we are, for a short time, upon the yellow Jurassic sandstones. Near Camp No. 75 we found crystals of white gypsum distributed on the clays, and red sandstone. The plateau rises gradually, and we find a diluvium of jasper, silex, and grains of garnet.

*December* 2.—*From Camp No.* 75 *to Camp No.* 76—(11 *miles.*)—We travelled towards the southwest, all of the time on the upper Trias ; the strata dip to the N.N.W. at an angle of from five to seven degrees. A sandy red clay is abundant, and sometimes it is brownish-red at the base. Many fossil trees were seen. Some of them are four feet in diameter, and are divided into blocks one or two feet long. They are silicified, and are brilliantly colored. Some of them contain very clear quartz crystals on the round part of the trunk. We saw a great ravine with numerous land-slips ; perhaps at the summit of a hill a trappean rock. Saw the Sierra Blanca, and an extensive table-land at the west and the north.

*December* 3.—*From Camp No.* 76 *to Camp No.* 77.—We descended the beds of Trias which continue to dip to the north, our direction being W. S. We found a great quantity of fossil trees turned into jasper and agate, with very brilliant colors—red, yellow, white, and black, and these sometimes combined. Trees, almost entire, were seen to-day in the sandstone. This sandstone is grey, a little pink, but especially whitish-grey ; it is hard, and thickly bedded, the layers being from three to six feet thick. The red clays predominate, and there is a little whitish-grey clay, with reddish concretions. We are, I believe, in the middle part of the Trias. No Jurassic. At the point where we cross a large river, there are in the sandstone some species of *Cardinia?* The shells are defaced and badly preserved. In the diluvium we find a mixture of little colored pebbles coming from the wrecks of the silicified trees. The country appears as a table-land descending towards the bed of the Colorado Chiquito ; some buttes or truncated cones rest on the plain at the south of us.

*December* 5.—*From Camp No.* 77 *to Camp No.* 78.—We travelled 12 miles W.W.S.,

rieure du Trias avec argile blanche et grise, épaisse, sans fossiles ; inclination au nord, beaucoup de drift de petits cailloux colorés et pièces de bois pétrifié. Dans le Rio Chiquito on a des fossiles carbonifères roulés, ce qui indique cette formation dans la Sierra Blanca et assez près de nous.

passing the inferior portions of the Trias, with red and blue and grey clays, thick, but without fossils ; inclination of these beds is to the north. There is much drift of little colored pebbles and pieces of petrified wood. In Rio Chiquito we found rolled carboniferous fossils, which indicate that this formation is found in the Sierra Blanca, and not far from us.

6 *Décembre.—Du No.* 19′ *au No.* 20′.—On suit 14 miles ½ la rivière Chiquito sur le côté droit, vallée large quelques buttes sur notre droite, Trias inférieur grès et marne rouge, et au-dessous des marnes blanches. Le diluvium venant de Mogoyon est nombreux à cailloux moyens ; avec débris de *Spirifer* et *Productus ;* surtout des silex grìs.

*December* 6.—*From Camp No.* 78 *to Camp No.* 79.—We followed the Rio Chiquito for 14½ miles, on right side. The valley is large ; some buttes on our right ; Trias inferior ; red sandstone and marl, and white marl under them. The diluvium comes from the Mogoyon Sierra ; it is abundant, and contains pebbles of medium size, especially of grey silex, and also fragments of *Spirifer* and *Productus.*

7 *Décembre.—Du No.* 20′ *au No.* 21′.—On fait 8 miles ; pas de changement géologique avec la marche d'hier.

*December* 7.—*From Camp No.* 79 *to Camp No.* 80—(8 *miles.*)—The geology is the same as observed yesterday.

8 *Décembre.—Du No.* 21′ *au No.* 22′.—On fait 5 miles ; même formation ; pas de changement.

*December* 8.—*From Camp No.* 80 *to Camp No.* 81—(5 *miles.*)—The formations continue the same, without change.

9 *Décembre.—Du No.* 22′ *au No.* 23′.—On fait un mille et demi ; pas de changement.

*December* 9.—*From Camp No.* 81 *to Camp No.* 82, (1½ *miles.*)—No change in the geology.

14 *Décembre.—Du No.* 23′ *au No.* 24′.—On fait 4 milles ; en traversant le Rio Colorado Chiquito, *New Red* avec gypse blanc en rognon épais. Diluvium nombreux très-petit, avec quelques fossiles carbonifères. *Productus semi-reticulatus* et *Polypi* venant de la Sierra de Mogoyon.

*December* 14.—*From Camp No.* 82 *to Camp No.* 83, (4 *miles.*)—In crossing the Rio Colorado Chiquito, white gypsum was seen in thick kidney-shaped masses in the New Red. Diluvium abundant and very small, containing carboniferous fossils; *Productus semi-recticulatus* and *Polypi* coming from the Sierra Mogoyon.

16 *Décembre.—Du No.* 24′ *au No.* 25′.—On fait 11 milles ¼, en descendant la rivière tout le temps sur le Trias inférieur. Grès rouge, argile rouge et blanc. Diluvium nombreux, mais avec petits cailloux.

*December* 16.—*From Camp No.* 83 *to Camp No.* 84.—We made 11¼ miles descending the river, and continually on the inferior Trias. Red sandstone and white and red clays were seen. Diluvium abundant, with small pebbles.

17 *Décembre.—Du No.* 25′ *au No.* 26′, 16 *milles.*—En descendant la rivière, grès et argile rouge du Trias inférieur, recouvert par du diluvium à cailloux très petits, venant de la Sierra de Mogoyon. Les assises plongent toujours au nord sous un angle de 8 à 10 dégrés. On voit des buttes basaltiques à l'est, est, nord, huit ou dix sur la plateau de Trias.

*December* 17.—*From Camp No.* 84 *to Camp No.* 85, (16 *miles.*)—We were yet descending the river, and passed red sandstone and red clays of the inferior Trias, covered with but little diluvium, of very small pebbles, coming from the Sierra Mogoyon. The strata all dip northward at an angle of from eight to ten degrees. We see basaltic buttes in the direction of E.E.N.; eight or ten of them being on the plateau of the Trias.

19 *Décembre.—Du No.* 26′ *au No.* 27′.—On fait 4 milles ½ sur le grès rouge et l'argile rouge; le grès derrière et formant des petites buttes à cliffs perpendiculaires. Presque pas de diluvium.

20 *Décembre.—Du No.* 27′ *au No.* 28′.—On fait 3 milles ½ en retrogradant sur la rivière, pour avoir du meilleur fourrage. *New Red* avec diluvium très-petit.

22 *Décembre.—Du No.* 28′ *au No.* 29′.—On fait 11 miles ½ à l'ouest, en quittant la rivière et en se dirigeant au pied sud du grand volcan éteint de *San Francisco mountain.* Jusqu'à deux miles ½ du camp on a le *New Red sandstone* sub-schisteux, avec *ripple-marks* et argile rouge. Puis on a au-dessous un calcaire magnésien ou dolomitique épais à stratification régulière de ½ à un pied d'épaisseur, plongeant au nord sous un angle de 10 à 15°, en stratifications concordante avec le *New Red,* et quelques assises du *magnesian limestone* alternant avec le grès rouge à la base. Dans ce *magnesian* on a une couche avec fossiles très-mal conservés; je crois reconnaître des fragments de *Belemnite?* un *Nautilus?* un *Pteroceras?* Quatre milles après avoir marché sur ce *magnesian* on a la lave du volcan qui la recouvre; et nons campons sur la base, non loin des cones secondaires du grand volcan. Pas de diluvium. Des cendres noires du volcan jusque près du Camp No. 28′.

23 *Décembre.—Du No.* 29′ *au No.* 30′.—Cendres volcaniques, laves et dykes de basalte; avec cônes volcaniques; pas d'erratiques; 13 milles.

26 *Décembre.—Du No.* 30′ *au No.* 31′.—On fait 12 milles, tout le temps sur les cendres et les laves volcaniques. Près du camp on a une grande montagne de roche siénitique rouge. Pas de diluvium.

27 *Décembre.—Du No.* 31′ *au No.* 32′.—Volcanique avec roche dioritique. Lave rougeâtre. La neige couvre les roches presque partout. Nous campons à Leroux's spring.

31 *Décembre.—Du No.* 32′ *au No.* 33′.—

*December* 19.—*From Camp No.* 85 *to Camp No.* 86, (4½ *miles.*)—We travelled upon the red sandstone and red clays; the red sandstone behind, and forming little buttes with perpendicular cliffs. Little or no diluvium.

*December* 20.—*From Camp No.* 86 *to Camp No.* 87, (3½ *miles.*)—We returned along the river to-day for 3½ miles in order to obtain better forage for the animals. New Red, with diluvium very slight.

*December* 22.—*From Camp No.* 87 *to Camp No.* 88, (11½ *miles.*)—We passed westward, leaving the river and going towards the southern base of the extinct volcano of San Francisco mountain. Two and a half miles from camp we found the New Red sandstones, subschistose with ripple-marks, and red clay; under this a magnesian limestone, or thick dolomite, regularly stratified, in beds of six inches to one foot in thickness, dipping to the north at an angle of from ten to fifteen degrees, in concordant stratification with the New Red. Some strata, also, of magnesian limestone, alternating with the red sandstone at the base. In that magnesian formation we found a bed of fossils, but very badly preserved. I believe that I recognised fragments of *Belemnites?* a *Nautilus?* and a *Pteroceras?* After having travelled four miles on this magnesian formation, we reached the lava of the volcano which covers it from view. We camped upon this lava, not far from the secondary cones of the great volcano. The overflows from the volcano are black, and reach nearly to Camp No. 87. No diluvium.

*December* 23.—*From Camp No.* 88 *to Camp No.* 89, (13 *miles.*)—Volcanic ashes, lavas, and basaltic dykes with volcanic cones were passed. No erratics.

*December* 26.—*From Camp No.* 89 *to Camp No.* 90, (12 *miles.*)—We were all of the way upon volcanic ashes and lavas. We found near the camp a great mountain of red sienitic rock. No diluvium.

*December* 27.—*From Camp No.* 90 *to Camp No.* 91.—We passed volcanic and dioritic rocks and reddish lava. The rocks are almost all covered by snow. Encampment at Leroux's spring.

*December* 31.—*From Camp No.* 91 *to Camp*

On fait huit milles nord ouest de la grande montagne de San Francisco. Roche volcanique comme à Leroux's spring, trap amygdaloïde avec noyau de calc spar. La neige recouvre la terre presque partout.

1 *Janvier*, 1854.—*Du No.* 33′ *au No.* 34′.—On fait six milles et demi dans la neige, mais toujours sur le volcanique, et nous campons au pied d'un autre cône, après en avoir laissé deux sur la gauche et trois cônes sur la droite.

2 *Janvier.—Du No.* 34′ *au No.* 35′.—On fait huit milles et demi au sud ouest, même formation que la veille. Près du camp 35′, on voit du sommet d'une colline, dans la direction du Grand Colorado de l'ouest, une grande mesa; et à l'ouest sud les montagnes volcaniques en continuant.

8 *Janvier.—Du No.* 35′ *au No.* 36′.—Près de dix milles. Tout le temps sur la lave volcanique, excepté à moitié chemin, où l'on passe un cañon creusé dans le *magnesian limestone?* horizontale couche ou allant plonger un peu au nord ouest. A droite et à gauche du chemin, cônes volcaniques; un au sud assez grand; *Bill Williams'* pic.

9 *Janvier.—Du No.* 36′ *au No.* 37′.—On fait dix milles, sur le terrain volcanique, à trois milles du camp on est au sommet d'une grande colline d'où l'on voit une vaste étendue de pays à l'ouest et au sud. Au sud on voit un grand volcan; et à l'ouest deux grands volcans; en descendant la côté, on quitte la lave pour des assises de calcaire magnesien, à rognon silicieux, roti en rose par la lave; près du pied de la montagne je trouve trois ou quatre assises remplies de fossiles, les mêmes qu' à Sandia mount et à Pecos. C'est les *Productus reticulatis, punctatus, Spirifer, Terebratula* et *Polypiers*, très communs et formant lumachelle; c'est le calcaire de montagne ou *lower carboniferous*. Pas de diluvium.

