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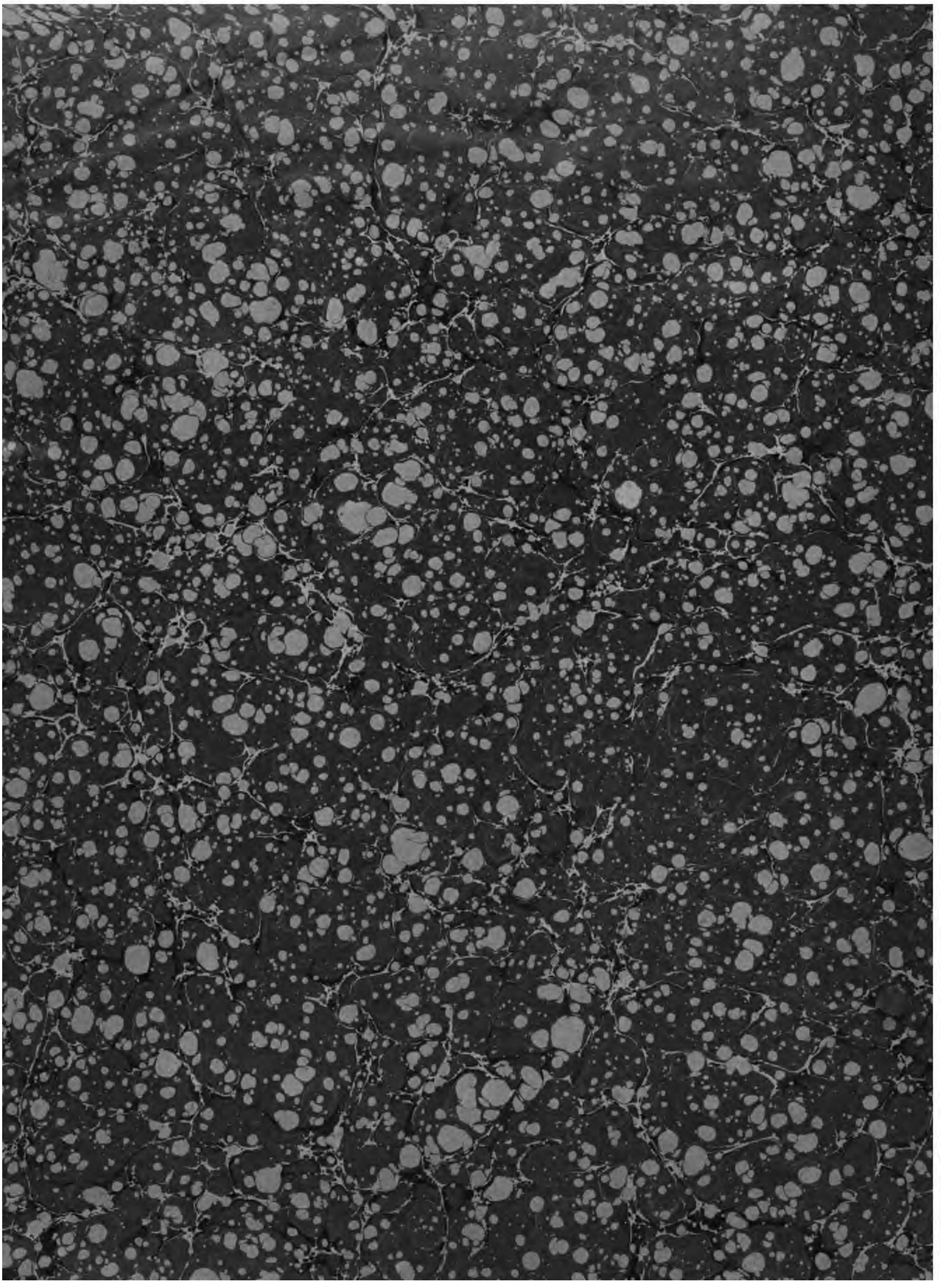

GEOLOGY

OF

NORTH AMERICA

BY

JULES MARCOU.

WITH THREE GEOLOGICAL MAPS AND SEVEN PLATES OF FOSSILS

ZURICH

PRINTED FOR THE AUTHOR, BY ZÜRCHER AND FURRER,

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LEIPZIC, Wilhelm Engelmann.

1858.

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TO

PROFESSOR LOUIS AGASSIZ

HARVARD-UNIVERSITY, CAMBRIDGE, MASSACHUSSETTS.

My dear Sir,

You had the kindness, in 1853, to allow me to dedicate to you, my first slight sketch of *A Geological Map of the United States*, published at Boston, in July of that year; I now offer you a second part of that work, completing the first, and giving an outline of the Geology of the Rocky Mountains, the Sierra Madre, and California.

After my return from the «Pacific Railroad Exploration», you expressed your satisfaction with my manuscript maps and my specimens, and, after the publication of my *Résumé Explicatif d'une Carte Géologique des Etats-Unis*, in the *Bulletin de la Société Géologique de France*, you said to me in one of your letters, dated Cambridge, 10 Feb. 1857: «*Vos combinaisons sur les rapports des terrains de l'Amérique du «Nord sont ce qu'il y a de mieux sur la Géologie des Etats-Unis*». You will excuse my bringing forward so favorable a judgment, but you are better able than any one to appreciate justly the value of a geological work on North America.

I send you this little work from a place where you began your University education, more than thirty years ago, and where you are far from being forgotten. At the foot of the Ütliberg, between the Alps and the Jura, in this beautiful valley of Zurich, there are still many of your class mates, and I can hardly meet a gentleman without being asked about you and your life in America. Since you left

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from the Rio Grande to Preston) an invitation to make a geological report upon his route. I had had the pleasure to make the acquaintance of Capt. Pope at Albuquerque, in October 1853, and as he had then received the order to make his exploration, and was in New Mexico, a country where geologists are unknown, I had given him verbal instructions on the manner of making collections of specimens and taking geological notes, promising him my cooperation for the geological part of his report. I undertook with pleasure the preparation of the geological report of Capt. Pope, and after a rapid examination of his fine collection, I sent him a geological *Résumé* which he wished to place at once in the octavo edition.

Having packed all my collections, books and other effects, and taken and paid my passage and that of my family consisting of four persons, on the Cunard Steamer *Niagara*; I was leaving my residence in Boston at nine o'clock in the morning the 27th September in order to embark, the steamer leaving the Wharf at East-Boston at noon, when I received letters from Captains Whipple and Pope containing orders from the Secretary of War to remain in the United States, or to give up my notes. The following are extracts from these letters.

WASHINGTON (District of Columbia), September the 25th 1854.

My dear Marcou,

I have just received a communication from the Secretary, objecting in the most decided terms to allow your notes to be taken out of the country. He says the report must be completed here and wishes you to remain in the United States until it is finished. I know the inconvenience this must put you to at so late a period, when your arrangements for leaving America are consummated. But I can only express my deep regret, and ask you to submit to the sacrifice if your health will permit you to do so. Etc. Etc. . . .

Truly your friend

(Signed) A. W. WHIPPLE,
first Lieut. Top. Eng. Corps. U. S. A.

Mr. Jules Marcou

Boston (Massachussetts).

WASHINGTON (D. C.), September the 25th 1854.

Dear Sir,

The Secretary of War has come to a determination which it is not worth while to discuss as it is conclusive so far as the officers of Pacific Railroad parties are concerned.

He insists that the report on Geology shall be made out in this country, and in consequence I find myself most unexpectedly and at this late hour compelled to notify of a conclusion as disagreeable to me as it can possibly be to you.

There is no one in the country, from the peculiar circumstances, who can do justice to the geological reports of the Surveys of Whipple and myself, except yourself, and I earnestly hope that you can be induced to remain. If you find it impossible to do so however, I am compelled to ask you to re-

turn my collections to this place, or to place them in the hands of Dr. Jackson or some scientific friend of yours who can describe them. * * * * * * * * * * * *

I would be glad to hear your determination, and I trust you will believe me when I say that I regret more than I can well express to you the annoyance I have occasioned, and I hope you will place the fault where it belongs and not upon my shoulders.

I am very truly yours

(Signed) JOHN POPE,

Brev. Capt. Top Eng. Corps. U. S. A.

The orders contained in these letters took me completely by surprise; I was no longer free to obey either of the alternatives they offered. I had two days before embarked twenty boxes containing my collections, books and other effects, and it was materially impossible to land them again and open them to look for the specimens and notes belonging to the government; especially as these specimens and note-books were scattered in several boxes and mixed with specimens and notes that belonged to me. It only remained for me to resign, which I did and embarked for Europe.

On arriving at Salins I found a letter from Washington, which threatened, in case I did not at once relinquish the specimens and note-books belonging to the Government, to prosecute me in conformity with a treaty of extradition lately concluded between the United States and France. I might have taken my chance in a lawsuit with the American Government, but I preferred to give up every thing, indignant at such treatment, and I replied that I would place in one box all the specimens and notes that the Secretary of War demanded, and would give them up to any responsible person who could give me a receipt in due form, which would release me from all subsequent claim on the part of Mr. Jefferson Davis.

The 28th February 1855 Mr. John B. Wilbor jr., Premier Attaché à la légation des Etats-Unis de l'Amérique, came to see me at Salins and delivered me the following letter.

UNITED STATES LEGATION.

Mr. Jules Marcou

Salins (Jura).

PARIS, February the 26th 1855.

Sir,

I have received from the State Department at Washington, a despatch in relation to a claim which the Secretary of War has upon certain notes and geological specimens now in your possession and belonging to the Government of the United States.

By my instructions I am empowered to take such steps as may seem expedient to recover this property, either to treat with you directly or to proceed at once under our recent Treaty.

Taking advantage of a visit the bearer, Mr. J. B. Wilbor jr., is making to the neighbourhood of Salins, I have requested him to see you and to effect with you an amicable settlement of this affair. Mr. Wilbor has in his possession all the despatches and documents bearing upon this case now in the

possession of this Legation; and any arrangement made by him with you will be ratified by me, and through me by the Departments of State and War at Washington.

Yours very respectfully

(Signed) DONN PIATT,

Chargé des affaires des Etats-Unis. Par-intérim.

Having come to an understanding upon all the points contained in his instructions, I delivered to Mr. Wilbor the specimens and note-books, and received from him the following receipt.

SALINS, February the 28th 1855.

I acknowledge the receipt from Mr. Jules Marcou of the specimens and notes, alluded to in this letter, and which are to be transmitted to the Secretary of War at Washington; through the United-States Legation at Paris.

(Signed) J. B. Wilbor jr.

For a year I heard nothing more of this affair, when in the month of February 1856 I received the following letter.

WASHINGTON (D. C.), January the 31th 1856.

Sir,

Captain Humphreys Top. Engrs., in charge of the office of the United States Pacific Railroad Explorations and Surveys, has sent the geological collection made by you when with Lieutenant Whipple, and your two note-books to me, and wishes me to describe the collection and prepare a report on the geology of the line explored by Lieutenant Whipple to accompany his final report in quarto form.

I regret that it is not in your power to perform this duty, and in consenting to undertake it, I am actuated by a desire to secure the publication of your results in connection with the official reports. It is my intention to present a translation of your notes, and your preliminary ***Résumé*** already printed in the octavo volume, and to add a full description of your collection with such observations on it, and on the geology of the route as shall appear desirable and necessary.

If you prefer that the preliminary ***Résumé*** should not appear in the final report, — its place being supplied by the translation of your notes — or if you wish to present any modification or explanation of your views, please write me and I will regard your wishes. I do not write officially, but in my private capacity, being desirous to accord you every privilege which I could desire if similarly situated.

I find in the collection which you returned from France, several specimens without tickets or memoranda of their locality. Among them are several ***Ammonites***, a ***Gryphæa*** like ***G. incurva***, and a fine ***Plagiostoma***. Please inform me of the locality of these at your earliest convenience. I would also like to receive copies of your recent publications on American Geology.

Respectfully yours

(Signed) W. P. BLAKE.

To Jules Marcou,
Geologist, etc.
Salins (Jura). — France.

I answered it at once as follows.

Monsieur W. P. Blake
Géologue, etc.
à Washington. (D. C.)

Salins (Jura), le 27 Février 1856.

Monsieur,

Je viens de recevoir par la dernière « American mail » votre honorable lettre du 31 Janvier dernier et je m'empresse de répondre à votre communication.

Vous m'annoncez, non-officiellement, que le Capt. Humphreys vous a remis les spécimens et notes recueillis par moi pendant l'expédition du Lieut. Whipple, et que votre intention est de donner une traduction de ces notes et « a full description of the collection with such observations on it, and on the geology of the route as shall appear desirable and necessary ». En même temps vous me demandez si j'ai des modifications ou explications à donner et qu'alors vous y aurez égard dans votre travail.

En acceptant les propositions du Capt. Humphreys, vous avez eu très certainement connaissance des circonstances et de la manière dont ces notes et spécimens m'ont été enlevés. N'ayant plus aucun contrôle sur cette affaire, j'aurais désiré beaucoup ne plus entendre parler, et si votre lettre eut été *officielle*, je n'y aurais pas donné la moindre réponse. Mais comme vous avez soin de me déclarer que c'est dans votre *private capacity* que vous m'écrivez, j'ai l'honneur de répondre aux questions dont vous voulez bien m'honorer, malgré tout le déplaisir que j'éprouve d'avoir encore à m'occuper de ce triste ouvrage.

Les notes, si j'ai bonne mémoire, sont dans un état qui doit les rendre assez difficile à publier par quelqu'un qui ne les a pas écrit lui-même et qui de plus n'a jamais visité aucune partie de la région des Prairies et des Rocky Mountains. Il y a des parties qui doivent être retranchées et que je crois avoir barré par un trait, d'autres doivent être modifiées, et enfin il y a beaucoup à ajouter. De plus, je pense que les numéros des camps ne correspondent pas à ceux employés par le Lieut. Whipple, et j'ai changé trois fois, dans le cours du voyage, la manière de numéroter les camps. D'après ces considérations, je ne suis pas d'avis que vous publiez une traduction de mes deux *note-books*, et si vous le faites ce sera entièrement contre mes désirs. Je pense que vous pouvez réimprimer le *Résumé*, avec les quelques notes que j'ai renvoyées, il y a deux mois, au Lieut. Whipple.

Quant aux collections, elles sont en bon état, chaque spécimen est accompagné d'un memoranda indiquant sa localité et le terrain d'où il provient. Mais il peut se faire que des étiquettes aient été mêlées postérieurement à ma possession de ces collections et je ne veux nullement en être rendu responsable.

Je ne vois aucun inconvénient à ce que vous donniez *vous-même* une description des échantillons, ayant bien chacun un memoranda indiquant la localité où je l'ai recueilli. Mais ici se présente une difficulté, que voici: j'ai appris indirectement que vous avez porté à Albany, pendant l'été dernier, les fossiles recueillis par moi et que vous les avez remis entre les mains de James Hall. Indépendamment de la valeur *très contestable* des déterminations et descriptions que cet homme fera de ces spécimens, vous savez sans doute que sa conduite envers moi n'a pas été celle d'un *gentleman* pour ne pas la caractériser par un mot plus significatif. Je m'oppose donc à toute participation de James Hall dans la description des spécimens de fossiles recueillis par moi.

De plus cette description des échantillons devra, soit m'être soumise avant l'impression; ou bien vous direz en tête de votre travail, et *non en note*, que j'y suis entièrement étranger, sauf d'avoir recueilli les spécimens. Si les choses n'ont pas lieu ainsi, je vous préviens que je protesterai par un

pamphlet que j'enverrai à tous les géologues d'Europe et d'Amérique, pour décliner toute responsabilité et participation à ce travail.

Quant aux spécimens sans memoranda de localités et parmi lesquels vous me dites avoir trouvé des *Ammonites*, *Gryphœa incurva* et *Plagiostoma*, ils ne peuvent pas appartenir à ma collection faite sur la route du Lieut. Whipple, car je n'y ai pas trouvé de pareils fossiles; et je ne m'explique leur présence parmi les spécimens renvoyés de France, que par un mélange de paquets qui aura eu lieu à Salins lors de mon arrivée d'Amérique; dans le triage et le déménagement que j'ai fait de toutes mes collections, précisément à ce moment-là. Ces spécimens proviennent probablement des environs de Salins, car ce sont les seuls dans mes collections auxquels je ne mets pas de memoranda de localités.

J'envoie une copie de cette lettre au Lieutenant Whipple et je me réserve de la publier le cas échéant.

J'ai l'honneur de vous saluer. Votre serviteur

(Signé) JULES MARCOU.

P. S. — Suivant votre désir je vous envoie *franco* par la poste mes dernières publications «On American Geology».

I will add that my note-books were written in pencil, with abbreviations and conventional signs, and in the French language, and that I know nothing of Mr. Blake, either personally, or as a man of science.

The letter above cited is the only communication I have received from this savant, who, I have been told, was the geologist of the first expedition commanded by Lieutenant B. S. Williamson to survey the most practicable pass between the Rio Colorado and the southern part of California. But he did not accompany the expedition in the exploration of the Mohavee river; and he is said further to have never even crossed the Mississippi river, having made his trips to and from California by the Panama route.

As an illustration of Mr. Blake's desire to „regard my wishes", as he expresses himself disposed to do in the letter with which he honoured me; I have learned since from good authority that the Secretary of War, in accordance with the advice of Mr. Blake, refused to put in the quarto edition my *Résumé* with some additional notes I had forwarded for that purpose; Mr. Blake having placed in their stead a translation of my note-books, with a French version on the opposite column; a translation and version necessarily full of faults, errors, and falsifications, which I must entirely refuse to acknowledge as my production.

Not satisfied with an act so wanting in courtesy toward me, Mr. Blake read a paper, at the Meeting of the American association for the advancement of science, held at Albany in August 1856, entitled „*On a geological Map of America made in Europe*", which has since been published in *Silliman's Journal*, under another title; „*Review of a Portion of the geological Map of the United States and British Provinces*, by Jules Marcou". In this article Mr. Blake insinuates that my map is merely a compilation, that it was made in Europe, not even hinting that I have visited the Rocky Mountains; and that I have not known how to make a faithful use of the means in my power for the execution

of this work. If Mr. Blake had practically studied on the spot, the geology of the British Provinces, the Southern and Western States, the Prairies, the Rocky Mountains, Texas and New Mexico; I should understand in a degree a part of the criticism contained in his pamphlet. But having in his hands my note-books, that had been forcibly taken from me, without my being able to use them; being reduced to my memory, my private journal, and the letters I had written, it is rather strange that Mr. Blake should reproach me with not having made a good use of the means at my disposal; and I think all impartial geologists will agree, that the Secretary of War Mr. Davis, in giving my note-books and specimens to Mr. Blake, did not give them into friendly keeping, nor to a geologist of great practical experience.

I repeat then, that I decline all responsibility as to the use that may have been, or may hereafter be made by others of my official note-books and specimens, which for me have no existence; and I recognize as my productions only the two *Résumés* published with my signature in the octavo edition of the Pacific Railroad Explorations, Washington, 1855; reports that I give here *verbatim*, with the addition of notes and a Chapter of Paleontology.

With the help of my private journal and several letters written during my stay in New Mexico, I have been able to give a sketch of the Geology of that Territory under the form of a daily journal. The situation of New Mexico, a sort of oasis in the midst of the American desert, renders it a central point for the Geology of the New World, and as such deserves particular notice; and as explorations are rendered doubly difficult, by the barrenness of the country and the terrible and treacherous tribes of Comanche, Apache et Navajo Indians, some years may pass before another Geologist enters that part of the United States. For these reasons my work and map although very imperfect will perhaps be received with some interest by persons occupied with the study of Geographical Geology.

The extremely short *Résumé* in explanation of the Geological Map of the United States and the British Provinces, was published in German with the title: *Über die Geologie der Vereinigten Staaten und der Britischen Provinzen von Nord-Amerika*, in July 1855, in the 6th number of the first volume of *Geographischen Mittheilungen* of Dr. A. Petermann, and is only an extract from a much larger work published in March 1856 in the „Bulletin of the Geological Society of France; meeting of the 21st of May, 1855; vol. XII., second series", entitled «*Résumé explicatif d'une Carte Géologique des Etats-Unis et des Provincee Anglaises de l'Amérique du Nord*». A work in which I introduced all the discoveries made during my exploration of the Rocky Mountains and the Sierra Nevada, and which gives for the first time a complete Geological Map of the United States and British Provinces of North America, and was the first attempt at a geological description of the whole of this vast country.

Some strange notions upon the geological discoveries that have been made in America, and some facts quite distorted and misrepresented, having found admittance into several works, especially an address: *On American geological history*, by James D. Dana, president of the American As-

sociation for the year 1854 (see: *Silliman's Journal of Science*, vol. XXII., second series, Nov., 1856.), and in the text of a «*Geological Map of the United States and British North America*», by Henry D. Rogers, where there is a paragraph entitled: *History and Literature of geological research in the United States*; I thought it would be more just to those who made these discoveries, to cite from their own works, giving the official date of their publications, so that each one may be able to judge for himself of the truth and value of these discoveries. To this end I have given a Chapter entitled: *A synopsis of the Progress and Discovery of Geology in America*, in which I have placed quotations taken from all the official sources to which I have had access; and if I have not been able to give exact dates, I have at least made every effort to do so, notwithstanding the difficulty created by my temporary absence from the United States, and my actual residence in a small town of German Switzerland.

Urged by the same motive of rendering justice to the geologists who have contributed the most to the progress of American geology, I have added a list of general geological maps, giving at the commencement a reprint of the first memoir of Maclure, with map; a work now very rare and almost impossible to obtain.

To this is added a list of books consulted for the completion of this work, and the translation of two memoirs published in French; *On the Gold of California* (See: *Bibliothèque Universelle de Genève*, Février 1855; *Sur le Gisement de l'or en Californie.*); and the *Systems of Mountains in a part of North America* (See: *Annales des Mines*, tome VII., 1855; *Esquisse d'une classification des chaines de montagnes d'une partie de l'Amérique du Nord.*).

ZURICH (Switzerland), September the 25th 1857.

CHAPTER I.

RÉSUMÉ

OF A GEOLOGICAL RECONNAISSANCE EXTENDING FROM NAPOLÉON, AT THE JUNCTION OF THE ARKANSAS WITH THF MISSISSIPPI, TO THE PUEBLO DE LOS ANGELES IN CALIFORNIA.

(Extract from *Report of Explorations for a railway route, near the thirty-fifth parallel of latitude, from the Mississippi river to the Pacific Ocean;* by Lieutenant, now Captain A. W. Whipple, corps of Topographical Engineers. Chapter VI.; page 40 etc.; Washington, 1855. House of Representatives, Documents N. 129.)

Boston, July 26th 1854.

Dear Sir,

In obedience to the instructions contained in your letter of the 2d July, dated Washington city, District of Columbia, I have the honour to send you the *Résumé* of the geological reconnaissance that I made in connexion with your survey for a railway route near the Thirty-fifth parallel of latitude, from the Mississippi river to the Pacific Ocean, extending from Napoléon, Arkansas, 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 *Résumé*; in which, however, I will endeavour 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.

Napoléon 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 deposit 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 gray 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 to the Rio San Saba, Texas. Our survey has traversed this basin 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 re-

servoir 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 (latitude 34°, 44′, 27″; longitude west from Greenwich 96°, 57′, 37″.), which is formed of *upheaved* and *dislocated beds* of *Carboniferous limestone* or *Mountain limestone* [1]), whose direction is from south-south-west to north-north-east, 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 eruptive 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 (See: *A geological map of the United States and the British provinces of North America*; page 42; Boston, July 1853.), 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 certain 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 vermillion 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; but then the sandstone becomes argillaceous. Generally this sandstone is very fine-grained, like sand; but some beds are quite coarse, and resemble a species 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 [2]), as well as that which forms the shore of

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[1]) In the vicinity of our camp N° 19, called in Whipple's Report, Branch of Topofki creek, at the western foot of Delaware mount, I found in a gray sandy limestone, an immense quantity of the remains of Encrinites, and a bed containing a great number of a fossil *brachiopoda*, called by James Hall in Stansbury's *Report on the Great Salt lake*, page 412, *Orthis umbraculum*. De Verneuil and de Koninck who have examined the specimens, say that this *Orthis* is a *Productus*, and I give a figure and description of it in the Chapter on Paleontology; see: *Productus Delawarii* (Plate V., fig. 3.). I found in the same bed a true *Orthis* also, but not sufficiently well preserved to be drawn or described.

[2]) Dr. Charles T. Jackson first announced the existence of the *New Red Sandstone* or *Trias* at Lake Superior. Struck with the resemblance between the sandstone of Lake Superior and those of the shores of Maine, New Brunswick and Nova Scotia, he did not hesitate to refer them to the same formation not-

the Bay of Fundy (Nova Scotia and New Brunswick), and also a part of the sandstone strata 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 *Bunter Sandstein* of the German geologists, the *Grès Bigarrés* of the French, and 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 thickness of the beds in this Middle Group is about fifteen hundred feet. We met with it on our route constantly from Rock Mary to the Arroyo Bonito, or Shady creek, with the exception of two points, where the direction taken by our ex-

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withstanding the contrary opinion of Bayfield and Logan, who had considered them as either *Old Red Sandstone* or *Potsdam sandstone*. Dr. Jackson made a discovery in 1848 that confirmed the justice of his first view; he found at l'*Anse*, near the mouth of Sturgeon river, in Keewenaw bay, beds of magnesian limestone filled with *Pentamerus oblongus* and consequently of the Upper Silurian epoch, *much upheaved* and surrounded by *horizontal beds* of the red sandstone of Lake Superior. In 1848 I made the complete *tour* of Lake Superior and carefully studied this question: my observations agreed entirely with those of Dr. Jackson and I at once adopted his opinion.

Foster, Whitney, James Hall, Norwood, Whittlesey and Owen, in their Reports upon the Geology of Lake Superior published in 1851 and 1852, have maintained the old opinion as to the relative age of the sandstone formation of Lake Superior, synchronizing it with the Potsdam sandstone of the New-York Survey, although their reasoning in support of this determination is entirely inconclusive. It may be thus resumed. The *Potsdam sandstone* with *Lingula* and *Trilobites* characteristic of the formation, is found on the rivers Escanaba, Menomonee and Sainte-Croix, to the south of the line dividing the waters of Lake Superior, Lake Michigan and the Mississippi river. A sandstone containing *Lingula prima* has been found in Tequamenon bay, Lake Superior, and therefore this sandstone is of the same age as the Potsdam. It is true, they add, that the sandstone of Lake Superior is never seen in intimate connection with, and continuation of, the strata of *Potsdam sandstone* of the Escanaba and Ste. Croix rivers; but the reason of this is found in the existence of a chain of eruptive rocks which was interposed before the deposit was formed. As to the *mineralogical character* and *thickness* of the formation, although they admit very *striking differences*, they are *rejected* as not being *available* in the determination of stratified rocks. To this I reply — That the *Potsdam sandstone* is found south of the dividing ridge referred to above, on the banks of the rivers Escanaba, Menomonee and Sainte-Croix, is not disputed; but Foster, Whitney and Hall have forgotten to mention that the sandstone with *Lingula prima* found at Tequamenon bay, was a fragment taken from a *boulder* by Forest Shepherd in 1845, and that neither before nor since has any fossil been found in the sandstone strata *en place* of Lake Superior. Consequently Paleontology cannot be invoked to aid the determination of the age of this sandstone. As to the superposition, it is as we have seen in favor of Dr. Jackson's opinion, as well as the lithology and the thickness of the beds. Since then explorations, in which I participated during the year 1853, have proved that the sandstone formation of Lake Superior was a continuous series, and in direct relation with the beds of *New Red Sandstone* which cover and form the majority of the immense Prairies bordering the rivers Missouri, Platte, Arkansas and Red river of Louisiana. In looking at the Geological Map (See: frontispiece.) it will be seen that Lake Superior formed a gulf resembling the bay of the valley of the Connecticut river, in the *Triassic sea* which enveloped the Paleozoic continent of North America.

In regard to David Dale Owen, who since the death of Maclure and Vanuxem is the greatest geo-

pedition, near camp N° 31 (latitude 35°, 32′, 21″; longitude west from Greenwich 99°, 14′, 40″), crossed strata of the *Neocomian* epoch, and at Antelope Hills (latitude 35°, 53′, 14″; longitude west from Greenwich 100°, 08′, 00″.) whitish-gray sandstone, which belongs to the Upper Division of the *Trias*. I connect with this Middle Group the gypsum found in the *New Red Sandstone* of New Jersey 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 and of Saltz-Kammergut, gypsum, rock salt and dolomite. The first fossils which I found in the Trias were in this division. It was near camp N° 33 (latitude 35°, 42′, 32″; longitude west from Greenwich 99°, 36′, 10″.) — 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

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logist now living in the United States, and whose opinion on Western Geology must always be looked for with great care and respect; I must say, that in his first Geological Survey of Lake Superior he was of the same opinion as Dr. Ch. T. Jackson. To quote his own words, he says «Various views have been advanced by different writers regarding the Age of the Red Sandstone Marls and Conglomerates of Lake Superior. Some authors have referred them to the date of the oldest sandstones of the New-York system; others believe them to be contemporaneous with the *New Red Sandstone* of Great Britain, and the *Bunter Sandstein* of Germany».

«In the absence of all conclusive evidence derived from organic remains — the safest and surest guide in the identification of rocks — it is impossible, at present, to decide between these conflicting opinions. Judging, however, from lithological and mineralogical character, there certainly is *strong presumptive evidence* that they were *deposited subsequently to the carboniferous era*. Comparing their composition and appearance with that of the formations of the United States, hitherto described, below the Coal formation, *hardly any points of analogy can be traced*. On the other hand, there is a *strong resemblance between them and the formations above the Coal Measures*, not only of the States, but of some parts of Europe».

«Ranging through Connecticut, New-Jersey, Maryland and Virginia, there are Red Sandstone and Marly beds that are almost a *counterpart* of some portion of the Lake Superior formations, as well *in aspect* as *in composition*: like them, too, they are traversed by ranges of intrusive trap, with accompanying veins of copper».

«The descriptions which we have by Elie de Beaumont of part of the *Grès des Vosges*, coincides also in many of its features with those of Lake Superior». (Extract from *Report of a geological reconnaissance of the Chippewa land district of Wisconsin*; etc., by D. D. Owen; pages 57 and 58; Washington, 1849.)

Why Owen changed his views is quite a mystery, because in his great and valuable work entitled: *Report of a Geological Survey of Wisconsin, Iowa and Minnesota*, he places this formation of Lake Superior below the Paleozoic base of the Mississippi valley, without giving any proof, referring only to the Reports of Dr. J. G. Norwood and Col. C. Whittlesey accompanying his work, in which nothing positive and conclusive is given upon the age of that formation.

Dr. D. Houghton whose numerous observations on Lake Superior entitle his opinions to be considered with great care; says: «The Conglomerates and Sandrocks lying westerly from Keewenaw-Point, and flanking the trap on the north, dip to the north, mostly at a high angle. These last-mentioned rocks *are probably contemporaneous with the New Red*». (See: *Abstract of the Proceedings of the fourth Session of the Association of American Geologists and Naturalists*; Albany, April 1843; in *The American Journal of Science and Arts*, vol. XLV., page 160.)

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*. 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 whole trees, are often met with. On the western declivity of the Sierra Madre, between Zuni and the Rio Colorado Chiquito, there is really a petrified[1]) 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[2]). 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 Sandstone, containing footprints and fishes, of the Connecticut valley, 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 *Liassic*, and even *Oolitic*[3]). Its equivalent in Europe is, without doubt, the *Marnes Irisées* of France, the *Keuper* of Germany, and the *Variegated Marls* of England.

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[1]) The cellular tissue has almost entirely disappeared, and the wood is replaced by a very compact flintstone of an extremely brilliant color, presenting beautiful specimens for the exercise of the lapidary's art. The Indians of these regions use them for ornaments, and also to make points for their arrows.

[2]) In the same locality, at the point where the expedition crossed the Lithodendron Creek, near our camp N° 77 (latitude 34°, 57′, 56″; longitude west from Greenwich 109°, 47′, 27″.), I found in this gray reddish Sandstone several valves of a fossil shell, that I refer without doubt to the Genus *Cardinia*, though they are not in a state of sufficient preservation for specific description. The genus *Cardinia*, in Europe, is confined to the Carboniferous, New Red Sandstone (Permian and Trias), and Jurassic epochs.