10 *Janvier.—Du No.* 37′ *au No.* 38′.—On fit 13 milles et demi au sud ouest. On traverse du calcaire carbonifère, puis la lave; puis le grès carbonifère supérieur disloqué, et plon-

*No.* 92.—We travelled eight miles northwest of the great San Francisco mountain. The volcanic rocks were as at Leroux's spring; amygdaloidal trap was met, the cavities being filled with calc-spar. The snows cover nearly the whole surface.

*January* 1, 1854.—*From Camp No.* 92 *to Camp No.* 93.—We travelled 6½ miles in the snow, but were always on the volcanic rocks; and we camped at the foot of another cone, after having left two cones on the left and three upon the right.

*January* 2.—*From Camp No.* 93 *to Camp No.* 94.—We travelled 8½ miles to the southwest on the same formations as yesterday. Near Camp 94 we saw from the summit of a hill, in the direction of the Great Colorado of the West, an extended *mesa*, and the volcanic mountains are continued towards the southwest.

*January* 8.—*From Camp No.* 94 *to Camp No.* 95.—We travelled nearly ten miles upon the volcanic lava, except at half-way, where we crossed a cañon excavated in the magnesian limestone?; the beds horizontal, on inclining gently towards the northwest. Volcanic cones are on the right and left of the road, and those on the south are quite large. Bill Williams' mountain.

*January* 9.—*From Camp No.* 95 *to No.* 96.—We made ten miles on the volcanic ground. At three miles from the camp reached the summit of a great hill, from whence we saw a vast extent of country at the west and south. We saw a greatv olcano in the south and two large ones in the west. On descending the hill, we leave the lava for strata of magnesian limestone, with silicious kidney-shaped masses, baked to a rose-color by the lava; near the foot, I found three or four beds filled with fossils, the same as at Sandia mount and at Pecos; they are the *Productus reticulatus* and *punctatus, Spirifer, Terebratula,* and *Polypi,* very abundant, and forming a *lumachelle.* It is the mountain limestone or lower carboniferous. No diluvium.

*January* 10.—*From Camp No.* 96 *to No.* 97.—We travelled 13½ miles to the southwest. We crossed carboniferous limestone, then lava, then the upper carboniferous sandstone in dis-

geant au sud sud ouest sous un angle de 60 à 80 degrés; les assises sont brisées; la direction générale des têtes des couches est l'ouest ouest nord; on voit dans cette direction une grande montagne non volcaniques, à vingt milles de nous. Vers le Camp No. 38′, la lave recouvre de nouveau les grès carbonifères et l'on a la lave jusqu'an Camp 38′. Ces grès carbonifères rouges sont schisteux très-durs, plus durs en général que ceux du *New Red* des Prairies. Pas de diluvium.

12 *Janvier.—Du No.* 38′ *au No.* 39′.—On fait quatre milles et demi dans une direction sud sud ouest. Tout le temps sur la lave volcanique. Le ravin du ruisseau où l'on campe est semblable à celui du Cineguilla près de Santa Fé.

13 *Janvier.—Du No.* 39′ *au No.* 40′.—On fait 13 milles ¾ au sud ouest; on suit d'abord un cañon de la veille jusqu'à sa fin, au sud est. Lave tout le temps. Puis on traverse une plaine, mesa, corverte de lave et laissant voir, dans differents endroits, le calcaire blanc grisâtre du carbonifère? Le Picacho mont est au nord, et paraît être du *granite*. Notre Camp No. 40′ est sur le grès carbonifère. Les couches plongent au nord. Pas de dilvium.

16 *Janvier.*—Nous avons changé le camp, à un mille au sud ouest de No. 40′, et nous sommes sur le *granite* ou gneiss, avec du *red sandstone* carbonifère au sommet. La direction de la dislocation se voit très-bien; est sud est au nord ouest.

19 *Janvier.—Du Camp No.* 41′ *au No.* 42′.—On fait 7 milles ½, orage très sévère de neige. Nous campons au pied d'une mesa de calcaire carbonifère; les couches plongent au nord. Une vallée large de huit milles nous sépare d'une mesa à l'est. Diluvium dans le ruisseau du Picacho, formé de roche granitique volcanique et gneiss et calcaire carbonifère assez petits *boulders*.

20 *Janvier.—Du No.* 42′ *au No.* 43′.—On fait 9 milles en zig-zag. Dans le calcaire carbonifère au pied de la mesa, je vois des *Crinoids* et *Productus* dans un ruisseau. On campe à une ravine après avoir passé

located beds, dipping to the S.S.W. at an angle of from 60° to 80°. The strata are broken; the general direction of the heads of the beds is W.W.N. We saw a great non-volcanic mountain in that direction, and about twenty miles from us. Towards Camp No. 97 the lava again covers the carboniferous sandstones, and the lava continues as far as Camp 97. These red carboniferous sandstones are schistose and are very hard, generally more hard than those of the New Red of the prairies. No diluvium.

*January* 12.—*From Camp No.* 97 *to No.* 98.—We travelled 4¼ miles in a S.S.W. direction, all of the time upon the volcanic lava. The ravine of the brook, where we are encamped, is similar to that of the Cineguilla, near Santa Fé.

*January* 13.—*From Camp No.* 98 *to No.* 99.—We travelled 13¾ miles to the S.E., following first the cañon of the valley near its end, at the S.E. We were constantly on lava. Then we crossed the plain (mesa) covered with lava, and in different places showing the greyish white limestone of the carboniferous formation. The Picacho mountain is on the north, and appears to be of granite. Our Camp No. 99 is on the carboniferous sandstone, and the beds dip to the north. No diluvium.

*January* 16.—*From Camp No.* 99 *to No.* 100.—We have changed camp from No. 99 to one mile further towards the southwest, and are now upon the granite, or gneiss, with some red carboniferous sandstone at the summit. The direction of the dislocation is very well seen, and is northwest and southeast.

*January* 19.—*From Camp No.* 100 *to No.* 101.—We travelled seventeen and a half miles in a very severe snow-storm, and encamped at the foot of a *mesa* of carboniferous limestone; the beds dip to the north. We are separated from the mesa on the east by a valley eight miles wide. The diluvium in Picacho brook is composed of volcanic and granitic rocks, gneiss and carboniferous limestone, the boulders being rather small.

*January* 20.—*From Camp No.* 101 *to No.* 102.—We travelled nine miles in a zig-zag course in the carboniferous limestone at the foot of the mesa. I saw *Crinoids* and some species of *Productus* in the brook. We camped at a

le grès rouge du carbonifère. Neige sur le terrain.

21 *Janvier.—Du No.* 43′ *au No.* 44′.—On fait six milles; presque tout le temps sur le granite, quelquefois sur le *sandstone* carbonifère, très der; dans la vallée de Pueblo *creek* on voit de nombreux exemples de roches isolées et *rocking*. Veines de quartz.

22 *Janvier.—Du No.* 44′ *au No.* 45′.—On fait 7 milles, sur le granite tout le temps, à

notre droite on a un cliff de 1200 pieds d'élévation. De la base à la moitié on a le *granite*, puis une bande de grès rouge, Devonien ou *Old Red;* puis des couches de calcaire et de grès grisâtre appartenant au *Mountain limestone*. Un peu de diluvium dans le ruisseau.

23 *Janvier.—Du No.* 45′ *au No.* 46′.—On fait six milles, trois milles sur le granite, le reste sur *l'old red sandstone*, d'ailleurs comme hier; on passe aussi deux collines de trap amygdaloïde.

24 *Janvier.—Du No.* 46′ *au No.* 47′.—On fait six milles un peu sur le carbonifère *limestone;* puis trois milles sur le banc et l'on campe de nouveau sur le calcaire carbonifère.

27 *Janvier.—Du No.* 47′ *au No.* 48′.—On fait 12 milles et demi; tout le temps sur la lave volcanique. On a un grand volcan à l'ouest de nous; à droite, c'est un cliff incliné de *carboniferous limestone*. A gauche des montagnes de *granite* à peu près 1500 à 2000 pieds au-dessus de notre camp.

28 *Janvier.—Du No.* 48′ *au No.* 49′.—On fait trois milles au sud ouest; et on revient sur nos pas. Tout le temps sur le volcanique.

30 *Janvier.—Du No.* 49′ *au No.* 50′.—D'abord sur la lave basaltique pour un mille et demi, puis sur le gneiss qui s'étend à la base de la

ravine after having passed the red sandstone of the carboniferous. Snow upon the ground.

*January* 21.—*From Camp No.* 102 *to No.* 103, (6 *miles.*)—We were most of the way on granite, but sometimes on very hard carboniferous sandstone. In the valley of Pueblo creek we saw numerous examples of isolated and rocking rocks. Veins of quartz seen.

*January* 22.—*From Camp No.* 103 *to Camp No.* 104.—We travelled seven miles upon the granite, and on our right we found a cliff twelve hundred feet high. From the base to the middle we found the granite, then a band of red sandstone, (Devonian or Old Red.) Above this, the beds of limestone and grey sandstone belonging to the Mountain limestone. A little diluvium in the brook.

*January* 23.—*From Camp No.* 104 *to Camp No.* 105.—We travelled six miles; three miles on the granite, and the remainder upon the Old Red sandstone; the rest as yesterday. We also have two hills of amygdaloidal trap.

*January* 24.—*From Camp No.* 105 *to Camp No.* 106, (6 *miles.*)—We travelled a short distance on the carboniferous sandstone; then three miles on the lava, and encamped again on the carboniferous limestone.

*January* 27.—*From Camp No.* 106 *to Camp No.* 107, (12½ *miles.*)—We were to-day on volcanic lava, and found a great volcano west of us; on the right is an overhanging cliff of carboniferous limestone; on the left, granitic mountains about 1,500 to 2,000 feet above our camp.

*January* 28.—*From Camp No.* 107 *to Camp No.* 108.—We travelled three miles to the S.W., and retraced our steps, but all of the way upon volcanic rocks.

*January* 30.—*From Camp No.* 108 *to Camp No.* 109.—We passed first upon basaltic lava for one and a half miles, and then upon the

mesa au nord de nous. Sur ce gneiss se trouve un grès Tertiaire plongeant à l'ouest surmonté d'une espèce de poudingue crayeux épais de 15 à 20 pieds, corrodé par l'eau atmosphérique en petits trous. Ce poudingue parait être un ——— [?] de cendre volcanique, conglomerat de nombreux fragments de lave non roulés. Puis trois milles du Camp No. 50′, on rencontre deux chaines granitiques rouges allant du sud au nord. Au nord on a la mesa carbonifère qui le termine, et l'on a les petites collines granitique, au sud le grand volcan Whipple mount ——— [?]; il est très-large, peu élevé, et s'entre mêle avec le *granite*.

31 *Janvier.—Du No.* 50′ *au No.* 51′. Peu après être sorti du Camp 50′, on monte une colline qui est de la lave recouvrant le granite. Cette lave s'étend sur de vastes étendues au nord et à l'ouest á cinq milles du Camp 50′, dans un rio, on à des assises de sables et de calcaire grossier, tertiaires inclinant fortement à l'ouest, la direction de dislocation étant du sud au nord. On a parmi des dykes de trap et de porphyre rouge. Pas de diluvium. Pays montagneux et difficile au point de vue géologique.

1 *Février.—Du No.* 51′ *au No.* 52′.—Au sommet de Cactus Pass, on a un large filon de siénite rouge, allant N.S.; puis du gneiss, porphyre quartzifère, veines de quartz blanc. Le gneiss est contourné, les schistes p ongent à l'ouest. Au Camp 52′ on a, à l'est, les montagnes Aquarius, avec plateau de conglomerat de lave, avec mesa de laves. Pas de diluvium

4 *Février.—Du No.* 52′ *au No.* 53′, *on fait* 11 *milles* ¾.—La moitié sur le *granite* avec quelque veines de quartz, moitié sur le diluvium.