[3]) The first examination (1834) of the Richmond coal-field, led Richard C. Taylor to refer it to the regular coal-measures of the *Carboniferous* period. In 1843, William B. Rogers, after a more careful survey and basing his opinions upon several species of fossil plants resembling more or less some jurassic plants found in Yorkshire and Scotland, referred without hesitation « the *coal of Eastern Virginia to a place in the Oolite System on the same general parallel with the carbonaceous beds of Whitby and Brora* — that is, in the lower part *of the Oolite group* ». (See: *Reports of the Association of American Geologists*; page 300; Boston, 1843.)

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

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I must add however that Rogers says in the following page : « I may here incidentally remark, that certain fossils (*Posidonomya Keuperi?* etc.) which I have recently found in a particular division of the New Red Sandstone (*Middle Secondary*) of Virginia, have led me to infer the existence in that formation, of beds corresponding to the *Keuper* of Europe. A more particular account of this discovery is reserved for a future occasion ». This *future occasion* has not yet come; and until now, William B. Rogers and his brother Henry D. Rogers, regard this formation as *Jurassic coal formation.*

In accord with the geologist James Hall, the brothers Rogers refer all the *Red Sandstone Formation* along the Atlantic slope (See: *Geological Map of the United States*, by Henry D. Rogers, page 32; in *the Physical atlas of Natural phenomena*; Edinburgh, 1856.) to the Jurassic epoch. Their opinion, however, is not explained by H. D. Rogers in a very clear and concise manner. In page 29, he says positively « *Jurassic*; represented in Virginia and North Carolina by a group of bituminous coal-measures, and in the valley of the Connecticut and on the Atlantic slope, from the Hudson to North Carolina; and again, in Nova Scotia and Prince Edward Island, by belts of a red shale and sandstone. *Triassic* and *Permian*, not represented by any known American deposits »; and in page 32 Rogers says: « the Continent (North America) embraces an extremely small extent of the Older Mesozoic or *Triassic and Jurassic* formations ». Further: « Geographical distribution. — Commencing at the North-East, the first tract of *Triassic or Jurassic* red sandstone, etc. » I call the attention of the reader to the expressions first Triassic *and* Jurassic; and next Triassic *or* Jurassic; *and*, *or*, are two very different words. A few lines further on he says: « The red rocks of Prince Edward Island pertain probably to both the Coal period and to the *earliest Jurassic*, etc. . . . »; and also: « The vegetable fossils in the Connecticut sandstone, display such alliances with those of the *Jurassic* coal rocks of Eastern Virginia as to place the *early Jurassic* or *late Triassic* age of the deposit beyond a question ». — Is Keuper *early Jurassic?* or Lias *late Triassic?* the author is silent on these two questions. — And also « . . . . in the *Liassic* coal rocks of Eastern Virginia, etc. . . » ; also « The few organic remains hitherto procured from this Carolina (Deep River) coal field are identical with forms found either in the Virginia *Jurassic* coal strata, or in the Virginia Middle Secondary red sandstone, of *nearly coincident Jurassic date* ».

It is difficult to present an age of strata in a manner more ambiguous, dark and *empâtée*. The brothers Rogers and James Hall, try their best to suppress the *New Red Sandstone formation* in North America; but they do not know exactly what to do with these five or six thousand feet of strata. On the *Geological Map* of H. D. Rogers, the *New Red Sandstone* is unknown in the Magdalen Islands; on the North-East of the Baie des Chaleurs it is colored as Jurassic Red Sandstone, though the Honorable Sir William E. Logan, Chevalier of the legion of honor, calls it *Carboniferous Sandstone.* In Prince Edward Island, Connecticut valley, New-Jersey, Pennsylvania, Maryland, Virginia and North Carolina, the *New Red* is colored as *Older Mesozoic* { *Jurassic coal.* / *Jurassic red sandstone.* In Lake Superior it grows older and the New Red is colored as *Cambrian* or { *Matinal.* / *Auroral.* / *Primal.* In the Prairies, Texas, Rocky Mountains, New Mexico, etc., the *New Red*, that seems to change its age with Protean facility, has once more renewed its youth and is colored as *Cretaceous*; and sometimes also as *Umbral* and *Vespertine*, or, in ordinary language, as *Lower Carboniferous.* They have not yet thought of putting the *New Red* in the *Upper Silurian* or the *Tertiary*; I would advise these honorable savants to consider if one of these determinations would not be preferable.

Having visited the coal-basin of Chesterfield County, Virginia, in April 1849, my first impression was that the age of the strata was the same as the *Keuper*; and in a letter published in the *Bulletin de la Société Géologique de France*, tome sixième, deuxième série, Paris 1849, séance du 18 Juin, page 575;

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.

I say: «Je suis disposé à regarder la formation houillère du comté de Chesterfield, près de Richmond, comme étant plus *ancienne* que l'*Oolite Inférieure*, et appartenant soit au *Keuper*, soit au *Lias*, et plutôt à cette dernière époque, comme l'indique le petit nombre de poissons que l'on y a trouvé jusqu'à présent». I was induced to refer it to the *Lias* by the Memoir of Lyell and Bunbury (*On the Structure and probable age of the Coal-Field of the James river, near Richmond Virginia*; in the *Quarterly Journal of the Geol. Soc. of London*, vol. III., page 261; 1847.); and also by Prof. Agassiz determination of the fishes, who told me that those species were indicative of the *Lias*.

In my *Geological map of the United States*, published at Boston in July 1853, I maintain the same determination of *Liassic formation*, with the remark that perhaps it may be *Keuper*. But having seen the Trias and Jurassic with their superposition and details in the Prairies and Rocky Mountains, in September, October, November and December 1853, I do not hesitate to refer the coal-basin of the vicinity of Richmond, Virginia, to the *Keuper*, and not to the *Lias*, and even less to the *Inferior Oolite* or *Great Oolite*. I have developed my opinions at some length in my *Résumé explicatif d'une Carte Géologique des Etats-Unis* (See: *Bulletin de la Soc. Géol. de France*, deuxième série, tome XII., page 872 et 873; Paris, 21 Mai 1855.). Lately — January 1857 — I have received from the author: *Geological Report of the Mid land Counties of North Carolina*; by Ebenezer Emmons; New-York, 1856; and I have read with the greatest pleasure in Chapter XXXVIII. and XLII. of this very interesting and valuable work, that Emmons is of the same opinion; giving paleontological facts so evident and conclusive as regards the North Carolina and Virginia Coal-basin, that doubt is no longer possible, even without taking into consideration my discovery in the Far West.

Not having the pleasure to be personally acquainted with Emmons, I was entirely ignorant of his discovery of New Red Sandstone (Permian and Triassic) fossils in the Deep and Dan river basin, until I received his work; and I congratulate Mr. Emmons on his discoveries, which are certainly more important and interesting than mine; being satisfied myself to join him in his own conclusions, which are the following: «According then to my present view, the Deep and Dan river (North Carolina) series admits of the following divisions:

Trias.	1. Red sandstones, marls, etc. 2. Black or blue slate, with plants and a coal seam. 3. Conglomerate.
Permian.	Drab colored sandstones. Calcareous and bituminous shales. Coal, fire-clay, argil, oxide of iron. Red Sandstone, sometimes gray and drab. Conglomerate.

«If fossils are to be relied upon as tests of age, the Richmond coal-field is formed of rocks which were deposited contemporaneously with the upper series on Deep river, beginning with the upper Conglomerate; or in other words, the Richmond coal-field is *Triassic* and the Deep river *Permian*». (See: *Geological Report of North Carolina*, by E. Emmons, pages 273 and 341.)

Further in a new volume published in May 1857 and entitled: *American Geology*, part VI., Emmons announces the discovery of three lower jaws belonging to a species of insectivorous mammal in the Chatham coal field, in North Carolina. This mammal of the Permian epoch is certainly the most ancient that has been found until now; it is described by Emmons under the name of *Dromatherium Sylvestre*, and is found in the same beds with the remains of Thecodont Saurians, far below the strata containing impressions of leaves that belong to the species found in the European Keuper.

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.

In order to verify still further the specific determinations of fossil plants made by Emmons, I placed in the hands of my friend, Professor Oswald Heer, a part of the collection of plants made by me in April 1849 at the coal-mines of Chesterfield county, Virginia, and also the descriptions and drawings published by Emmons, W. B. Rogers, Bunbury and Lyell; aud I give below the result which Mr. Heer was kind enough to send me.

(TRANSLATION.)

ZURICH, July 25th 1857.

* * * * * * *. The *Taniopteris magnifolia* W. B. Rogers, is a species of the genus *Strangerites*, that differs by its large size from all the European species.

Acrostichites oblongus Emmons. This species, at first considered by Bunbury and W. B. Rogers as the *Pecopteris Whitbyensis*, is entirely different. In the first place the form of the *sari* is not the same; then the American plant has a *nervatio reticulata*, or at least its secondary nerves are united to each other, while in the English plant the secondary nerves are digitated and dichotomous, and are never united laterally.

Pecopteris falcatus Emmons. Resembles so much the *Laccopteris germinans* of Gœppert (See: *Fossil Flora*, livr. 1. and 2., pl. VI, fig. 8.) that it is very probable it belongs to this species. The *Laccopteris germinans* is found, according to Braun, in the Upper Keuper of Baireuth, Franconia.

Pecopteris Carolinensis Emmons. This species belongs to the genus *Gutbieria*.

Pecopteris (Aspidites) *bullatus* Bunbury. Resembles so much the *Pecopteris Stuttgartiensis* of Brongniart, that I do not hesitate to regard it as belonging to the same species. It is surprising that Bunbury has not recognized its great resemblance, at least, to the European species, so abundant in the Keuper of the environs of Stuttgart and Basle, and in Bavaria.

Neuropteris linnæfolia Bunbury. Does not belong to the genus *Neuropteris*, but is a *Cyclopteris* similar to the *Cyclopteris pachyrachis* of the German Lias.

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Finally some species, such as: *Pterozamites longifolius*, *Equisetum columnare*, *Calamites arenaceus* and *Pecopteris Stuttgartiensis*, are fossils characterizing the Keuper of Germany and of the Swiss Jura. Some other species are similar to species found in Europe in the Keuper and Lias, although specifically entirely different; so that I am led to regard this coal flora of Chesterfield county, Virginia, and of Deep river, North Carolina, as contemporaneous with that of the Keuper of Wurtemberg, of Switzerland and of Bavaria; and I find nothing in it to indicate the Jurassic epoch.

Very truly yours

OSWALD HEER.

The authority of Professor Heer in fossil botany is like that of Agassiz for fossil fishes; and Lyell who until now (See: *Supplement to the fifth edition of a manual of Elementary Geology*, page 30; second edition, revised; London, 1857.) had regarded the strata of the Richmond coal-field in Virginia as belonging to the lower part of the Jurassic series, has not hesitated to change his opinion in consequence of Heer's determination; and during a visit to Zurich, in August 1857, he recognized these coal-fields of Virginia and North Carolina as of the age of the Keuper, and not liassic or oolitic as he had previously thought. Further, in a letter dated Florence, Tuscany, 5th October 1857, Sir Charles Lyell says:

«Another subject on which I am desirous of writing to you, is the Virginia Keuper. My brother-in-law, C. Bunbury, observes in a letter on this point, referring to his paper in the *Quarterly Journal of the Geol. Soc.* on the Richmond plants, that he said: «The formation might belong to the Jurassic (in which he included the Lias) or to the Triassic periods, and that it might with almost equal probability be referred to either».

«He, Bunbury, adds «at the time I wrote this the Basle and Baireuth beds were supposed to be Lias. The only specimen I saw of the supposed *Pecopteris Whitbyensis* was very imperfect indeed»».

As the Basle and Baireuth beds are recognized now by every geologist as belonging to the Keuper, it will appear that Bunbury has never intended to put the Virginia coal field in the true Jurassic of England. So that we all agree to regard the Red Sandstone of Virginia and North Carolina as *Keuper*; and the brothers Rogers and James Hall stand alone in their opinion of *Great Oolite*, *Inferior Oolite* and *Lias*.

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 False Washita river — Comet creek (latitude 35°, 32′, 21″; longitude 99°, 14′, 40″.) — near our camp N° 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-gray color, containing an immense quantity of *Ostracea*, which I consider as identical with the *Exogyra* (Gryphæa) *Pitcheri* Mort. (Pl. IV., fig. 5., 5 a, 5 b, and 6.); having the closest analogy with the *Exogyra Couloni* of the *Neocomian* of the environs of Neuchâtel (Switzerland). As it is the first time the *Neocomian* has been recognized 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. G. Shumard has made a large collection of fossils, such as: *Pecten quadricostatus*, *Gryphæa Pitcheri*, *Cardium multistriatum*, *Ammonites acuto-carinatus*, *Holaster simplex*; all fossils or genera characteristic of the *Neocomian* of Europe. Further, at Fort Washita, the *Neocomian* is covered by the *Green-Sand*, containing very fine *Hemiaster*, large *Ammonites flaccidicosta*, *Gryphæa sinuata* var. *Americana*, *Exogyra Texana* [1]), etc.

This Neocomian has been almost wholly destroyed and carried away by denudations; for it is only found on the summits of the hills, where it appears like ruins of ancient buildings; it occupies actually only a width of three or four miles. Probably at the time of the deposit 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 band in the immense basin of the Prairies.

The second point where the expedition has quitted the strata of the Trias for a more recent formation, is at the place where we crossed the Llano Estacado (latitude 35°, 17′, 18″; longitude 102°, 53′, 24″.). 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 (latitude 35°, 01′, 16″; longitude 103°, 52′, 29″.), there is a second steppe, one hundred and fifty feet higher than the first, also forming a vaste *mesa*, which extends to the Pecos. This second *mesa* [2]) is entirely formed

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[1]) See: Fossils of the Cretaceous period, pages 204 and following, by Dr. B. F. Shumard; in the *Exploration of the Red river of Louisiana in the year* 1852, by Capt. R. B. Marcy. Washington, 1853.

[2]) Our camp N° 49 on the Tucumcari creek, in a beautiful valley called by the Mexicans Plaza Larga, was environed by high hills called Big Tucumcari, Little Tucumcari, Monte Revuelto and the cliffs of the northern side of the Llano Estacado. A better locality for geological explorations is seldom met with; but unhappily the situation is very inaccessible, in the middle of the country over which the Comanche Indians range; exploration without a strong escort is very dangerous; and at that time the expedition was progressing rapidly towards the West. Hurried by the fatigue of men and animals, we were looking

of blue clay at the base, then yellowish sandstone; and, finally, the summit is again a very compact, white siliceous 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

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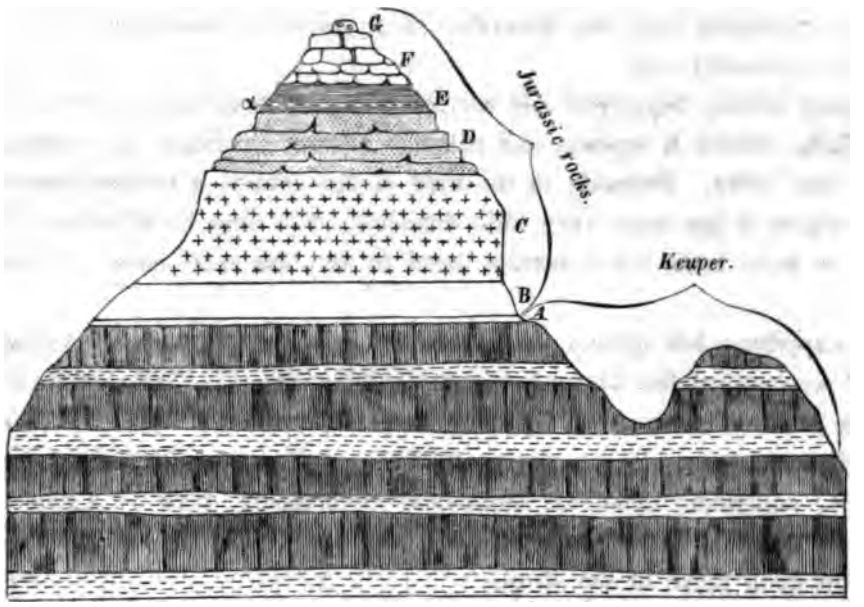
for the valley of the Rio Grande del Norte to recruit our strength and forget the privations and hardships of the Prairies.

Obliged to confine myself to a single excursion, I chose an isolated hill, on the left of our road, six miles from our camp N° 49, and which we called Pyramid Mount, (Latitude 35°, 01′, 16″; longitude 103°, 58′.), its shape being that of a quadrangular pyramid. The north side of Pyramid Mount is entirely precipitous, perpendicular as a wall, without any particle of vegetation and showing all the strata; it is impossible to desire a clearer or better geological section. The height of the bluff, where the beds outcrop, is five hundred feet. I give below the section as I observed it in a short examination of only four hours duration.

Pyramid Mount.



	Feet.	
G. White limestone . .	2	
F. Yellow limestone . .	50	
E. Blue clay	30	
D. White sandstone . .	25	
C. Yellow sandstone .	80	
B. White sandstone . .	8	
A. Grayish blue clay .	1	*Keuper.*

Jurassic rocks.

α. Zone of the *Gryphæa dilatata* var. *Tucumcarii* and *Ostrea Marshii* in division E. Blue clay.

From the base nearly half way up, the first two hundred feet are composed of strata of *Variegated Marls*, red, green and white, having the same appearance as the upper part of the *Keuper* in the quarries of Boisset near Salins, France. A bed of grayish-blue clay (A.), one foot thick, forms the last strata of *New Red Sandstone*, and is in contact with a *white* very fine-grained *sandstone* (B.), which is eight feet thick, and belongs to the *Jurassic formation.* Above there is an enormous mass, eighty feet in thickness, of very hard fine-grained *sandstone* (C.) of a light *yellow* color and cut by cleavage perfectly perpendicular like a wall. Beds of *white sandstone* (D.) are superposed; they are very fine, soft and easily disintegrated by the action of the atmosphere; at the foot of each bed little heaps of sand are seen which result from this decomposition; the thickness of the beds is twenty-five feet. Then comes *clay* (E.) of a slightly *grayish-blue* color and subschistose structure, thirty feet thick.

In this *blue clay*, six inches distant from the white sandstone, I found a zone (*α.*) of *Gryphæa* not more than three inches thick, but the specimens are so abundant that they are in contact with each other. The *Gryphæa* that I had collected at the foot of the bluff and on the ascent, though rolled and worn, had struck me as resembling in shape the *Gryphæa dilatata* of Oxford and of the Vaches Noires

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 fi-

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in Normandy. When I had found them in the strata itself and had collected a hundred in perfect preservation, I no longer doubted their identity with the *Gryphæa dilatata* (Plate IV., fig. 1., 1 a, 1 b, 2. and 3.) of the *Oxfordian group* of England and France. Soon after, in the same zone with the *Gryphæa*, I found two specimens of a valve of *Ostrea Marshii* (Plate IV., fig. 4.) a very characteristic fossil of the *Lower Oolite* of England, France and Germany. This discovery of Jurassic fossils proved to me that I had at last met with the *true Jurassic rocks* in North America.

To return to Pyramid Mount. — Above the fossiliferous *Blue clay* are beds of a sandy *limestone* (F.) of a deep *yellow* color, and very hard; when broken it shines and shows brilliant points, like the yellow limestone of the Inferior Oolite of the Jura. These beds are each five or six feet thick and rise to the top of the Pyramid, where the upper strata is a *white* siliceous and very compact *limestone* (G.), resembling lithologically the *Forest Marble (Calcaires de la Citadelle)* of the environs of Salins and Besançon.

I have no doubt that a minute survey, and a month's stay in the vicinity of Plaza Larga and Tucumcari, would give more ample evidence of my determination of the *Jurassic formation*, by bringing to light more species of fossil remains. But as it is, my discoveries show clearly that this formation is *older* than the *Cretaceous* — I have since found the *Cretaceous rocks* lying *upon* the *Jurassic formation* in discordance of stratification at Galisteo near Santa Fe, New Mexico — and *more recent* than the strata of the *Keuper* or *New Red Sandstone* which underlies it. Besides, the fossils that I found at Pyramid Mount when submitted to d'Archiac, de Verneuil, Deshayes, Elie de Beaumont, Dufrenoy, Agassiz, Barrande, Lyell, Murchison, d'Orbigny, Pictet, Oppel, Mérian, Thurmann, Studer, Escher de la Linth, etc., were identified with the *Gryphæa dilatata* Sow. and *Ostrea Marshii* Sow. of England, France, Switzerland, Germany and East Indies. The natural consequence is, evidently, that this formation of the Llano Estacado, Tucumcari and Pyramid Mount, is equivalent to the *Jurassic rocks* of Europe and Asia; and that it represents in North America, the well known rocks of my native mountains, the Jura.

Until that discovery the existence of the *Jurassic formation* in both Americas was quite problematic, and the great Leopold de Buch, in his last memoir published a few days before his death, denies the existence of the *Jurassic rocks* in South and North America; except in Russian America, where Grewingk has found it at the peninsula of Aliaska, in the bay of Katmaï, Katmaiskoï village; but, as de Buch remarks, that part of Russian America is more Asiatic than American. However I think de Buch has gone too far in his criticism of thè fossils discovered by Domeyko and Darwin in Chili, and described by Ed. Forbes, d'Orbigny, Bayle and Coquand; and to Domeyko is due the honor of having first discovered the *Jurassic Rocks* in the New World.

The *Jurassic Rocks do not exist on the Atlantic slope of North America, nor anywhere East of the Mississippi river;* they are first found at 102° of longitude west from Greenwich, and are confined to the most central part of the continent, bordering the Rocky Mountains which they form in part. I suspect that they will not be found in Old Mexico, except perhaps in the northern parts of the States of Chihuahua and Cohahuila; but they extend towards the sources of the Missouri river, and along the Mackensie river; covering probably a large space of the North-Western territory of the Hudson bay Company, of the Russian American territory (Doroschin, Mining Engineer, has found jurassic fossils in the vicinity of Sitkha and other Russian localities.), and of the numerous Islands signalized by Mac-Clure, Parry, Belcher (Vertebræ and ribs of a Jurassic *Ichthyosaurus* discovered at Exmouth Island.), in the North Polar Sea.

nally between Inscription Rock and the Pueblo of Zuni, where it again forms *mesas*, which extend in the direction of Fort Défiance and the Cañon de Chelly. It will be seen that these rocks 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 until now 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 *Gryphæa* which has the greatest analogy with the *Gryphæa dilatata* of the *Oxford clay* of England and France, and which I call provisionally *Gryphæa dilatata* var. *Tucumcarii* (Plate IV., fig. 1., 1 a, 1 b, 2. and 3.)[1]); and a very large *Ostrea* having much resemblance to the *Ostrea Marshii* (Plate IV., fig. 4.) of the Inferior Oolite of Europe. I found also a *Trigonia* and a species of *Astarte* resembling very much the *Astarte Duboisiana* d'Orb. of the Jurassic formation of Moscou (See: *Géologie de la Russie et de l'Oural*, par Murchison, de Verneuil et de Keyserling; vol. II., page 455.). 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.

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 localities, as at El Ojo Pescado near Zuni, in the neighbourhood of Fort Défiance, 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 (See: the *Profil géologique du Fort Smith au Pueblo de los Angeles*; on the same plate with the *Geological Map*); and for a space of five miles, all the Triassic 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, also Albuquerque Mountains; black schistose clay is seen, belonging to the *Coal-measures*, then grayish blue limestone, containing a great quantity of fossils. These last strata of schist and limestone are very much upheaved, dipping to the East at an angle of 30 or 40 degrees; they rest on metamorphic rocks. The principal fossils found in the limestone, which belongs to the *Mountain Limestone* or *Lower Carboniferous*[2]), are: *Productus semi-reticulatus*, *P. cora*, *P. Flemingii*, *P. punctatus*, *P. pustulosus*

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[1]) See Chapter III., *Paleontology*; where I describe several new species of fossils found in the centre of the continent.

[2]) Having reached Albuquerque, New Mexico, the 5th October 1853, the expedition remained there until the 10th November, to recruit the strength of the party and prepare for crossing the Californian desert. I profited by this interval to explore the country comprised between Albuquerque, San Antonio, Pecos and

and *P. pyxidiformis*; *Terebratula plano-sulcata; Spirifer lineatus*, *S. striatus*; *Amplexus coralloïdes*; *Zaphrentis Stansburyi*; all fossils very characteristic of the *Mountain Limestone* of Arkansas, Missouri, Iowa, Illinois, Indiana, Kentucky, Tennessee, Virginia and Pensylvania, as well as in Europe, and even in Asia, 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, in effect, 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*, which form the centre of the line of dislocation

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Santa Fe; and the 8th October I started with my friend Dr. John Bigelow, the botanist of the expedition, to ascend the highest peak of the Sierra de Sandia. The *Geological Profile* which accompanies my *Geological Map of North America* was arranged from the observations made in this excursion, during which I saw *several times the superposition of the Cretaceous Rocks upon the Jurassic formation with discordance of stratification*; *the superposition with concordance of the Jurassic Rocks upon the New Red Sandstone*; *all the divisions of the New Red Sandstone being superposed upon each other in the most clear and incontestable manner*; *then the strata of the New Red superposed in concordant stratification upon the Black Slate of the Upper Carboniferous or Coal Measures*, *and below the Carboniferous Limestone resting upon Metamorphic Rocks, and these last upon Granite.*

In this exploration, which continued until the 20th October, I studied with attention the rocks of San Antonio Pass, of Antonito and of the Summit of the Sierra de Sandia, also those of the environs of the villages of San Pedro, Tuerto, Galisteo and Pecos. The ascent of one of the most elevated Summits of the Rocky Mountains, — which after all is not a very easy matter, considering the wilderness, the difficulty of the roads and the fear of the Apache Indians — was effected by Dr. Bigelow and myself the 10th of October 1853. We chose the most elevated point of the Sierra de Sandia seen from Albuquerque, which attains the height of 12,000 feet above the level of the sea. The culminating points of all this Sierra are composed of *Carboniferous Limestone*, which here merits most truly its name of *Mountain Limestone*, for it is the only limestone of any importance met with in the Rocky Mountain region. From the five or six upper beds, I collected the following fossils: *Productus Cora*, *P. scabriculus*, *P. Flemingii*; *Zaphrentis cylindrica*, *Z. Stansburyi* and *Orthoceras Nova-Mexicana.*

In going from Albuquerque to San Antonio, in the middle of the Pass or Cañon of San Antonio, ten minutes from the village of Tigeras, there is a bluff of *Mountain Limestone* on the right of the road, forming a grand perpendicular wall. Fossils abound in the strata of this bluff, and I collected the following species: *Productus semi-reticulatus*, *P. Cora*, *P. Flemingii*, *P. punctatus*, *P. pustulosus*, *P. pyxidiformis*; *Terebratula plano-sulcata*, *T. subtilita*; *Spirifer lineatus*, *S. striatus*, *S. Rockymontani*; *Amplexus coralloides* and *Zaphrentis Stansburyi.*

Finally at the village of Pecos, where the valley is reduced to a deep gorge, giving passage only to the river and the road, the rocks of the *Mountain Limestone* are very much developed and extremely rich in fossils. On the left side of the river especially there are strata composed entirely of *Spirifer*, *Productus* and *Terebratula*; the most common species I found are the following: *Productus semi-reticulatus*, *P. Cora* and *P. scabriculus*; *Terebratula subtilita*, *T. Rockymontana*; *Spirifer triplicata*, *S. striatus*; *Orthis Pecosii*; *Myalina Apachesi*; *Amplexus coralloides.*

The mean thickness of the *Mountain Limestone* of the Rocky Mountains in the region environing Santa Fe and Albuquerque is 700 feet.

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, the Sierra de Yemez and Mount Taylor or Sierra de San Mateo. On some points, as at Galisteo, it is covered by a grayish schistose clay, containing nodules of iron and numerous *plaquettes*, composed of fragments of *Inoceramus* shells and fragments of scales and 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 Novi-Mexicani*; *Scaphites*; *Inoceramus Lerouxi*; *Ostrea congesta*; *Tellina occidentalis* Mort.; *Cytherea Missouriana* Mort., and the teeth of a superb *Ptychodus Whipplei*, which indicates, for the relative age of this formation, the *Cretaceous Rocks*, and further, the group of 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 recognized; and now the *Cretaceous Rocks* are found to be composed of four divisions, precisely as in Europe: the *Neocomian*, which I have found on the Canadian, the False Washita, Fort Washita and near Preston, Texas; the *Green-Sand* of Timber creek, near Philadelphia; the *Marly-Chalk* of Bordentown, New Jersey, of the Bad Lands (Mauvaises Terres), 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[1]), 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

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[1]) The first extinct volcano that I met with in exploring the Rocky Mountains is found between Galisteo and Pena Blanca. It is named Cerrito and is situated in the middle of the Rio del Norte valley, as a connecting link between the Sierras of Santa Fe, Yemez, Sandia and Placeres. This ancient volcano is not very elevated, the different cones of which it is composed being only 800 or 1000 feet above the plateau from which they rise; the lava extends over the whole country between the rivers Galisteo, Cieneguilla, Naule and the Pueblos of Cochiti and of San Felipe; the ranchos of Cerrito are even at the bottom of the crater. The Rio del Norte and the Rio Bajado or of Cieneguilla have made their beds in the lava of the volcano, and in the sections discovered by these means, it is seen that the streams of basaltic lava have recovered the *Drift* and in some places even have changed it into volcanic conglomerate.

Between the Rio Grande and the Rio Puerco, a little north of Albuquerque, there is a volcanic cone whose lava extends over the Sandstone which is the equivalent of the *White Chalk*, and whose streams are seen as far as the old Pueblo of San Felipe, on the top of the hill opposite the town of Albuquerque, and on the right side of the road from Albuquerque to the Rio Puerco.

There are several volcanic cones where the route to the Pueblo of Zuni crosses the Sierra Madre, and 30 miles further south a large volcanic cone is seen with two or three secondary ones near it.

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 strata of the Trias, and finally the white and yellow sandstones of the Jurassic, with streams of volcanic lava in the valleys. Inscription Rocks, and the whole *mesa* that extends nearly to Zuni, are formed of the Jurassic rocks. A stream of lava spreads itself in the valley of Ojo Pescado, and terminates three miles from the Pueblo of Zuni.

The valley of the Pueblo and river of Zuni is of Triassic rocks, formed here, as in the Prairies, of sandstone and red clay, with dolomite and gypsum. On the plateau which we cross from Zuni to the Colorado Chiquito, and from there till we arrive at a distance 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 (Latitude 35°, 18′, 43″; longitude 110°, 49′, 56″.) we found below 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 recognized, however, a *Nautilus*, a *Gasteropoda*, and perhaps a *Belemnites?* This formation, which is placed between the Carboniferous and the Trias, corresponds, without doubt, to the *Magnesian Limestone* (or *Permian*) of England, and is a new member which I add to the series of the 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 eastward to occupy one of the lesser chains of the Sierra de Mogoyon.

From the Sierra of San Francisco (Latitude 35°, 15′, 02″; longitude 111°, 16′, 26″.) to Cactus Pass (Latitude 35°, 13′, 22″; longitude 113°, 27′, 16″.), 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[1]) 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-

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[1]) According to the venerable baron Alex. von Humboldt, who has examined specimens of Trachyte that I collected in the Sierra of San Francisco and in the Rocky Mountains (Mount Taylor and Cerrito), the volcanic rocks of that region (New Mexico), are formed of Oligoclase and of Amphibole (Hornblende), exactly like the rocks composing the volcanoes of Gunung-Parang at Java, and those of the Canary Islands (ancient *Domite* of von Buch.). While the volcanic rocks of Colima and Popocatepetl, Mexico, and those of Pasto and Cumbal, New Granada, are composed of Oligoclase and of Pyroxene. (See: *Lettre du baron Alex. de Humboldt à L. Elie de Beaumont;* Berlin, 10 Mai 1857, in the: *Comptes Rendus de l'Académie des Sciences*, tome XLIV, page 1067; Paris, 1857.)

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 largest being that of San Francisco, which is 12,500 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* (between our camp N° 95, Lava creek, and N° 96, Cedar creek) — the last containing fossils in abundance, the principal ones being the *Productus semi-reticulatus*, *P. Cora* var. *Mogoyoni* and *P. costatus*; *Spirifer striatus* and the *Terebratula subtilita*[1]).

These stratified rocks are upheaved, and dip generally to the north-north-east, 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 (Latitude 34°, 55′, 41″; longitude 112°, 49′, 08″.), 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, New-York.

The system of dislocation of the Sierra de Mogoyon, the direction of which is east-east-south and west-west-south, is anterior to the apparition of the Rocky Mountains and the Sierra Madre, and I put it at the end of the Triassic period, and before the deposite of the Jurassic rocks.

From Cactus Pass to the junction of Bill William Fork with the Rio Colorado (Latitude 34°, 17′, 46″; longitude 114°, 05′, 29″.), 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 Cerbats 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 William Fork several veins of argentiferous lead — an indication that silver is common in these mountains.

From the Rio Colorado to Monte, 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 river 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 Eocène.*

From Monte to Los Angeles, and at San Pedro the road is constantly over Modern alluvium, which probably conceals beds of the Tertiary epoch.

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[1]) On the borders of the Rio Colorado Chiquito (Latitude 34°, 53′, 01″; longitude 109°, 59′, 57″.) I found several fossils of the Mountain Limestone formation, such as: *Productus semi-reticulatus*, *P. costatus* and *Terebratula subtilita*, much rolled and worn, and brought, without doubt, from the gorges of the Sierra de Mogoyon or Blanca, where the Colorado Chiquito has its sources. These fossils are of a red or rose color, and resemble Agate or Jasper. My friends, the geologist Dr. Randall, President of the California Academy of Natural Sciences, and the celebrated *voyageur* F. X. Aubry, who have both crossed the Sierra Blanca in following the banks of the Rio Colorado Chiquito and Rio Prieto, gave to me at San Francisco, in April 1854, some of these fossils found in *situ*, in a very hard marble limestone of rose, almost red color, and which crops out on several points of the Sierra. Finally Lieutenant A. W. Whipple, who has passed several years on the borders of the Rio Gila, occupied in running the boundary line between the United States and Mexico, collected in place and not rolled, at the junction of the Rio San Pedro with the Rio Gila, the same Mountain Limestone of a grayish rose color, containing the following fossils: *Productus semi-reticulatus* and *Terebratula subtilita.*

In the Cajon Pass I found granite, 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 *Placeres* 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 Eocène 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 Miocène, or Pliocène; I have not been able to determine to which of these two this System of dislocation corresponds.

Accompanying this will be found a Geological Section [1]) of the country passed through, as correct as possible, for the short time I have left to make it.

I am, dear sir, your most obedient servant,

JULES MARCOU,

Geologist and Mining Engineer of the Expedition.

A. W. Whipple, *first Lieut. Top. Eng., U. S. A.*,

In charge of Exploration of route near 35th *parallel.*

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[1]) The geological profile accompanying this report: see frontispiece, is not a speculative one; I have traversed every inch of ground comprised in it, and if it does not mathematically represent all the features of the country on the line from Fort Smith to the Pueblo de los Angeles, it is owing to the smallness of the scale. The heights are exaggerated in relation to the distances, though they are by no means absurdly disproportioned. I adopted this profile after numerous trials, and I must say that it appears to me to give the same general aspect that presents itself to the eye of the observer from the summits of the Rocky Mountains, the Sierra de San Francisco and the Sierra Nevada. I know there is a great difference between this appearance and a true profile, where the proportions of the heights and distances are the same, and where the curve of the earth's surface is considered. But I thought it more useful to give an idea of that which strikes the eyes of travellers in these regions, than to establish an exact and rigorous trigonometrical profile.

The distances and the heights are copied from the profile made by Lieut. Whipple, the Commander of our expedition.

This Geological Section may be regarded as the *résumé* of my Report and of what I saw in my exploration. I have taken the *greatest care in giving the superposition of the rocks*, their concordant and discordant stratification, and *there is nothing supposed or doubtful*, it is the result without exception of *direct* and numerous observations. To understand this section perfectly, not only must the Report to Lieut. Whipple be consulted, but the Geological Map beneath it, must be attentively regarded. The position in which the Secretary of War, Jefferson Davis, has placed me, and the delivery of my note-books to a mineralogist with whom I have no acquaintance and who has further shown himself to be unfriendly, obliges me to define my observations precisely, in order to leave the least opportunity possible for hostile criticism, which seeks to make me say what I have never said, and even the contrary of what I have written and printed in two or three languages.

CHAPTER II.

GEOLOGICAL NOTES

OF A SURVEY OF THE COUNTRY COMPRISED BETWEEN PRESTON, RED RIVER, AND EL PASO, RIO GRANDE DEL NORTE.

(Extract from *Report of Exploration of a route for the Pacific Railroad, near the thirty-second parallel of latitude, from the Red River to the Rio Grande*, by Brevet Captain John Pope, Corps of Topographical Engineers. CHAPTER XIII. — GEOLOGICAL REPORT, page 125 etc. Washington, 1855. House Doc. 129.)

BOSTON, September 21st 1854.

Dear Sir,

I have the honor to submit these geological notes in relation to the route you have surveyed from El Paso del Norte to Preston, with a view to the construction of a railroad from the Mississippi valley to the Pacific coast.

I have availed myself of the notes which you sent to me in your letter of the 12th of September, and of the excellent collections of minerals, rocks, and fossils which you made during your survey. The short time allowed me to prepare this *Résumé* must be the excuse for its brevity and imperfection. To complete the study of your collection will take several months, and then I shall be able to send you a detailed Report, with a map, descriptions, and drawings of the new fossils, and an analysis of the minerals you have collected in your very interesting survey. Meanwhile, I hope these notes will suffice to give you a slight sketch of the mineralogical and geological resources of the country.

Preston and its environs are formed of the Cretaceous Rocks that extend along the Red River and the False Washita, and as far as the Canadian river. These rocks form also the beds of several tributaries of Trinity river, especially of the Elm Fork of Trinity, where your survey has found this formation very well developed with numerous fossils. The Cretaceous Rocks consist, at the base, of yellowish-gray limestone, filled with broken oysters, of which the most common species is the *Gryphæa Pitcheri*; then pale grayish-blue clays are superposed, containing numerous fossils, such as: *Gryphæa sinuata* var. *Americana*; *Exogyra Texana*, a species of Ostracæ, having the greatest similarity to *Ostrea flabellata* Goldf.; *Ostrea carinata*; *Pecten quinquecostatus*; *Toxaster Texanus*; etc. Upon these clays are sandy limestones, grayish-white, containing large *Ammonites*, *Hamites*, and *Baculites*: the most common are *Hamites Fremonti*, and several other new species, such as: *Ammonites Shumardi*, *Ammonites Belknapii*, *Ammonites peruvianus*, *Ammonites Gibbonianus*; *Isocardia Washita*; *Holaster Comanchesi*; that you collected, and which I will describe in the final Report (See: the following Chapter III, *Paleontology*.). The lower part, formed of limestone with *Gryphæa Pitcheri*, *Caprotina Texana*, aud blue clay with *Toxaster Texanus*, corresponds to what is called by geologists

the *Neocomian formation*[1]); while the upper portion, containing *Ammonites Shumardi*, *A. peruvianus*, and *Hamites Fremonti*, corresponds to the formation designated as *Green-Sand* and *Marly-Chalk.*

The Cretaceous rocks are very useful in the construction of a railroad. Lying in horizontal strata, they form excellent embankments, contain numerous springs of water, and the limestone especially yields excellent lime for building. The road is upon these rocks from Preston to the Lower Cross Timbers, where, beneath the Cretaceous, is seen pinkish-gray and often violet sandstone, with an inclination south-south-east, and in discordant stratification with the Cretaceous rocks. This sandstone formation belongs to the *Carboniferous* rocks, whose different beds occupy the whole

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[1]) The Neocomian rocks were not known to exist in North America before my exploration in company with Capt. Whipple. More than ten years previous d'Orbigny had recognized the Neocomian in the collections made and the sections constructed by my friend, the late Colonel Acosta, in New Grenada, South America; which rendered it probable that these rocks existed also in the United States and in Mexico. The Neocomian formation of the environs of the town of Preston, of Fort Washita and of the banks of the False Washita river, rests in discordant stratification either upon the Carboniferous rocks, or upon the New Red Sandstone; further, all the fossils found in it are either identical with, or have forms analogous to those that form the Neocomian fauna of the environs of Neuchâtel (Switzerland), and the Lower Green Sand of England; and as the rocks in which they are found belong to the lowest beds of the Cretaceous formation of America, it is natural to conclude that this formation corresponds to the Neocomian of Europe. Thus, when in «*A Geological Map of the United States, with an Explanatory Text*, etc.» published in Boston in July 1853, I said page 45, that «it was highly probable the Neocomian would be found in the Indian Territories of the Far West»; I was right, and only two or three months after the publication of this book I discovered the Neocomian formation at Fort Washita, on the False Washita river, and in the Prairies (Longitude 99°, Greenwich, latitude 35°.). Since then, from specimens submitted to me and descriptions, I do not hesitate to regard as belonging to the Neocomian, a band of limestone extending from the river Vert-de-Gris making a curve towards the west to redescend the banks of the False Washita river in passing by Preston; this band forms afterwards the first plateaux of Texas, especially those west of New Braunfelds and Fredericksburg, from whence issue the Rios San Saba, Piedernales and Guadalupe; finally it continues upon these plateaux as far as the southern end of the Llano Estacado, and there at the sources of the Rio Colorado of Texas, a great number of *Exogyra Texana* are found. Its thickness varies from 6 to 50 feet. It is thinnest in the places where it has been very much washed away, and where there are only the remains of beds, as on the banks of the False Washita. As to its elevation above the sea-level, the Neocomian occupies a much lower position than the Jurassic rocks of the Llano Estacado, and at the same time superior to that of the Upper Green Sand and the Marly Chalk which succeed it in relative age and superposition. Thus in my line of exploration of the Prairies, following nearly the 35th degree of latitude, the following are the heights. The *Upper Green Sand* found in the very bed of Little river and almost at its fall into the Canadian, at a Shawnee indian village, is 800 feet above the level of the sea; the *Neocomian*, which is 200 miles to the west of this point, has an altitude of 2,000 feet; finally the first place on this line where the *Jurassic* formation is found, is on the Llano Estacado at 230 miles distance from the Neocomian rocks, and has 4,300 feet of elevation. I think that further south on the 32^{d} degree of latitude, these differences of altitude and the distance between these three formations are much diminished, and further I am very much inclined to believe that the Neocomian formation will be found superposed upon the Jurassic, somewhere upon the plateau extending from the source of the Rio Colorado of Texas to the Rio Pecos and Leon spring. At any rate these differences sufficiently show that great changes have taken place in the relief of these regions between the Jurassic and Neocomian epochs, and it is at this moment I place the dislocations and elevations of the principal chains of the Rocky Mountains.

country of the survey between the Lower Cross Timbers and the Elm Fork of Trinity river, and the sources of the Clear Fork of the Rio Brazos.

On different points of the cliffs of the Rio Brazos, especially in the neighbourhood of Fort Belknap, several coal-beds outcrop, and show the richness of this coal-field of Texas. The Carboniferous rocks of the Rio Brazos are connected with those of the Arkansas river, being covered only for a width of thirty miles by the Cretaceous formation at Red and Trinity rivers; and as those of Arkansas continue without interruption further north than the river Des Moines, in Iowa, it is evident that the immense coal-field west of the Mississippi is fully equal to that on the east of this river, and that the population of the western prairies will have at hand large supplies of this precious mineral. Besides the coal, the presence of which upon your route is of immense advantage for the construction of a railway, the Carboniferous rocks present excellent sandstone for the construction of bridges and embankments, iron in abundance, and black slate.

The upper part and the headwaters of the Rio Brazos are situated on the rocks of the *Trias* [1]). This important formation remained unrecognized (some regarding it as Carboniferous, and others as Lower Silurian and Cretaceous) until my exploration of the Canadian. Dr. Ferdinand Rœmer, in his exploration of the part of Texas that surrounds the German settlements of Fredericksburg and New Braunfelds, had thought that he recognized the Triassic rocks; but he cites them with hesitation [2]). Hitchcock, in his report to Capt. Marcy on the Red river exploration, thinks justly, from the sections of Dr. Geo. G. Shumard, that this formation, which he calls *Gypsum formation*, is not Carboniferous; but he does not know exactly to what geological epoch it belongs [3]). My survey along the Canadian river, and yours, show clearly that the Triassic rocks rest upon the

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[1]) I have since used the more general expression of *New Red Sandstone* formation, to designate all the strata in America that lie between the Carboniferous formation and the Jurassic rocks (See: *Résumé Explicatif d'une Carte Géologique des Etats-Unis*, etc., page 864.). The beds of the same age in Europe are known by the following names: Permian, Magnesian limestone, Todtliegendes, Zechstein, Grès Vosgien and Trias. The Trias is subdivided in Germany, Switzerland and France into three principal groups called: Bunter Sandstein (Grès Bigarré), Muschelkalk (Conchylien) and Keuper (Marnes Irisées).

[2]) Rœmer says: «The existence of the Triassic formation, in Texas, has not been distinctly recognized. But it is possible to suppose, from some remarks found here and there in the Journey of Falconer (*Notes of a Journey through Texas and New Mexico in the years* 1841 *and* 1842, by Thomas Falconer, in the *Journal of the Royal Geograph. Soc. of London*, vol. XIII, pag. 210; London, 1843.), that he met with the Triassic rocks at the headwaters of the Red river. This traveller speaks of finding on the borders of Red river, to the west of the river Wishitaw, very extensive beds of a red sandstone intercalated with fibrous gypsum. He adds also that he had already observed, west of the Cross Timbers, the water and sand of the rivers and creeks that he had crossed, to be of a deep red color, and that all the stagnant and even the running water contained much salt. This red color of the rocks at the head of the Red river (giving it doubtless its color and its name), the salt and the beds of gypsum found there, appear to synchronize this formation with the Bunter Sandstein of Europe. But a synchronism founded solely on petrographic characteristics, without any knowledge of the superposition, or of the fossils, cannot be confidently relied upon». (See: *Die Kreidebildungen von Texas*, von F. Rœmer, pag. 6.)

[3]) See: *Exploration of the Red river of Louisiana in the year* 1853, by Capt. R. B. Marcy. Appendix D. Geology; *Notes upon the specimens of rocks and minerals collected*; by Ed. Hitchcock. pag. 168. Washington, 1853.

Carboniferous beds in discordant stratification[1]), and that they are below the Jurassic rocks which form the summit of the immense table-land called the Llano-Estacado.

From your specimens, I perceive the Trias is composed principally of red friable sandstone, with red and gray clay; in a word, it is *variegated*, with interposition of beds of gray sandstone, of dolomite or magnesian limestone; and finally it contains an immense mass of white gypsum, amorphous or crystallized, having the same structure and texture as the Triassic gypsum of France and Germany. Salt springs and saline efflorescences are also found in this formation. The characteristics of the American Trias are very easily recognized at first sight. It has red rocks, giving a reddish aspect to the whole country, with grayish-white bands of gypsum. All the water running through or springing from this formation is red and brackish; and one may say, without hesitation, that everywhere to the east of the Rocky Mountains there is a *Red river* or *Vermillion river*, or *Salt Fork* or *Rio Colorado*. These rivers run through, or have their source in, the Triassic rocks.

Your road was upon the Trias, from the time that you quitted the banks of the Clear Water Fork of the Rio Brazos, until you reached the base of the Llano Estacado, at the source of the Rio Colorado of Texas.

For the construction of a railroad the rocks of the Trias present great facilities. They furnish sandstone, plaster, or gypsum; excellent hydraulic lime from the magnesian limestone; and, finally, they are very easy to work, and at the same time firm enough to form excavations or embankments. Also numerous springs issue from the beds of red clay, and give water in abundance.

At the foot of the Llano Estacado, in following the ravines where the headwaters of the Rio Colorado flow, and at Big Spring, is found a sub-chalky whitish limestone, containing fossils, such as: *Exogyra Texana*, *Ostrea vesicularis* var. *Aucella* Rœm., *Ostrea anomiæformis*, which indicate that these rocks belong to the group of the Marly Chalk of the Cretaceous formation. It is probable that these strata of Marly Chalk are found again along the Rio Colorado, and are in continuous relation with those of the bluffs in the environs of Austin, New Braunfelds, Fredericksburg, and the Rios Guadalupe and Piedernales, etc.

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[1]) I have ascertained, by direct observations, the *superposition* and the *concordance of stratification* between the Carboniferous rocks and the New Red Sandstone at Tigeras, Antonio and San Pedro, in the Sierra de Sandia (Rocky Mountains); at the Pueblo de Pecos and near Santa Fe; on the two declivities of the Sierra Madre, near the Agua Fria, as well as at several points of the lesser chain of the Sierra of Mogoyon. Lastly I recognized very distinctly all along the western declivity of Mount Delaware in following the Topofki creek, an affluent of the Canadian river, that the beds of the New Red Sandstone are superposed in *discordant stratification* upon the Lower Carboniferous or Mountain Limestone which has been very much broken and upheaved before the epoch of the New Red Sandstone. Mr. Dawson has proved (*On the New Red Sandstone of Nova Scotia*; see: Quart. Journal of the Geol. Soc. of London; 1847.) that in Nova Scotia the New Red Sandstone is superposed upon the Carboniferous rocks, only he did not find it covered by the Jurassic rocks as I did in the Rocky Mountain region. On the rest of the Atlantic Coast as well as at Lake Superior, the New Red Sandstone lies directly upon the granite, and other eruptive and metamorphic rocks. It is probable that it will at some future day be found, between the Sault S^{te} Marie and S^{t} Joseph's island resting on the Lower, or perhaps even on the Middle Silurian.

By the side of these Cretaceous rocks, at the foot even of the Llano, are beds of red sandstone, with variegated marls, forming the summit of the Trias; which are surmounted by whitish-gray limestone with flint. Some beds are oolitic, very white, chalky; and the first strata are formed of a very hard conglomerate, often very fine-grained, and then passing to a pinkish sandstone. These rocks, covering the *Variegated Marls* of the Trias, form the whole plain of the Llano Estacado as far as the river Pecos; they belong to the *Jurassic* epoch. Fragments of the *Gryphæa dilatata* var. *Tucumcarii* are found in the limestone — a species of fossil very characteristic of this formation at Plaza Larga and at Tucumcari Mount, near the Canadian river. These rocks of the Llano Estacado dip gently east-south-east; and as the heads of the strata outcrop at the foot of the Rocky Mountains — called Sierra de Manzana, Sierra Blanca, Sierra del Sacramento — in having artesian wells on any point of the Llano, abundant columns of water would be found to gush out over this immense plain; so that the want of water is not an objection to the establishment of a railroad on the Llano Estacado, for it may be obtained everywhere.

Descending the cliffs of the Llano Estacado which border the river Pecos, at the foot of the bluffs are found again the Variegated Marls, the red sandstone, and finally the crystallized and saccharoid or amorphous gypsum.

At the junction of the Delaware creek with the Pecos, there are found in the bed of the Rio Pecos thick strata of dolomitic limestone; further down it is red, friable sandstone, very easily decomposed. On both sides of the Pecos there is drift and a sort of Quarternary conglomerate, formed of the rolled fragments of all the rocks through which the Pecos runs, from its source to the east of Santa Fe. This drift is chiefly composed of sand, and quartzose rocks in small, rolled fragments.

Ascending Delaware creek to the base of Guadalupe mountains, there is an immense field, for fifty-eight miles, of white gypsum, amorphous or crystallized, with some beds of red and gray sandstone of the Trias. These gypsum rocks are prolonged along the river Pecos to Horse Head crossing, and they surround the southern foot of the Sierra of Guadalupe, forming the saliferous basins of the Salt lake, fifteen miles to the south of the road to El Paso.

At the headwaters of Delaware creek, Independence spring and the Ojo of San Martine come out from grayish Jurassic limestone, the same as that forming the Llano Estacado. As the beds here are raised by the dislocation of the Sierras of Guadalupe, of Cornulas, of Los Alamos, of Sacramento, etc., in ascending to the Guadalupe Pass, all the strata of the Trias and Jurassic are passed through; the Jurassic limestone being covered here by grayish-white sandstone, often yellow, as at Tucumcari Mount and Cañon Blanco, near Anton Chico. In descending the west side of the Sierra of Guadalupe, and traversing the various other chains which intervene before reaching El Paso, the Carboniferous limestones are found strongly upheaved and in contact with the eruptive rocks, which are granite, red sienite, and black sienite, with hornblend, with the trap forming a part of the Organ mountains, and finally with white horizontal sandstone, extending into the valley between the sierras. This sandstone is very friable, and decomposes into white sand. As far as I can judge without having the fossils of this Sandstone, I think it represents the *Upper Chalk*, and is only a continuation of the sandstone which extends into the valley of the Rio Grande del Norte between Peña Blanca, Albuquerque and Las Lunes.

The Organ mountains are celebrated for their rich mines of argentiferous lead, of which you have collected magnificent specimens.

As regards the construction of a railroad, the rocks between Delaware creek and El Paso are very favorable. There are sandstone, limestone, granite; and it is probable that in choosing the points, artesian wells could be established with success by selecting the Carboniferous limestone, or the White Sandstone, for the operation.

Accompanying this will be found a rough sketch of a geological section [1]) of the country traversed by the survey, which I have made as complete as possible, not having gone over the ground myself.

JULES MARCOU,
Geologist and Mineralogist.

Captain John Pope,
Corps Topographical Engineers, United States Army.

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1) This geological profile was published on the margin beneath the map of Capt. Pope with the title: *Profile of the route from El Paso to Preston.* (See: *Map of the Survey of a route for the Pacific railroad near the 32d Parallel between the Rio Grande and Red River*, by Capt. John Pope assisted by Lieut. K. Garrard. Washington, 10 Febr., 1855.)

CHAPTER III.

PALEONTOLOGY.

I have placed in this Chapter descriptions and notes relating to the fossils that I met with in my travels in the Far West. Several of them are new, others are European species not previously pointed out in North America, and some are American species already well known, whose geographical distribution is extended by the new localities in which I found them. The greater part of these fossils have been submitted to Messieurs Agassiz, de Verneuil, de Koninck, d'Archiac, Jules Haime, Pictet and Deshayes, who were kind enough to aid me in their determination; I thank them most cordially for their assistance, and I have endeavoured in the following pages to profit by the counsels with which they have honored me.

N. B. — All the specimens are represented of the natural size, exactly as they are; and I have not attempted to restore the imperfect portions, as has been done by many paleontologists, from a fear of making too fantastic additions to nature, which are very difficult to avoid in such cases.

FOSSIL OF THE TERTIARY ROCKS.

OSTREA VIRGINICA var. CALIFORNICA.

Plate V, fig. 2. 2 a.

Description. — Ostrea testa elongata, angusta, crassa; valva inferiore convexo-tectiformis, sublamellosa; umbonibus elongatis, acuminatis; fossula cardinali valvæ inferioris late sed obsolete canaliculata, utroque latere margine plano-convexo circumdata.

Observations. — This oyster is certainly a variety of the *Ostrea Virginica* Gmelin; it has the same characters, size, form, as well as texture. The only perceptible difference that I find in comparing it with well preserved specimens of the living species, is that the sulcus for the ligament is not so deep. This character distinguishes it also from the *Ostrea Moreleti* Desh. (See: *Note sur quelques fossiles rapportés par M. Morelet du Yucatan*, par Deshayes, in the *Bull. de la Soc. Géol. de France*, deuxième série, tome X, pag. 509. Paris, 1853.), which has a very deep sulcus.

Conrad has described under the name of *O. Heermani* (See: *Journ. Acad. Nat. Sc.*, Philadelphia.) a very irregular oyster, found in the same locality of the Colorado desert, California: but as he gives no drawing, I cannot decide if it is the same species.

Locality. — The specimen, here figured, is the only one that I have ever seen; it was found by Captain A. W. Whipple in the Colorado desert, California; near Carrizo creek, between San Diego and Fort Yuma.

The Virginian oyster, *Ostrea Virginica*, is found in a fossil state in the *Faluns de la Touraine*, at Saucats near Bordeaux, at St. Paul near Dax, in the neighbourhood of Bayonne, in the Mollasse

of the Canton of Zurich, and in the Upper Sands of Montpellier. Its stratigraphical position in Europe is in the Miocène epoch. It is probable that the strata of Carrizo creek belong to the Miocène or perhaps the Pliocène epoch.

Explanation of figures. — Plate V, fig. 2. Lower valve, broken; front view.
» V, fig. 2 a. The same, side view.

FOSSILS OF THE CRETACEOUS ROCKS.

PTYCHODUS WHIPPLEI n. sp.

Plate I, fig. 4. 4 a.

Description. — Tooth having the form of an obtuse rather square cone; the great folds of enamel are confined to the apex of the tooth, and are quite worn away on the specimen figured; the body of the tooth is finely granulated; its height is considerable, and the edges of the base are ornamented with small irregular folds.

Observations. — The great folds of enamel being worn away, probably in eating, would lead one to doubt that this tooth is a true *Ptychodus*; but Prof. Agassiz examined this specimen and recognized it at once as a new species of his genus *Ptychodus*. It resembles very much the *Ptychodus altior* Agass. (See: *Poissons Fossiles*; vol. III, page 155; and especially *The Geology and Fossils of Sussex*, by Fred. Dixon, page 362. tab. XXX, fig. 10.) of the *White Chalk* of Europe.

Locality. — Is found in the gray sandy marls three miles north of Galisteo, on the road from Galisteo to Pecos, New Mexico. I found in company with this *Ptychodus* a septa of a large Ammonite, too badly preserved to admit of a specific determination; numerous fragments of a large *Inoceramus*, probably the *Inoceramus Cripsii* Mant. (see: *Die Kreidebildungen von Texas*, by Rœmer, pag. 56, tab. VII, fig. 2,); and also a small sinuous *Ostrea*, with a very thin shell, that Meek and Hayden (See: *Proceedings Acad. Nat. Sc.*; Philadelphia.) identify with *Ostrea congesta*. These gray sandy marls of Galisteo represent the upper part of the Cretaceous rocks of the United States, and are probably equivalent to the *White Chalk*. They rest, in *discordant stratification*, upon the yellow sandstone strata of the Jurassic epoch. It must be remembered that these gray sandy marls have nothing to do with the *Jurassic Blue Clay* containing *Gryphœa dilatata* var. *Tucumcarii* of the Llano Estacado; they are much younger.

I dedicate this beautiful species of cretaceous fish to my friend Capt. A. W. Whipple, the able and learned chief of our Exploration in the Rocky Mountains.

Explanation of figures. — Plate I, fig. 4. Tooth of natural size, side view.
« I, fig. 4 a. The same, front view.

AMMONITES SHUMARDI n. sp.

Plate I, fig. 1. 1 a.

Description. — Shell inflated, large, carinated, each whorl ornamented near the umbilicus with 20 prominent tubercles, which must have been armed with points, and are placed at the angle of the whorl. Each tubercle generally gives rise to two large rounded ribs that terminate at the keel in bending slightly toward the mouth. Each rib is ornamented with a tubercle, placed at the angle of the whorl near the back, less prominent than those near the umbilicus. Breadth of whorls equal to height, form subquadrangular, larger toward the umbilicus than at the tubercles forming the angle near the back. Back convex, large, with a sharp keel. Lateral septa trilobated.

Observations. — This species differs from all the Cretaceous Ammonites hitherto described; it resembles slightly the *Am. coronatus* of the Oxfordian, but is distinguished by its two lines of tubercles and its keeled back. It is one of the largest species found as yet in America.

Locality. — The *Ammonites Shumardi* appears to be quite rare; I have only seen the specimen figured which was found in the Cretaceous rocks on the borders of Red river near Preston, Texas. I have dedicated it to the learned geologist of Arkansas, my friend Dr. George G. Shumard of Fort Smith.

Explanation of figures. — Plate I, fig. 1. Shell natural size, side view. The second row of tubercles, near the back, is only visible on a part of the last whorl; the specimen being very much worn.

Plate I, fig. 1 a. The same, back view. This part of the keel has been destroyed, and instead of being sharp it is hollowed into the back; but it is prominent on the whorl that is covered by the mouth.

AMMONITES BELKNAPII n. sp.

Plate II, fig. 1 a, 1 b.

Description. — Shell oval, compressed, subdiscoidal, sharp and strongly carinated. The sides are ornamented with large rounded ribs, widening towards the back, slightly flexuous; they usually occupy the entire breadth of the sides but some irregularly distributed stop at two thirds the distance, beginning at the back. Although this specimen has lost its central portion, it is easy to see that the spire increases very rapidly and that the whorls are compressed and two thirds concealed by each other. The last whorl is almost as large as half the diameter of the entire shell. In regard to the keel, the ribs do not correspond, but alternate, as fig. 1 b shows very distinctly. Septa with four trifid lateral lobes widely separated and very distinct upon this specimen

Observations. — This species resembles very much the *Ammonites cultratus* d'Orb. (*Paléontologie Française, Terrains Crétacés*, tome I, page 144, plate 46.) found in the upper Neocomian at Escragnole, in the department of the Var, and I am by no means sure they are not identical. In the *Am. cultratus* the ribs appear more flexuous, more numerous, and the whorls are less hidden by each other, that is the spire is larger. As to the *Ammonites flaccidicosta* Rœm. (*Die Kreidebildungen von Texas*, page 33, plate I, fig. 1 a, 1 b.) it differs in having no keel, cylindrical whorls, a sort of tubercle alternating on the ribs near the umbilicus; and by the convergence of the ribs which meet at the back or are only separated by a line.

Locality. — The only specimen I possess and the only one I have seen, was found in the Cretaceous rocks near the town of Preston, Texas, in the bed of a little creek flowing into Red river. I have dedicated this species to A. E. Belknap, Esq. of Boston, so well known for his beautiful collection of living shells.

Explanation of figures. — Plate II, fig. 1 a. Side view.

» II, fig. 1 b. Back view of a portion of the same specimen, showing the keel and especially the alternation of the ribs.

AMMONITES PERUVIANUS de Buch.

Plate V, fig. 1, 1 a, 1 b.

Description. — Shell much compressed, discoidal, sharply carinated, ornamented with ribs, simple, distinctly elevated and much larger than the intervals that separate them; the ribs are slightly flexuous, narrow at the umbilicus and widening to within a short distance of the dorsal edge, where they are again more contracted; they all begin at the umbilicus on the small specimen fig. 1 a, with the exception of two that begin at a third of the distance from the umbilicus. Dorsal carina prominent, sharp, smooth, marked on each side by a shallow depression; the ribs do not cross the dorsal carina, but stop on each side at the shallow depression. The lobes are very large; the upper lateral lobe is placed at the middle of the side, and the lower lateral lobe almost touches the edge. The last spire near the mouth envelops very imperfectly the preceding one.

Observations. — Alex. von Humboldt in ascending the Rio Marañon (Upper Amazon) from Tomependa to Caxamarca, at the little village of Montan, Peru, on the dividing ridge of the Cordilleras, 2800 metres

above the sea-level, found beds of shells containing an immense quantity of oysters and fragments of Ammonites. These shell fields are known in the country by the name of *Choropampas*. Among the fossils collected at Montan, de Humboldt brought back very large fragments, more than a foot in length and half a foot in width. Léopold de Buch, the great german geologist, who published the fossils of this exploration under the title: «*Pétrifications recueillies en Amérique*, par Alex. de Humboldt et par Charles Degenhardt; in folio; Berlin, 1839», recognized these fragments as belonging to an Ammonite of the *Cristati* family; although they presented certain characters usually proper to the *Hamites*; and he gave them the name of *Ammonites peruvianus*. Since then Dr. Hermann Karsten has found it at Barbacoes near Truxillo in Venezuela.

It is rather remarkable that I have also a large fragment of nearly the same size and form with the one figured by de Buch under the number 5; but I have also a young and complete specimen of the same species. This complete specimen shows that de Buch was right to connect the fragments found by Humboldt with *Ammonites* and not with the *Hamites*, and that with his accustomed sagacity, so well known to all geologists, he had rightly judged regarding them.