5 *Février.—Du No.* 53′ *au No.* 54′.—Le *granite* affleure de temps à autres sur la gauche, quoique souvent le drift le recouvre, le drift

gneiss, which extends to the base of the mesa at the north of us; upon this gneiss is found a Tertiary sandstone dipping to the west, surmounted by a thick pudding-stone, from fifteen to twenty feet thick, and which is very chalky, and much corroded into cavities and little holes by the action of the atmosphere and water. This pudding-stone appears to be a mixture of volcanic ash, conglomerated with numerous fragments of lava, not worn by rolling. Then at Camp No. 109, we found two granitic chains trending north and south. On the north we find a *mesa* of carboniferous rocks which comes to an end, ("*le termine,*") and we find small granitic hills. At the south the great volcano, "*Whipple Mount,*" is still seen. It is very large and but little elevated, and is intermixed with granite.

*January* 31.—*From Camp No.* 109 *to Camp No.* 110.—A short distance from Camp No. 109, we ascended a hill which is composed of lava covering granite. This lava extends for great distances on the north and west. At five miles from Camp No. 109, we found, in a river, beds of sand and of coarse limestone, Tertiaries inclining strongly to the west; the direction of the dislocations being north and south. We found dykes of trap and red porphyry traversing the formation. No diluvium. The country is mountainous, and difficult in a geological point of view.

*February* 1.—*From Camp No.* 110 *to Camp No.* 111.—At the summit of Cactus Pass, we found a large vein of red sienite trending north and south; then gneiss and quartziferous porphyry, and veins of white quartz.

The gneiss is contorted; the schists dip to the west. At Camp No. 111, we found at the east the Aquarius mountains, with a plateau of lava conglomerate, and a *mesa* of lavas. No diluvium.

*February* 4.—*From Camp No.* 111 *to Camp No.* 112, (11¾ *miles.*)—Half of the distance traversed to-day was upon granite, containing some veins of quartz, and the other half was upon diluvium.

*February* 5.—*From Camp No.* 112 *to Camp No.* 113.—Granite appears now and then upon the left, although it is often covered by drift.

forme entièrement la droite il parait s'étendre jusqu' au pied de Cerbat mont.

6 *Février.—Du No.* 54′ *au No.* 55′.—On fait neuf milles tout le temps sur le diluvium, très puissant et à gros cailloux, dans le lit de *Big Sandy creek.*

7 *Février.—Du No.* 55′ *au No.* 56′, quatre milles et demi. Sur le diluvium qui a 1,000 pieds d' épaisseur. Presque pas de terre végétale.

8 *Février.—Du No.* 56′ *au No.* 57′.—Les deux premiers milles sont sur le diluvium; puis on entre dans un cañon à l'ouest, au milieu de montagnes de 5 à 800 pieds de hauteur, de *granite,* gneiss veines de quartz et de feldspath. Direction générale sud sud est, nord nord ouest.

9 *Février.—Du No.* 57′ *au No.* 58′.—Tout le temps entre des collines granitiques. A l'opposite du Camp 58′, on a un cliff perpendiculaire avec table de lave basaltique venant du nord est. Dans le diluvium qui forme une petite mesa au camp même, à cause de la vallée qui s'élargit et du point d'affluence du *Bill Williams' fork* avec *Big Sandy creek,* il y a des cailloux de lave noire et rougeâtre.

10 *Février.—Du No.* 58′ *au No.* 59′, 6¼ *milles.*—Une partie sur le diluvium; des montagnes granitiques autour; et une mesa volcanique à notre grauche; on vient camper à l'entrèe d'un nouveau cañon.

11 *Février.—Du No.* 59′ *au No.* 60′.—Tout le temps dans un cañon, il suit en zig-zag S.S.E. et quelquefois S.O., c'est un *granite* à gros cristaux de feldspath blanc et rose, mica. Noir, porphyre rouge quartzifère, quelquefois dykes de trap de quartz allant S. 70° E. à N. 70° W. qui est la direction des montagnes de Mogoyon. Le Mont Artillery au pied duquel est notre camp est pointu avec flanc noirâtre, comme de la lave volcanique diluvium plus considérable dans le fond de la vallée.

12 *Février.—Du No.* 60′ *au No.* 61′, 7½ *milles.*—On sort du cañon à l'extremité, il y a du trap formant deux grandes montagnes. La

This drift bounds our route on the right, and appears to extend as far as the foot of Cerbat mountain.

*February* 6.—*From Camp No.* 113 *to Camp No.* 114.—We travelled nine miles upon the diluvium, very thick, and containing large pebbles, in the bed of Big Sandy creek.

*February* 7.—*From Camp No.* 114 *to Camp No.* 115, (4½ *miles.*)—We passed upon the diluvium, which has a thickness of 1,000 feet. There is scarcely any soil or vegetable mould.

*February* 8.—*From Camp No.* 115 *to No.* 116.—The first two miles are upon the diluvium; we then enter a cañon in the west in the midst of mountains from 500 to 800 feet in height; these are of granite and gneiss, and traversed by veins of quartz and feldspar. General direction south-southeast, north-northwest.

*February* 9.—*From Camp No.* 116 *to No.* 117.—We were continually among granitic rocks. Opposite Camp No. 117 we found a perpendicular cliff with a table-like summit of basaltic lava, which came from the northeast. In the diluvium which forms a little *mesa* just at camp, by reason of the widening of the valley and of the point of affluence of Bill Williams' fork with Big Sandy creek, there are pebbles of reddish and black lava.

*February* 10.—*From Camp No.* 117 *to No.* 118, (6¼ *miles.*)—A part of the way we were upon the diluvium; granitic mountains are around us and a volcanic mesa at our left. We came to camp at the entrance of a new cañon.

*February* 11.—*From Camp No.* 118 *to No.* 119.—The whole distance traversed was in a narrow and zig-zag cañon, in a south-southeast direction, sometimes southwest. The rock is granite, with large crystals of white and rose-colored feldspar and black mica. Also quartziferous red porphyry and dykes of quartz and trap running in the direction south 70° east to north 70° west, which is the direction of the Mogoyon Sierra. Artillery mountain, where we are encamped, is pointed, and has a blackish side, like volcanic lava. Diluvium in the bottom of the valley is more abundant.

*February* 12.—*From Camp No.* 119 *to No.* 120, (6½ *miles.*)—We leave the cañon, and at the end there is trap-rock forming two great

vallée s'élargit de nouveau et l'on est encore entre deux couches de diluvium assez abondant, et le même que précédemment.

13 *Février.—Du No.* 61′ *au No.* 62′, 6½ *milles.*—On passe des montagnes de trap amygdaloïde, rougeâtre du systême N.S. qu'ont relevé des grès et poudingues rouges tertiaires, probablement pliocene le grès rouge très-fin et très friable, et a une couleur rouge-jaune très différente de la couleur du grès rouge plus ancien. La vallée s'élargit, et est remplie de diluvium plus petit que dans le cañon. Le systême nord sud finit à peu de distance au sud de nous, et une nouvelle chaine du systême E.E.S. à O.O.N. commence au sud de nous.

15 *Février.—Du No.* 61′ *au No.* 62′, 9¼ *milles.*—On entre bientôt dans un cañon de sept milles de long qui traverse une troisième, chaine des monts Cerbat, E.E.S., O.S. N. ce cañon —— [?] abrupte à montagne et cliff de 300 à 600 pieds, est formé de roches métamorphiques, conservant des indices de stratification avec quelque plications. Les roches sont des quartzites blanchies, par veines; alternant avec des micaschistes bruns noirs et verts; il y a des veines de fer dans le cañon. Au sortir du cañon on a un immense développement de drift qui semble indigner le voisinage du Rio Colorado Grande.

16 *Février.—Du No.* 62′ *au No.* 63′, 6 *milles* ¾.—On entre de nouveau dans un cañon à un mille de distance ; ce cañon est formé de roches trappéennes et de quartzites métamorphiques. Puis on entre dans une région de poudingue rouge et de grès rouges tertaires. Les Poudingues sont redressés par le système Nord sud qui vient ——— [?] ici contre le systême Mogoyon. Vallée assez étroite.

17 *Février.—Du No.* 63′ *au No.* 64′ 7 *milles* ¼.—L'eau disparait encore, le cañon est large mais le lit sableux de la rive, l'occupe entèrement ; à gauche système Mogoyon à droite système Cerbat ; mêmes roches éruptives et métamorphiques, basaltiques, formant le sommet d'une mesa, à droite près de Camp 64′.

mountains. The valley again widens, and we are still between two beds of diluvium, which is abundant, and the same as before.

*February* 13.—*From Camp No.* 120 *to No.* 121, (6½ *miles.*)—We passed mountains of amygdaloidal trap of a reddish color, and belonging to the north and south system. They have raised some Tertiary sandstones and conglomerates of a red color, probably pliocene. This very fine red sandstone is very friable, and has a reddish-yellow color, which differs from the color of the older red sandstones. The valley widens, and is filled with diluvium smaller than in the cañon. The north and south system ends at a short distance south of us, and a new chain of this system E.E.S. to W.W.N. commences at the south of us.

*February* 15.—*From Camp No.* 121 *to No.* 122, (9¼ *miles.*)—We soon entered a cañon seven miles long, which crosses a third chain of the Cerbat mountains, which has the direction of E.E.S. and W.W.N. This cañon is abrupt, with a mountain and cliff of 300 to 600 feet high, formed of metamorphic rocks, preserving indications of the stratification, with some plications. The rocks are of quartzite, whitened by veins, alternating with brown, black and green mica-schists. There are some veins of iron ore in the cañon. On leaving the cañon we found an immense development of drift which appears to indicate the vicinity of the Great Colorado river.

*February* 16.—*From Camp No.* 122 *to No.* 123, (6¾ *miles.*)—At the distance of a mile from camp we again enter a cañon, which is composed of trappean rocks and metamorphic quartzite ; we then enter a region of red pudding-stone and Tertiary red sandstones. The conglomerates are raised up by the north and south systems, which interfere at this point with the Mogoyon system. The valley is rather narrow.

*February* 17.—*From Camp No.* 123 *to No.* 124, (7¼ *miles.*)—We are yet without water. The cañon is wide, but is entirely occupied by the sandy beds of the river. The Mogoyon system is on the left, and the Cerbat mountains are on the right. We find the same metamorphic and eruptive rocks. In the Cerbat mountains there is much basaltic trap forming the summit of a *mesa* on the right near camp.

18 *Février.—Du No.* 64′ *au* 65′.—On traverse une vaste plaine de sable et nous Campons à l'entrée d' un grand cañon, qui est entièrement dans le système Cerbat.

19 *Février.—Du No.* 55′ *un No.* 66′, 8 *milles* ¾.—Tout le temps dans un cañon dont les hauteurs sont couronnées par un trap basaltique, et la base est des grès rouge argilleux, puis un poudingue rouge, sans marque de stratification. On voit, de temps à autres, de larges dykes de talcose schiste et de gneiss. La couleur des roches, en général, est brune rougeâtre. Pas de diluvium dans le cañon.

20 *Février.—Du No.* 66′ *au No.* 67′, 8 *milles* ½.—Les quatre premiers milles on est dans le même cañon avec gneiss porphyroid rouge, couronné par le trap basaltique au sommet. A droite le cañon s'élargit et l'on a de vastes collines de 200 pieds de hauteur de —— [?] drift et l'on arrive à l'embouchure du *Bill Williams' fork* dans le grand Colorado.

Au sud le Rio Colorado s'engage dans un cañon étroit de même roche rougeâtre; au nord, où l'on remonte, la vallée est du drift quaternaire, à un endroit on a ce grès rouge avec couches de drift et argile redressès de 20° et plongeant à l'ouest; c'est le même tertiaire que précédemment.