My friend Dr. George G. Shumard of Fort Smith, Arkansas, has found numerous examples of the same species at Cross Timbers, Texas; and his brother, Dr. B. J. Shumard, described and figured it in the report of the *Exploration of the Red river*, by Capt. Marcy, under the name of *Am. acuto-carinatus* (See: *Paleontology* of the *Expedition of the Red river of Louisiana*, page 209, plate III, fig. 1.). It cannot be recognized by the figure, it is so badly drawn, but the description of Shumard is so exactly applicable to my specimens, that I have no doubt they are the same species.

Locality. — In the Cretaceous strata forming the bed of Elm Fork river, an affluent of Trinity river, Texas.

Explanation of figures. — Plate V, fig. 1. Side view of a large fragment.
» V, fig. 1 a. Young individual, side view.
» V, fig. 1 b. The same, front view.

AMMONITES GIBBONIANUS Lea.

Plate II, fig. 2 a, 2 b.

Description. — The only fragment I possess shows that this Ammonite must be of large size. The whorls are compressed, not much overlapped; ribs simple, elevated, carinated, not crossing the back, slightly flexuous at the umbilicus, large and somewhat distant at the periphery; back probably sharply carinated, section of the whorls elongate-cordate; septa narrow, with lobes quite numerous and ramified.

Observations. — This species appears to be identical with that figured and described by my friend Isaac Lea in vol. VII of the *Philosophical Transactions*, Philadelphia, called by him *Am. Gibbonianus* (See: *Notice of the Oolitic Formation in America*, with descriptions of some of its organic remains; plate VIII, fig. 3. 1840.).

It is singular that the fragment in my possession is hardly larger than that of Lea, mine having eleven ribs while his has only six; but mine is better preserved and shows a little of the keel. Lea's specimen was found in the Cretaceous rocks between Tocaima and La Messa, New Grenada, by Dr. Gibbon.

Locality. — My specimen was found in the Cretaceous limestone forming the bed of the Elm Fork, one of the affluents of Trinity river, Texas.

Explanation of figures. — Plate II, fig. 2 a. Side view.
» II, fig. 2 b. Section of whorls, and A B of specimen fig. 2 a.

AMMONITES NOVI-MEXICANI n. sp.

Plate I, fig. 2, 2 a.

Description. — I have only two very incomplete fragments of this species. I have figured the smallest, which is the best preserved of the two. My principal inducement for publishing it is the large and square form of the

back, with a strongly marked, but not prominent keel, and the quadrangular form of the whorl, giving it much resemblance to the species *A. varians*, *A. tricarinatus*, *A. Gouptilianus*, etc. (see: *Paléontologie française*, *Terrains Crétacés* par d'Orbigny,), of the *Craie Chloritè* of France. The ribs do not all begin at the umbilicus, more than half of them begin at a third of the distance from the umbilicus; they are sinuous and at the back turn rapidly towards the mouth. Several of these ribs appear to be ornamented where they bend towards the keel, with a sort of round swelling, which seems also to exist near the umbilicus; but only on the ribs starting from the umbilicus, each one of these umbilical ribs being separated by two lateral ribs. This character of round swellings must not be considered as certain, owing to the imperfection of the specimens, and even in the figures 2 and 2 a the artist has neglected to mark them.

Observations. — This species has the general form of *Am. inflatus* of Sowerby; but it is distinguished by the great difference in the ribs.

Locality. — The *Am. Novi-Mexicani* is found not far from Albuquerque and also las Lunes, in the *White Sandstone* that constitutes the sandy mountain extending between the Rio Grande del Norte and the Rio Puerco. I found it in company with fragments of *Baculites* and *Inoceramus* too badly preserved to be described. I consider this white sandstone as lying immediately below the clay containing teeth of *Ptychodus Whipplei*, of the environs of Galisteo, and the whole as belonging to the *Upper Cretaceous* or the *White Chalk* of Europe.

Explanation of figures. — Plate I, fig. 2. Side view showing a part of the umbilicus
» I, fig. 2 a. The same, back view.

HAMITES FREMONTI n. sp.

Plate I, fig. 3 (falsely named *Baculites Fremonti.*).

Description. — Shell elongated, forming an elliptic and very open spire; the shell is crossed obliquely, from the back to the front, with ribs, prominent, distant from each other, disappearing on the ventral side, and on every third rib on either side the back, is seen a truncated tubercle. These tubercles appear to have given rise to points. Mouth oval. Lobes unknown.

Observations. — This species resembles the *Hamites elegans* d'Orb. and the *Ham. armatus* Sow. of the Cretaceous rocks of France and England. It is easily distinguished from the *Ham. elegans* by the much larger opening of its spire and by its more compressed mouth, and it differs from the *Hamites armatus* in having one tubercle on each side instead of two.

Locality. — This Cephalopod is not rare in the Cretaceous rocks that border the Red river at the town of Preston, Texas; fragments are very common. I have dedicated it to Colonel J. C. Fremont, the celebrated explorer of the Rocky mountains and California.

Explanation of figure. — Plate I, fig. 3. Natural size. Side view.

INOCERAMUS LEROUXI n. sp.

Plate II, fig. 3.

Description. — Shell nearly round, very compressed, ornamented with concentric undulations, strongly marked and separated; the hinge margin is very large and the shell appears to narrow rapidly towards the opposite side. The umbones are very prominent and nearly straight.

Observations. — This species differs from all the others by the length of its hinge margin and the beaked form of its umbones.

Locality. — The stratigraphical position of this species is in the black sub-schistose marls, belonging to the Upper Cretaceous, that forms the ravines along the Rio Galisteo, New Mexico,

precisely at the point where the road from Santa Fe to Algodones crosses the Rio. I have dedicated this fossil to my friend and travelling companion, the celebrated guide and mountaineer Antoine Leroux, called by the Mexicans Don Joachin.

Explanation of figure. — Plate II, fig. 3. Shell, natural size.

ISOCARDIA WASHITA n. sp.

Plate III, fig. 2, 2 a, 2 b.

Description. — Shell orbicular, slightly triangular, length and breadth nearly equal, entirely smooth, sub-equilateral, gibbous, umbones very depressed, narrow and curved forwards. The cast which I describe is destitute of muscular and palleal impressions.

Observations. — This species resembles extremely the *Isocardia neocomiensis* of d'Orb. (*Paléontologie Française, Terrains Crétacés;* tome III, page 45, pl. 250, fig. 9 — 11.) and the *Ceromya neocomiensis* Agass. (*Monographie des Myes*; page 35, tab. 8 f., fig. 11 — 16.); the only difference I have observed being in the keel, which is less distinct in the *I. Washita* than in the *I. neocomiensis.* The European species is well known to me, having often found it in the Neocomian of Nozeroy and Censeau, Jura; and also at Hauterive near Neuchâtel; and I thought at first the Texian species identical with it, and should not be at all surprised if a better specimen should show this to be the case.

Locality. — Rare, in the Cretaceous rocks on the borders of Red river near Preston, Texas.

Explanation of figures. — Plate III, fig. 2. Cast, side view.
» III, fig. 2 a. Same, buccal side.
» III, fig. 2 b. Same, umbones side.

GRYPHAEA SINUATA var. AMERICANA.

Plate III, fig. 1 (Under the name of *Gryphæa sinuata* Sow.).

Description. — Shell sub-orbicular, of gigantic form, one side cuneiform, beak very small laterally incurved and partly hidden and covered by the shell. The lower valve is convex, very thick, deep, rounded and ornamented with rounded ribs, converging from the edge of the shell towards a centre placed above the beak; some of these ribs are nodulous, slightly undulated and rough. The upper valve is nearly flat.

Observations. — This species is without doubt the most gigantic Gryphite yet found in North America; it has the greatest resemblance to *Gryphæa sinuata* Sow. (*Mineral Conchology of Great Britain*, table 336.) of the Neocomian of England, the distinguishing characters do not appear considerable enough to make a new species and I regard it as a variety of the above and give it the name of *Gryphæa sinuata* var. *Americana.* The characters distinguishing it from the true *G. sinuata*, are, that the lower valve of the American species is not sub-carinated but largely rounded, and the beak also is less prominent and smaller than in the species of the Lower Green Sand of Kent and Yorkshire, England. It is distinguished from the *Gryphæa aquila* Brong. by its form being neither oblong nor so much flattened, and from the *Gryphæa Couloni* Defr. being neither angular nor triangular.

Beyrich figures under the name of *Exogyra Overwegi* var. *laevigata*, tab. 1, fig. 2 (See: *Report on the fossils found by Overweg during his journey from Tripoli to Murzuk and from Murzuk to Ghat,* by Beyrich, in *Monatsberichte über die Verhandlungen der Gesellschaft für Erdkunde zu Berlin*; neue Folge: IX. Band, page 154 and following. Berlin, 1852.), a small specimen of *Gryphæa*, that he considers as a variety of the *Exogyra Overwegi* Léop. de Buch. According to Beyrich it resembles very much the *Exogyra laeviuscula* Roem. from Texas (See: *Die Kreidebildungen von Texas*, pag. 70 and tab. IX, fig. 3, 3 a, 3 b, 3 c. Bonn, 1852.), and he says they can hardly be distinguished from each other. If Roemer's figures and descriptions of the *E. laeviuscula* are exact, there is a great difference in these two oysters and it appears to me that this species from the deserts of Fezzan, Africa, is much more nearly related to the

Gryphæa sinuata var. *Americana*, than to any other; and I am inclined to consider the *Exogyra Overwegi* var. *laevigata* Bey. as the young of the *Gryphæa sinuata* var. *Americana*. Overweg did not find the specimen figured by Beyrich as the variety *laevigata* of the *E. Overwegi* in the same localities of the Wadi (creek) Zemzem and Wadi Taghije (See: *Dr. H. Barth's travels in North and Central Africa*, sheet N° 3, vol. I, London, 1857.), where he met with so large a number of *E. Overwegi* and *Inoceramus impressus*; but the specimen was given to him during his stay at Tripoli, and it was probably picked up during a journey with a caravan from Fezzan to Tripoli. However, Texas and the route from Fezzan to Tripoli being both comprised between the 30th and 33d degrees of north latitude, it is not impossible that the same species existed in Africa and America during the Cretaceous period.

Locality. — This gigantic Gryphite appears to be rare in Texas, the specimen figured is the only one I have ever seen. It was found in the Cretaceous rocks of the borders of Red river near Preston, Texas.

Explanation of figure. — Plate III, fig. 1. Shell natural size, lower valve.

GRYPHAEA PITCHERI Morton.

Plate IV, fig. 5, 5 a, 5 b, 6.

Description. — Shell sub-triangular, thick, gibbous, irregular; inferior valve curved, oblique and inflated, very narrow near the beak and broad at the opposite side, divided externally into two unequal lobes by a longitudinal furrow which begins at the beak and runs the whole length of the shell; both lobes are more or less carinated with knobs upon each of them. The beak is large, elongated, oblique and *specially compressed laterally*, which is very characteristic of this species. Superior valve irregular, sub-oval, nearly plane, marked with concentric imbricating lamellae. The muscular impression is well marked on the two valves.

Observations. — This species differs from all other known *Gryphæae*. It resembles somewhat the *Gryphæa Couloni* Defr. of the Neocomian of Neuchâtel in its general oblique form, and the knobs upon the lobes of the lower valve. Roemer thinks it resembles very much the *Gryphæa arcuata* Lamk. of the Lias of England, and the figure 1 a (See: *Die Kreidebildungen von Texas*, pag. 73, pl. IX, fig. 1, 1 a, 1 b, 1 c.) that he gives of it resembles in fact this species. This figure must have been taken from a specimen subjected to lateral pressure, for I have seen perhaps more than 4,000 specimens of this species, and have only found one having partly the form of fig. 1 a of Roemer. This one specimen had evidently been pressed laterally and the beak showed wounds that explain the prominence. Fig. 1 b of Roemer shows neither the obliquity of the beak nor its compression, and I have not seen a single specimen of this form. As Roemer observes, this species varies; but I will add that the flattening of the beak and the knobs upon the carinated lobes do not vary, and are fixed characters in all the specimens I have seen in Texas or Arkansas. Morton has figured a small specimen, incomplete and without the superior valve (See: *Synops. Cretaceous Group*, page 55, pl. XV, fig. 9.). Roemer has given a large specimen, probably badly executed by the draughtsman or the lithographer, and he gives no figure of the superior valve, saying that he has never found a complete specimen. I found a single complete specimen of a young individual, and it is given in plate IV, fig. 6. Further I have given two drawings fig. 5 and fig. 5 a of two adult individuals, and also fig. 5 b the inferior face of the superior valve. The drawings in plate IV are very exact, and were done from nature by Humbert, the most skilful artist for fossils, in Paris.

Locality. — This species is found in the first strata of the Cretaceous rocks of Texas, where it is as numerous as the *Gryphæa arcuata* is in the Jura mountains and the Wurtemberg Alb. The limestone of the False Washita and of the Canadian river might be called with propriety *Gryphite limestone*. These beds being the lowest of the Cretaceous rocks of Texas, and the form of the *Gryphæa Pitcheri* having more resemblance to the *Gryphæa Couloni* than to any other species, have

led me to consider these strata as the equivalent of the Neocomian group of Europe. This species was obtained from the hills surrounding Comet creek, one of the affluents of the False Washita river (Longitude 99°, latitude 35°, 50′.); on the banks of the Canadian; at Fort Washita; in the plain of Kiameska, Arkansas; at the fall of the Vert-de-Gris river, affluent of the Arkansas; near Preston; in the vicinity of New Braunfeld; and at Wacco camp on the Rio Guadalupe, Texas. I do not know that this species has been found except in the Far West of the United States. The learned Léopold de Buch thought he recognized the *Gryphæa Pitcheri* in some specimens of *Gryphææ* sent from Chili by Domeyko, and figured and described by Bayle and Coquand under the names of *Gryphæa cymbium* and *Ostrea Rivoti* (See: *Mémoire sur les fossiles secondaires recueillis dans le Chili par I. Domeyko*, page 13 and 24; pl. I, fig. 7, 8; and pl. V, fig. 6, 7; in *Mém. de la Soc. Géol. de France*; tome IV. Paris, 1851.). He also thought that probably the *Gryphæa* n. sp.? plate V, fig. 8, 9 of Copiapo, Chili (See: *Geological observations on South America*, page 266, by Charles Darwin; London, 1851.), was the *Gryphæa Pitcheri*; and that the *Gryphæa Darwinii* of Forbes in the same work, pl. V, fig. 7, is identical with the *Gryphæa imbricata* Krauss (See: *Über einige Petrefacten aus der untern Kreide des Kaplandes*, pl. 50; fig. 2 a, 2 b, 2 c, 2 d.). Sustained by these determinations, the illustrious geologist of Berlin denied the existence of the Jurassic rocks, not only in South America, but in the whole southern hemisphere, in his last publication (See: *Über die Juraformation auf der Erdfläche*; in *Bericht über die Verhandlungen der Preussischen Akademie der Wissenschaften zu Berlin*, pag. 662. 1852.). De Buch goes farther in the same work and denies the existence of the Jurassic rocks in the whole of North America with the exception of the village of Katmaiskoï in the gulf of Katmaï, Russian America, where they have been found by the naturalist Wosnessenky of St. Petersburg.

I have before my eyes, at this moment, specimens coming from Chili and the Cape of Good Hope, as well as all the figures of *Gryphææ*, *Exogyræ* and *Ostracææ* published by Darwin, d'Orbigny, Bayle, Krauss, Forbes and Sharpe, and I confess that notwithstanding my best efforts, I cannot identify any one of them with the *Gryphæa Pitcheri*, they are all of entirely distinct species, and are more nearly related in form to the Jurassic *Gryphææ* than to the Cretaceous. The *Ostrea cymbium* of Bayle (See: *Mémoire etc.*, p. 13; pl. IV; fig. 1, 2, 3, 4, 5, 6, 7; pl. V; fig. 6, 7.) resembles much more the *Gryphæa dilatata* than the *G. cymbium*, and the figures 1, 2 and 4 of Bayle are exactly like several specimens of *G. dilatata*, that I have found in the Argovian of Salins. So that this *G. cymbium*, or *Ostrea hemispherica*, as d'Orbigny calls it (See: *Paléontologie du Voyage dans l'Amérique Méridionale*, p. 106; pl. XXII; fig. 3, 4; Paris, 1842.), of Mauflas and Tres Cruces in the vicinity of Coquimbo, Chili, appears to me identical or at most a variety of the Oxfordian *Gryphæa dilatata* of the Jura. The *Gryphæa Darwinii* Forbes is not at all the same, as Bayle thinks, with his *G. cymbium*, and I agree with Léopold de Buch in identifying it with the *Gryphæa imbricata* of Krauss. I have specimens of the *G. imbricata* found at Utenage by Krauss, which do not differ at all from fig. 7, pl. V, of the *G. Darwinii* of Forbes. The researches and surveys of my friend, Dr. Ferdinand Krauss of Stuttgart, have led him to regard the secondary strata of Algoa bay between Port Natal and Cape Town as of the Cretaceous epoch, and von Buch was perfectly justified in saying in 1852 that « for a long time the formations of this bay had been recognized as Cretaceous » (See: *Über die Juraformation auf der Erdfläche*, pag. 680.). But later and fuller observations upon the colony of the cape of Good Hope, made by Andrew G. Bain and recently pub-

lished, 1857, under the title: *On the Geology of Southern Africa* (*Trans. of the Geol. Soc. of London*, second series, vol. VII, page 175.), show that the secondary strata of Algoa bay are more probably Jurassic than Cretaceous; and Sharpe, who described the fossils collected at Sunday river and Zwartkop river by Dr. Atherstone and A. G. Baines, thought the forms of these fossils resembled very much those found in the middle and lower part of the Oolitic series of Europe. The probability is therefore that the Jurassic formation exists in Southern Africa. This *Gryphæa imbricata* or *G. Darwinii* does not resemble the *G. Couloni*, as Krauss thought, but on the contrary is much like the *G. arcuata* of the lower Lias, from which it differs by its oblique beak and its form being more elongated and laterally compressed.

Explanation of figures. — Plate IV, fig. 5. Inside of lower valve.
» IV, fig. 5 a. Outside of lower valve from another specimen.
» IV, fig. 5 b. Inside of upper valve.
» IV, fig. 6. Young individual with both valves.

HOLASTER COMANCHESI n. sp.

Plate III, fig. 3, 3 a, 3 b.

Description. — Shell oval, cordate, very convex, longer than it is wide, enlarged and sinuous in front, acuminated at the opposite side. The top of the shell is very convex and slightly pointed, the point corresponding to the apical disk, and is placed a little in advance of the middle of the total length. Underneath the shell is entirely flat, excepting a slight elevation towards the rear, and a little depression in front and on the sides of the mouth. The anterior sinus from the mouth to the apex is straight, shallow, rounded, and disappears entirely before reaching the apical disk. The mouth is large, transversely oblong and placed near the anterior edge. The anal extremity is obtusely truncate, with a vertically elliptical orifice, placed at about, or a little lower than, half the height of the test. The ambulacra are straight, regularly radiate and linear lanceolate, extending to the outline of the shell, and increasing gradually in width to the inferior margin. The pores are transverse and oblong. There are rather large tubercles not far from the apex in the interambulacral spaces; these tubercles are very numerous on the under side of the shell and are all perforated and set upon bosses with crenulated summits. The apical disk is very indistinct and cannot be described.

Observations. — This species is nearly allied to the *Holaster simplex* Shumard (Paleontology of the *Exploration of the Red river of Louisiana, in the year* 1852, by Capt. R. B. Marcy, p. 210, pl. III, fig. 2.), and for a long time I thought it identical. The figure of Shumard is so badly lithographed, and further his specimen being broken near the anus, that the drawing is useless; but in his excellent description Shumard says that the ambulacra are flexuous, while in the *H. Comanchesi* they are straight, and the *H. simplex* is a shell regularly rounded superiorly, while this species is a little pointed and consequently not regularly rounded. The *Holaster Comanchesi* has also numerous points of resemblance to *Holaster* (Ananchytes) *fimbriatus* Morton (Silliman's *Journal*, vol. XVIII. p. 245, pl. 3, fig. 9.); *Holaster subglobosus* Agass. (*Description des Echin. Fos. de la Suisse*, p. 13, pl. 2, fig. 7 — 9.); *Ananchytes* (Holaster) *subglobosa* Forbes (*Brit. Org. Rem.*, decade IV, pl. VII.), and especially to the *Holaster Trecensis* Leymerie (in d'Orbigny's *Paléontologie française*, *Ter. Crét.*; tome VI, p. 101, pl. 817.).

Locality. — This fine specimen was found in the Cretaceous rocks of the borders of Red river near Preston, Texas.

Explanation of figures. — Plate III, fig. 3. Shell natural size, seen from above.
» III, fig. 3 a. Same, beneath.
» III, fig. 3 b. Same, vertical profile.

N. B. — I have collected or met with many other fossils from the Cretaceous rocks of Texas, the Prairies and New Mexico. But some have been already described by Morton, Roemer, Owen

or Shumard, and others are in such a bad state of preservation that I cannot describe them with any precision. I wish however to say a few words concerning some of the species described by my predecessors. That which is most wanting in the knowledge of the Cretaceous rocks of the United States, is the local study of details relating to the strata, and the exact stratigraphical position of each fossil. It is true that these rocks, being scattered over the country from the Upper Missouri to the mouth of the Rio Grande del Norte, and the environs of Philadelphia, make such a study quite difficult, and also that the dangers presented by the Indian country of the North of Texas, the Upper Arkansas, New Mexico and Nebraska, place geologists far from the desirable condition of security required for making good surveys. Thus the greater part of the American Cretaceous fossils hitherto described were collected by persons having little or no geological knowledge, and placed in the hands of paleontologists who had never seen the regions from whence they came. Morton had a profound knowledge of the Cretaceous strata of New Jersey; but he had not seen them in the South or West. Roemer has published good observations on the Cretaceous rocks of the vicinity of New Braunfelds and Fredericksburg, Texas, but he gives no details, and his generalities are very vague. I have seen and studied the strata of the Upper Green Sand and the Marly Chalk at Timber creek and at Burlington, New Jersey; in the bed of Little river, one of the affluents of the Canadian; further I have recognized the Neocomian resting in discordant stratification on the New Red Sandstone on the left bank of the False Washita, near Comet creek; and finally I have found in the beds of white sandstone and gray marl of the environs of Albuquerque and Galisteo, New Mexico, fossils that have led me to consider these strata as the equivalents of the White Chalk of Europe. But notwithstanding this practical knowledge, and my numerous researches in the Cretaceous rocks of Neuchâtel, the Jura mountains, of Burgundy, the environs of Paris and the South of England, I confess I feel myself unable to classify with certainty all the Cretaceous strata found in the United States, and in my VII. Chapter, Terrain Crétacé (See: *Résumé Explic. d'une Carte Géol. des Etats-Unis*, etc., in the *Bulletin de la Soc. Géol. de France*, 2ième série, tome XII, page 883.), I divide them provisionally into three principal groups, taking care to premise that as yet we possess no sufficiently exact study of details upon this formation.

James Hall does not find the same difficulties and hesitations in his way, and without having studied practically the Cretaceous rocks either of America or Europe, he has classed them in a memoir entitled: *Observations upon the Cretaceous strata of the United States*, in the volume of *Geology* of the *Report of the United States and Mexican Boundary Commission*; Washington; 1856. It is true that the results arrived at are quite excentric, for he places in the Cretaceous period all the strata deposited in the West during the New Red Sandstone and Jurassic epochs; and it is doubtless owing to this, that Henry D. Rogers has given so grandiose an extent to the Cretaceous rocks of the West in his *Geological Map of the United States.*

EXOGYRA FLABELLATA Goldf.

Observations. -- Dr. F. Roemer gives beautiful figures and an excellent description of this Texan oyster, that he calls *Exogyra Texana.* The figures are even too beautiful, of this and all the other Texan fossils given by the learned Professor of Breslau, and his desire to present perfect specimens has led him too far in restoring by combination, or even by induction, imperfect specimens. until the true condition of the fossil is no longer discernible.

The *Ex. Texana* is very common in the Cretaceous rocks of Texas, and I have seen several hun-

dred specimens from the following localities: Cross Timbers, Fort Arbuckle; Headwaters of the Rio Colorado, Texas; and the vicinity of Fredericksburg and New Braunfelds. This species varies very much, and I agree with Dr. B. F. Shumard who says: «They (*Ex. Texana*) vary very much in their characters, « scarcely any two examples being alike. In some the shell is quite thin, in others massive; some ex- « hibit prominent rugose ribs, while in others the ribs are but slightly elevated and nodulose» (See; *Paleontology*, in the *Exploration of the Red river of Louisiana, in the year* 1852, by Capt. R. B. Marcy; pag. 205.). Roemer, though he remarks the great similarity of this species to the *Ostrea Boussingaultii* d'Orb. and *Exogyra Overwegi* L. de Buch, and even goes so far as to identify it in part with certain forms of the *Ostrea Matheroniana* d'Orb., persists nevertheless in considering it a distinct species. After an attentive comparison, I see no reason for such a conclusion, and I regard it as identical with the *Ex. flabellata* Goldfuss (*Petrif. Germ.*, tome II, pag. 38; pl. 87, fig. 6 a.) and the *Exogyra Boussingaultii* d'Orbigny (*Paléont. Franç., Ter. Crét.*, tome III, pag. 702, pl. 468; and *Coquilles Fossiles de la Nouvelle Grenade recueillis par Boussingault*, pag. 57, pl. III, fig. 20; and pl. V, fig. 8, 9.). So that the *Ex. flabellata* is one of the Cretaceous fossils having the widest geographical extension, being found in France; England; Germany; Spain; Mount Lebanon, Asia; Texas, North America; New Grenada and Venezuela, South America. In consequence of the vast extent of surface occupied by this fossil, I consider it as forming a family of which the *Exogyra plicata* Goldf. (*Petrif. Germ.*, tome II, pag. 37, pl. 87, fig. 5 a f.) is a variety having the umbones nearer the edge, and the general form more elongated and carinated. The *Ostrea Matheroniana* d'Orb. (*Paléont. Franç., Ter. Crét.*, tome III, pag. 737, pl. 485.) is another variety of it, narrower and more carinated; and finally the *Exogyra Overwegi* Léopold de Buch (*Bericht über die von Overweg auf der Reise von Tripoli nach Murzuk, und von Murzuk nach Ghat gefundenen Versteinerungen*, by Herr Beyrich, pag. 161 of *Berliner Monatsberichte*, neue Folge, tome 9, tab. I, fig. 1 a, 1 b, 1 c.) is a third variety of the *Ex. flabellata*; it is more convex and the beak is more enrolled and more distant from the cardinal edge. Beyrich takes the *Ex. plicata* Goldf. as type of a family, and compares with it the *Exogyræ* of Overweg, of Matheron, of Boussingault and the Texan. On the contrary, d'Orbigny in his *Paléontologie Française* considers the *Ex. plicata* Goldfuss as identical with the *Ex. flabellata*, and he unites them by the name of *Ex. flabellata*. Further he says, vol. 3, page 703, that the *Ex. Boussingaultii* resembles so closely the *Ex. flabellata*, that he can not distinguish the specimens from each other, and that he would not hesitate to unite them, if *they had been found in the same strata*; thus sacrificing the zoological characters to a preconceived and false idea of the complete extinction of all the species in each division of the Earth's strata.

CYTHEREA MISSOURIANA Mort. and TELLINA OCCIDENTALIS Mort.

Description. — See: *Description of some new species of organic remains of the Cretaceous group of the United States;* by S. G. Morton, in the *Journal of the Academy of Natural Sciences*, vol. 8, pl. XI, fig. 2 and 3. Philadelphia, 1842.

Observations and *Locality.* — I identify with these two fossils a great number of bivalves forming a lumachella in a yellowish-gray limestone placed between the gray marls that occupy the country between Gold Mount and the villages of Galisteo and Algodones in New Mexico. These marls and limestones belong to the upper Cretaceous epoch, and are probably of the same age as the *White Chalk.*

CAPROTINA TEXANA Roem.

Description. — See: *Die Kreidebildungen von Texas*, von F. Roemer, plate V, fig. 2 a, 2 b, 2 c; page 80.

Observations and *Locality.* — I have seen several specimens of this species in the limestones with *Gryphæa Pitcheri* of the hills surrounding Comet creek, on the left bank of the False Washita. Roemer also says that he found it in company with the *G. Pitcheri* in the vicinity of New Braunfelds; so that this species may be considered as one of the Neocomian fossils of Texas.

FOSSILS OF THE JURASSIC ROCKS.

GRYPHAEA DILATATA var. TUCUMCARII.

Plate IV, fig. 1, 1 a, 1 b, 2, 3.

Description. — Shell orbicular, distinctly lobed; upper valve flat, circular and cuneiform, lower valve boat shaped, sub-hemispherical and elongate. The lateral lobe varies, in some specimens it is very distinct and strongly marked in both valves, in others obscure, but it may always be traced.

Observations. — Many specimens of this species are not distinguishable from the *Gryphæa dilatata* var. β. Sow. (See: *The Mineral Conchology of Great Britain*, tab. 149, fig. 2.)

It differs from the true *Gr. dilatata* only by its more elongated and less orbicular form, and this difference does not appear sufficient to make a new species, more especially as the hinge presents the distinction of divergence on the two valves, which is so characteristic of the true *G. dilatata* of England and Normandy.

In my *Résumé Explicatif d'une Carte Géologique des Etats-Unis et des Provinces Anglaises de l'Amérique du Nord*, I say page 883 (See: *Bulletin de la Soc. Géol. de France*, vol. XII; Paris, 1855.): «La *Gryphæa dilatata* var. *Tucumcarii* n'a *aucun rapport* avec la *Gryphæa Pitcheri*».

James Hall, in *Observations upon the Cretaceous strata of the United States* (See: *The American Journal of Science*, conducted by Silliman and Dana, vol. XXIV; New Haven, 1857.), says page 84: «Having «examined the specimens in Marcou's collection, I have *no hesitation* in saying that the specimens labelled by «him *Gryphæa Tucumcarii* (= *G. dilatata* var. *Tucumcarii*, «Bull. de la Soc. Géol. de France», tome XII, «plate 21) are the *Gryphæa Pitcheri* of Morton, and present *no features either in form, character, condition «of preservation, or otherwise*, which can serve to *distinguish them* from *Gryphæa Pitcheri*».

Here are two clear and decided opinions diametrically opposed to each other. Paleontologists and Geologists must decide between them; always bearing in mind that Hall infers from the identity of the *G. dilatata* var. *Tucumcarii* with the *G. Pitcheri*, that the rocks of Pyramid Mount «*are of unquestionable cretaceous age*», and that he mentions neither the *Ostrea Marshii*, nor the superposition, also regarding the Keuper of Pyramid Mount as of *unquestionable cretaceous age.*

Locality. — This fossil is very common in the bluffs surrounding Plaza Larga, in the bed of Fossil Creek, at the Big and Little Tucumcari, Pyramid Mount, Monte Revuelto and the Llano Estacado. (See: *Geological Map of New Mexico*, plate VIII.)

I can say without exaggeration that the members of our expedition have collected three or four hundred specimens, and I have seen there myself at least two or three thousand. I met with it also near the village of Covero New Mexico, and on the table land or Mesa between Inscription rock and the Cañoncito Bonito west of the Sierra Madre. Capt. Pope has found the *Gryphæa dilatata* var. *Tucumcarii* in the southern part of the Llano Estacado, and Dr. Kennerly gave me specimens of that species picked up by him at Léon Spring, between Fort Inge, Texas, and El Paso, Chihuahua.

Explanation of figures. — Plate IV, fig. 1. Lower valve of a fullgrown individual.
» IV, fig. 1 a, 1 b. Upper valve of the same.
» IV, fig. 2. Young specimen with both valves, showing well the lobe upon the upper one.
» IV, fig. 3. Lower valve of a very long fullgrown specimen.

OSTREA MARSHII Sow.

Plate IV, fig. 4.

Description. — Shell oblique, strongly depressed, longer than wide, both valves deeply plaited in six or seven angular diverging undulations, edge thick, flatted.

Observations. — I find no difference between the two specimens collected at Pyramid Mount, and more than fifty of the true *Ostrea Marshii* Sow. (*The Mineral Conchology of Great Britain*, table XLVIII.) found by me in the Lower Oolite of the Jura mountains. It resembles the *Ostrea pes-leonis* Forbes, of Pondicherry, East India (See: *Report on the fossil invertebrata from Southern India*, pl. XVIII, fig. 5.); but the furrows towards the margin are less deep, the plications less acutely angular, and the shell is not ovate but oblique.

Locality. — I found this fine Jurassic species in the same bed *a* of clay with the *Gryphæa dilatata* var. *Tucumcarii* at Pyramid Mount. It is much more rare than the *Gryphæa*, for I only found two specimens, but it is probable, that a longer and more minute search in the vicinity of Plaza Larga would result in the discovery of a more considerable number.

Explanation of figure. — Plate IV, fig. 4. Valve natural size, front view of the exterior.

FOSSILS OF THE MOUNTAIN LIMESTONE OR LOWER CARBONIFEROUS ROCKS.

ORTHOCERAS NOVA-MEXICANA n. sp.

Plate VII, fig. 1.

Description. — Shell elongate, cylindrical, smooth, section circular; the siphuncle is not visible on my specimen, which has only the two last chambers; if we can judge from the last chamber but one, they must have been numerous, regularly concave and succeeding each other at small distances. The last chamber is large, its length being twice its diameter. In this last chamber is seen the section of a *Bellerophon*. I notice this *Bellerophon* because I have found no other in the Rocky mountains, and it is probable they are numerons there but that I failed to find the bed in which they lay.

Observations. — This species is related to the *Orthoceras giganteum* Sow. (See: *Min. Conch. of Great Britain*, tab. 246; and *Fossiles du Carbonifère de Belgique*, par de Koninck; p. 510, tab. 44, 45, 46 and 47.), but it is more cylindrical and the chambers appear much nearer together.

Locality. — I found only one specimen of this species; it was in a block of blue limestone, with several beautiful specimens of the *Productus semi-reticulatus*, in a deep ravine near the summit of the Sierra de Sandia, behind Albuquerque.

Explanation of figure. — Plate VII, fig. 1. Natural size, side view.

MYALINA APACHESI n. sp.

Plate VII, 6, 6 a.

Description. — Shell oblique-elongated, depressed, thick; concentric striæ; beak pointed with small crochet slightly bent, the cardinal border is not visible in my specimens, the three other borders are more or less round.

Observations. — This fossil resembles very much the *Myalina virgula* of de Koninck (See: *Descr. des Foss. Carbonif. de Belgique*, p. 127; pl. VI, fig. 3.), but it is larger and its form is more elongated and not sub-rhomboidal. It is entirely distinct from the only species of *Myalina* hitherto discovered in the United States, and described under the name of *Myalina sub-quadrata* Shumard (See: *First Report of the Geol. Survey of Missouri*; second part, p. 207; pl. c, fig. 17 a, 17 b; found in the Coal Measures of the Missouri river.).

Locality. — It is found in company with the *Productus semi-reticulatus*, the *Spirifer striatus*, and the *Terebratula subtilita*, near the ranchos of Pecos village. This species is rare; I have seen only three specimens and not one is perfect.

Explanation of figures. — Plate VII, fig. 6. Side view of a specimen without the beak or the cardinal border.
» VII, fig. 6 a. Side view of the beak.

PRODUCTUS DELAWARII n. sp.

Plate V, fig. 3.

Description. — This species is related to the *Productus Cora*; it has a pointed beak; hinge line short, folded, with three or four rounded wrinkles, that become rapidly effaced before reaching the front, across which only very faint interrupted waves of growth may be occasionally seen. Surface covered with slightly flexuous, regular, narrow, thread like striae; intervening sulci deep, much narrower than the striae. The tubes and tubercles are rare and very small.

Observations. — Related to the *Pr. Cora*; but its hinge line is longer and its form less gibbous. James Hall has figured it in the *Paleontology of the Exploration of the valley of the Great Salt Lake of Utah*; by Capt. Stansbury; p. 412; pl. III, fig. 6, under the false name of *Orthis umbraculum*. Stansbury found it on the banks of the Missouri river above Fort Leavenworth, Kansas. It resembles also the *Prod. hemisphericus* var. *minor* Keyserling, plate 5, fig. 2 b (See: *Reise in das Petschora Land, im Jahre* 1843; S' Petersburg, 1846.), which was found in the Mountain Limestone of Podtscher on the Petschora river.

Locality. — It is found in a siliceous limestone at the western foot of Delaware Mount on the bank of an affluent of the Topofki creek, Texas. This fossil is very common but never well preserved, being always a little flattened, and the shell is so thin that it is easily broken or destroyed. In company with the *Productus Delawarii* a true *Orthis* is found, but I found none sufficiently well preserved to be described.

Explanation of figure. — Plate V, fig. 3. Front view.

PRODUCTUS CORA d'Orb.

Plate VI, fig. 4, 4 a.

Description. — Shell elongated, very gibbous, hinge line very short; etc. (See for the full description: *Monographie du genre Productus*, by L. de Koninck, p. 50; pl. 4 and 5; Liège, 1847. I refer to the same Monograph, for the descriptions of all the other *Productus*.)

This species as well as all the other Carboniferous *Brachiopodae* described in this Chapter were submitted to de Koninck himself, and also to de Verneuil, and I have followed their determinations.

Locality. — This fossil abounds in the Carboniferous limestone of the Rocky mountains; I found several dozen specimens in the course of four or five hours exploration, at Tigeras cañon of San Antonio, at Pecos village, and lastly at the summit of the Sierra de Sandia, at 12,000 feet above the sea-level.

Explanation of figures. — Plate VI, fig. 4. Front view of specimen showing tubercles on the surface.
» VI, fig. 4 a. Dorsal valve, flattened by vertical pressure.
The two specimens figured come from Pecos village.

PRODUCTUS CORA var. MOGOYONI.

Plate VI, fig. 5.

Description. — I collected five or six specimens of a *Productus*, so nearly resembling the *P. Cora* that I do not venture to call it a new species, but regard it as a variety, under the name of *P. Cora* var. *Mogoyoni*. It differs from the *P. Cora* in the length of the hinge line, which is longer than the transversal axe of the shell, while in the *P. Cora* the hinge line is always shorter.

Locality. — I found this variety of the *P. Cora* in the Sierra de Mogoyon or Sierra Blanca, near the extinct volcano of San Francisco, at camp N° 96, Cedar creek; see: *Map N° 2*; *Reconnais-*

sance and Survey of a Railway route from Mississippi rivev near 35th *parallel north latitude to Pacific Ocean*; by Lieut. A. W. Whipple; Washington, 1855 (The latitude of camp N° 96 is 35°, 17′, longitude 112°, 13′.); in the country of the Tontos Indians.

Explanation of figure. — Plate VI, fig. 5. Front view. Some tubercles are visible; the striae are rather worn.

PRODUCTUS SEMI-RETICULATUS Mart.

Plate V, fig. 4, 4 a. — Plate VI, fig. 6.

Description. — Few fossils are better known or more widely spread than this. De Koninck gives a very minute description and history of it in his *Monograph of the genus Productus*, page 83; plate 8, 9 and 10. Frederick Mc Coy gives also an excellent description of it (See: *Description of the British Paleozoic Fossils in the Geological Museum of the University of Cambridge*; page 471.). As I have not seen the first work of Martin, in which there is a figure and description of this *Productus*, noticed by any Paleontologist, not even by de Koninck, Mc Coy or de Verneuil, these savants quoting always from the memoir of William Martin entitled: *Petrificata Derbiensia; or figures and descriptions of Petrifactions collected in Derbyshire*; in 4°, 1809; I give here *verbatim* the description published by William Martin in 1793. This work is very rare even in England; its title is: *Figures and Descriptions of Petrifactions collected in Derbyshire, to which are added a systematical list of the Minerals and an introduction to the knowledge of Petrifactions in general;* Wigan; in 4°, 1793. The *Productus semi-reticulatus* is found plate 22, fig. 1, 2, 3. The description is as follows:

«A fossil shell of the genus *Anomia*, striated in a longitudinal direction, and (in some specimens) set with a few, «small distant tubercles; the hinge on a streight line; the under or larger valve convex, the margin produced or «lengthened out beyond the extent of the other valve, and in its general form approaching a cylindric figure; the «beak small, curved over the hinge; the upper valve flat or slightly concave, very small, and hid, in the fossil «state, by the cylindric part of the larger valve.

«This curious *Anomia* is found in many parts of Derbyshire; some of the best specimens, I have seen, I col-«lected in a mine near Croom-Hill, about four miles south of Buxton.»

Locality. — This fossil is very common in the Rocky mountains, the Sierra Madre and the Sierra de Mogoyon. At the village of Pecos near Santa Fe it constitutes almost the whole of a bed of limestone two feet thick, and in an hour or two several hundred specimens in good preservation might easily be collected. It is also very abundant at Tigeras in the Cañon of San Antonio, at the very top of the Sierra de Sandia; and at Cedar creek in the Sierra de Mogoyon. I have received specimens coming from the borders of the Great Salt Lake, from the sources of the Rio Colorado Chiquito in the Sierra Blanca; from the town of El Paso, state of Chihuahua; from the junction of the Rio San Pedro with the Rio Gila, Arizona Territory; and lastly from Vancouver island.

Explanation of figures. — Plate V, fig. 4. Front view with tubercles, from Pecos village.
» V, fig. 4 a. Same, side view.
» VI, fig. 6. Large specimen, front view; from Cedar creek, west of the extinct volcano of San Francisco.

PRODUCTUS COSTATUS Sow.

Plate V, fig. 5.

Description. — Shell transversely oblong, with an angular depression in the middle, costated; costæ few, broad, convex, irregularly unequal, longitudinal and crossed on the rostral portion only by regular concentric wrinkles, thus producing a regular reticulate tuberculation. Spine cylindrical, strong, a single one on each longitudinal rib. For more details see: *Monographie du genre Productus*, par L. de Koninck; p. 92.

Locality. — This is a bad specimen, rolled and worn, but still having the characters of the species. I possess some better specimens collected by me in the Sierra de Mogoyon at Cedar creek,

but the specimen figured was given to me by my unhappy and celebrated friend, the Count de Raousset Boulbon[1]), who found it in company with a *Productus semi-reticulatus* on the banks of one of the creeks that rise in the Sierra of Arizona and flow into the Rio Gila. I have also seen specimens found at the sources of the Colorado Chiquito. I did not find this species in the Rocky mountains. De Koninck cites it in the vicinity of St. Louis.

Explanation of figure. — Plate V, fig. 5. Rolled specimen collected by Count de Raousset Boulbon in Sonora. Front and side view.

PRODUCTUS FLEMINGII Sow.

Plate VI, fig. 7.

Description. — Shell quadrangular, nearly twice as broad as long, sides steep, nearly parallel; the sides of the convex valve gibbous; the front indented, longitudinally furrowed; spines on the sides. Striae coarse, rounded, nearly of equal size on all parts of the shell, separated by deep, very narrow sulci (See: *Monog. du genre Prod.*, p. 95.).

Locality. — This species, common in the Mountain Limestone of the states of Ohio, Indiana and Arkansas, is found in great abundance at Tigeras in the Cañon of San Antonio, and near the summit of the Sierra de Sandia. I found it also at Pecos village.

Explanation of figure. — Plate VI, fig. 7. Convex valve, front view. Tigeras specimen.

PRODUCTUS SCABRICULUS Mart.

Plate V, fig. 6, 6 a (under the false name of *P. scabiculus*,).

Description. — Shell rotundato-quadrate, very gibbous, with or without a wide, shallow, undefined, mesial hollow in the receiving valve. Surface covered with thick, close, sub-regular, rounded, longitudinal striae; swelling at irregular intervals into oval prominent tubercles in quincunx (See: *Monog. du genre Productus*, par de Koninck; page 111.).

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[1]) Gaston Raoulx de Raousset Boulbon, born at Avignon, France, 2 Dec. 1817, was condemned by a Mexican Court Martial as a conspirator and rebel, and shot the 12th Aug. 1854 at Guaymas, Mexico. During my stay at San Francisco in March and April 1854, I was intimately acquainted with de Raousset. One evening, at the house of our mutual friend, the late Mr. Dillon, then Consul General of France for California, de Raousset gave me two fossils; one was the *Productus costatus* and the other the *Productus semi-reticulatus*, that he had found in the dry bed of a creek in the Sierra de Arizona. He also showed me a very fine manuscript map of Sonora, made by him, which was by far the best I have ever seen of that country so little known. The conqueror of Hermosillo intended to publish this map, but as I have never heard more of it, I suppose the manuscript may have been lost during the last stormy months of his life. In all my various wanderings I have never met with so brave and chivalrous a man as de Raousset. With three or four hundred thousand dollars he would have conquered Sonora and the whole of Mexico, and have become a second Fernando Cortez. Son of one of the noblest families of Provence, he followed freely the movement of the age, and valued labor more than his escutcheon; in California he was known only as Gaston Raousset, and did not disdain to gain a subsistence as Stevedore in the harbour of San Francisco. His tragical end, although foreseen by himself and his numerous friends, was nevertheless an infamous act of the Mexican government and its President Santa Anna. France also was wanting to her own dignity in this affair, and de Raousset died without the power of claiming the protection of the flag of his country. England does not thus abandon her children, and wherever an Englishman's life or even property is threatened, he is sure to be sustained by his government backed by the whole nation. By this course England has covered the world with her colonies, while France has only made unsuccessful attempts.

Locality. — This species has not been pointed out before in America. I found it at Pecos village and on the summit of the Sierra de Sandia; but it is not very abundant.

Explanation of figures. — Plate V, fig. 6. Front view of specimen found at Pecos village.
» V, fig. 6 a. The same, side view.

PRODUCTUS PYXIDIFORMIS de Kon.

Plate VI, fig. 3, 3 a.

Description. — Shell very gibbous, very transverse and of moderate size. Dorsal valve very gibbous, divided in the middle by a deep hollow sinus. Sides abrupt and rounded. Beak pointed, slightly recurved and prolonged beyond the cardinal edge. Surface covered with numerous elongated tubercles. Concentric folds traverse the dorsal valve near the beak and render the surface undulating. The ventral valve is plane, excepting two slight lateral and oblique depressions, that give place to a small elevation corresponding to the sinus of the opposite valve; it is covered with small cavities regularly distributed on the concentric wrinkles of the beak.

Locality. — This species was clearly pointed out for the first time in 1847 by L. de Koninck; see: *Monographie du genre Productus*, p. 116, pl. 11, 12 and 16; who had it from Belgium, from Yorkshire and from Ireland. It had not been met with in America, when I found it near the village of Tigeras, New Mexico; it appeared to be quite common.

Explanation of figures. — Plate VI, fig. 3. Front view. Tigeras specimen.
» VI, fig. 3 a. Same, side view of the ventral valve. The two lateral depressions and the small elevation are not well drawn, though they are very well developed in the specimen.

PRODUCTUS PUSTULOSUS Phill.

Plate VI, fig. 1.

Description. — The following is the description given of this fossil by my honorable friend Professor John Phillips of Oxford University. «Rotundo-quadrate, gibbous, ear angular, furrowed, spineless; transverse undulated «wrinkles, bearing numerous scattered spines, which become more and more depressed toward the margin». (See: *Geology of Yorkshire; Part II; Mountain Limestone district;* p. 216; pl. VII, fig. 15. See for a longer and more minute description: *Monographie du genre Productus*, by de Koninck; p. 118; pl. 12, 13 and 16.)

Locality. — This species had not been met with before in America. I found only one specimen well preserved at Tigeras, New Mexico.

Explanation of figure. — Plate VI, fig. 1. Specimen natural size, front view.

PRODUCTUS PUNCTATUS Mart

Plate VI, fig. 2.

Description. — Shell rotundo-quadrate; less gibbous than the *P. pustulosus*; a shallow mesial sulcus extends from about six lines from the beak to the front margin. Surface of both valves concentrically marked by flat imbricating sub-regular bands of growth, each closely and variously punctured with numerous rows of perforated spinulosae. See for more details: *Monographie du genre Productus*, page 123; and also: *British Paleozoic Fossils*, by M^c^ Coy: page 469.

Locality. — This species is not rare in the Rocky mountains. I have seen it at Tigeras, Pecos village and in the Sierra de Mogoyon.

Explanation of figure. — Plate VI, fig. 2. Front view. Tigeras specimen.

ORTHIS PECOSII n. sp.

Plate VI, fig. 14, 14 a, 14 b.

Description. — Shell oval, sides semi-elliptically rounded, lateral and front margins in one plane; beak obtuse, prominent; mesial fold indistinct; surface radiatingly striated, very finely, with thread like striae.

Observations. — This species resembles the young of the *Orthis resupinata* Martin; but it differs in having an oval form, while the other is transverse.

Locality. — This species is rare; I found only one specimen at Pecos village, New Mexico.

Explanation of figures. — Plate VI, fig. 14. View of dorsal valve.
» VI, fig. 14 a. Same. View of the ventral valve.
» VI, fig. 14 b. Same. View of the beak.

ORTHIS CRENISTRIA Phill.

Description. — «Surface of the valve radiated with strong divaricating striæ, crenulated by the lines of growth». See: *Geology of Yorkshire; Part II, the Mountain Limestone district*, p. 216; pl. IX, fig. 6. I have not figured this species my specimens being too imperfect; but several of my fragments resemble so much the figure of the *O. crenistria* of Phillips, that, aided by the advice of de Koninck, I do not hesitate to regard them as identical.

Locality. — Is quite common in company with the *Productus semi-reticulatus*, the *P. Cora* and the *Ter. subtilita* at the village of Pecos.

SPIRIFER STRIATUS Mart.

Plate VII, fig. 2, 2 a.

Description. — This species is well known and found wherever the Mountain Limestone exists. The following is the description of it given by William Martin in 1793. «*Conchyliolithus (striatus) Anomiæ* — a fossil shell — valves «convex, semi-orbicular, longitudinally striated; the *striæ* strongly marked, close and numerous. Beak of the larger «valve pointed, and curved over the hinge, which extends, on a straight line, the whole breadth of the shell. «Margin obsoletely waved. A convex fold down the middle of the smaller valve, proceeding from the valve of the «margin to the beak — in the large valve, a concave fold. The folds slight; that of the larger valve scarcely dis«tinguishable. A triangular aperture under the beak of the large valve». (See: *Figures and Descriptions of Petrifactions collected in Derbyshire*, by William Martin, plate 23; Wigan, 1793. Also, *British Paleozoic Fossils*, by M^c^ Coy, p. 422; London, 1855. Also, *Fossiles du Carbonifère de Belgique*, by de Koninck, p. 256; Liège, 1844. Also, *Paléontologie de la Russie et de l'Oural*, by de Verneuil, p. 167; Paris, 1845.)

Locality. — This *Spirifer* is one of the largest and also one of the most characteristic fossils of the Carboniferous epoch. It is quite common in the Lower Carboniferous of the States of Ohio, Kentucky, Tennessee, Indiana, Illinois, Iowa, Missouri and Arkansas; and it forms a complete bed of limestone a foot thick, in the *Mountain Limestone* of Pecos village. This bed of *Spirifer striatus* is separated from that of the *Productus semi-reticulatus* by only twenty feet of limestone, in which the *Terebratula subtilita* is very common. I found it also at the summit of the Sierra de Sandia, 12,000 feet above the sea-level, and also at the village of Tigeras, New Mexico. I have received this species from persons who had found it near Great Salt Lake city, Utah; in Shasta county, California; and at Vancouver island.

Explanation of figures. — Plate VII, fig. 2. Specimen from Pecos village, view of dorsal valve.
» VII, fig. 2 a. Same, ventral valve.

SPIRIFER STRIATUS var. TRIPLICATUS.

Plate VII, fig. 3.

Description. — In common with all species widely distributed over the Earth's surface, the *Sp. striatus* presents several varieties. I saw several thousand specimens in the Rocky mountains lying in the same strata mingled together, which when studied separately would seem to belong to at least three distinct species: the true *Sp. striatus*; a second more transverse and with an area more developed than the *Sp. striatus*, and which D. D. Owen doubts is identical with the *Spirifer fasciger*? lastly a third, having the same general form as the *Sp. striatus*, distinguished

only by a division of the striæ, that simple at their origin, soon subdivided into three, which are continued to the margin without further division; this one has been named *Sp. triplicata* Hall. But on studying a considerable number of specimens, it becomes apparent that they pass insensibly from one of these species to the other, and that in fact there is only one, the true *Sp. striatus* with the varieties *triplicatus* (See: *Paleontology* of *The Exploration of the Great Salt Lake*, by Capt. Stansbury, p. 410.) and *Owenii* (See: *Illustrations to the Geological Report of Wisconsin, Iowa, and Minnesota*, by D. D. Owen; plate V, fig. 4; under the name of *Sp. fasciger*? Philadelphia, 1852.).

The *Sp. fasciger* of Keyserling (See: *Wissenschaftliche Beobachtungen auf einer Reise in das Petschora-Land, im Jahre* 1843, pag. 231; pl. VII, fig. 3. 3 a, 3 b. St Petersburg, 1846.) is a good species, different from the *Owenii* variety of the *Sp. striatus*, although it has some resemblance to it. Mr. de Koninck writes to me that he considers the *Spirifer Condor* of d'Orbigny (See: *Paléontologie du Voyage dans l'Amérique Méridionale*, p. 46; pl. V, fig. 11—14. Paris, 1842.) as a variety of *Sp. striatus*.

Locality. — The *Sp. striatus* var. *triplicatus* and *Sp. striatus* var. *Owenii* are abundant in the Rocky mountains, especially at Pecos village, at Tigeras, on the summit of the Sierra de Sandia, at Great Salt lake, and at Vancouver island.

Explanation of figure. — Plate VII, fig. 3. Front view of specimen from Pecos village.

SPIRIFER ROCKY-MONTANI n. sp.

Plate VII, fig. 4, 4 a, 4 b, 4 c, 4 d, 4 e.

Description. — Shell transverse, gibbous, subsemi-circular, length and breadth nearly equal, cardinal angles rounded. Beak large, elevated, incurved; hinge line shorter than the width of the shell, straight. Sinus of the dorsal valve shallow, extending from the beak to the margin, covered with ribs, like the other parts of the two valves. The ribs are simple, sharp and very distinct. Area small and triangular. The lines of growth are indistinct on the two valves.

Observations. — This species slightly resembles in form the *Sp. rotundatus* Mart. (See: *Fossiles du Carbonifère de Belgique*, by de Koninck; p. 263; pl. XVII, fig. 3, 3 a, 3 b, 3 c.), but it differs in having a smaller sinus covered by the ribs, while the *Sp. rotundatus* has larger and less numerous ribs, and the sinus is without any.

Locality. — I found this beautiful species in the Mountain Limestone of Tigeras, Cañon of San Antonio, New Mexico; where it is not rare.

Explanation of figures. — Plate VII, fig. 4, 4 a, 4 b. Different views of a large specimen.
» VII, fig. 4 c, 4 d, 4 e. Young shell a little compressed.

SPIRIFER LINEATUS Mart.

Plate VII, fig. 5, 5 a, 5 b, 5 c.

Description. — Shell transversely oval, moderately convex, hinge line half the width of the shell; beaks approximate; cardinal angle and sides semi-elliptically rounded; no sinus in front; margins in one plane. Cardinal area low, triangular, no trace of mesial fold. Surface of both valves covered with subregular concentric lamellæ; sometimes marked with a row of strong longitudinal notches, producing a very delicate imperfect reticulation.

Locality. — This species, so common in Europe (See: *Paléontologie de la Russie et de l'Oural*, by de Verneuil; p. 147; pl. VI, fig. 6, 6 a, 6 b.), is also found in the Rocky mountains. I found it at Pecos village and at Tigeras, where it is not very common.

Explanation of figures. — Plate VII, fig. 5, 5 a, 5 b. Different views of specimen from Pecos.
» VII, figure 5 c. Specimen from Tigeras, showing to the naked eye the reticulation of its surface.

TEREBRATULA ROCKY-MONTANA n. sp.

Plate VI, fig. 13, 13 a, 13 b, 13 c.

Description. — Shell reniform, sub-triangular, depressed convex; beak sharp and pointed; sinus very wide and shallow, furnished with two or three longitudinal ridges; no lateral ribs. Surface smooth.

Observations. — This species, related to the *Ter. reniformis* Sow. (See: *Mineral Conchology of Great Britain*, plate 496, fig. 1, 2, 3, 4.), differs from it in not being transverse, and also because the sides of the beaked valve are not inflated so as to hang below the edges. The *Rhynchonella Missouriana* Shumard (See: *First and Second Reports of the Geological Survey of Missouri*, by Swallow; *Part II*; *Paleontology*, p. 204; pl. C, fig. 5 a, 5 b, 5 c. Jefferson city, 1855.) also resembles very much the *Ter. Rocky-montana*; but it is more gibbous and its sinus is larger.

Locality. -- I met with but two imperfect specimens that appear to have been laterally compressed. Pecos village, New Mexico, where it is found in company with the *Prod. semi-reticulatus* and the *Ter. subtilita*.

Explanation of figures. — Plate VI, fig. 13, 13 a. Imperfect specimen.
» VI, fig. 13 b, 13 c. Another specimen laterally compressed.

TEREBRATULA MORMONII n. sp.

Plate VI, fig. 11, 11 a, 11 b, 11 c.

Description. — Longitudinally orbicular; lateral and front margin in one plane, without trace of medial sinus; valves equally convex. Beak small, prominent; ridges equal, simple, rounded, radiating; intervening sulci deep and angular.

Observations. — This species resembles much the *Ter. radialis* Phillips (See: *Geology of Yorkshire, Part II, the Mountain Limestone district*, p. 223; pl. XII, fig. 40, 41. London, 1836.), differing only by its more elongated form and more prominent beak.

Locality. — This fine fossil was found in the Mountain Limestone of the vicinity of the capital town of the Mormons, Great Salt Lake city.

Explanation of figures. — Plate VI, fig. 11, 11 a, 11 b, 11 c. Different views of the same specimen.

TEREBRATULA UTA n. sp.

Plate VI, fig. 12, 12 a, 12 b, 12 c.

Description. — Shell inequivalved, as wide as long, more or less irregularly triangular. Beak small, acute, not much recurved. The sinus of the large valve is wide, about half the total breadth, the surface of the two valves are decorated each with nine ribs, sharp near the margin, and beginning at a certain distance from the beak; the mesial fold has three ribs.

Observations. — This species is unlike any hitherto found in the Carboniferous rocks, and resembles in its form the *Terebratulæ rimosa*, *furcillata* and especially *cynocephala* of the Lias and Lower Oolite of Europe. Davidson figures a variety of the *Rhynchonella cynocephala* with three plaits on the mesial fold (See: *A Monograph of British Oolitic and Liassic Brachiopoda*, by Thomas Davidson; pl. XIV, fig. 12, 12 a, 12 b; p. 77. London, 1852. — *Paleontographical Society* —) that is very similar to the *Ter. Uta*; but the fossil of Davidson is larger, wider, and less triangular.

Locality. — This species was found in company with the *Ter. Mormonii*, *Royssii*, *subtilita*, and with the *Prod. semi-reticulatus*, near the Great Salt Lake city in Utah Territory.

Explanation of figures. — Plate VI, fig. 12, 12 a, 12 b, 12 c. Different views of specimen, natural size; fig. 12 c is badly printed, and not much like the original.

TEREBRATULA ROYSSII Léveillé.

Plate VI, fig. 10, 10 a, 10 b.

Description. — Transversely oval, moderately gibbous; lateral and front margins nearly in one plane, till after half an inch in length, when a semi-elliptical sinus becomes developed in the front margin, with a corresponding

concave mesial hollow in the dorsal valve, and a smaller, undefined, rounded, mesial ridge in the ventral valve. Beak of the dorsal valve tumid, incurved, small, with a moderate opening at the apex. Surface smooth, with a few distinct imbricating lines of growth. (See: *Fossiles du Carbonifère de Belgique*, p. 300.)

Locality. — The specimen figured was found near Great Salt Lake city in company with the two last species of *Terebratula* described. Leroux gave me some also, from the vicinity of El Paso, Chihuahua, and from the headwaters of the Rio Colorado Chiquito.

Explanation of figures. — Plate VI, fig. 10, 10 a, 10 b. Different views of Great Salt Lake specimen.

TEREBRATULA PLANO-SULCATA Phill.

Plate VI, fig. 8, 8 a, 8 b.

Description. — Shell pentahedral, depressed, middle of each valve plano-sulcate. (See: *Fossiles du Carbonifère de Belgique*, p. 301; and *Geology of Yorkshire, Part II, the Mountain Limestone district*, p. 220.)

Locality. — This well known species of the *Mountain Limestone* of Europe is also found in the States of Ohio, Indiana, Illinois, Kentucky and Arkansas. I have met with it at Tigeras, New Mexico, where it is quite common.

Explanation of figures. — Plate VI, fig. 8, 8 a, 8 b. Different views of Tigeras specimen.

TEREBRATULA SUBTILITA Hall.

Plate VI, fig. 9, 9 a, 9 b, 9 c, 9 d, 9 e, 9 f.

Description. — Shell sub-orbicular, more or less gibbous; lateral and front margins in one plane, except near the front margin, where a contorted sinus becomes developed with a corresponding concave mesial hollow in the dorsal valve. The hollow begins generally at a third of the length from the beak; sometimes very near the beak (see fig. 9 e), and sometimes near the front margin. The ventral valve has a large mesial ridge corresponding, broadly rounded; sometimes indistinct and even with a little depression in the middle (see fig. 9 a). Surface smooth, marked by imbricating lines of growth. Beak of the dorsal valve small, incurved, with quite a large opening at the apex.

Observations. — This species is variable in its characters, and its name of *subtilita* is very appropriate. It was first found on the banks of the Missouri, near Weston, by Capt. Stansbury (See: *Exploration of the Great Salt Lake*, Paleontology, p. 409; pl. II, fig. 1, 1 a, 1 b, 2, 2 a, 2 b, 2 c.). It has since been recognized in the Carboniferous rocks of the States of Illinois, Indiana, Kentucky and Arkansas. Its general form resembles rather the *Terebratulæ* section *Jugatæ* of the Secondary epoch, than the *Terebratulæ* of the Paleozoic rocks.

Locality. — Occurs in great abundance in the Mountain Limestone of the Rocky mountains, of the Sierra Madre, of the Sierra de Mogoyon, and in the vicinity of Great Salt Lake. I have seen several thousand specimens of this species at Tigeras, at Pecos village, on the summit of the Sierra de Sandia, and the Sierra de Mogoyon. I have received it from the vicinity of El Paso, Chihuahua; from the junction of the rivers San Pedro and Gila, Arizona; from the sources of the Rio Colorado Chiquito; the Great Salt Lake; Shasta county in California; and finally from the southern coast of Vancouver island.

Explanation of figures. — Plate VI, fig. 9, 9 a. Specimen showing the sinus on both valves.
» VI, fig. 9 b, 9 c. Larger specimen, more elongated.
» VI, fig. 9 d, 9 e, 9 f. Very gibbous and elongated specimen.
These three specimens were found at Pecos village, New Mexico.

ZAPHRENTIS STANSBURYI Hall.

Plate VII, fig. 7.

Description. — *Corallum* curved, somewhat elongated, and encircled with a few well marked constrictions. *Calice* circular, deep, with a thin margin. *Fossula* situated toward the dorsal side, or large curve of the corallum. *Septa* numerous, lamellate, thin, extending to the edge of the fossula.

Observations. — Some specimens of this coral are quite large and sometimes much curved, having a semi-circular form. It was first found on Stansbury's island, in Great Salt Lake, by Capt. Stansbury, and described under the name of that skillful officer by Hall; see: *Exploration of the Great Salt Lake*, p. 408; pl. I, fig. 3, 3 a, 3 b. The figures in this report are evidently of a young specimen of this species.