21 *Février.—Du No.* 67′ *au No.* 68′.—Sur le diluvium quaternaire près de la rivière, quelques endroits d'argile rouge du tertiaire relevés et inclinant à l'ouest, angle 20°. A trois milles à l'est, on a les montagnes de gneiss porphyröide rouge du Cerbat système. De l'autre côtè de la rivière, Cerbat système aussi. Hauteur des montagnes de 1,000 à 1,200 pied.

22 *Février.—Du No.* 68′ *au No.* 69′, 10 *milles.*—On entre au sortir du camp dans des montagnes qui viennent butter au rio; ces montagnes sont des grès et poudingues rouges tertiaire métamorphiques et endurcis par des traps basaltiques et amygdaloïdes, à 7 milles le long du Rio Colorado, on a des granites serpentineux et des quartz protogenes très beaux. De l'autre côte du rio mêmes mon-

*February* 18.—*From Camp No.* 124 *to No.* 125.—We crossed a vast plain of sand and encamped at the beginning of a great cañon which is entirely in the Cerbat system.

*February* 19.—*From Camp No.* 125 *to No.* 126.—We were all the way in a cañon the heights of which are surmounted by a basaltic trap, the base being of red argillaceous sandstone, then a red conglomerate without any trace of stratification. We saw, now and then, large dykes of gneiss and talcose schists. The color of the beds, in general, is reddish-brown. No diluvium in the cañon.

*February* 20.—*From Camp No.* 126 *to No.* 127, (8½ *miles.*)—For the first four miles we travel in the same cañon with red porphyroid gneiss, surmounted at the summit by red basaltic trap. On the right the cañon widens, and we found vast hills, two hundred feet in height, of —— [?] drift. We arrived at the mouth of Bill Williams' fork, in the Great Colorado.

South of the Colorado, we pass in a narrow cañon of the same reddish rock. On the north, where we ascend the valley is of quaternary drift. At one place we found the red sandstone, with beds of drift and red clay, upraised at an angle of twenty degrees, and dipping to the west; it is the same Tertiary formation before mentioned.

*February* 21.—*From Camp No.* 127 *to No.* 128.—We travelled on the quaternary diluvium near to the river, and passed in some places the red clays of the Tertiary, upraised and inclining towards the west at an angle of twenty degrees. Three miles eastward we found mountains of red porphyritic gneiss of the Cerbat system. The Cerbat system also extends on the other side of the river. Height of the mountains from 1,000 to 1,200 feet.

*February* 22.—*From Camp No.* 128 *to No.* 129, (10 *miles.*)—On leaving camp, we entre mountains which abut upon the river. These mountains are of metamorphosed Tertiary red sandstones and conglomerates, and are hardened by basaltic traps and amygdaloids. Seven miles from camp along the river, we found serpentinoid granite, quartzose, protogine, and very fine. On the other side of the river we

tagnes qu' hier semblant à une distance de deux milles du rio.

23 *Février.—Du No.* 69′ *au No.* 70′.—On traverse des collines et mesa de drift du quaternaire, la vallée va —— [?] rétrécissant des deux cotés du rio. On campe au pied d' une montagne d' où le rio sort.

24 *Février.—Du No.* 70′ *au No* 71′.—Nous traversons une grande montagne contrefort du Cerbat. D'abord on a une roche rougeâtre brune, qui est du trap amygdaloïde qu'a recouvert le conglomerate, le grès rouge et l'argile crayeuse du tertiaire que l'on voit non métamorphique dans la vallée le jour précedént. Puis on a de larges filons de porphyre rouge de quartzite, de trap, de gneiss, et enfin de granite vers l'est ; en revenant à la rivière on a de nouveau le conglomérat et l'argile blanche crayeuse métamorphique. La vallée s'élargit de nouveau et l'on a la vallée du Mojave. Ces montagnes sont extrêmement abruptes, à pics comme dans les Alpes ; hauteur au-dessus de la rivière de 300 à 1000 pieds.

26 *Février.—Du No.* 71′ *au No.* 72′, 10 *milles.*—Au milieu de la vallée d'alluvion de terre noirâtre du Rio Colorado des Mojaves.

27 *Février.—Du No.* 72′ *au No.* 73′—On traverse le Rio Colorado. Pas de cailloux, tout de sable et de boue noirâtre. Couleur de l'eau, brun rongeâtre.

1 *Mars.*—Rien de nouveau.

2 *Mars.—Du No.* 74′ *au No.* 75′.—A 8 milles de distance, ou rencontre les roches quartzeuses éruptives de la première chaine Californienne. On la traverse ; elle a quartre milles de large, trap, conglomérat, métamorphique ; puis on a une large plaine inclinée, recouverte avec un peu d'alluvial, mais généralement des roches granitoïdes décomposées sur place. Pas d'erratique.

3 *Mars.—Du No.* 75′ *au No.* 76′.—On finit de traverser la plaine inclinée et l'on pénètre dans la seconde chaine de montagnes, où il y a de l'eau courante. Cette seconde chaine est formée de conglomérat rouge métamorphique,

saw the same mountains, as yesterday, which appeared to be at the distance of two miles from the stream.

*February* 23.—*From Camp No.* 129 *to No.* 130.—We travelled hills and a *mesa* composed of drift, (quaternary). The valley becomes narrower, and we camped at the foot of a mountain by the river.

*February* 24.—*From Camp No.* 130 *to No.* 131.—We travelled over a high mountain—a spur of the Cerbat system. We at first found a reddish-brown rock which is amygdaloid trap, and which is covered by conglomerate, and also the red sandstone and the chalky clay of the Tertiary which we yesterday saw non-metamorphic in the valley. We then found large veins of red porphyry, of quartzite, of trap, and of gneiss, and finally of granite, towards the east. On returning to the river we again found the conglomerate and the white, chalky metamorphic clay. The valley again widens, and we found the valley of the Mojave river. These mountains are extremely abrupt, with peaks, as in the Alps. Height above the river from 300 to 1,000 feet.

*February* 26.—*From Camp No.* 132 *to Camp* 133, (10 *miles.*)—We travelled in the middle of the alluvial valley of the Colorado ; this alluvium is black.

*February* 27.—*From Camp No.* 133 *to Camp No.* 134.—We crossed the Colorado river ; no pebbles ; everything of sand and blackish mud ; color of the water reddish-brown.

*March* 1.—*From Camp No.* 134 *to Camp No.* 135.—Nothing new.

*March* 2.—*From Camp No.* 135 *to Camp No.* 136.—At the distance of eight miles we met the quartzose eruptive rocks of the first California chain. We crossed this chain and found it four miles wide. Trap and metamorphic conglomerate were found ; then we found an extended inclined plain covered with a little alluvium, but generally with the debris of the granitoid rocks which decompose on the spot. No erratics.

*March* 3.—*From Camp No.* 136 *to Camp No.* 137.—We ceased to traverse the inclined plain and penetrated among the second chain of mountains, where there is running water. This second chain is composed of red meta-

recouvert par un trap phonolitique, no ir tre, brilliant, tout-à-fait basaltique. Pas d'erratique.

4 *Mars.—Du No.* 76′ *au No.* 77′.—On traverse la seconde chaine qui est partout du trap; puis on a devant soi un vaste plateau, qui s'étend jusqu' à la troisième chaine, le plateau de roche éruptive, décomposée et recouvert en plusieurs endroits d'un calcaire bréchiforme, blanchâtre horizontal et Tertiaire. Hauteur du plateau, 4,500 pieds.

5 *Mars.—Du No.* 77′ *au No.* 78′.—On vient de traverser la plaine où il y a du calcaire, et l'on entre dans la troisième chaine, formée de granite amphibolique très dur; et l'on voit a distance du trap répandu au sommet des montagnes.

7 *Mars.—Du No.* 78′ *au No.* 79′, 20 *milles.*—On traverse la troisième chaine, qui a 5 ou 6 milles de long, tout de granite à hornblende, très-dur, excepté au nord du Camp 78′ où il y a une roche blanchâtre dioritique [?] on entre dans un nouveau plateau incliné, granitique et l'on vient camper sur ce même granite à hornblende au pied de la quatrième chaine.

8 *Mars.—Du No.* 79′ *au No.* 80′, *trois milles.*—On traverse la quatrième chaine, qui est moins élevée que la précédente, mais plus longue, elle est formée pour 12 milles de granite quartzifère. A 10 milles de distance au nord du sentier on voit sept on huit petits cônes volcaniques rangès est ouest. On arrive au sommet des côtes de drift, très escarpées. Ce drift a 800 pieds d' épaisseur, formé de gros blocs très-peu roulés, avec sables. On arrive, à 12 milles à droite, à une grande montagne de trap greenstone métamorphique; cela finit la quatrième chaine; on a pour 15 milles les sables modernes du Rio Mojave, et un lac sec avec efflorescence alumineuse et salée. L' eau salée se trouve partout à ½ pied de profond. J'ai vu aujourd' hui jusqu à la Sierra Nevada, et il y a 9 ou 10 chaines nord sud, parallèles entre la Colorado et la Nevada, avec quelques petils pâtés de montagnes entre quelque cônes.

morphic conglomerate covered by black and shining phonolitic trap; also basaltic. No erratics.

*March* 4.—*From Camp No.* 137 *to Camp No.* 138.—We crossed over the second chain and trap-rock was everywhere visible; we then saw before us a vast plateau which extended as far as the third chain. This plateau of decomposed eruptive rocks is covered in several places with a whitish limestone which is brecciated, horizontal and Tertiary. Elevation of the plateau 4,500 feet.

*March* 5.—*From Camp No.* 138 *to Camp No.* 139.—We arrived at the other side of the plain, where there is limestone, and entered the third chain, formed of very hard amphibolic granite, and we saw in the distance trap-rock spread out on the summit of the mountains.

*March* 7.—*From Camp No.* 140 *to Camp No.* 141, (20 *miles.*)—We crossed the third chain, which is five or six miles wide, and composed of a very hard hornblendic granite, except at the north of Camp No. 140, where there is a whitish dioritic? rock. We reached another inclined plain of granitic rocks, and we encamped on the same hornblendic granite at the foot of the fourth chain.

*March* 8.—*From Camp No.* 141 *to Camp No.* 142, (31 *miles.*)—We crossed the fourth chain, which is less elevated than the preceding, but longer; for twelve miles it is formed of quartziferous granite. Ten miles north of the pass we saw seven or eight small volcanic cones of a red color; direction east and west. We reached the summit of steep banks of drift. This drift is 800 feet thick, and formed of large blocks, but little rolled, and sands. At the distance of twelve miles, on the right, we reached a great mountain of trap and greenstone, metamorphic, and which ends the fourth chain. We followed for fifteen miles the recent sands of the Rio Mojave, and a dry lake covered with a salty and aluminous efflorescence. Salt water is everywhere found at the depth of six inches. I have seen to-day as far as the Sierra Nevada, and there are nine or ten north and south chains running parallel between the Colorado and Sierra Nevada, with some "*pâtés de montagnes*" between some cones.

9 *Mars.—Du No.* 80′ *au No.* 81′ 13 *milles.*—On achève de traverser ce lac salé et sec, puis les sables modernes qui s'élèvent de chaque côté sur les montagnes ; puis on vient camper dans un cañon au pied de la 5me chaine, où il y a des roches métamorphiques, des dykes de quartz et de greenstone porphyroïde. Direction du dykes de quartz N. S.

10 *Mars.—Du No.* 81′ *au No.* 82′.—On traverse la 5me chaine qui n'est pas trés élevée, elle est formée en partie de roches métamorphiques, trap, quartzites, et appuyée contre la côté de l'ouest ; il y a un énorme drift, 800 à 1,000 pieds d' épaisseur ; cailloux assez petits entremêlés avec du sable grisâtre ; ces cailloux sont un peu stratifiés, non rayés, et quelques couches sont cementées par du *carbonate of lime*, et forment un poudingue. Au Camp 82′ le pays est plus découvert, il y a beaucoup d'efflorescences salines aux environs du camp.

11 *Mars.—Du No.* 82′ *au No.* 83′, 11¾ *milles.*—On remonte la vallée du Mojave river, qui est large avec mesa de drift et dunes de sables. Quelques-unes des dunes de sables s'élèvent sur les montagnes au sud de nous.

13 *Mars.—Du No.* 83′ *au No.* 84′.—On continue à remonter le Mojave ; la vallée est très-large ; c'est du drift assez petit. Près du chemin des Mormons, on a des montagnes au nord de roches métamorphiques et de porphyre rôse. Où nons nons arrêtons, dans l' après midi, il y a des roches métamorphiques.

14 *Mars.—Du No.* 84 *au No.* 85′.—On a les mêmes roches qu' hier.

15 *Mars.—Du No.* 85′ *au No.* 86′.—La vallée du Mojave se rétrécit trois ou quatre milles avant l' endroit où l'on quitte la rivièrè, et l'on voit les roches trapéennes et de mica schistes, se trouvant jusqu au bord de l'eau. En quittant le Mojave creek on s'élève graduellement sur un plateau formé de poudingue tertiaire.

16 *Mars.—Du No.* 86′ *au N.* 87′.—On arrive on sommet de Cajon Pass et l'on descend un ravin dans le quaternaire ou drift. Ce quaternaire, formé de sable endurci avec cailloux

*March* 9.—*From Camp No.* 142 *to Camp No.* 143.—We crossed to the other side of the dry and salty lake ; there the recent sands succeed and rise on the mountains on each side. We encamped in a cañon at the foot of the fifth chain, where there are metamorphic rocks, dykes of quartz, and of porphyroid greenstone. The direction of the quartz-dykes is north and south.

*March* 10.—*From Camp No.* 143 *to Camp No.* 144.—We crossed the fifth chain, which is not much elevated ; it is in part formed of metamorphic rock, trap quartzites, resting on the side towards the west. There is an enormous body of drift, from 800 to 1,000 feet in thickness ; the pebbles are rather small, and are intermixed with grey sand. They are slightly stratified, not in red bands, and some beds are cemented by carbonate of lime, and form a conglomerate. At Camp 144 the country is more open, and there are many saline efflorescences around the camp.

*March* 11.—*From Camp No.* 144 *to Camp No.* 145, (11¾ *miles.*)—We ascended the valley of the Mojave river, which is wide, and bounded with plains, mesas of drift, and sand-dunes. Some of the sand-dunes rise on the mountains south of us.

*March* 13.—*From Camp No.* 146 *to Camp No.* 147.—We continued the ascent of the Mojave ; the valley is very wide, and there is some fine drift. Near the Mormon road, we have mountains at the north, of metamorphic rocks and roseate-porphyry. There are metamorphic rocks where we stopped in the afternoon.

*March* 14.—*From Camp No.* 147 *to Camp No.* 148.—We find the rocks the same as yesterday.

*March* 15.—*From Camp No.* 148 *to Camp No.* 149.—The Mojave valley narrowed three or four miles before we left the river, and we saw the trappean rocks and mica-schists as far as the border of the stream. On leaving the Mojave river, we gradually ascend a plateau formed of Tertiary conglomerate.

*March* 16.—*From Camp No.* 149 *to Camp No.* 150.—We arrived at the summit of Cajon Pass, and descended a ravine in the quaternary or drift. This quaternary is formed of

roulés par *beds*, ou isolés ; à stratification tout-à-fait indistincte et confuse, excepté que la masse est élevée de 15 à 45 dégrés par la Sierra Nevada et plonge à l'est.

Le cañon a 4 milles de long et est formé surtout d'une roche métamorphique noirâtre, avec veines de quartz ; on trouve aussi du granite.

18 *Mars.—Du* 87′ *au* 88′.—On sort du Cajon Pass, et l'on suit le pied ouest de la Sierra Nevada. Les roches sont des sienites noirâtres, comme avant hier. Il y a des cônes de dégagement des montagnes, avec cailloux roulés, pas très-gros.

20 *Mars.—Du No.* 88′ *au* 89′.—On est constamment sur un sol recouvert d'herbe, sans voir les roches sous-jacentes.

21 *Mars.—Du* 89′ *au* 90′.—On trouve près de la ville de Los Angelos une petite ligne de collines où il y a du drift quarternaire.

sand, hardened, with rolled pebbles, isolated, or in beds. The stratification is quite indistinct and confused, and the mass is upraised from 15 to 45 degrees by the Sierra Nevada, and dips to the east.

The cañon is four miles long, and is principally formed of a blackish metamorphic rock, with veins of quartz. We also find granite.

*March* 18.—*From Camp No.* 150 *to Camp No.* 151.—We left the Cajon Pass and followed the western foot of the Sierra Nevada. The rocks are blackish sienites, like those in the journey of day before yesterday ; and there are cones formed from the wash (*degagement*) of the mountains with rolled pebbles, but not very large.

*March* 20.—*From Camp No.* 151 *to Camp No.* 152.—We were continually upon a soil covered with grass, without seeing the underlying rocks.

*March* 21.—*From Camp No.* 152 *to Camp No.* 153.—We found near the town of Los Angeles a slight line of hills, where there is quartenary drift.

P.R.R.S. PACIFIC RAIL-ROAD EXPLORATION & SURVEY
WAR DEPARTMENT

# GEOLOGICAL SECTION
FROM THE
# MISSISSIPPI RIVER TO THE PACIFIC OCEAN.

Along the route explored by Lieut. A.W. WHIPPLE, Corps of Topl. Engrs
near the Parallel of 35° North Latitude.
1853-1854.

Prepared to accompany the preliminary Report,
BY MR. JULES MARCOU,
Geologist of the Expedition.

Granite and Metamorphic rocks | Triassic | Devonian | Lower Carboniferous | Coal Measures | Magnesian lime Stone | Trias | Jurassic | Neocomian | White Chalk | Tertiary | Quaternary

# RESUMÉ

OF A

# GEOLOGICAL RECONNAISSANCE,

EXTENDING

## FROM NAPOLEON, AT THE JUNCTION OF THE ARKANSAS WITH THE MISSISSIPPI, TO THE PUEBLO DE LOS ANGELES, IN CALIFORNIA.[1]

BY JULES MARCOU, GEOLOGIST AND MINING ENGINEER.

BOSTON, *July* 26, 1854.

DEAR SIR: In obedience to the instructions contained in your letter of the 2d July, dated Washington city, D. C., I have the honor to send you the *Resumé* of the geological reconnaissance that I made in connexion with your survey for the southern Pacific railroad, extending from Napoleon, on the Mississippi, to the Pueblo de los Angeles, in California.

Having in my possession, as yet, neither the specimens which I collected, nor a good map of the country passed through, and the time being very short which is left me to make my report, I trust you will excuse the brevity of this Resumé; in which, however, I will endeavor to show the principal geological results of my exploration, in order to give a general idea of the mineralogical resources of the route with regard to the construction of a railroad.

Napoleon is situated on the alluvium of the Mississippi; which extends on the two banks of the river Arkansas as far as Little Rock, and is composed of a very fine-grained, reddish-yellow earth. This alluvial deposite forms the richest agricultural portion of the State of Arkansas; and as it constitutes the whole of the basin which extends from Little Rock to the Mississippi, and is always in horizontal beds, these rocks, it will be seen, offer no obstacle to the construction of a railroad.

At Little Rock the alluvium is replaced by rocks, forming a line of mountains, whose direction is from west west-south to east east-north.

These rocks continue for three or four miles along the river, and are formed of black slates, of grey, quartzose metamorphic masses, traversed by veins of white quartz, having the same direction as the mountains.

On the left bank of the Arkansas, two miles higher than Little Rock, the sandstones and limestones of the carboniferous period begin to appear, resting horizontally upon the metamorphic rocks. Here begins the fine coal-basin of Arkansas, which is only a continuation of the immense coal-field of Iowa, Missouri, Kansas, and which extends even to Fort Belknap, Rio Brazos, and

[1] This Resumé is reprinted from the preliminary or first report of Lieutenant Whipple, in 8vo., Chap. VI, p. 40. (Reports of Pacific Railroad Surveys, House Doc. 129: Washington, 1855.)

to the Rio San Saba, Texas. Our survey has traversed this basis from the vicinity of Little Rock to Delaware mount, a distance of more than four hundred miles, coal being found almost everywhere from Petit Jean mountain to Coal creek and the Shawnee mountains. It forms a vast reservoir for the sustenance of industry and commerce along the whole line of the Pacific railroad. This carboniferous basin contains, in addition to the coal, an abundance of excellent sandstone for building bridges and embankments, good beds of limestone for the manufacture of lime, and also iron. Artesian wells will give an immense supply of water for agricultural or other uses, and it may be predicted that this region will be one of the richest portions in the southern States of the Union.

Immediately after crossing Delaware mount, which is formed of upheaved and dislocated beds of carboniferous limestone, whose direction is from south-southwest to north-northeast, we meet with horizontal beds of red and blue clay that belong to another geological epoch. This new formation, corresponding to that which European geologists have agreed to call the *Trias*, holds a very important position in the west; and it may be said, with some few exceptions—such as being sometimes covered by a more modern formation, or replaced by carboniferous, devonian, or modern rocks—with these exceptions, the Trias may be said to form the whole of the immense square comprised between the 96th and 114th degrees of longitude, and the 32d and 48th degrees of latitude; extending one arm to the Sault St. Marie, at the entrance to Lake Superior, of which it forms a part of the contour.

This formation, which I was the first to notice and recognise in the west, (a Geological Map of the United States and the British Provinces of North America, page 42,) attains a very considerable development, and, according to my observations, has a thickness of four or five thousand feet. The few observations as yet made on this American Trias, and its great extent of surface, prevent the establishment of very accurate divisions; but, from what I have seen, I will establish provisionally three principal divisions in these rocks.

The lower division is composed, especially at the base, of red and blue clay; the red predominates as you ascend, and becomes of a vermilion color; then red sandstone, with green spots and a very friable texture, a massive and sometimes schistose stratification, intercalates with the clays, and finishes by entirely replacing them; this sandstone is very fine-grained, like sand, though some beds are quite coarse, and resemble a sort of conglomerate.

This lower group, which attains from two to three thousand feet of thickness, forms our whole route from Topofki creek to Rock Mary. I connect with this lower group the red sandstone that forms more than half the contour of Lake Superior, as well as that which forms the shore of the Bay of Fundy, (Nova Scotia and New Brunswick;) and also a part of the sandstone forming Prince Edward and the Magdalen islands. In Virginia and New Jersey, that part of the red sandstone which is without fossils and does not contain any gypsum, belongs to this lower division, which closely corresponds to the *bunten sandstein* of the German geologists, the *grès bigarés* of the French, and to the *upper New Red sandstone* of the English.

The second group, or middle division, is formed of beds of red clay, containing, very often, immense masses of white gypsum, amorphous, furrowed with veins of crystallized gypsum, with interposition of strata of magnesian or dolomitic limestone, and frequently beds of rock-salt or saliferous clay are found superposed upon the gypsum. The height of the beds in this middle group is about fifteen hundred feet. We met with it on our route from Rock Mary to the arroyo Bonito, or Shady creek, with the exception of two points, where the direction taken by our expedition, near Camp No. 31, crossed strata of neocomien, and at Antelope Hills whitish-grey sandstone, which belongs to the upper division of the Trias. I connect with this middle group the gypsum found in the red sandstone of New Jersey; at Windsor, Nova Scotia; at Plaster cove, Cape Breton; and at Prince Edward island. As to its synchronism with European formations, I regard it as corresponding to the *muschelkalk* of Germany. It contains, like the *muschelkalk* of Wurtemberg, rock-salt and dolomite. The first fossils which I found in the Trias were in this division. It was near Camp No. 33—a full-grown tree, with branches, very

much resembling the *Pinites fleurotii* of Dr. Mougeot, which is found in the New Red sandstone of the Val d'Ajol in the Vosges; and this establishes a connexion between the New Red of France and that of America.