Locality. — Abundant in the *Mountain Limestone* of the Rocky mountains. I saw a great many at Tigeras, on the summit of the Sierra de Sandia, and at Pecos village. The limestone in which it is found is so hard, that it is difficult to obtain well preserved and complete specimens.

Explanation of figures. — Plate VII, fig. 7. Fragment showing the interior of the turbine. Found at Tigeras.

ZAPHRENTIS CYLINDRICA Milne Edwards and Jules Haime.

Plate VII, fig. 8.

Description. — «Coral very long, almost cylindrical, more or less curved and having large circular accretions, «etc.» (See: *A Monograph of the British Fossil Corals*, third part. *Corals from the Mountain Limestone*, page 172; plate XXXV, fig. 1, 1 a, 1 b.)

Locality. — This gigantic species of coral, so common in the Mountain Limestone of England, Belgium and France, had not been found previously in America. I saw a great number of specimens in ascending the Sierra de Sandia from Antonito, and several limestone beds were full of them. I also found it at Tigeras.

Explanation of figure. — Plate VII, fig. 8. Fragment of a large specimen from the Sierra de Sandia.

AMPLEXUS CORALLOIDES? Sow.

My late and lamented friend Jules Haime with some hesitation connected with this species (See: *A Monograph of the British Fossil Corals*, p. 173; pl. XXXVI, fig. 1, 1 a, 1 b, 1 c, 1 d, 1 e.) a fragment, three inches long, that I found at Pecos village. I have also found at Tigeras, on the summit of the Sierra de Sandia, at Pecos village, and at Cedar creek in the Sierra of Mogoyon, several unpublished *Bryozoa*, all belonging to the Mountain Limestone strata.

CHAPTER IV.

GEOLOGY OF NEW MEXICO.

GEOLOGICAL MAP OF NEW MEXICO. — PLATE VIII.

The geological map of a portion of New Mexico, represented plate VIII, was drawn with the help of my private journal, several letters written to geological friends during my stay at Albuquerque, Santa Fe and the Pueblo of Zuni, and some notes marked by me on several maps of New Mexico in my possession while travelling in that country. I have marked by a broken line the uncertain limits of several geological formations; having followed one line of march, I could not fix the limits of the different rocks on the north and south of this line. The track of the survey is marked by a dot and line, and the positions of the different camping grounds are marked by numbers.

I have not divided the Carboniferous rocks into two parts, as is usually done; both on account of the small scale of the map, and also because the *Coal-measures* are represented only by thin strata of black argillaceous schist. The Mountain Limestone is much more developed than the Coal-measures, and forms the principal part of the Rocky mountain Carboniferous rocks. This map must be regarded as a first essay upon a country about which the geological notions have hitherto been very vague, and I publish it only as a first attempt upon a *terra incognita*.

Camp N° 1. Rocky Dell creek. — The camp is situated on a whitish-gray sandstone, of very massive stratification, with intercalation of red-colored schistose beds. These rocks are easily disintegrated and denuded by atmospheric action and running water, and in the ravine of Rocky Dell creek present several caves with Indian hieroglyphics sculptured on the walls, and on the plateau where the camp was placed there are many grotesque forms produced by these causes, such as gigantic pot-holes, sugar loaves, enormous cakes etc. This sandstone forms the lower part of the Keuper of New Mexico. Two miles west of the camp is an isolated mountain, whose abrupts are formed of the upper part of the Keuper, consisting of red and variegated sandy marl, two hundred feet thick. The summit is capped by beds of a compact gray limestone very analogous to the Lower Oolite — Calcaire de la citadelle de Besançon — of the Jura mountains. This Jurassic limestone is fifteen feet thick and contains no fossils.

Camp N° 2. — From N° 1 to N° 2 the road is constantly on the red and variegated sandy marl of the Upper Keuper and skirts the northern foot of the Llano Estacado.

Camp N° 3. — From N° 2 to N° 3 red sandy marl as before. In the beds of several creeks running from the Llano Estacado are seen several specimens of the *Gryphæa dilatata* var. *Tucumcarii* much broken and worn away. From camp N° 3 the immense table-land of the Llano Estacado is seen to have

a second gigantic step or grade, called by the Mexicans Monte Revuelto. This augmentation of the Llano and the worn fossils found in the creeks, show that the Jurassic rocks have become more developed and contain fossils.

Camp N° 4. — From N° 3 to N° 4 the road continues on the red and variegated sandy marl of the Upper Keuper; but on the south are seen the magnificent cliffs and ravines of Monte Revuelto, and the Big Tucumcari, and on the north the two isolated pie-formed mountains known by the name of Little Tucumcari. These cliffs and ravines are almost perpendicular, generally denuded and without vegetation, and show all the strata.

From the base half way up, the formation is the red marl of the Upper Keuper, then come white and yellow sandstones, with some beds of limestone of the same colors, and a band of blue clay near the summit. We found in the beds of Fossil and Tucumcari creeks several specimens of *Gryphæa dilatata* var. *Tucumcarii*.

Monte Revuelto, the Big and Little Tucumcari are certainly most important points for the geology of this region, and I have no doubt that a careful examination of them will be productive of useful results; the rapidity of our march did not permit me to visit either, although we passed within half a mile of the base of each one of them.

Camp N° 5. — From N° 4 to N° 5 the road is on the red and variegated marl of the Upper Keuper, until within two miles of camp N° 5 Laguna Colorada, where we found the red and gray sandstone of the lower part of the Keuper. Plaza Larga and Pyramid Mount are situated between these two camps, and as I have described my excursion to Pyramid Mount in the notes of the first chapter, see pages 17, 18 and 19 of the present volume, I will not add any thing on that subject.

Camp N° 6. — The water of the Laguna Colorada flows over strata of red sandy marl and soft red sandstone, which impart to it so much red color that it resembles chocolate more than water. Our road is constantly on the Keuper, and the Llano Estacado two or three miles to the south is no longer capped by Jurassic rocks as was the case before we reached the Laguna Colorada, but is formed by the red sandstone of the Keuper. All the different creeks we pass contain red and brackish water.

Camp N° 7. — From N° 6 to N° 7 the road is on the red sandstone of the lower part of the Keuper, but we see at some distance to the North several hills of the same form as Little Tucumcari, which appear to be capped by Jurassic rocks. These isolated mountains are called by the Mexicans los Esteros.

Camp N° 8. — From N° 7 to N° 8 the road is quite hilly, and we begin to enter the true Rocky mountain region, whose summits we see for the first time three miles west of Hurrah creek. The elongated hill separating Hurrah creek from the Rio Gallinas is capped by a whitish gray limestone similar to the Jurassic limestone of the Llano Estacado. In the valley of the Rio Gallinas we meet with an *Alluvium* coming from the Rocky mountains, composed of pebbles of mean size, of rose granite, sienite, quartz, and more commonly of green trap or basalt. During our whole journey from Napoléon to the Rio Gallinas I was often struck by the entire absence of alluvium; from time to time you see a few inches of sandy alluvium with small quartz pebbles generally of the size of a robin's egg, never larger than the fist; and yet you see all round you evidence that the country has been denuded and washed away on an immense scale. This absence of alluvium in the Prairies near the 35th degree of latitude is very striking as contrasted with the immense quantity of alluvium that covers the northern region, as in New England, Canada, New York, Michigan, Wisconsin, etc.

Between the valleys of the Rio Gallinas and of the Rio Pecos our road was on the alluvium or on the Keuper, but as it is evident that the alluvium rests on the strata of the New Red Sandstone, I have colored the whole road as New Red on the map. On our right we see a table land, called *Man of war Butte*, which appears to be capped by Jurassic rocks.

The Rocky mountains when first seen are at a distance of forty miles, and do not give the idea of majesty and grandeur you expect from such celebrated mountains; they have nothing alpine in their

form and at first view reminded me of the Jura mountains between Aarau and Soleure, as seen at some distance from the plains of Switzerland.

Camp N° 9. — Anton Chico is situated on the New Red Sandstone rocks, in which are found numerous beds of gypsum and dolomite at some distance in following the river towards Cuesta. Our road rises and we pass over strata of white and yellow Jurassic sandstone before reaching the Cañon Blanco, where the bottom of the narrow valley is formed by the upper part of the Keuper. We encamped at the top of a perpendicular cliff, eight hundred feet above the Rio Pecos and the village of Cuesta. The bottom of the valley or cañon in which the Rio Pecos flows is formed by rocks belonging to the New Red Sandstone, and two thirds of the cliff, including the top, are Jurassic rocks.

Camp N° 10. — We cross entirely the Cañon Blanco; the formation is constantly the same as on the previous day's march.

Camp N° 11. — I do not find any geological notes in my private journal of this day's march.

Camp N° 12. — Near the village of Galisteo is a trap dyke, direction 30° east-east-north and 30° west-west-south, cutting through the strata of the New Red Sandstone. A thick alluvium composed of angular fragments of granite, sienite and quartz of moderate size, covers the whole country between camps N° 11 and 12. — N° 12 is placed in the midst of volcanic cones, called Cerrito, that surround us on all sides.

Camp N° 13. — From Cerrito to the Pueblo de San Domingo we pass by the village of Cieneguilla. It is situated at the entrance of a deep cañon at the junction of volcanic rocks with porphyric dyke and the strata of the New Red Sandstone. The upper part of the cañon is formed by basaltic lava, while the lower is a volcanic conglomerate superposed upon New Red Sandstone. In the direction of Peña Blanca we met with a very thick formation of white friable sandstone, the equivalent of the White Chalk of Europe. Our camp N° 13 is near the Rio Grande del Norte on the Quarternary formation.

Camp N° 14. — From Santo Domingo to Sandia our road lay all the time on the Quarternary rocks, except at the Pueblo of San Felipe, where the valley is contracted and the volcanic lava covers the mesa on each side of the river.

Camp N° 15. — From Sandia to Albuquerque, Quarternary rocks with sand-dunes in the process of formation near Alameda.

Camp N° 16. — From Albuquerque to Tigeras the first twelve miles are on the alluvium of the Rio del Norte valley, then the road enters the Canon of San Antonio and is on granite for three miles, until near a very narrow pass, where the granite is replaced by a sort of serpentine trap. These last rocks appear to be metamorphic and are only two hundred feet thick; masses of limestone strata of the age of the Mountain Limestone are superposed upon them. Fossils are common, and I found in this Lower Carboniferous limestone the following species: ***Productus semi-reticulatus***, ***P. Cora***, ***P. Flemingii***, ***P. punctatus***, ***P. pustulosus***, ***P. pyxidiformis***; ***Terebratula plano-sulcata***, ***T. subtilita***; ***Spirifer lineatus***, ***Sp. striatus***, ***Sp. Rocky-montani***; ***Amplexus coralloides*** and ***Zaphrentis Stansburyi***. The strata are upheaved, dipping to the east, at an angle of 35 degrees. The limestone is bluish-gray, sometimes black, very hard and about four hundred feet thick.

Camp N° 17. — For one mile from camp N° 16 to the village of Tigeras the road is on the Carboniferous rocks; the New Red Sandstone begins at the village, and in the ascent to San Antonio and Antonito we pass through all the different divisions: the red sandstone, dolomite, gypsum and variegated marls, exactly the same rocks we met with for so long a distance in the Prairies from Delaware mount to Anton Chico.

Camp N° 18, 19, 20, 21, 22, 23, 24, 25. — As I have given the most important details of this part of the survey in the note on pages 20 and 21 of the present volume I will add nothing more here, more especially as the geology of this part of the country is quite complicated and would require volumes to do justice to it.

Camp N° 26. — From N° 25 to 26 Rio del Norte alluvium.

Camp N° 27. — From Atrisco to the Rio Puerco we cross a sandy mountain entirely composed of white sandstone of the Upper Cretaceous epoch; fossils are rare, except pieces of petrified wood. I found *Ammonites Novi-Mexicani*, a piece of a *Baculites* and an *Inoceramus*.

Camp N° 28. — Almost immediately on leaving the Rio Puerco we met with a sort of gray marl containing a great quantity of nodules of oxide of iron, with numerous fragments of fossil silicified trees. These marls are of the age of the Upper Cretaceous epoch. Our camp N° 28 at Alamo is again on the New Red Sandstone rocks.

Camp N° 29. — From Alamo to Laguna the road follows the foot of bluffs composed of the New Red Sandstone rocks, such as white gypsum, dolomite, red sandstone and red marls. Half way to Laguna the bottom of the valley is occupied by a lava stream coming from the large extinct volcano of Mount Taylor or Sierra de San Mateo.

Camp N° 30. — The bluffs bordering the road on each side are composed of massive strata of the yellowish-white Jurassic sandstone. There is an isolated mountain at the village of Covero, composed of Jurassic sandstone and clay, capped at the top by a stream of basaltic trap. The clay contains numerous fragments of the *Gryphæa dilatata* var. *Tucumcarii*.

Camp N° 31. — We follow the same valley bordered by bluffs of Jurassic sandstone, with a lava stream at the bottom of it. This lava stream is one of the most beautiful I have seen, and reminds me of the Mer de Glace at Chamounix. Nothing resembles a glacier so much as a lava stream, the difference being that one is white and the other dark, and also that the lava stream is stopped by the cold, while the glacier is only stopped by heat. After seeing a lava stream it is difficult not to admit of a certain plasticity in the motion of glaciers.

Camp N° 32. — Near the camp are seen the strata of the New Red, then a high bluff composed of Carboniferous Limestone, and finally the camp is placed on rose colored granite.

Camp N° 33. — From N° 32 to 33, at Agua Fria, the road follows the junction of the granite with the lava stream, and red sandstones of the New Red epoch are seen a little distance to the south of our camp.

Camp N° 34. — Shortly after leaving the Agua Fria we cross the culminating point of the Sierra Madre. We pass on our road a narrow strip of blue-gray limestone of the Lower Carboniferous, a part of the numerous strata of the New Red Sandstone epoch, and finally we cross a large stream of lava which occupies the bottom of the valley between the Sierra de Zuni and the *mesa* or table land of Inscription Rocks. On each side of the Sierra de Zuni the strata dip east and west at an angle varying from 15 to 40 degrees.

Camp N° 35. — I do not find any geological notes in my private journal for this day's march. Camp N° 35 is situated in the narrow valley of Ojo Pescado. The bluffs of the valley are formed at the top of massive strata of rose colored sandstone, then black marl, intercalated with yellow limestone and also containing two or three little seams of bituminous coal, from half to one foot in thickness. All the strata are Jurassic. The bottom of the valley is occupied in part by a lava stream.

Camp N° 36. — We follow the same valley with Jurassic bluffs on each side and the lava stream at the bottom. When we enter the broad valley of Zuni, the strata of the New Red Sandstone crop out from under the Jurassic rocks, and we establish our camp on the red marl of the Keuper. The lava stream terminates near our camp.

Camp N° 37. — New Red Sandstone strata.

Camp N° 38. — New Red Sandstone strata; all the country round Zuni is of a deep red and vermillion color, and has the same characters as the part of our route between Beaver-town and Antelope-hills, Texas.

CHAPTER V.

ON THE GEOLOGY

OF THE UNITED STATES AND THE BRITISH PROVINCES OF NORTH AMERICA.

GEOLOGICAL MAP OF NORTH AMERICA. — See: FRONTISPIECE.

(Extract from Dr. A. Petermann's *Geographischen Mittheilungen*, Heft 6, in 4°. Gotha, 1855.)

General sketch of the physical features of North America. — The United States and the British Provinces may be divided into three principal regions. 1° the eastern or Atlantic region, 2° the central or Rocky mountain region, 3° the western, or the region of the Pacific ocean. These divisions correspond exactly with the three great geological divisions of this continent. The eastern region is that of the Paleozoic formation, the Rocky mountain region contains especially the Secondary rocks, and the western region is that of the Tertiary rocks. The distinctive characters of these different divisions of the country are very numerous. I shall try to give a sketch of these, but first I would call attention to a physical character common to all three, namely, that all the mountain chains have a direction from north to south. This direction of north-south is not to be understood absolutely; the Alleghanies incline to the east, and the Rocky mountains to the west, but these deviations have no influence on the general conformation.

1°. The eastern or Atlantic region embraces the whole country situated between the Atlantic ocean and the gulf of Mexico, and the Prairies or elevated plains of the West. The western limit of this region may be marked by a line drawn from Eagle Pass, on the Rio del Norte, to Fort Washita; from thence to Council-Grove, Council-Bluffs, the sources of the Mississippi, and the northern (Canadian) Red river. It is bounded on the north by a low range of mountains known by the name of the Lawrentine mountains, running from east to west, and forming the dividing ridge for the waters flowing into Hudson's bay and those discharging themselves into the Atlantic ocean and the gulf of Mexico. The Lawrentine mountains consist of hills and mountains from 1200 to 2000 feet high, and this small elevation prevents them from influencing the northern winds which cross them without hindrance, this being one of the chief causes of the extreme cold that prevails in these countries.

Thus bounded, the eastern region embraces all that part of the country actually inhabited and cultivated by the white man, including the whole course of the Mississippi, Ohio, Hudson and S^{t} Lawrence rivers, and the basins of the Great Lakes.

The mountains included in this eastern region are: first the Notre Dame mountains in the district of Gaspé, their medium height is 2500 feet and their greatest elevation does not exceed 4000 feet;

then the Green mountains, the White mountains, the Berkshire mountains and the Alleghanies, all running from north-east to south-west with slight deviations north-south. The highest summits of the White mountains do not reach 7000 feet, and those of the Alleghanies in North Carolina do not exceed 6700 feet.

The Ozark mountains, forming the western boundary of this first region, are still lower than the Alleghanies, of which they seem to be a continuation and a sort of appendix, having the same direction from north-east to south-west, and having been formed at the same period, the end of the Coal formation. Their height varies from one to two thousand feet.

Between the Ozark, Alleghany and Lawrentine mountains, are extensive plains, furrowed by deep ravines, and presenting in consequence numerous undulations, whose medium height is not more than three hundred feet, and the maximum does not exceed six hundred.

2°. The central or Rocky mountain region embraces the country lying between the western limit of the eastern region and the 113° longitude west, meridian of Greenwich. It is chiefly formed by high mountains surrounded by elevated table lands. These elevated plains rise from the extremities towards the centre of the region with so gradual an inclination that it is almost imperceptible; their medium height is four thousand feet, some attain seven thousand and then they form passes between two chains of the Rocky mountains.

The Rocky mountains form a narrow line running from south to north, with a slight deviation of a few degrees toward the west. This line is not continuous, being several times interrupted, thus forming several chains parallel to each other, and imbricated exactly like tiles upon a roof. The eastern chains are called Sierra de los Organos, Sierra de Guadalupe, Sierra de Manzana, Sierra de Sandia, Sierra de Santa Fe, Moro Peaks, Pike's Peak, the Rocky mountains proper, Long's Peak and Laramie Peak. Their elevation above the level of the sea varies from 10,000 to 12,500 and 13,000 feet, and they are the reservoirs for nearly all the rivers flowing into the gulf of Mexico. Thus the Rio Grande del Norte, the Rio Pecos, the Canadian, the Arkansas, the Platte and the Missouri, have their sources in these mountains. I will here remark that the Red river of Louisiana, which geographers have so long confounded with the Canadian, takes its rise at the foot of the Llano Estacado, and has no communication with the Rocky mountains; the same is the case with the Rio Brazos and the Rio Colorado of Texas. Farther to the west the Rocky mountains are formed by the following chains: Sierra de los Ladrones, Mount Taylor, Sierra Madre, Sierra de Jemez, Sierra de San Juan and the western mountains of the South, Middle and North Parks. Their height varies from 8,000 to 11,000 feet. The last named chains form the dividing ridge between the waters of the Atlantic and those of the Pacific ocean.

The Wahsatch mountains forming the western side of the Great Salt Lake, also belong to the system of the Rocky mountains; their elevation is from 5,000 to 8,000 feet above the level of the sea.

The Sierra Blanca or Sierra de Mogoyon, the different chains of which run from north-west to south-east, their heights varying from 10,000 to 14,000 feet, occupies the southern part of this central region. The Rio Gila, the Rio Colorado Chiquito, and Bill William Fork have their sources in this sierra.

3°. The western or Pacific region begins where the high table lands of the basin of the Californian Rio Colorado meet one of the chains of the Sierra Nevada, and terminates at the Pacific

shore. It includes colonel Fremont's *Great Basin*, or the *Californian desert* of the trappers; the Sierra Nevada proper, the Coast Range of California and Oregon, the Umpqua and Shasty mountains between California and Oregon, the Cascade Range of Oregon, and finally the fine and fertile Prairies of California and Oregon.

The *Californian desert*, or *Great Basin*, is composed of a series of mountain chains running from north to south, of which the Sierra Nevada is only the most western chain. The mean elevation of this part of the country is from three to four thousand feet (the peaks attain to eight or nine thousand feet); the soil is arid, sandy and dry. Rivers and lakes, although quite numerous, are cut off from all communication with the sea, the dryness of the atmosphere and the excessive evaporation exhausting their waters long before they reach the vicinity of the ocean, and giving to them a salt and brackish flavor. The traveller across the desert, on reaching the beautiful Prairies of California, beholds one of the most striking contrasts possible. After having followed for weeks a road scarcely marked by a trace in the sand and the rocks, where the vegetation is limited to a few bushes of *Artemisia (A. tridentata, A. Canadensis)*, long and thorny stems of the *Fouqueria splendens* and *spinosa* and the *Cacti*, *Cereus giganteus*, *Mamillaria aggregata*, *Echinocactus Engelmanni*, and *Opuntia arborescens*; on descending the passes of the Sierra Nevada he finds himself at once without transition, in plains of perpetual verdure, that rival in beauty and productiveness the classic plains of Lombardy. The Sacramento, San Joachin, Willammette and Columbia rivers, water this colossal garden, and maintain its continual freshness.

The mountains of the Californian desert and the Sierra Nevada, although generally less elevated than the Rocky mountains, have a more imposing and grandiose aspect. They have an alpine look, and are indeed the only mountains in the United States that can be compared to the Alps. The Rocky mountains have rounded peaks; their summits are dome-shaped, like the *ballons of the Vosges*; in a word they bear the impress of antiquity, the geological ages have worn them away and softened their asperities, while those of the Sierra Nevada are covered with sharp peaks, and needles slender and pointed like gigantic cathedral spires. It is comparatively speaking but a short time since the appearance of the Nevada Range, we see that they have but slightly experienced the destructive action of the various agents in activity on the surface of our planet.

The Cascade Range of Oregon and Washington Territory contains several active volcanoes and some that are extinct, the height of which exceeds that of the highest summits of the Rocky mountains, for they reach 14,000 and 15,000 feet; but this system is only a secondary branch and appendage of the Californian Sierra Nevada. The Umpqua and Shasty mountains cross the Sierra Nevada and run from north-west to south-east, like the Sierra de Mogoyon; they are less elevated than the peaks of the Sierra Nevada and the Cascade Range, not exceeding 6,000 feet.

The Coast Range, extending the whole length of the coast, is a very unimportant system of mountains, only rising a few hundred feet above the Pacific. The Golden Gates of the bay of San Francisco intersect a part of this system of mountains, and Monte Diablo seen from afar like a sentinel posted in advance to guard the Placers of the Sierra Nevada, also belongs to the Coast Range.

This Pacific region may also justly be called the gold region, and with the same reason the Atlantic may take the name of the coal region, and the central region is the land of gypsum and

the red sandstones, and also the true country of the red American Indian, the buffaloes and the antelopes.

Silurian formation. — The strata containing the organic remains of the first living forms that inhabited our planet, so well described by Murchison under the name of *Silurian formation*, occupy a vast extent of the North American Continent. Their position is of the first importance among the Sedimentary rocks, partly owing to their wide geographical distribution, and partly to the thickness of their strata. The Silurian formation is divided, as in Europe, into three principal groups. The Lower group embraces the *primordial fauna* of Barrande, and is characterized by *Trilobites* of peculiar forms, *Lingula*, *Obolus* and *Orbicula*; it is known in the State of New York as *Potsdam sandstone*, and in Wisconsin and Minnesota is called the *Lower Sandstone of the Upper Mississippi* and *Lower Magnesian Limestone*. The Middle group is formed by a mass of limestones and blue marls containing numerous fossils, as: *Trilobites*, *Orthoceras*, *Orthis*, *Spirifer*, *Bellerophon*, *Corals* and *Crinoides*. It is called in America *Trenton group* and *Blue limestone*, and is much developed near Trenton falls and in the vicinity of the town of Cincinnati. The Upper group consists principally of a grayish-white limestone containing numerous fossils, as: *Pentamerus*, *Spirifer*, *Terebratula*, *Leptæna*, *Hypanthocrinites*, *Caryocrinus*, *Favosites*, *Cyathophyllum* and *Catenipora*. The Upper Silurian forms the celebrated falls of the Niagara river, and has therefore been named *Niagara group*.

The Silurian strata occupy especially the eastern or Atlantic region; they form the north coast of Labrador and the whole extent of the Hudson's bay, as well as a great number of islands and coasts in the Arctic regions. The numerous expeditions, by land and water, sent out to discover the celebrated North-West Passage, have brought back stones and fossils proving that the Silurian strata, especially of the Upper group, are very much developed there; and Parry, Franklin, Ross, Richardson, Back, Rae, Mac Clure and others, have shown that the Silurian forms part of the coasts of Winipeg, Athabasca, Great Slave and Great Bear lakes, of Victoria land and the peninsular of Melville.

In the gulf of St Lawrence we find some small islands, called Mingan islands, off the coast of Labrador, formed of the Silurian formation; it is also in Newfoundland near the straits of Belle Isle; the island of Anticosti is wholly Silurian, and it appears also at Port Daniel near the bay of Chaleurs.

In Nova Scotia the Silurian is not much developed, it is only met with at Arisaig and behind Windsor and Kentsville, where it forms only a narrow band. In the provinces of New Brunswick and Lower Canada and the States of Maine and Vermont, large tracts are occupied by Silurian strata; beginning at Cape Gaspé, the Silurian extends over nearly the whole of the country from Eastport, Bangor, Kammouraska and Quebec; it ascends the valley of the St Lawrence and enters the valleys of the Ottawa, of Lake Champlain and of Lake Memphremagog.

The Silurian forms an immense band extending from the falls of St Anthony on the Upper Mississippi to the northeastern corner of the State of Alabama, crossing the States of Minnesota, Iowa, Wisconsin, Michigan, the province of Upper Canada, and lastly the States of New York, New Jersey, Pennsylvania, Virginia, North and South Carolina, Georgia and Alabama. This Silurian band forms consequently a part of the coasts of Lakes Michigan and Huron, includes the whole of Lake Ontario, and constitutes several of the long parallel chains of the Alleghany mountains.

The environs of Cincinnati, Ohio; Madison, Indiana; and Frankfort,Kentucky; present a fine development of the Silurian, entirely distinct from the band above mentioned. It is the same with the Silurian of the vicinity of Nashville, these rocks occupying the middle part of the State of Tennessee. The Silurian is found on the Lower Missouri from the environs of St Louis to Jefferson and Franklin, and forms part of the mountains situated in the south-eastern part of the State of Missouri. Finally, Roemer has met with Silurian strata in Texas, where they form two narrow bands near the Rio San Saba and the Rio Llano. I found no trace of the Silurian in the Rocky mountains or the Pacific region, and I doubt if it exists there.

Devonian formation. — Although the Devonian formation holds an important place among the American rocks, it has not so great a stratigraphical and geographical development as the Silurian. It attains its maximum of importance in the States of New York and Pennsylvania, where, as in Europe, it is divided into two principal groups. The Lower group is chiefly formed by strata of limestone and clay, and the Upper by beds of red sandstone. A part of the strata at Schoharie near Albany, and the whole of the Helderberg mountains belong to the Lower group, while the Upper group forms the Catskill mountains. In the other parts of North America where the Devonian is found, it consists of a group of limestone strata containing numerous fossils, and the falls of the Ohio near Louisville, and the island of Mackinaw in Lake Huron, may be taken as types of this formation. The fossils characterizing the Devonian are: species belonging to the genus *Calymene*, *Terebratula*, *Spirifer*, *Chonetes*, *Zaphrentis*, *Emmonsia*, and *Syringopora.*

On looking at the Geological Map — *see frontispiece* — we shall see that the Devonian recognized near Gaspé, Lower Canada, occupies a part of that peninsula and enters the north-western part of New Brunswick. Beginning in the south-eastern part of Tennessee it follows up the whole line of Alleghany mountains, covers entirely the southern part of the State of New York, and embraces the whole of Lake Erie and Lake St Clair, and a part of the shores of Lake Huron and Lake Michigan. It descends from Lake Erie to the Ohio valley and surrounds the Silurian of Cincinnati and Frankfort, then reaches the northern part of Illinois, crosses the Mississippi near Davenport, and runs up the valley of the Red Cedar river in the State of Iowa, where it ceases. Some detached portions are found in the State of Missouri, and in the environs of Nashville and in Perry county, Tennessee. This formation has not been verified further west than the Red Cedar valley of Iowa; during my explorations in New Mexico and the Rocky mountains I found none of the strata, but among the spurs of the Sierra de Mogoyon or Sierra Blanca, I met with beds of red sandstone lying under the Mountain Limestone; these might belong to the Devonian period, but it is doubtful as I was unable to discover any fossils.

Lower Carboniferous or Mountain Limestone. — The Lower Carboniferous has everywhere the same characters, whether in Europe, Asia, the two Americas or Australia, and offers the most beautiful geognostical horizon to be met with in North America. Its strata always consist of hard grayish limestone, well stratified and containing numerous marine fossils. It extends almost without interruption from Cape Breton to Vancouver island, with a lithological character almost identical, at least with very slight variation, and containing the same fossils, the most characteristic of which are the following: *Terebratula plano-sulcata*, *Ter. subtilita*; *Spirifer striatus*, *Sp. lineatus*; *Orthis crenistria*; *Productus semi-reticulatus*, *Pr. Cora*, *Pr. Flemingii*, *Pr. pyxidiformis*, *Pr. punctatus*, *Pr. costatus*, *Pr. pustu-*

losus, *Pr. scabriculus*; *Pentremites florealis*; *Favosites parasitica*; *Amplexus coralloides*; *Zaphrentis cylindrica*, *Z. Stansburyi*, and *Retepora Archimedes*.

The Lower Carboniferous forms the contour of the Coal Measures in Cape Breton island and the provinces of Nova Scotia and New Brunswick, and if it is not indicated on the map, it is owing to the smallness of the scale. The Lower Carboniferous forms the highest ranges of the Alleghanies and extends round the immense coal basin of Pennsylvania, Virginia, Maryland, Ohio, Kentucky, Tennessee and Alabama; it extends into the north-eastern corner of the State of Mississippi and covers the greater part of the States of Indiana, Illinois, and Michigan. It forms the bed and both the shores of the Mississippi river, from Burlington at the rapids of the Mississippi to the neighbourhood of Cairo at the mouth of the Ohio, it then descends the river des Moines, reaches the Prairies of Missouri, of which it forms a part, passes by Council-Bluffs, Fort Leavenworth, Council-Grove, Delaware mount, Clear Fork of the Rio Brazos, and ends finally at the Rio San Saba, Texas. I found this formation in Washington county, Arkansas. Captain Stansbury was the first to find it in the Rocky mountains; he met with it at Fort Laramie, on the western shore of the Great Salt Lake, and on an island in the lake.

During my exploratiou of the part of the Rocky mountains near the 35th parallel of latitude in 1853 and 1854, I found that the Mountain Limestone formed the lesser chains, and even some of the principal peaks of these mountains and of the Sierra Madre. It appears in narrow bands from two to four miles wide (See: *Geol. Map of New Mexico*, plate VIII.), beginning in the neighbourhood of El Paso on the Rio Grande del Norte, and crossing Manzana, Tigeras, Antonito, San Pedro, Pecos, Spanish peak, Pikes peak, the environs of Fort St Vrain and Laramie peak. It is also found in the Sierra of Jemez, opposite to Santa Fe, in Agua Fria, and near Fort Défiance in the Sierra Madre. Farther west I found the Mountain Limestone in the lines of dislocation of the Sierra de Mogoyon or Sierra Blanca; it disappears about fifty miles east of the Rio Colorado at the 35th parallel of latitude; taking a northern direction it crosses the Mormon settlements of Fillmore, on Lake Utah and the Great Salt Lake. My friend Lieutenant Whipple discovered it near the new boundary line between Mexico and the United States at the junction of the San Pedro and Gila rivers, and according to the celebrated and unhappy Count de Raousset Boulbon it forms the lesser chain of the Sierra de Arizona in the state of Sonora.