The third division, or upper group of the Trias, is subdivided again into two parts. The lower is formed of thick beds of whitish-grey sandstone, often rose-colored, and even red; and the upper consists of beds of sandy calcareous clay, of very brilliant colors—violet, red, yellow and white—in a word, of variegated marls. This upper portion presents a striking resemblance, as to the rocks, with the *Marnes irisées* of France, or the variegated marls of England. With the exception of the amaranth yellow color, which I have never seen in Europe, I could have imagined myself transported to some points in the Jura or the Vosges. These rocks having very little consistency, have been carried away almost everywhere by denudations. It is only where they are capped by the Jurassic strata that they can be observed. The sandstone of this third division is very much developed, with rather an indistinct and very massive stratification. Its thickness is one thousand feet, while the variegated marls are only four or five hundred feet thick—making a whole of fifteen hundred feet for the upper group of Trias. Upon our route this sandstone forms the summits of the table-lands or mesas which extend on each bank of the Canadian river, from Antelope Hills to the Llano Estacado; then it forms the bottom of the valley from Rocky Dell creek and the Plaza Larga to Anton Chico and the Cañon Blanco. In this group of Triassic rocks, numerous remains of petrified wood, and even of whole trees, are often met with.

On the western declivity of the Sierra Madre, between Zuñi and the Rio Colorado Chiquito, there is really a petrified forest of trees thirty and forty feet long, divided into fragments from six to ten feet in length, with a diameter of three or four feet, some being still upright enclosed in the sandstone. These trees and remains of petrified wood belong nearly all to the family of the conifers, and some to that of the ferns with arborescent stems, and to the *Calamodendron*.

I connect with this third division the red sandstones of the Connecticut valley, containing foot-prints and fishes, as well as the coal-basin of Chesterfield county, in Virginia, and the red sandstone in North Carolina, contrary to the opinion of Messrs. Rogers and Hall, who call it Liasic, and even Oolitic. Its equivalent in Europe is, without doubt, the *Marnes irisées* of France, the *Keuper* of Germany, and the variegated marls of England.

The easy decomposition of the sandstone of this third group has given it all sorts of curious forms, which have been compared to ruined temples, natural fortifications, natural mounds, or to the forms of gigantic statues, rivals of those of Karnac and Nineveh. The celebrated Chimney Rock, on the route to Fort Laramie, is entirely of this formation.

The strata of American Trias comprise valuable rocks for building a railroad. There are found in abundance sandstone for embankments and bridges; dolomite, which produces an excellent hydraulic lime; gypsum in incalculable quantities, for exportation; and, finally, salt.

I have mentioned two points between Topofki creek and Anton Chico where the Triassic rocks are covered by more modern formations. The first of these points is upon one of the tributaries of the Washita river, near our Camp No. 31, where, upon the heights, are found the remains of beds of a limestone filled with shells, which I connect with the neocomien of Europe; or, in other words, with the lower division of the cretaceous rocks. This limestone is only five feet thick; it is of a whitish-grey color, containing an immense quantity of *Ostracea*, which I consider (provisionally) as the *Exogyra ponderosa*,[1] Roemer; having the closest analogy with the *Exogyra* of the neocomien of the environs of Neuchatel. As it is the first time the neocomien has been recognised in North America, where, until now, only the green-sand and chalk-marl, or lower chalk, have been found, I will add that these strata are much more developed at Fort Washita, where Dr. G. C. Shumard has made a large collection of fossils, such as *Pecten quinque costatus*, *Panopea*, *Toxaster complanatus*, and another species of *Toxaster*, all fossils or genera

[1] Mr. Marcou subsequently determined this fossil to be *Gryphæa Pitcheri*, Morton.—W. P. B.

characteristic of the neocomien of Europe. Further, at Fort Washita, the neocomien is covered by the green-sand, containing very fine *Hemiaster*, large *Ammonites*, &c.

This neocomien has been almost wholly destroyed and carried away by denudations, for it is only found on the summits of the hills, resembling the remains of ancient buildings; it occupies actually only a width of three or four miles. Probably at the time of the deposite it covered more space; but, as at Fort Washita, where it has been very little denuded, it is only twenty-five or thirty miles wide. This shows it to have been but a narrow bend in the immense basin of the prairies.

The second point where the expedition passed from the strata of the Trias to a more recent formation, is at the place where we crossed the Llano Estacado. The base of the Llano is formed wholly of the upper strata of the *Keuper*, which reaches half way up the height of the plateau. These strata, which are of a red color, are suddenly replaced by white sandstone, containing numerous calcareous concretions, then by a compact white limestone, sometimes oolitic, that forms the summit of the Llano. These beds are superposed in concordant stratification upon those of the *Keuper*.

The Llano Estacado consists of two table-lands of different elevations. We crossed the lower one but forty miles further west. Near Fossil creek and Tucumcari mount there is a second steppe, one hundred and fifty feet higher than the first, also forming a vast mesa, which extends to the Pecos. This second mesa is entirely formed of blue clay at the base, then yellowish sandstone; and, finally, the summit is again a very compact, white silicious limestone.

In the whole, this formation of the Llano Estacado does not exceed four hundred feet in thickness.

This formation is not limited to the Llano, but it forms the summits of all the plateaux that are seen to the north, in the direction of the Canadian river, and between the Canadian and the Raton mountains, as well as the majority of the mesas, which extend from the Rio Pecos to the foot of the Sierra de Sandia. Our survey has also met with it on the other side of the Rio Puerco, forming with volcanic lava almost the whole road between Covero and the Sierra Madre, and finally between Inscription Rock and the Pueblo of Zuñi, where it again forms mesas, which extend in the direction of Fort Defiance and the Cañon de Chelly. It will be seen that those of the Llano Estacado occupy, geographically, a large place in the geology of the Rocky mountains; but as regards their relative age, they are still more important, for they fill a void heretofore left in the series of stratified rocks of North America; these rocks belong to the Jurassic or Oolitic epoch. Fossils are very rare in the sandstone and limestone; but the beds of blue clay which are found in the middle of this formation contain in abundance a *Gryphœa* which has the greatest analogy with the *Gryphœa*[1] *dilatata* of the Oxford clay of England and France, and which I call, provisionally, *Gryphœa Tucumcari*, and a very large *Ostrea* having much resemblance to the *Ostrea Marshii*[2] of the inferior oolite of Europe. I found also trigonia and a species of *Cardinia*. This American Jurassic presents, at least thus far, one point of considerable difference from the Jurassic of Europe and Asia, where such large quantities of *Cephalopods* are found, such as *Ammonites* and *Belemnites;* while here the *Ammonites* are only found in the green-sand, and the *Belemnites* in the marly chalk; and even there these fossils are never so abundant as in the corresponding strata of Europe.

[1] Mr. Marcou has since decided that this fossil is identical with *G. dilatata* of the Oxford clay. I append here a copy of his recent description of this shell, and of *Ostrea Marshii*.—W. P. B.

*Gryphœa dilatata*, Sow. (pl. ——, figs. 1, 2 et 3.)—Cette coquille, dont nous faisons représenter l'état adulte et l'état jeune, ne laissera aucun doute sur son identité avec celle de l'oxford-clay de l'Europe occidentale. La figure 3 représente une forme plus allongée, que nous distinguons provisoirement à titre de variété, en lui assignant le nom de la montagne de Tucumcari (*Gryphœa Tucumcarii*) près de laquelle nous l'avons trouvée et qui est célèbre dans les plaines de l'Ouest. Les caractères essentiels de la charnière sont d'ailleurs ceux du type de l'espèce.

[2] *Ostrea Marshii*, Sow. (pl. ——, fig. 4.)—La seule valve de cette coquille que nous ayons rencontrée avec l'espèce précédente, nous paraît également ne pas différer de celle à laquelle nous la rapportons; et est identique aux specimens *d'Ostrea Marshii*, trouvées en Angleterre et en France.

In a practical point of view the Jurassic rocks are rather poor.

The limestone will furnish lime; the sandstone can be used for embankments and bridges, and with some advantage over that of the Trias, for it is harder. Finally, in some locations, as at El Ojo Pescado, near Zuñi, in the neighborhood of Fort Defiance, at the cañon of Chaca, there are beds of bituminous coal in the clay, but only three or four inches thick, so that probably they would not be rich enough to be successfully worked.

Continuing our itinerary, we find that from Anton Chico to near San Antonio we are almost constantly on white and yellow Jurassic sandstones. Three miles before reaching San Antonio the Trias is met with again, which now is found upheaved and dislocated, the strata dipping to the east; and for a space of five miles, all the strata are passed through with the gypsum, dolomite, sandstone, and red clay—exactly the same sort of rocks that were seen before in the Trias of the prairies. Immediately on leaving the village of Tigeras, which is situated in the middle of the pass that crosses the Rocky mountains, called here Sierra de Sandia, and also Albuquerque mountains, black schistose clay is seen, belonging to the coal-measures, then greyish-blue limestone, containing a great quantity of fossils. These last beds of schist and limestone are very much upheaved, dipping to the east at an angle of thirty or forty degrees; they rest on metamorphic rocks. The principal fossils found in the limestone which belongs to the mountain limestoné or lower carboniferous, are the *Productus semireticulatus, punctatus et flemingi*, the *Spirifer striatus et lineatus*, *Terebratula*, *Crinoids* and *Corals*, which are all fossils very charcteristic of the mountain limestone of Arkansas, Missouri, Iowa, Illinois, Indiana, Kentucky, Tennessee, Virginia, and Pennsylvania, as well as in Europe, and even in Australia and South America.

We have not met upon our route with beds of coal; but the presence of the black slate between the mountain limestone and the red clay of the Trias, indicates the existence of beds of coal on several points of the Rocky mountains; and, indeed, the inhabitants of New Mexico pointed out to me, in several places, beds of bituminous coal belonging, without any doubt, to the rocks of the coal measures.

On quitting the last beds of limestone that rest upon the quartzose metamorphic rocks, we find serpentine; then we come upon masses of granite, somewhat sienitic, which form the centre of the line of dislocation of the Rocky mountains. After going through the pass, which is fifteen miles long, we come out in the plain of the Rio Grande del Norte, where the granite is found covered with drift and alluvium, which form the whole plain as far as the right bank of the river, where the formation is sandstone. This sandstone is white, friable, horizontal in stratification, and forms almost the whole of the bottom of the valley which lies between the Rocky mountains and the Sierra de Jemez, and Mount Taylor or Sierra de San Mateo. On some points, as at Galisteo, it is covered by a greyish schistose clay, containing nodules of iron and numerous *plaquettes*, composed of the scales and fragments of bones of fishes, belonging to the genus *Ptychodus*. In this sandstone and clay, which rest horizontally on the upheaved beds of the Trias, the Jurassic and the Carboniferous, are found the remains of *Ammonites*, *Scaphite*, *Inoceramus*, and the *Ptychodus*, which indicates, for the relative age of this formation, the cretaceous group, and, further, the white chalk of Europe. This fact is a new one in the geology of America, where, until now, the true chalk has not been recognised; and now the cretaceous is here found to be composed of four divisions, precisely as in Europe: the *neocomien*, which I have found on the Canadian, the False Washita, and at Fort Washita: the *green-sand* of Timber creek, near Philadelphia; the *marly chalk* of Bordentown, New Jersey, of the Bad Lands, Nebraska, and of Fort Washita; and finally the *white chalk*, or *craie blanche*, of New Mexico. Besides, the discordance of stratification of the upper cretaceous of New Mexico, with all the sedimentary rocks found there, indicates that this formation was deposited after the principal dislocation of the Rocky mountains, which took place at the end of the American Jurassic period.

From the Rio Puerco to the Sierra Madre, our route was constantly upon beds of Trias and Jurassic, which are often covered in this region by immense overflowings of lava, coming from

the ancient extinct volcano of Mount Taylor, that is seen some distance to the north. These streams of lava which spread over the bottom of the valleys are exactly similar to the streams from volcanoes in actual activity, and, like these, are destitute of vegetation, and give to the country, where they are found, an arid and desolate aspect, named by the Mexicans, very appropriately, Mal Pais.

Near the culminating point of the Sierra Madre the Trias is replaced by the carboniferous limestone; then, for a distance of twelve miles, the rocks are eruptive granite, gneiss, and mica schist. Beyond, on the western declivity of the Sierra, comes the carboniferous again, the beds of the Trias, and finally the white and yellow sandstones of the Jurassic, with streams of volcanic lava in the valleys. Inscription Rock, and the whole mesa that extends nearly to Zuñi, are formed of the Jurassic rocks. A stream of lava spreads itself in the valley of the Ojo Pescado, and terminates three miles from the pueblo of Zuñi.

The valley of the pueblo and river of Zuñi is of Triassic rocks, formed here, as in the prairie, of sandstone and red clay, with dolomite and gypsum. On the plateau which we cross from Zuñi to the Colorado Chiquito, and from there till we arrive at a distince of five or six miles from the secondary Cones of the great volcano of the San Francisco mountains, we are constantly upon the Trias. These rocks are nearly horizontal upon the table-land, after having dipped to the east and west near the Sierra Madre, where they are very much upheaved. As we approach the Rio Colorado Chiquito, the strata incline to the north at a varying angle whose maximum is fifteen degrees; the heads of the strata looking towards the Sierra of Mogoyon, which is seen forty miles to the south.

Shortly after quitting the Colorado Chiquito we found here with the last beds of the red clay of the Trias, and, in concordant stratification, a magnesian or dolomitic limestone, with very regular strata from half a foot to one foot in thickness. Several beds contain fossils badly preserved; among which I recognised, however, a *Nautilus*, a *Pteroceras*, and a *Belemnites*. This formation, which is placed between the Carboniferous and the Trias, corresponds, without doubt, to the magnesian limestone of England, and is a new member which I add to the series of secondary rocks in North America.

This magnesian limestone has only four miles of extent in the place where we crossed it, and disappears beneath lava and volcanic ashes. I have observed it further to the west, and it appears also to occupy eastward one of the lesser chains of the Sierra de Mogoyon.

From the Sierra of San Francisco to Cactus Pass the geology of the country we passed through is very complicated, on account of the immense extinct volcanoes, which have covered with their lavas and basaltic streams the sedimentary and granitic rocks that primitively formed this region. The study of this part of our route was rendered still more difficult by the snow-storms, that covered the ground with an immense white sheet during nearly the whole time of our exploration.

I will only say, in general, that there are four or five large extinct volcanoes over this space, the lagest being that of San Francisco, which is twelve thousand feet above the level of the sea. In places where the lava does not entirely cover the ground we find magnesian limestone, the sandstone of the coal-measures, and the carboniferous limestone—the last containing fossils in abundance, the principal ones being the *Productus semireticulatus* and *Punctatus*, and the *Spirifer striatus*.

These stratified rocks are upheaved, and dip generally to the north-northeast, following several lines of dislocation which belong to the chain of mountains called Sierra de Mogoyon, or Sierra Blanca. In several places, and especially at Pueblo creek, beds of Old Red sandstone are seen below the lower carboniferous, and in contact with the gneiss and granite, similar to the Old Red of the Catskill mountains.

This system of dislocation of the Sierra of Mogoyon, the direction of which is east east-south and west west-north, is anterior to the apparition of the Rocky mountains and the Sierra Madre, and I place it at the end of the Triassic period, and before the deposite of the Jurassic.

From Cactus Pass to the junction of Bill Williams' fork with the Rio Colorado, we cross successively three or four chains of mountains running from north to south, and crossing the chains of the Mogoyon system. These mountains, which belong to the system of the Sierra Nevada, and which we called the Cerbat mountains, are formed entirely of eruptive and metamorphic rocks, with some beds of conglomerate and red clay belonging to the Tertiary epoch. I have recognised along the course of Bill Williams' fork several veins of argentiferous lead—an indication that silver is common in these mountains.

From the Rio Colorado to Monté we cross a country of mountains, formed almost wholly of granitic rocks, with the exception of three plateaux, which are occupied by sandstones or limestones, and modern sand. From the point where we quit Mojave creek to Cajon Pass, there is a plateau formed by a white conglomerate sandstone of diffuse stratification, and much upheaved by the Sierra Nevada. This sandstone is evidently Tertiary and posterior to the Eocene.

From Monté to Los Angeles, and at San Pedro, the road is constantly over modern alluvium, which probably conceals beds of the Tertiary epoch.

In the Cajon Pass I found sienite, trap, and serpentine, exactly similar to those found between Rough-and-Ready, Grass Valley, and Nevada City, and which contain the veins of auriferous quartz.

As specimens were given to me at Los Angeles, very rich in gold, coming from the Cajon Pass, it is more than probable that this point will one day be one of the richest places in California.

In an economical point of view, the eruptive rocks which form almost the whole country between Cactus Pass and Cajon Pass will furnish excellent materials for construction—for bridges, roads, and houses ; there are also very beautiful marbles, red porphyry, and especially, I think, will be found there mines rich in silver and gold.

Before concluding, I will say that the relative age of the Sierra Nevada is much less than that of the Rocky mountains, although the direction of the two chains is the same—that of the meridian. The Coast range was raised at the end of the Eocene epoch, whose beds it has upheaved and dislocated, as may be seen in the environs of Monterey ; and the Sierra Nevada was raised later—at the end of the Miocene, or Pliocene. I have not been able to determine to which of these two this system of dislocation it corresponds.

Accompanying this will be found a geological section of the country passed through, as correct as consistent with the short time I have left in making it.

I am, dear sir, your most obedient servant,

JULES MARCOU,

*Geologist and Mining Engineer of the Southern Pacific Railroad Survey.*

A. W. WHIPPLE,

*First Lieut. Top. Engineers, U. S. A.,*

*in charge of Exploration of Route near 35th Parallel.*

# REMARKS ON THE MAP AND SECTION.

### THE MAP.

The Geological Map accompanying this report exhibits the line of the survey, with the camps, from Fort Smith to the Pacific. It also includes the valley of the Arkansas down to its intersection with the Mississippi river. The scale adopted is the same as that of the General Map of the Territories now being compiled and engraved in the office of the surveys. This scale is 1 : 3,000,000, or about forty-seven miles to one inch. The whole line is thus brought into a small compass, and can be easily referred to when consulting the report. Its width being less than the length of the quarto page, does not require it to be folded in more than one direction when placed in the report. The trail is indicated by a broken line, and the principal camps by numbers ; the intermediate camps being indicated, but not numbered.

The mountains are not shown by the ordinary shading used in maps, but by broken and slightly overlapping black lines, which are placed in the direction of the trends of the ranges. These lines, with the coloring used for the granitic rocks of which the ranges are nearly all composed, sufficiently indicate their position on the map. The scale is so small that some of the minor details of the boundaries of the different formations were necessarily sacrificed, and it was not possible to represent some of the dykes of trap by colors, of the size required by conformity to the scale. The outlines or boundaries of the formations are shown by a fine dotted line; and, except in a few instances, the attempt to show their extension far beyond the line of exploration has not been made.

### GEOLOGICAL SECTION.

The Geological Section which accompanies this report is designed to give an approximate representation of the chief features in the geology of the country, on and near the line of Lieutenant Whipple's survey. This line, as is known, extends from the Mississippi river westward to the Pacific ocean, at San Pedro, and for the greater part of its course is in the vicinity of the 35th parallel of north latitude. The line of the section does not, however, follow the line of the survey throughout its whole course, but has been modified so as to respresent, as nearly as possible, the configuration of the region on a direct line, avoiding the detours to the north and south unavoidable in the operations of the survey. The barometrical and viameter measurements of Lieutenant Whipple have served as the basis for the section, and the height and distances where the two lines correspond have been taken from them. The scale adopted for these representations on the section is two miles to one inch, or half an inch to one mile ; the scale for vertical and horizontal distance being equal. The profile of the section consequently shows, as nearly as possible, the slopes and grades with their natural inclination, and, indeed, is intended to be a truthful miniature representation of the relief of the country.

The belt of country represented extends over twenty-eight degrees of longitude, or about 1,590 miles from east to west. The whole distance along the circuitous line of the survey is 2,075 miles ; but the section is shortened and made more direct in its course, so that it repre-

sents 1,703 miles. Its entire length is 851.5 inches, and it is divided into twenty-three lines, each one, except the upper and lower, being 38.7 inches long. It was deemed best, even at the expense of marring the appearance of the section by crowding the lines, to place the whole representation on one sheet, in order to present a connected view from one end of the line to the other.

In constructing the section, it was necessary to consider that one prominent object was to present a view of the geology directly along the line as it was surveyed. To represent on the section, however, the succession and character of the rocks along the trail exactly as they occur, would not permit the geological structure of the region to be exhibited. The detours to the north and south were chiefly parallel with the trend of the rocks, and consequently they could not be represented on a section in which structure was to be shown. It was of course important that the line of section should be transverse to the principal lines of structure. To secure this, and at the same time to present a fair view of the geology along the trail, the line indicated below was adopted, and wherever it does not coincide in direction with the trail, it is drawn upon the map.

### DIRECTION OF THE SECTION.

From the Pacific ocean at San Pedro, the seaport of Los Angeles, by the trail to Camp 142.
From Camp 142 in a straight line to Camp 139.
From Camp 139 by the trail to Camp 133.
From Camp 133 in a straight line to Camp 110.
From Camp 110 by the trail to Camp 106.
From Camp 106 in a straight line to Camp 97.
From Camp 97 in a straight line to Camp 96.
From Camp 96 in a straight line to Camp 94.
From Camp 94 in a straight line to Camp 90.
From Camp 90 in a straight line to Camp 81.
From Camp 81 by the trail to Camp 72.
From Camp 72 in a straight line to Camp 70.
From Camp 90 by the trail to Camp 67.
From Camp 67 in a straight line to Camp 65.
From Camp 65 by the trail to Camp 63.
From Camp 63 to the Rio Grande at Albuquerque.
From Albuquerque in a straight line to Camp 58.
From Camp 58 in a straight line to Tucumcari hill.
From Tucumcari hill in a straight line to the eastern bluff of the Llano Estacado, south of Camp 42.
From Camp 42 in a straight line to Camp 35.
From Camp 35 in a straight line to Camp 19.
From Camp 19 in a straight line to the eastern side of Delaware ridge, south of Camp 17.
From Camp 17 by the trail to Fort Smith.
From Fort Smith in a straight line to Little Rock.
From Little Rock in a straight line to Helena, on the Mississippi river, about fifty miles south of Memphis.

It would be better for geological purposes that the section should continue its westward direction from the valley of the Mojave at Soda lake, and not follow the trail in its bend to the south and passage of the Bernardino Sierra at the Cajon Pass. If it was extended directly west from the Mojave to the Sierra Nevada, at the Tejon Pass, or at the sources of Kern river, it would be transverse to the trend of the mountains, and present a view of the Great Basin and the metamorphic rocks of the Sierra, with the Miocene strata at their western base. The alluvial and lacustrine deposites of the Tulares would also be shown, and the uplifted Tertiary

strata of the Coast mountains beyond. These formations are nearly parallel with the lines of uplift along the Mojave, and should be represented on the same section with them, if it were intended to show fully the geological structure from the Pacific to the Mississippi, along the 35th parallel. As, however, the line of survey did not extend across the Great Basin and reach the Sierra Nevada, and as the geology of that portion of the country is considered in my report on the geology of the routes surveyed in California by Lieutenant R. S. Williamson, Topographical Engineers, I do not extend the section in that direction, but follow the line of the survey, which, although deflected to the south, intersects the mountains at nearly right-angles with their trend.