Finally, this formation is found in Shasta and Siskiyou counties, in the north of California, and in the islands of Puget Sound in Washington Territory, and Captain W. C. Grant has recognized it in the centre of Vancouver island.

Upper Carboniferous or Coal Measures. -- Compared with the whole Earth, at least with the part geologically known, North America possesses more than a quarter of the whole superficial extent of all coal fields. The rocks of the Upper Carboniferous are the same as in Europe, sandstone, black marly slate, and limestone with intercalation of coal beds. The number as well as the richness of the coal seams varies much in different localities. In South-Joggins in the bay of Fundy, Nova Scotia, there are seventy six coal seams, while in most other places there are but from five to eight seams, and in the Albion mine near Pictou, Nova Scotia, there is one seam thirty feet thick, while elsewhere the coal seams are scarcely more than three or four feet thick. The coal is generally bituminous, except in the States of Massachusetts and Rhode Island, where granitic and

porphyric eruptions have metamorphosed it into anthracite, and sometimes even into plumbago. In the State of Pennsylvania there is also a large tract of anthracite, in the neighbourhood of the eruptive and metamorphic rocks of the Blue Ridge of the Alleghany mountains.

The thickness of the coal measures varies in different places; in Nova Scotia they are ten thousand feet thick, while in Iowa, Missouri, and Arkansas, they have only from two to three thousand feet of thickness. The fossil plants found in this formation are often of the same species as those found in the coal measures of Europe; the most characteristic ones are: *Lepidodendron elegans*; *Sigillaria Sillimanni*; *Neuropteris cordata*, *Neur. Losbii*; *Pecopteris lonchitica* and *Calamites cistii.*

The coal basin of the gulf of S^{t} Lawrence includes the shores of S^{t} George's bay, Newfoundland; nearly half the island of Cape Breton, and the whole coast from the straits of Canseau to Bathurst in the bay of Chaleurs. In the western part of Pennsylvania we find the immense coal basin of the Alleghanies, which extends through eight States of the American Union, from Blossburg, Pennsylvania; to Tuscaloosa, Alabama.

On looking at the geological map — *see frontispiece* — it will be seen that the large bituminous coal basin of the Alleghanies formerly joined those of Michigan, Illinois, Kentucky, Iowa, Missouri, Arkansas and Texas; and that all these different basins formed originally but one, which may be called the *great coal field of the Mississippi valley.*

The separation and division into several coal beds was effected by immense denudations that have carried away a part of the strata, and hollowed out the grand ravines in which are now flowing the Ohio, Illinois, Mississippi, des Moines, Missouri, Arkansas, Tennessee, Wabash and other rivers. These denudations took place at the moment of the dislocation of the Alleghanies, and have continued ever since until now.

The peninsula of Michigan contains the most distant of these basins, it is also the smallest. The State of Illinois is entirely formed of a large coal basin that extends beyond the limits of the State and occupies a part of the States of Indiana and Kentucky. This basin, usually called the *Illinois coal field*, is separated from the Iowa and Mississippi basin only by the valley of the Mississippi.

There is, finally, west of the Mississippi another immense coal basin extending without interruption from a point above Fort des Moines, in Iowa, to Fort Belknap and the Rio Colorado in Texas.

In the Rocky mountains this formation is seldom seen and the strata are of inconsiderable thickness. I found beds of bituminous coal between San Antonio and Manzana in New Mexico, and in the Sierra de Mogoyon near the headwaters of the Rio Colorado Chiquito; and Captain Stansbury discovered coal belonging to the Carboniferous epoch, near Independence Rock on the road leading from Fort Laramie to Fort Bridgers. The Mormons have also found it near their settlements Cedar and Parowan.

The coal measures have been found between California and Oregon on the Pacific coast, near the Umpqua river, and also at Soke harbour in Vancouver island.

New Red Sandstone formation. — The *New Red Sandstone* had been found only at some points on the Atlantic shore, from Prince Edward's island to North Carolina.

In the summer of 1848 I found it at Lake Superior, of which it forms the entire south shore,

and I agree entirely with my friend Dr. Charles T. Jackson upon the age of the Red Sandstone of Lake Superior. Afterwards, in 1853 and 1854, I found the *New Red* covering an immense extent of the Central region of the United States, in the Prairies and the Rocky mountains. The rocks composing this formation are especially red sandstone; red, green, yellow, and white sandy clay; amorphic and cristallized gypsum; dolomite or Magnesian limestone; and saliferous clay. In short, the rocks in the New World are the same with those composing the Trias and Permian of Germany and France, and often, in crossing the Prairies, the illusion was so strong, that I thought myself transported to the valley of the Neckar near Tubingen, or to the valleys of Argovie and the Canton of Basel.

In the gulf of S^t Lawrence the New Red Sandstone occupies a part of the northern coast of the bay of Chaleurs, the whole of Prince Edward's island, and the Magdalen islands. It extends along the coast of the bay of Fundy and Minas Basin, and continues as far as below the town of Lubec in the State of Maine. The celebrated red sandstone of the Connecticut valley, containing footprints, raindrops, and fish, belongs to the New Red Sandstone, as well as the Red Sandstone found in narrow well defined basins scattered through the States of New Jersey, Maryland, Virginia, and North Carolina. — In the environs of Richmond, Virginia, and in North Carolina, the upper part of this formation (Keuper) contains a strata of bituminous coal, forty five feet thick; this is the largest coal seam known.

In the West the New Red Sandstone formation begins near the Sault S^t Marie at the entrance to Lake Superior, surrounds this lake, passes by the headwaters of the Mississippi and the northern Red River, forms the *plateau du Coteau du Missouri*, extends into the western Prairies, and finally forms the basis of the high plains surrounding the Rocky mountains. It is found in the valley of the Rio Pecos, of the Rio del Norte in New Mexico, near Zuni, and in the country of the Navajo and Moqui Indians, on the Rio Colorado Chiquito and on the Rio Colorado Grande of California. I did not find it farther west than the 114° of longitude west from Greenwich. The red color of the rocks of this formation gives to the whole Central region a reddish appearance, and the rivers flowing through this Territory bear the names: Rio Colorado, Red River, Rivière Rouge, Rivière Vermillion, Rio Puerco, etc.

Jurassic formation. — The existence of this formation in North America was long doubted. In 1843 the brothers Rogers thought the Secondary coal field of the environs of Richmond, in Virginia, belonged to the age of the Lias or Oolite; but without very valid reasons; in 1854 I assigned this coal field to the New Red Sandstone, which is its true position in the Geological Series. In 1853 I found in the Rocky Mountain region, rocks belonging to the Jurassic epoch; this discovery is supported and demonstrated in *Chapter I*, page 17, 18, and 19 of the present volume; but previously, in the year 1847, the naturalist Ilia Wosnessensky brought from Russian America fossils, that were recognized by Dr. C. Grewingk as belonging to the Jurassic epoch.

The rocks of the American Jurassic consist chiefly of white and yellow sandstone, blue marl, and thin strata of oolitic or compact limestone of a white color. Fossils are rare and almost confined to the blue marl, where a variety of *Gryphæa dilatata*, which I have called var. *Tucumcarii*, and the *Ostrea Marshii* are very abundant.

The geographical distribution of this formation is limited to the Central region of the United

States and the shores of the northern Pacific Ocean. It forms the upper part of the high plains or table lands surrounding the Rocky mountains, and also of the famous Llano Estacado, the Tucumcari mountains, and los Esteros. Several extensive plateaux between Forts Bent, St Vrain, and Laramie, are partly formed by the Jurassic strata. It is also found, near the village of Covero, near the Pueblo d'Acoma, on the western slope of the Sierra Madre, and near Fort Défiance.

Since Grewingk's discovery of the Jurassic rocks at Katmaiskoï, this formation has been pointed out in the vicinity of Sithka by Doroschin; on Vancouver's island by Dr. Newberry; and finally in California by Dr. Trask.

Cretaceous formation. — This formation is, provisionally, divided in America into three groups; the first corresponding to the *Neocomian*, the second to the *Green Sand* and *Marly Chalk*, and the third to the *White Chalk* of Europe. The principal rocks composing it are: white yellowish limestone, green sandy clay, and white sandstone. Numerous fossils are found in each of the groups, the most characteristic are the following: *Gryphœa Pitcheri*, *Gr. sinuata* var. *Americana*; *Exogyra flabellata*; *Ostrea carinata*; *Caprotina Texana*; *Toxaster Texanus*; *Holaster Comanchesi*; *Pecten quinquecostatus*; *Ammonites peruvianus*, *Am. Piedernalis*, *Am. Shumardi*, *Am. nebrascensis*; *Hamites Fremonti*; *Inoceramus Lerouxi*; *Terebratula Harlani*; *Belemnites mucronatus*; *Ptychodus Whipplei*, etc.

Vannuxem first discovered the Cretaceous strata in New Jersey; they extend into Delaware, Virginia, both Carolinas, Georgia, Alabama, Mississippi, and Tennesse. This formation, bordering thus the Alleghany mountains on east and south, occupies a limited space at their foot, and is often covered by rocks deposited during the succeeding geological period. The *alluvium* of the Mississippi river does not allow the Cretaceous to appear in the valley of the river itself, but it is found again on the western side, in the southern part of the State of Arkansas, extending into Texas, where it forms a broad band reaching from Fort Washita and Preston to Laredo on the Rio Grande del Norte. The Cretaceous formation ascends the valley of the Rio Pecos, as far as Horsehead Crossing, also the Rio Colorado of Texas, nearly to its headwaters at the southern foot of the Llano Estacado, and it is found at the Elm Fork of Trinity river.

North of Fort Washita, the Cretaceous is found only in isolated patches, the connection between them having been destroyed by denudation. These isolated patches are found on both banks of the False Washita, on the Canadian river, at Little river, on the river Verdegris, the Arkansas near Fort Bent, the banks of the Republican Fork, the Blue river, and at Council Bluffs. Then they occur again along the right bank of the Missouri river, at Sage creek in the Bad Lands of Nebraska, and finally near Fort Union, Muscle Shell creek, and near the sources of the Missouri.

The junction of Muscle Shell creek with the Missouri river is the most northern point at which the Cretaceous formation has been found as yet in America.

In going up the valley of the Rio Grande del Norte, from Laredo to Santa Fe, the Cretaceous formation is found almost everywhere; it also forms the valley of the Rio Puercos near Albuquerque. It does not occur in the western slope of the Sierra Madre, and has not yet been noticed in the Pacific region[1]).

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[1]) I have learned since writing the above that Dr. J. Schiel, geologist of Capt. Gunnison's expedition, has found near Grand river, latitude 39°, longitude 109°, fossils that he thinks belong to the Cre-

two small detached basins, just at the foot of the Rocky mountains, near Fort St Vrain, on the southern fork of the Platte river.

In the Pacific region the Tertiary rocks occupy a large superficial extent of country; they form the sea coast from Puget Sound to the vicinity of Cape Mendocino, and include the whole of the beautiful valley of the Willammette river, in Oregon. Farther south, after crossing the Shasty mountains, the Tertiary formation is found in the rich and magnificent valley of the rivers Sacramento and San Joachin, where it extends as far as Contra Costa, opposite to San Francisco, and forms the celebrated Monte Diablo, which belongs entirely to it. The greater part of the Coast Range, from Monterey to Santa Barbara, is also formed by it; it continues, passing by San Pedro and San Diego, and enters Lower California, where it forms the Cape of San Bartholomeo. On the eastern slope of the Sierra Nevada proper — Cajon Pass — a white and red, very massive puddingstone is found, which belongs to the Miocene epoch. Finally, the Tertiary formation is found at the mouth of the Rio Colorado; it ascends the valley of this river, and occurs at several points on the Bill William Fork, and also near Lake Preuss in the Mormon country.

Quarternary formation. — The Quarternary or *Diluvial* formation covers almost the whole superficial extent of the Eastern and Western regions, but in the Central or Rocky mountain region this formation is but little developed, and lies scattered at the bottom of the valleys. This geographical distribution renders it impossible to color this formation on the map; a map devoted to the Quarternary strata alone would be necessary, in order to give a true and exact idea of it. On the whole line of the coast extending from the mouth of the Hudson river, New York, to the mouth of the Rio Grande del Norte, in the gulf of Mexico, *ancient sea margins* are seen, one hundred and fifty feet above the actual level of the sea, and containing in beds of sand and clay, shells in the fossil state, identical with those now living in those waters. Likewise, in ascending the rivers, as for instance the Mississippi, Arkansas, Missouri, Ohio, the Rio Grande del Norte, the Rio Pecos, the St Lawrence, etc., we find in banks from fifty to one hundred and fifty feet above their actual level, sand beds containing: *Unio*, *Anodon*, *Helix*, *Planorbis*, *Pupa*, etc., all belonging to the same species as those now living in the beds of these rivers. Numerous bones of mammalia are also found in this clay and sand of the Diluvial period, as: *Bison antiquus*, *Equus Americanus*, *Tapirus Americanus*, *Elephas Americanus*, *Mastodon giganteus*, *Megatherium mirabile*, *Megalonix Jeffersonii*, and *Mylodon Harlani.*

In the country north of the 41° of latitude, marked on the map by a line (See: *Frontispiece*; *Limite méridionale du Terrain erratique du Nord.*), the Diluvial formation of sand and clay covers *drift*, boulders, and polished and striated rocks also belonging to the same formation. This formation, called by Agassiz the *Ice Period*, on account of the agency of the ice in removing the materials that compose it, is widely developed; it covers the whole country, and is sometimes from four to eight hundred feet thick.

In California and Oregon the *drift* is very much developed; it covers all the rocks of the valleys of the Coast Range and the Sierra Nevada, and contains the rich golden deposits of the American Eldorado. We find too, at nearly all points on the Pacific Coast, *ancient sea margins*, sixty and one hundred feet above the actual level of the sea.

The second group of the Eruptive rocks consists of trap and greenstone, that have made their appearance during the New Red Sandstone epoch; they have spread over this formation, filling up the *faults*, and sometimes capping the strata, without causing much disturbance in the stratification. The trap contains numerous veins of pure copper mingled with pure silver, as well as copper, zinc, lead, and other ores. The famous copper mines of Lake Superior are among this trap. It is found on the Magdalen islands, on the northern coast of the bay des Chaleurs, on both shores of the bay of Fundy, in the valley of the Connecticut river, and in the New Red Sandstone basins of New Jersey. The *palisades* of the Hudson river, near New York, are formed of this trap, which here has the appearance of basalt. At Lake Superior it is found on the islands of Michipicoton, S^{t} Ignace, du Paté and Royale, at Thunder Cape, near Fort William, and near Kakabekka falls; it forms the greater part of Keevenaw point, and the Ontonagon mountains, and occurs again on the river S^{t} Croix, and near the rapids of the Upper Mississippi. The Black mountains, west of Fort Laramie, and the vicinity of Fort Webster or Copperınine in New Mexico, are also of this formation.

Finally, the third group of Eruptive rocks includes all the varieties of rocks produced by active or extinct volcanoes. No volcanoes exist in the Eastern or Atlantic region, but they are found in the Central and also in the Pacific region. They run from east to west, beginning with Raton mountain near the sources of the Canadian river, then the Cerrito between Santa Fe and Algodones; Mount Taylor, between Albuquerque and Fort Défiance, is an enormous extinct volcano, whose lava streams extend in all directions round the principal cone, for a distance of thirty miles. West of the Pueblo de Zuni are two large volcanoes, one of which attains gigantic proportions, its highest summit being more than thirteen thousand feet above the level of the sea. Five or six volcanic cones are grouped together in Soda lake, where the Mohavee river empties; and north-east of the Great Salt Lake, near Fort Hall, there are two large volcanoes called *Three Butes* and *Three Tetons*. There is still another series of volcanoes running from north to south, following the line of the Sierra Nevada. One of these volcanoes is in Lower California, opposite the town of Guaymas, another in the Sacramento valley, where it forms isolated mountains, called *Butes*. Farther north is Shasty Peak, then come Mounts Hood; S^{t} Helen, Rainier, and Baker, in the Cascade Range. The three last are still in activity, and Mount Baker especially sends forth frequently large lava streams.

SALINS (Jura), July 1855.

CHAPTER VI.

SKETCH OF A GEOLOGICAL CLASSIFICATION OF THE MOUNTAINS OF A PART OF NORTH AMERICA.

(Extract from the *Annales des Mines*, 5ième série, tome VII, page 329 etc.; Paris, 1855.)

An attempt to classify geologically, that is, according to their chronological order, the different chains of mountains in the United States and the British Provinces, is an undertaking which in reality can be only *preliminary*, if we consider the small number of observations which have been made, and the vast extent of country embraced in this portion of North America.

In Western Europe M. Elie de Beaumont has recognized and classified twenty one systems of chains of mountains, and, in addition, he has extended many of these systems to other parts of the World. Two of these extensions coincide perfectly with two systems of mountains in the part of North America included in this sketch. One designated as the *System of the Ballons des Vosges and the Hills of the Bocage*, and which has dislocated the beds of the Carboniferous rocks in Brittany, Westmoreland, the Vosges, and the Hartz mountains, coincides exactly with the *Alleghany and Ozark Mountains system*, which has upheaved in the United States the Carboniferous strata of the States of Pennsylvania, Maryland, Virginia, Kentucky, Tennessee, Arkansas, etc. The other; known under the name of the *System of the Thüringerwald and of the Morvan*, extended to North America, is found to coincide entirely with the *Keewenaw Point and Cape Blomidon system.*

By following the method introduced and explained with so much talent by Elie de Beaumont in his late and remarkable work, entitled: «*Notice sur les Systèmes de Montagnes*», and by the aid of some excellent observations made by Dr. Charles T. Jackson and Edward Hitchcock upon the directions of the ruptured rocks of New England, Nova Scotia, and Lake Superior, I am led to recognize thirteen chains of mountains in a part of North America. After deducting from this number the two systems that Elie de Beaumont has recognized previously by the extension of two of his systems of Western Europe, there remain eleven systems of mountains, which I add to those known in this department of Geology.

Nevertheless, I repeat, that this classification is only *preliminary*, and I present it with all reserve, considering the small number, the difficulty, and the insuffiency of the observations.

N. B. — Very little is known as to the relative age of the chains of mountains of the globe, and the methods pursued for this object are still very uncertain. Elie de Beaumont is, certainly, the geologist who has contributed the most to advance this part of the science; and in his: *Notice sur les Systèmes des Montagnes*, three volumes, 12mo; Paris; 1852, he has published his principles. Without being equally sanguine with M. de Beaumont as to the generality of his theory of the

parallelism of mountain chains of contemporaneous elevation, not only for countries out of Europe, but for the whole of Europe itself (See: An Analysis of Elie de Beaumont's work, in the *Anniversary Address of the President* of the Geological Society of London, by W. Hopkins Esq., p. XXVIII and following, of the *Quart. Journ. of the Geol. Soc.*, vol. IX; London, 1853.), we recognize, nevertheless, that such a parallelism of small contemporary chains exists in all circumscribed countries (See: *A Synopsis of the Classification of the British Paleozoic rocks*, in 4°; London, 1855; where the Rev. Adam Sedgwick says, pages XXXIX and XL: « I freely made use of M. Elie de Beaumont's theory of parallelism, «and turned it to good account: and whatever may now be thought of the great and controverted «extension which he has given to it, I can only express myself towards him, in terms of grati- «tude for the *great help*, which his work, on the theory of parallelism, has lent to me. I conclude «with this practical remark. While we contend against what we may suppose to be the unphilo- «sophical extension of a theory, let us not fall into an opposite error, and reject it altogether, «even when it helps us to compare and marshal facts together. The *parallelism of contemporaneous «elevations* is not a universal truth derived from any known *law of nature*. But, taken with proper «caution and proper limitations, it is, I believe, *a fact of geology* which admits of a very extensive «practical application, and greatly assists us in grouping together our unconnected phenomena. I «believe also that it is often suggestive of the right points towards which new observations ought «to be directed; and, on that account, an efficient help towards new generalisations and discov- «eries. What has been the cause of this parallelism — in the cases where it does occur —, is a «question of physics rather than of geology». Also: *Manual of Geology*, Crown 8°; London, 1855; where John Phillips, the celebrated nephew of William Smith, the *father of English geology*, says, page 575: «It is not too much to assert, that in the present state of geology, the facts known «are not clear and numerous enough to support this hypothesis — Elie de Beaumont's theory —; and «on the other hand, there are not facts to warrant the unconditional rejection of it. It must be «looked upon as a *first attempt in a new field*, as a *generalisation carried to extreme*; but it is certainly «*founded on important data*, and in several instances *agrees well with observations*».); and further, that this parallelism with the contemporaneity extends sometimes even to America; but, in this case, it is the exception, and not the rule. We think the question is *far from having been resolved*; and, above all, we cannot admit, without large reservation, so general a law, for so immense and complex a phenomenon. However this may be, we will try to class the dislocations that have affected the American strata included in our *Geological Map* (See: *Frontispiece.*), by means of the parallelism of arcs of a circle.

1. *Lawrentine system.* — The granitic, sienitic, and gneiss rocks, which make the foundation of the Lawrentine mountains, are affected with numerous dislocations that have uplifted them in different ways. These dislocations are not all of the same epoch; nevertheless, there is one main direction which prevails much over the other directions, and is almost from east to west, with an average deviation of 5°, which gives for the direction E. 5° N. and W. 5° S.

These systems of dislocations are the most ancient I have examined. I regard them as anterior to the deposition of the first beds of Lower Silurian, that is to say previous to the formation of the *Potsdam Sandstone* containing the primordial fauna of Joachim Barrande.

Being the most ancient, it follows naturally that these primitive dislocations, which form in truth the mass of the Lawrentine mountains, have been subjected to much alteration by the crossing of the

tion would be precisely from East to West. I think traces of the *Montreal system* will be found in other regions, and particularly in Upper Canada and the States of New York and Maine.

4. *Notre Dame mountains system.* — If the preceding system has but slightly raised and disturbed the strata, it is not so with the present one, which I call the *system of the Notre Dame mountains*, and which dates from the end of the deposition of the Middle Silurian. It will be remembered that the rocks forming the upper part of the Middle Silurian are numerous strata of black schist, distinguished in the State of New York by the name of *Utica and Hudson river group.* These strata, which form almost entirely the banks of the river Richelieu, of the S^t Lawrence below Montreal, and on which is situated the city of Quebec, have been upheaved along the whole of this line, to Cape Rozière at the extremity of Gaspé. The Notre Dame mountains, formed of eruptive and metamorphic rocks, some of whose summits attain three thousand five hundred feet, owe their origin entirely to this movement, whose general direction appears to be E. 20° N., and W. 20° S. On looking at the map (See: *Frontispiece.*), it will be seen that the group of igneous rocks forming the Notre Dame mountains is isolated, and entirely detached from the neighboring groups. A line of hills, of sedimentary rocks, of very slight elevation, extends between Madawaska and the river du Loup, and joins these mountains to those which are near Point Lévi. Many of the orographical accidents of the chains which extend from Point Lévi to Lake Champlain owe their origin, I think, to this system of dislocation; but the directions are uncertain, owing to the intercrossing with the system of dislocation which followed this, and formed the Green Mountains of Vermont. Nevertheless, considering only the Notre Dame mountains, where the phenomena of dislocation are very decided, a well-marked and independent direction is easily recognized.

5. *Green Mountains, or the Meridional system.* — For a long time Edward Hitchcock has indicated this system, which he distinguishes by the name of « Oldest Meridional and Hoosac mountain system ». Very much developed in the western part of Massachussetts, it forms entirely the Green mountains of Vermont, and extends into Lower Canada as far as the river Chaudière. Its general direction approaches the meridian, with a slight deviation to the east, which gives for the average N. 7° E., and S. 7° W. The dislocations which gave rise to this line of mountains took place much before the formation of the Alleghanies, yet, after the deposit of the Upper Silurian, as the metamorphic fossiliferous rocks, that Jackson and Logan have found in the Memphremagog and S^t Francis Lakes, prove. Thus I regard them as having appeared at the end of the Silurian period, and before the deposit of the Devonian beds. The igneous rocks, which then made an irruption through the surface of the Earth's crust, upheaved very strongly all the sedimentary strata previously deposited; and, more, they have often overturned, folded and waved them, by submitting them simultaneously to a powerful metamorphic action, which was felt at a great distance from the eruptive centres. The *Green Mountains system* extends, as I have said, from the river Chaudière, Lower Canada, into Vermont, which it forms almost entirely; it comprehends Berkshire, and the line of hills that extends between the Connecticut river and Worcester, Massachussetts; Litchfield and Fairfield, Connecticut; and terminates in the environs of Bridgeport on Long Island Sound. The boundary line between the States of New York and Connecticut presents crossings of this system with that of the Alleghanies, which much later has struck against the dislocations of the Meridional system, and even penetrated them in some places. The *Geological Map of the State of New York*, published by Legislative Authority, presents most clearly the points of contact of the two systems. Thus the valley of the Hudson, from Saratoga to West Point, is due to the *Green Mountains system*, and is parallel with its direction. The Green Mountains present, at several points of Vermont, and especially at the river Chaudière, Canada, quartzose veins traversing itacolumites, and containing native gold, in considerable quantities.

The White Mountains probably owe a part of their elevation to this system. But the insuffiency of geological observations obliges me not to risk any supposition as to the age, or ages, of the chains of this group.

I consider as belonging to the *Green Mountains system* the elevation in Nova Scotia, between Merigomish, Arisaig, and Cape S^t George.

ings of the Association of American Geologists. Boston. 1843.); a *wave theory* to explain the folding and orography of the Alleghanies, and further he has tried to extend that explanation to the Alps, the Jura, or to any other Chain of Mountains (See: *On the Laws of Structure of the more Disturbed Zones of the Earth's Crust*, page 431 etc., in the *Transactions of the Royal Society of Edinburgh*, vol. XXI, part III. Edinburgh, 1856.). From what I have observed in crossing the Alleghanies, I am far from admitting the theory of Rogers not only as to the details, but even in its main features; and geologists must wait until there is a good topographical map of the Alleghanies, before they can have just and exact ideas as to that beautiful chain of mountains. I must add that hypothetic and doubtful as the discovery of Rogers is, it has been claimed with some justice as the discovery of J. D. Whelpley and A. A. Henderson, formerly assistants in the Geological Survey of Pennsylvania; see: *Manual of Coal and its Topography*, by J. P. Lesley, page 123 etc.; Philadelphia, 1856. Lesley, in that interesting work, says: «That the «European Jura, although the home of geology for at least a century, had to *wait for its elucidation* «until the American Appalachians had been mapped, may seem strange, but it admits of easy expla- «nation». And also: «The region of the European Jura resembles it in general structure, and exhibits «the ancient action of similar forces under the same laws, but in less detail, and with far less delicacy. «The author was fortunate in being the *first* geologist who had an opportunity to approach the dynamic «phenomena of the Jura with an American eye trained on this typical ground. This was in 1844; Mr. «Rogers did the same in 1849». I am sorry not to agree with Lesley as to his being the *first* to explain the dynamic phenomena of the Jura, and if the one chain of mountains was to be elucidated by the other, it is the Alleghany that must be explained by the Jura. Jules Thurmann published his excellent and beautiful theory of the dynamic phenomena of the Jura in 1832, under the title of: *Essai sur les Soulèvements Jurassiques du Porrentruy* (Jura Bernois), Paris; and Lesley, Rogers, Whelpley, and Henderson were *probably* acquainted with that work when they began their Geological Survey of Pennvania in 1836 (*First Annual Report of the State Geologist*; Harrisburg, Pennsylvania.). Thurmann was prudent enough to limit his theory to the Jura mountains; and in his posthumous work, now in the course of publication at Geneva: *Essai d'Orographie Jurassique*, in 4°, 1857; he gives more true knowledge and facts concerning the dynamic and orographic phenomena of the Jura, than have ever been given upon any chain of mountains.

Many parts of the Alleghanies, especially in Virginia, North Carolina, and Georgia, contain auriferous quartz and itacolumites, which yield a profit to the miner, and have not been abandoned even since the discovery of the *Placeres* of California and Australia.

The group known under the name of the Ozark mountains belongs to this system of dislocation of the Alleghanies; it was formed about the end of the deposit of the Coal series, which it elevated and dislocated in the same direction, North-East and South-West. Only there is an essential geological distinction to establish upon what is called the Ozark mountains. Geographers, and especially Major Long (See: *Account of an Expedition from Pittsburgh to the Rocky Mountains, performed in the years* 1819 *and* 1820, two vol., 8°, with an atlas; Philadelphia, 1823.), who first made a scientific exploration in those regions, have comprised under the term Ozark, all the mountains found between the Mississippi, Kansas, the Prairies, and the Red river. But we have seen above, that I refer to the *Laurentine system* several masses of granitic mountains which are comprised in the limits indicated, and which run E. 5° N., and W. 5° S. The Carboniferous rocks repose horizontally at the foot of those granitic masses which they surround, and consequently the dislocations which they have undergone in these regions are much later than the appearance of these islets of eruptive rocks. Besides, the directions of the ruptures and upheaval of the Coal measures are altogether different, and coincide with those of the *Alleghany system.*

The chains of mountains forming the Ozark system, properly speaking, exclusive of the granitic masses of Fort Washita, Little Rock, and Potosi, are composed of parallel lines running from North-East to South-West, with a slight deviation towards the north, and having a breadth varying from 100 to

to 400 miles. These chains proceed from the sources of the Little Sioux, in the north-west of the State of Iowa; they traverse the Missouri and the Platte a little above the junction of these two rivers, and form the limit between the Prairies and the wooded country. In Arkansas we see them most developed in the County of Washington, near the towns of Ozark, Van Buren, and Shawnee; Mount Delaware, near Fort Arbuckle, is likewise a portion of those mountains. Finally, this system which is traversed by the Red river near Preston, proceeds into the northern part of Texas, where it forms the line of hills upon the Brazos, Trinity and Colorado rivers.

The group of Ozark mountains is not pierced in any part by eruptive rocks. It should be considered as a *second fold of the Alleghanies*, which is *parallel* to the first and at a distance of twelve hundred miles. The elevation of these mountains is nowhere very considerable, it varies from 200 to 1000 feet above the level of the surrounding plains.

8. *Keewenaw Point and Cape Blomidon system.* — The Triassic rocks, or more correctly the *New Red Sandstone* formation, in point of geographical extension in the United States, act a most important part, for they alone cover a third of that immense country, and added to the Carboniferous rocks, they form two thirds, leaving only a third of the surface of this portion of the continent to the eruptive rocks, and to the other periods of the sedimentary series. The strata of the Trias have been subjected to two special dislocations, one towards the middle of the deposit, and the other at the end. The last is far the most important; although the first has made itself perceptible at very wide distances, and with an intensity which, though inconsiderable, has produced very important ranges of hills, especially at Lake Superior and the Bay of Fundy.

After having made many observations upon the direction presented by the first dislocation, I arrived at an average direction of E. 35° N. to W. 35° S. In many localities, and more especially in the valleys of the Connecticut and New Jersey, we meet with numerous dykes of trap belonging to this system, whose direction is more to the north, sometimes being confounded with the direction of the *System of the Alleghanies*, or even with that of the *Green Mountains*; evidently in consequence of crossings which have changed the primitive direction of these dykes. In order to obtain the normal direction of this system it is necessary to study it at Point Keewenaw, Isle Royale, Thunder Cape, on Lake Superior, or upon the two parallel coasts of the Bay of Fundy, at the Capes Split and Blomidon, also at the Islands of Magdalen, in the Gulf of S^t Lawrence. These dislocations of the strata of lower New Red Sandstone envelope enormous dykes of basaltic trap, which have burst through, and are spread over, capping the sedimentary strata. We find in this trap some veins of native copper traversing the dykes perpendicularly. Besides, we frequently find there all the ores of copper, native silver, and many zeolitic minerals.