The portion of the section which conforms least to the line of the survey is between the Colorado and the Big Sandy rivers, or from Camp 133 to Camp 110, in Cactus Pass. Here the line of section is direct, and transverse to the trends of the ranges, and avoids the long curve to the south through the valley of the Colorado and the Hawilhamook or Bill Williams' fork.

The next point of divergence of the line of section is at Camp 106, where it extends in a straight line to Camp 97, and permits the horizontal position of the carboniferous strata to be conspicuously shown. In order to permit the full breadth of the Llano Estacado to be represented, I have carried the line eastward from the Sandia mountains over its surface, intersecting, however, the ravines which isolate Tucumcari hill from the plateau. If the section followed the trail in the valley of the Canadian, the full width of the Llano would not be represented by many miles, unless it was sketched in beyond the trail. The line of section being thus broken, is resumed again at Camp 42, nearly north of the eastern bluff of the Llano.

From the Antelope Hills to the eastern base of Delaware ridge the line is direct, but yet coincides very nearly with the trail, from which it is not far removed at any point. The direction of this part of the section is nearly southeast, and it thus makes a favorable section of Delaware ridge, which trends northeasterly. It is believed that if the section were continued in this direction to the Gulf of Mexico, it would present the best view of the geological structure of the line, for at this point the formations trend northeasterly, and are traversed by the survey in a nearly parallel line. If the section continued southeast beyond Delaware ridge, the outcrops of the granite along Boggy creek would be intersected, and the succession of Carboniferous, Cretaceous, and Tertiary formations would appear beyond. The granite of Boggy creek may be regarded as a portion of the same line of uplift which appears at the Hot Springs of Arkansas and at Little Rock. It was deemed best, however, to confine the section as much as possible to the line of survey, and thus a great breadth of carboniferous strata is represented between Delaware ridge and Little Rock—a much greater breadth than would appear if the line of section were transverse to the trend. The fact that these ridges of sandstone are for the greater part of the distance parallel with the section should be remembered when it is examined.

In general, where the line of section coincides with the trail, the formations, as they appear along the trail, are shown; but in some cases important or interesting features which occur within a short distance either north or south, are represented as if they were intersected by the trail. Where the line of section does not coincide with the trail, but diverges from it, the formations which it intersects are represented if they are known or can be correctly inferred, but in some cases outcrops of strata found *along the trail* are referred to the line and represented as if intersected by it. Examples may be found in the representation of Rock Mary, which rises north of the section-line, and in the natural mounds near Camp 37, and the cretaceous deposites near Camp 39. Sugar-Loaf mountain, although only thirty miles south of Fort Smith, is sketched in upon the section near Dardanelle rock, it being regarded as forming a portion of that line of elevation. This mountain might, however, be very properly represented near Fort Smith, as that portion of the section is nearly parallel with the strata, and does not purport to be a representation of the structure of the region.

The several volcanoes are sketched in above the other formations, and are not represented in section, as neither of them were ascended and the forms of their craters ascertained.

In those portions of the section which do not follow the line of the trail, and which represent a region over which no measurements were made, the distances of the important points were determined by measurement upon the maps. Some of these measurements were made upon the manuscript general map of Lieutenant Whipple's report, and others on the general map of the office and on the geological map. The scale of these maps is so small, compared with that of the section, that slight inaccuracies in measuring, or in the maps, become very apparent when placed on the section. If, therefore, the distances on the section be compared with those on the geological map, many unimportant discrepancies, arising from these several sources of error, may doubtless be found; but they are believed to be, in general, of little consequence to the accuracy of the geological representation for which the section is intended. In many cases, also, it will be found that the distances between the camps, where the section is said to be along the line of the trail, do not correspond exactly with those obtained by the viameter measurements, and given in the tables of the report. This discrepancy arises from the disregard of the short and circuitous winding of the road, which increases the distance between the camps, without adding any new features to the geology. Indeed, in some instances the distance between the camps was taken by the dividers from the map and transferred to the section, without regard to the distance measured by the viameter and recorded in the report.

The level of the trail is shown on the section by a straight and continuous fine line, and the elevations and bluffs are generally sketched above it, as may be seen along the representation of the Llano, where the bluffs, or escarpments, rise above the general line of profile. In this case the trail line forms a convenient line of separation between the colors representing the cretaceous strata and the red sandstone containing gypsum below, and is made use of for that purpose. When, however, the trail leaves the valleys and ascends to the surface of the plateaux, the upper line of course becomes the line of trail, and the line below, dividing the cretaceous, or other formations, from those next below, is not continuous but broken. All the lines dividing one formation from another are continuous, when above the trail, but on descending below that line—below the line of observation—they are broken, dotted, and show that the position of the formations is not accurately known.

As the scale adopted did not permit altitudes of less than 500 feet to be very distinctly represented, it became necessary to slightly distort the altitudes of portions of the line in order to make them distinctly visible. The alluvial deposites of the Mississippi could hardly be separated by the eye from the base-line of the profile if they were drawn according to the scale. They have, therefore, been distorted. So, also, the hills at Little Rock, which are probably less than 300 feet in elevation, are sketched as if they were 600 feet. The bluffs also along the valley of the Colorado Chiquito, and in general the depths of the cañons and channels of the streams, are slightly overdrawn. These departures from the scale are, however, of little importance, and do not materially affect the truthfulness of the section.

Of course, the greater part of the representation of those portions of the strata which are below the surface is ideal, and is based only upon the indications presented at the outcrops and by the form of the surface. The representations might have been confined to the outcrops which were seen above the trail, leaving the space between the profile-line and the base-line blank; but although this would be sufficient for the geologist, it would fail to convey an idea of the geological structure of the line to the general reader. The *probable* position of the underlying rocks is shown; that their position and relation to each other is accurately displayed is not claimed. It is most probable, as has already been explained, that the carboniferous formations are much more bent and flexed than appears in the parts of the section east of the horizontal outcrops at the Aztec and Aquarius mountains.

U.S. PACIFIC RAIL ROAD EXPLORATIVE
WAR DEPARTMENT

# GEOLOGICAL MAP

OF THE

Route explored by Lieut. A.W. WHIPPLE Corps of Top.l Engrs.

near the Parallel of 35° North Latitude

FROM THE

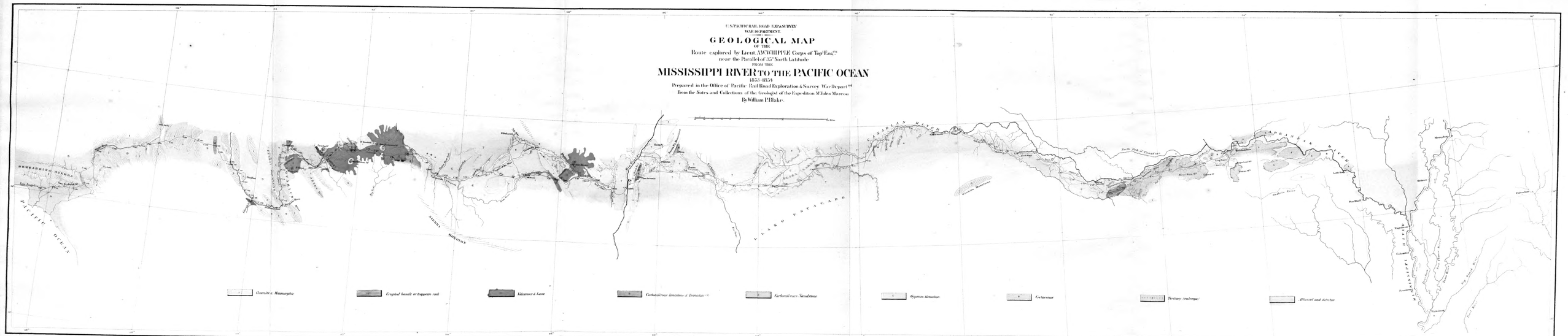
# MISSISSIPPI RIVER TO THE PACIFIC OCEAN

1853-1854

Prepared in the Office of Pacific Rail Road Exploration & Survey, War Depart.nt

from the Notes and Collections of the Geologist of the Expedition M.r Jules Marcou

By William P.P.lake.



U. S. PACIFIC RAIL ROAD EXP.ⁿ & SURVEY.
WAR DEPARTMENT.

# GEOLOGICAL SECTION
FROM THE
# MISSISSIPPI RIVER TO THE PACIFIC OCEAN

Along and near the route explored by Lieut. A.W. WHIPPLE, Corps of Topl. Engrs.
near the parallel of 35° North Latitude
**1853–1854**

Prepared in the Office of Pacific Rail Road Exploration and Survey, War Department,
From notes & collections of the Geologist of the Expedition, Mr. Jules Marcou,
By **William P. Blake.**

Granite, Syenite, Gneiss, Mica-slate & Metamorphic.
Gneiss & Mica Slate
Basaltic and Trappean Rocks.
Extinct Volcanoes and Lava.
Carboniferous limestone.
Carboniferous Sandstone & Shales.
Red Sandstone and Clay containing Gypsums.
Cretaceous.
Tertiary.
Post-Tertiary Detritus and Alluvial.

Scale of 2 Miles to 1 Inch.

PACIFIC OCEAN
Coco Mang.ᵗ Cr
Cajon Cr
BERNARDINO SIERRA
Cajon Pass
Camp 100
Los Angeles
Mayor R.
Camp 142
San Gabriel Creek
Camp 146
Camp 145
Camp 144
Mayor R.
Camp 133
Salt Lake Camp 140
VALLEY OF MOJAVE RIVER
Camp 140
Camp 139
Camp 138
Camp 132
Camp 136
Sacramento Sp.
Camp Elias Gabriels R.
DIVIDE BETWEEN COLORADO & MOJAVE RIVER
AH MOK AVE RANGE
GERBAS RANGE
Red Sandy
AQUARIUS MOUNTAINS
Cactus Pass
Camp 103
Volcano (South of the Gila)
Colorado R.
Camp 107
Camp 106
AZTEC MOUNTAINS
Old Fort Thom
Pinos Altos
Volcano (Bill Williams Mt.)
Partridge Cr
Cedar Cr
Camp 94
Camp 95
Mt. Silcreaves
Mt. Kendrick
Leroux
San Francisco Volcano
Stillwaters Sp.
Camp 80
Volcanic
Colorado Chiquito
Cotton Wood Fk
Camp 79
Camp 78
Lorenzo's Fork
Lithodendron Cr
Sabinas Bastos
Carrizo Cr
Cabezon Butte
VALLEY OF RIO COLORADO CHIQUITO
VALLEY OF RIO PUERCO OF THE WEST
Camp 77
Zuni
Camp 76
Old Zuni Route
Camp 90
Jaramillos Creek
SIERRA MADRE
Cerro
San Mateo Mt
Camp 83
Camp 64
Rio San Jose
Rio Puerco
SANDIA MOUNTAINS
Rio Grande
Albuquerque
San Antonio
Peralta R.
Cubero R.
Rotorah Cr
Arroyo Gordito
Valley south of Camp 54
Pyramid Mt
Big Tannarosa
Camp 85
Deer Camp 84
VALLEY OF TUCUMCARI CREEK
LLANO
Camp 86
ESTACADO
South of Camp 30
Round Mounds
Camp 35
Mother Hills
Camp 33
Arquero Cr
CANADIAN RIVER VALLEY
Round Mounds
Rock Mary
Branch Cr
Camp 25
Coal Cr
Camp 13
Delaware Ridge
Agency Camp 17
Shawnee Town
Camp 18
Camp 12
Coal Cr
Crimora Cr
Camp 10
San Bois Mountains on the south, trending parallel with the section.
Santa Rita Cr
San Bois Cr
Camp 7
Capote Cr
Camp 4
Camp 3
Camp 2
Shawnee Hills
Devils Backbone
Burdandella Rock
Fort Smith
Boundary line of Ark. & Indian Territory
Petit Jean R.
Petit Jean Mt.
Little Rock
Red River
Mississippi River

Lith. of J. Bien & Cᵒ. Buffalo