The knowledge of this important *system of Point Keewenaw and Cape Blomidon* is entirely due to my friend Dr. Charles T. Jackson, a celebrated geologist of Boston, known especially in the scientific world for his discovery of anæsthesia by ether. Several American geologists have in vain attempted to refer this system of dislocation to the more ancient systems, going so far even as to connect it with the *System of the Laurentine mountains*. After having investigated the question with the greatest care, and in many places, I am entirely of the opinion of Dr. Jackson.

Guided by the observations of Sir R. H. Bonnycastle and Logan, I refer to this system several dykes of basaltic trap and strata of Red Sandstone, found at Cape S^t George, Newfoundland; in the Bay des Chaleurs, between the river Ristigouche, Richmond and Port Daniel. Besides, from the information which I have received respecting a portion of the mountains surrounding Fort Webster, in the Sierra Madre of New-Mexico, I think the dykes of copper-bearing trap which have been worked there, at a place called Santa Rita del Cobre, belong to the *System of Point Keewenaw and Cape Blomidon.* I refer also to it the trap dykes of the vicinity of Galisteo and Fort Défiance (see: *Geological Map of New Mexico*, Plate VIII).

9. *Sierra de Mogoyon system.* — In one of the most central and unexplored parts of North America, we find a system of mountain chains called by trappers and hunters, Sierra de Mogoyon or Sierra

Blanca, which extends between the Sierra Madre, the Rio Colorado Chiquito, the Bill William Fork, the Great Rio Colorado of California, and the Rio Gila; or in other words, between 35° and 33° of latitude, and 108° and 114° of longitude, west of Greenwich. This system is composed of a great number of chains and parallel ridges, of which the general direction is N. 60° W. to S. 60° E. The highest points of these mountains are near the sources of the Rios Gila and Prieto, where they appear to be 9,000 to 10,000 feet above the sea-level.

From the small number of observations I have been able to make in a rapid geological reconnaissance of that region, I think these chains of mountains belong to a system of dislocations, which has ruptured and elevated the strata of the Upper New Red Sanstone, and ended the Triassic period of North America.

The rocks which the Sierra de Mogoyon has brought to the surface are as follows: — a highly amphibolic granite forming the centre, then metamorphic quartzose rocks covered by strata of the Old Red Sandstone or Devonian; these strata are formed of beds of very hard red sandstone, resembling the sandstone of Catskill in New-York State. Above we find the Mountain Limestone or Lower Carboniferous highly developed, and containing numerous characteristic fossils of that series, then sandstone of the Coal-Measures or Upper Carboniferous, Magnesian Limestone or Permian, and, finally, numerous strata of Trias. The Jurassic series is deposited horizontally upon slightly elevated strata of Trias and in a discordant stratification, such as I have observed at Fort Défiance and the Chevelon Fork of the Colorado Chiquito.

I think the dislocations which have affected the Upper Trias, containing the Coal seams near Richmond, Chesterfield County, in Virginia, belong to this system, as also the mountain chains extending between the Great Salt Lake and the Serpent river or Lewis' Fork of the Columbia.

The Shasta Range, forming the boundary between California and Oregon, and occupying all the country comprised between the Sacramento and Willammette rivers, and Capes Mendocino and Umpqua, has a direction coinciding precisely with the *System of the Sierra de Mogoyon.*

10. *Rocky Mountains and Sierra Madre system.* — The Rocky Mountains and the Sierra Madre form, in the centre of the American continent a mass of rounded elevations *(bombements)* following parallel lines, in some degree symmetrical. These *bombements* are often broken by long narrow lines, and then the eruptive rocks have forced themselves a passage through, elevating and dislocating the sedimentary rocks belonging to the Carboniferous, Triassic and Jurassic series.

The general direction of these chains is on an average N. 15° W. and S. 15° E., and the time of upheaval is at the end of the Jurassic period and before the deposit of the Neocomian series of America. The Carboniferous strata, and especially the Mountain Limestone are broken and upheaved, for they are found in contact with the eruptive and metamorphic rocks; and I have seen the Mountain Limestone with its most characteristic fossils, even at an elevation of 12,000 feet above the sea-level.

Having ascended one of the highest peaks of the Rocky Mountains in the vicinity of Santa Fe, in New Mexico, the elevation of which is 13,000 feet, — from that height, favored by the pure and light atmosphere peculiar to that region, I discovered a horizon having a radius of 150 miles, embracing many chains of the Rocky Mountains; such as the sierras de Manzana, de Sandia, de Jemez, de Taos, de San Juan; a part of the Sierra Madre; groups of old and extinct volcanoes, and two sierras which run in the direction of the Rio Pecos. I have never seen, even from the summits of the Alps, the lines of dislocations so well determined, and their parallelism so visible, with the most neatly marked outlines.

The ridges *(écaillements)* and convexities forming this system of the two groups of the Rocky Mountains and of the Sierra Madre, occupy a breadth varying from 120 to 200 miles; the eruptive rocks do not appear at all the ruptures, and do not exceed a breadth of 12 or 15 miles, sometimes only appearing for a space of two miles.

In the Rocky Mountains, as in all great mountain chains, there are lines and accidents of dislocation anterior and posterior to the principal upheaval. Thus, the Placeres mountains south of Santa Fe, and the mountains east of San Pedro, have a direction and accidents of stratification, indicating a date anterior to the appearance of the neighbouring Sierra de Sandia.

The insufficiency of my observations upon the vast regions of the Rocky Mountains and the Sierra Madre, obliges me to confine myself to these summary indications of a portion of the dislocations which are found there. Being the first pioneer of Geology in these desert countries, I have fixed only a single landmark.

11. *Coast Range system.* — All along the Pacific coast from Cape S^t Lucas, in Lower California, to Cape Mendocino, Humboldt County, in Upper California, we observe chains of mountains of small elevations, being in general 500 to 1200 feet above the level of the sea, known under the name of the Coast Range of California. The direction of this system of mountains is not far from N. N. W. and S. S. E.

The part of the coast where this system is the most distinct and easy for observation, is from the Pueblo de los Angeles to the Bay of Humboldt, and between the sea and the rios San Joachin and Sacramento. In the small number of rapid observations I have been able to make, around Los Angeles, Santa Barbara, Monterey, Santa Clara, San Francisco, and Contra-Costa, it appeared to me that the dislocations and ruptures have taken place at the end of the Eocene Tertiary epoch, as seems to be indicated by the beds of limestone and sand containing fossils characteristic of the Eocene, which are found especially south of Monterey and at Monte Diablo in the County of Contra-Costa.

The celebrated Golden Gates, of the Bay of San Francisco, traverse this system. The rocks composing it are chiefly of metamorphic and eruptive origin, and they contain rich mines of quicksilver, silver, copper, and iron; but thus far no gold has been found there.

Most of the chains of the Coast Range are crossed and penetrated by subsequent dislocations, which have given birth to the *System of the Sierra Nevada.* These crossings are seen particularly near the mission of San Fernando and the Tajon Pass, and also near the sources of the Russian river in the County of Mendocino.

According to a manuscript chart and verbal communications made to me in 1854, by the celebrated and unfortunate de Raousset Boulbon, I refer to this *system of the Coast Range*, the mountains of Sonora, comprised in the country of the Papayos Indians, and the Sierra of Arizona. There, as in California, we do not find gold, but many very rich mines of silver, copper, lead, and quicksilver.

12. *Sierra Nevada system.* — We comprise in this system not only the chain of the Sierra Nevada, known among geographers as forming the eastern limit of California, but likewise a group of eight or ten other parallel chains, extending to the east, even to the further side of the Rio Colorado. In a word, the group of mountains forming this system comprises all the *Great American desert*, from near the Salt Lake and settlements of the Mormons, to the plains of the Sacramento and San Bernardino, running north and south for ten degrees of latitude.

The lines of dislocation run North and South, giving thus a *second meridian system* in North America. As the rocks which compose all these chains are principally crystalline, eruptive, and metamorphic, and as they contain veins of auriferous quartz, directed likewise from north to south, and of the same epoch as the appearance of the other rocks of this system — we see that there seems to exist a relation between the deposit of gold and the *Meridian* direction of the chains of mountains, especially if we recall to mind that the three systems of mountains where gold is most common, are the *Meridian systems* of the Ural, the Sierra Nevada, and the Australian Cordilleras.

The sedimentary rocks are very rare in the mountains of this group. They are mostly puddingstone, white and red sandstone badly stratified, and white limestone. Fossils being very rare in this elevated and often highly inclined strata, it is difficult to assign a precise epoch for the relative age of the Sierra Nevada. That which is certain in my mind, is that this system is later than the Eocene period, and yet earlier than the Quaternary epoch. It may be at the end of the Miocene, or after the Pliocene. In this respect I agree with Sir Roderick I. Murchison, who considers, in his late and excellent work, entitled *Siluria*, the deposits of auriferous sand of the Ural and of Australia, as effected at the epoch of the *Quaternian drift*, which gives as the geological age of the veins of auriferous quartz, the end of the Tertiary epoch, or the end of the Miocene period.

The Sierra de Batuco and the mountains which limit the basins of the rivers San Miguel, Sonora, San Jose, de Cruz, in the State of Sonora, belong to the *system of the Sierra Nevada.* Their direction is likewise North and South, and they contain in their bosom veins of auriferous quartz, identical with those of California.

13. *Sierra of San Francisco and Mount Taylor system.* — We have, at the 35° of latitude, from Soda Lake, which terminates the river Mohavee, near the Colorado of California, to the sources of the Arkansas and Canadian rivers, a volcanic belt running from West to East, and consisting of immense extinct volcanoes, the two principal ones bearing the names of the Mountains or Sierra of San Francisco and Mount Taylor.

The height of many of these volcanoes is considerable; thus the principal cone of the Sierra of San Francisco is 15,000 feet, and Mount Taylor surpasses 10,500 feet. The lava streams and Secondary cones of all these volcanoes occupy a great surface; though they are actually extinct, and do not appear to have been active for many ages.

The current of lava covers in many places, particularly in the valley of the Rio Grande del Norte, the drift of the Quaternary epoch, and also the alluvium. A fact which seems to indicate for the relative age of this volcanic band, the end of the Quaternary period.

More to the north, and following one of the lines of dislocation of the Sierra Nevada, we find, running North and South, on the meridian of 122° west of Greenwich, a line of volcanoes, most of which are still in a state of activity, especially Mount S^t Helena, near the Columbia river in Oregon, and Mount Baker in Washington Territory. The age of this last volcanic belt appears to be the same as that of the belt of extinct volcanoes above-mentioned, so that we have a rectangular volcanic system, the two directions cutting at right angles, and yet both of the same geological age. This system appears to me to belong to that noticed by Elie de Beaumont as composed of three volcanic bands, forming a single tri-rectangular system.

I have not yet found, with certainty, the system of dislocation which took place at the end of the Cretaceous period, and I am greatly disposed to adopt the opinion of Elie de Beaumont, who a long-time since pointed out in the Alleghanies, ruptures which should belong to this period. Those dislocations are found principally in North Carolina and Georgia.

In closing this hasty and imperfect attempt at a classification of the mountains of a part of North America, I call the attention of Geologists to the relations existing between the different periods or groups of American strata, and the lines of dislocation and the elevations which traverse this great country. Here, as in Europe, the chains of mountains have intimate relation with each division of the chronological scale of stratified rocks.

The fossil remains are the «medals of creation», while the mountains are its *colossal statues*; with a collection of a certain number of fossils and minerals, one may write, and even stereotype, a chapter of the World's history; but this chapter always begins with an immense *capital letter*, which is a chain of mountains.

CHAPTER VII.

ON THE GOLD OF CALIFORNIA.

(Extract from the *Bibliothèque Universelle de Genève*, Février 1855.)

Shortly after my last return to Europe, my friend, Professor Alphonse Favre of Geneva, requested me to send him some notes on the gold of California, as the geology of that country was very little known. The knowledge of the gold region was limited to the short *Report* of P. T. Tyson *Upon the Geology of California*; Washington 1850; and a note just then published in the *Quarterly Journal of the Geological Society of London*, by James S. Wilson, under the title: *On the Gold Region of California*, pag. 308, etc., vol. 10. Tyson made a rapid reconnaissance from Benicia to the American and Calaveras rivers in 1849, when the gold fever was at its height; and Wilson was himself a miner, who tried his luck for nearly three years in the southern district of the mines.

On my arrival in California in March 1854, I rushed to the mines as soon as my duty with the expedition of Capt. Whipple was over, and in the course of a few days visited the northern district, at that time the richest and most productive in gold. Of course I do not give my notes as a minute description of what I saw during those few days, they are only a very rough sketch of the geology bordering the road from Marysville to Nevada-City, in the district of the northern mines. Since the publication of these notes in the *Bibliothèque Universelle de Genève*, the two excellent reports of Dr. John B. Trask entitled: *Report on the Geology of the Coast Mountains and Part of the Sierra Nevada*, 1854 and 1855, have appeared, and they give a better idea of the geology of California in general, and especially of the mining district.

The route from San Francisco, ascending the Sacramento river and then Feather river to Marysville, is constantly on the modern alluvium, with the exception of some localities near Hock Farm, the residence of the celebrated Captain John Sutter, the original discoverer of gold in California; where *drift* or Quaternary rocks are found. Leaving Marysville and crossing the Sierra Nevada from west to east, we have the following section: modern alluvium till we reach the vicinity of Long Bar, Yuba river; two miles before reaching Long Bar dykes of trap are seen running from north to south, cropping out here and there, and then forming the whole country for a width of ten miles. This trap is a greenish feldspathic rock, containing lamellae of feldspar of the sixth system, and lamellæ of white and sparry carbonate of lime are disseminated through the mass; there are also some grains of iron pyrites. This trap is very hard, irregular, and scaly when broken, sometimes serpentinous and contains no gold. Near the little town of Rough-and-Ready some veins of sienitic granite containing common feldspar or orthoclase, and hornblende

are seen in the trap. The sienite and trap alternate from Rough-and-Ready to Grass-valley, where the trap disappears entirely, giving place to the sienitic granite, which extends indeterminately to the east.

The veins of quartz commence near Grass-valley, and are found chiefly at the line of contact of the veins of trap and sienite, also running from north to south in the general direction of the chain. The gold is scattered in very fine particles through the quartz, and is seldom visible to the naked eye. One of these veins near Nevada-City has been and still is worked with profit; I will describe it in a few words, as an example of the mines in general, as they differ very little from each other. This vein, called *Canada-Hill mine*, on account of its discovery by French Canadians, runs from north to south, dipping to the west at an angle of 30 degrees; it is from six to eighteen inches thick, the rock forming the wall of the vein is the common sienitic granite of the Sierra, formed of crystals of common feldspar and hornblend. The orthoclase decomposes easily under the combined influence of atmospheric and magnetic actions, and is transformed into the true *kaolin* or porcelain clay.

The gold quartz of Canada-Hill has a cavernous structure, with cells containing oxyd and hydrous-oxyd of iron, which often shows thin laminæ of gold and branching threads of this precious metal visible to the naked eye. Frequently greenish-yellow iron pyrites occur crystallized in dodecahedrous cubes, whose faces are striated. This auriferous quartz is less hard than usual, on account of its cellular structure; when broken it is irregular and scaly, and its color is a thick milky white, often yellow from the quantity of iron it contains. The exterior surface of the vein is yellow and black, and there are no striae or other marks showing that the vein has been rubbed against the sides of the sienitic mass forming the walls.

This summary description of the gold-bearing quartz of Canada-Hill applies, with little variation to the other quartz mines of California. The quartz is rarely found entirely impregnated with gold. One of the finest fragments, called by the miners a *big lump of gold*, was taken from the *Lafayette and Helvetia mine*, at Grass-valley; it weighed 150 pounds, and contained the value of 1200 dollars in gold. The vein of this mine is at the line of contact of the sienite and greenstone trap; it is three feet thick, and at one point even five feet: it is very productive, and is the first vein that was discovered and worked.

The principal mines of auriferous quartz are in Nevada, Sierra, Buttes, Eldorado, Calaveras and Mariposa Counties; they are always situated in the sienitic granite or the trap, and the richest veins are found where these two rocks meet. In the spring of 1854 there were forty mines of auriferous quartz in California, more or less profitably worked.

The valleys of the Sacramento and San-Joachin rivers contain a sort of muddy clay or *lehm*, that changes, with the elevation of the Sierra Nevada, into a true *drift* containing rolled pebbles, sand, gravel, and plastic clay. This *drift* covers more or less all the eruptive rocks at the base of the Sierra Nevada; and as the greatest number of the California *placers* (gold diggings) are in this deposit, I will describe a section of it. Its greatest thickness in the region of the northern mines is one hundred and fifty feet; generally it is from forty to one hundred feet thick. The following is the description of the Quaternary *drift* in the placers of Nevada-City, at the western entrance to the town; the section is from the top down. At the summit a yellowish-white plastic

clay, very tenacious, and sometimes containing sand pouches with pebbles and grains of gold; the gold is never in the clay, which is here from 25 to 60 feet thick. Below this is the *drift* proper, formed of sand and pebbles varying in size according to the position of the drift on the sides of the hills, or at the bottom of the ravines; there is also a little clay mixed with the sand, and much oxyd of iron, giving a reddish color to the whole deposit. It is in this part of the Californian Quaternary that the gold is found either in lumps, grains, or dust, and the richest part of the drift is that next to the eruptive rocks that lie beneath. This is easily explained by the great density of the gold, causing it to descend to the lower part of the deposit, and further, the easy decomposition of the sienite gives to the two or three first feet of these rocks, the appearance and consistence of a soft stone penetrated by golden lumps and grains.

The geological period for the gold of the Sierra Nevada was probably the end of the Tertiary, or the beginning of the Quaternary. It has been thought until now that the gold did not exist until the Quaternary epoch; and Murchison in his *Siluria* (edition of 1854) says, page 446: «What «then was probably the geological period when these rich auriferous impregnations of the Uralian «rocks took place? We cannot believe that it occurred shortly after the Permian era, nor even «when any of the Secondary rocks were forming; since no golden debris is found even in any of «the older Tertiary grits and sands which occur on the Siberian flank of the chain. *If, then, the «mammoth drift be the oldest mass of detritus in which gold occurs abundantly*, non *only* in the Ural but in «*many parts of the world*, we are led to believe that this noble metal, though for the most part formed «in ancient crystalline rocks, or in the igneous rocks which penetrated them, was only abundantly «imparted to them at a comparatively recent period; — *i. e.* a short time (in geological language) «before the epoch when the very powerful and general denudations took place which destroyed «the large extinct mammalia.»

But my friend Prof. Ebenezer Emmons in his last valuable *Geological Report of the Midland-Counties of North Carolina*, New York, 1856, says, page 130, 131 and 135: «The second geological position «in which I find gold, is in *layers or beds in the rock* with which it is contemporaneous. If this view «is correct, gold is a sediment; and belongs, as I shall show, to the Paleozoic period.» -- «These ancient auriferous deposits may be distinguished from veins by the absence of walls; there «is really no line of demarcation between the auriferous layers and the adjacent ones.» — «I am «not able, at this time, to state how widely gold is disseminated in the Paleozoic rocks; but from «indications derived from a few facts, it appears probable that it may be widely diffused or con- «tained in most of the rocks in North Carolina which belong to the Taconic system.» — «One of «the most interesting instances of the occurrence of gold in the consolidated sediments, is at a place «called Sion, twelve miles from Troy, in Montgomery County. It is both interesting and important, «because here the fact, that gold is a sediment, is attested by the presence of fossils. This loca- «lity has been already described, and the geological position of the rocks stated. The series con- «sist of sandstones and chert, which rest upon a thick mass of brecciated conglomerate, which in «its turn overlies talcose slate. Those part of the rock which contain gold are brown and of a «loose texture from the presence of the oxyd of iron, which undoubtedly originated from the «sulphuret of iron, which is sometimes visible in the rock. There is no doubt respecting the beds «from which gold is derived.»

So that the appearance of the gold is of much more ancient date than has been thought, and it is probable that it has existed at least as far back as the deposit of the first strata.

There is no doubt that the geological position or *gisement* of gold is at or near the surface of the Earth, and that, as de Humboldt says, «it had some closer relation to or dependence upon the «atmosphere than that of the baser metals lead, copper, and iron. Dr. Perry is disposed to «believe, that it may have been thrown down by deposition from an aqueous medium.» (See : *Siluria*, p. 447). The observations of Prof. Emmons in North Carolina seem to confirm these views.

As to the depreciation of gold relatively to silver, as many economists have lately feared would be the case, it is purely imaginary, and any mining engineer who has seen both gold placers and mines of silver, will be convinced that such an occurence is impossible. Some fluctuation in value may take place, and has already several times, but this is only what occurs universally in commerce, and the gold will always keep its relative position to silver as the white man will keep his superiority to the actual animal kingdom.

not been geologically drawn at the time of Lyell's publication. These additions are principally due to David Dale Owen for the Upper Mississippi from St Louis to Lake Winipeg, Ferdinand Roemer for Texas, M. Tuomey for Alabama, O. M. Lieber for the State of Mississippi, Safford for Tennessee, G. C. Swallow for Missouri, Charles T. Jackson for the southern part of Lake Superior, and J. W. Dawson for the British Provinces. Further, my friend Dr. Charles T. Jackson permitted me to use his manuscript geological map of the State of Maine, and Prof. J. F. Frazer showed me one of a considerable part of Pennsylvania. I have also had the use of manuscript notes upon Newfoundland, Cape Breton Island, Hudson Bay Territory, Lower Canada, Kentucky, Tennessee, Florida, Louisiana, the Osage Indian Country, Chihuahua, Sonora, Arizona, Utah, the vicinity of Forts Laramie and St Vrain, Oregon, and Vancouver Island, that were given to me by travelling geologists, or officers of the Army and Navy, with full liberty to employ them as I pleased. I am especially grateful to Richard Brown, superintendent of the Coal mines of North Sydney, Cape Breton; J. W. Dawson, formerly of Pictou, now Principal of Mc Gill College, Montreal; Admiral, Earl of Dundonald, Commander in Chief of the British North American squadron in 1849; Dr. Charles T. Jackson of Boston; Isaac Lea of Philadelphia; Dr. Charles Girard, the celebrated zoologist of Washington, my old friend and fellow student in the house of Prof. Agassiz, and until lately one of the most useful *attachés* of the Smithsonian Institution; Dr. Samuel Royal of the vicinity of Richmond, Virginia; Dr. L. P. Yandell of Louisville; John Gebhard Jr. of Schoharie, New York; Prof. Eben. Emmons of Albany; Prof. J. M. Safford of Lebanon, Tennessee; Dr. Geo. G. Shumard of Fort Smith, Arkansas; Capt. A. W. Whipple, Corps Top. Engrs. U. S. A., who during a campaign of ten months in the Rocky Mountains was my constant companion, and is one of my most valued friends; Capt. John Pope of the same Corps; Capt. W. Swift, an old pupil of General Bernard, and one of the companions of Major S. H. Long in his *Rocky Mountain exploration*; Major J. H. Carleton of the 1st Dragoons U. S. A.; Colonel W. C. Grant of Soke Harbor, Vancouver Island; the late Dr. Randall of Monterey, California; the celebrated French botanist A. Trécul, my friend and travelling companion in 1848; and lastly my friend, Antoine Leroux of Taos, the best of the Guides in the Rocky Mountains.

I have travelled myself for seven years in the following countries, for the purpose of making geological observations: Cape Breton Island, Nova Scotia, New Brunswick, the New England States, Upper and Lower Canada, made the complete tour of Lake Superior and a part of the road between Lake Superior and Lake Winipeg; the States of New York, New Jersey, Pennsylvania, Maryland, Virginia, Kentucky, Ohio, Michigan, Indiana, Illinois, Wisconsin, Missouri, Tennessee, Arkansas, Texas; the Cherokee and Choctaw countries; New Mexico, and California. So that, if two thirds of this map is only a compilation from the labors of others, the other third was made from my own observations, and I think, I may say truly, that at the time of its publication in 1855, I had seen more of North America than any other living geologist either of America or Europe. Having crossed by land the whole Continent from the Coal mines of Sydney, Cape Breton, to the gold diggings of the Sacramento, it is evident I could not devote myself to the study of minute details, as those geologists do who remain stationary at one point; and the map should not be judged by the details, but the *ensemble*; and I will say of it as de Saussure said of mountains, « *qu'elles ne doivent pas être observées avec un microscope* ».

am *very far* from being satisfied with it; but my excuse for publishing so imperfect an attempt is, that few observers have occupied themselves with the *ensemble* of the geology of North America, and as a *geological pioneer* in the Rocky Mountains I have perhaps some right to present a *rough sketch*. From a pioneer nothing very perfect must be expected; the hard life, in which I have been tossed about for years, has taught me rather to use the rifle and the axe, than the pen and pencil; and I ask the indulgence of my fellow geologists for an essay *written and drawn under the canvass of a tent or by a camp-fire*; during the torrid heat of a Texas summer, or the extreme cold of a winter campaign in the Rocky Mountains.

As rough as they are, my sketches have attracted considerable attention, especially in America, and if their value may be estimated by the vivacity of the criticism they have called forth, they must be of some worth. The critics go so far however, that I cannot accept all the benefit I ought to receive from them, for, as the French say, «*en vérité, je ne suis pas digne de votre colère*».

There is a sort of association in America composed of half a dozen geologists, who try to impose their opinions, *unguibus et rostris*, upon all who attempt to look at the rocks of the New World. The recognized leader of this association is Mr. James Hall of Albany, and the estimation in which he is held by the members, may be seen by a remark of one of them, who declared before a Select Commitee of the Legislative Assembly of Canada, appointed to report on the Geological Survey of Upper and Lower Canada, «*Mr. James Hall, whose opinion is law in American geology, etc.*» (Examination of T. S. Hunt, Knight of the legion of honor of France, chimist and mineralogist of the geological commission of Canada[1]).)

It is useless to say that I do not belong to this association, and also that I do not admit Hall's opinions «as law in American geology»; *indè iræ*.

James D. Dana, the son-in-law of B. Silliman Sr., who since the retirement of the elder Silliman has the care of the geological part of the *American Journal of Science and Arts*, is one of Hall's disciples, and devotes its pages exclusively to the association, confining his remarks upon me to hostile criticisms, and never giving a word of my reports and observations. I give below the criticisms as they were published.

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(Extract from the *Silliman's Journal of Science*, second series, vol. XVII, N° 50. March, 1854, pag. 919 etc., New Haven).

Notice of a Geological Map of the United States and the British Provinces of North America, with Explanatory Text, Geological Sections and Plates of the Fossils which characterize the formations[*], *by J. Marcou.*

A geological map of the United States by a member of the Geological Society of France is likely to command attention both in this country and Europe; and it is therefore important to know how far it is a correct exposition of the present state of American Geological Science. We have therefore examined the map of Mr. Marcou and the accompanying text with *much interest*, and with no *less disappoint-*

[*]) A Geological Map of the United States and the British Provinces of North America, with explanatory text, geological sections and plates of the fossils which characterize the formations. By Jules Marcou. Boston, Gould and Lincoln. 1853.

[1]) See: *Report of the Select Committee on the Geological Survey*, page 61; Quebec, 1855.

of Wahlenberg, and refers the name to a figure of *Cameroceras trentonense*, evidently copied from *Palæontology of New York*, vol. i, pl. 56, fig. 4; a fossil *very unlike* the *O. communis* in every respect. Still further, he cites it as common in New York, Pennsylvania, Canada, the Mingan Islands, on the coast of Labrador, and in Newfoundland, near the straits of Belle Isle. Now the form figured is a rare fossil, known only in a few specimens found in New York.

The author cites *Orthis testudinaria* and *Verneuili*, Dalm., as «species of Brachiopods related to Spirifer, which are found equally in Europe and America.» If the author has been as *careless* of his localities as he has been in his citations of *authorities*, we can judge very well of *his accuracy* in this case. The *O. Verneuili* is one of Eichwald's species, and the figure in Marcou's book is copied directly, reduced in size, from Murchison and de Verneuil's *Russia and the Ural Mountains*, vol. ii, pl. 12, fig. 1; and is there cited from two localities in Russia, viz., Reval and the island of Dago. This is the *first intimation* of its having been found in America; and as no locality is given, we may be permitted to *discredit* it altogether. *Orthis testudinaria* is an abundant species in Europe and America.

On page 23, it is asserted that most of the blue limestone in the neighborhood of Cincinnati is of the Trenton formation. This *was believed* ten years since. The author appears not to be *aware* of what has been published during the last three or four years, or he would not have made the *mistake.*

On page 24, speaking of the Hudson river group and Utica slate, he says: «Fossils are rare in this division.» Perhaps no portion of the palæozoic rocks is more densely crowded with fossils than this group when in an unaltered condition. In central and north New York, in «Upper Canada and Bay des Noquets,» the two latter localities cited by our author, — the fossils are *extremely abundant.* While Mr. Marcou says the only fossils of these rocks are *Graptolites* and fragments of *Trilobites*, it is shown in the *Palæontology of New York* that more than sixty species of fossils are restricted to these beds, and more than thirty others are common to this formation and the Trenton limestone.

Under the term Upper Silurian our author includes numerous rocks and groups, and among them the *Pentamerus limestone* of New York. This rock was so named from its containing great numbers of *Pentamerus galeatus*, this being, with its associated shaly limestone, the only position of that fossil. Now our author makes the *rock Silurian*, (p. 25) and describes and figures the *fossil as Devonian* (p. 31). He asserts that it is «common to Upper Silurian and Devonian of Europe, and is in the same geological position in America, but on this side of the Atlantic, it is especially found in the Devonian division.» Now this fossil is *never found* in any rocks of America included by this or any other author under *Devonian*; nor is it *true* that it occurs in the *Devonian of Europe.* Had our author *read* whad was published on the other side of the Atlantic *as long ago as* 1848, he would have known this.

The author cites Upper Silurian rocks as forming «the upper part of the Falls of the Mississippi at Fort Snelling.» The explorations of Dr. Owen and others have shown that the rock is the Trenton limestone; and it is underlaid by a soft, shaly and fucoidal mass representing the Birdseye limestone; and that this rests on a sandstone belonging to the lower formations. It will *surprise* the ardent collectors of Ohio to learn that they have upper silurian rocks «in the environs of Cincinnati.» *)

We much incline to doubt whether Fremont, Stansbury, or Wislizenius have brought unequivocal Silurian rocks or fossils from «several points in the Rocky Mountains,» and we equally question whether *Pentamerus oblongus* has been found in North Carolina and Minnesota. Lockport, N. Y., Chicago and Minnesota are given as localities of *Favosites gothlandica*, which is not known in either of these places. On page 28, we learn for the first time that «*the Upper Silurian in America often contains beds of rock salt.*» The italicising is *ours*, the *statement* is the author's.

*) We know something of the rapid growth of western towns, but we cannot suppose that the *environs of Cincinnati* extend to *forty* or *fifty* miles. (N. B. — «One of the standard books on Geology is certainly the: *Géographie «Minéralogique des environs de Paris*, by Cuvier and Brongniart, which comprehends a circuit of *several hundred* miles; «and so I am justified in saying «the environs of Cincinnati» for *forty* miles; but only a glance at the Map is «needed to show clearly the meaning of my phrase». — J. Marcou.)

is it the *Spirifer heteroclitus*; though not only it, but one other species of that vicinity, resembles the *Sp. heteroclitus* still more strongly than the one figured: and finally, *we venture* to say, that *neither the species figured, nor either of those* at the Ohio Fall or Charlestown Road, have *been found* in the other localities cited.

As an offset to the above, *Chonetes nana*, which is abundant and almost universal in rocks of this age, is cited as found *only* in the environs of Louisville.

Our author commences his description of our carboniferous rocks by insisting upon the existence of «vast beds of gypsum and rock salt.» The former is true of a few localities; as to the latter, *one* well authenticated locality only, so far as appears, furnishes rock salt.

It is very remarkable that our author should have *repeated* the *same rocks* and *groups* under carboniferous, which have been decribed under Devonian, viz.: «The bituminous shale, (or black slate) and Waverly sandstone series, and the fine-grained sandstones of Ohio, Illinois Indiana, the black slate of Tennessee,» etc. These names, it is true, are not used, since he has omitted reference to all the western states in his Synonyma of Devonian sedimentary rocks; but as will be seen, he cannot *extricate* himself from this difficulty. On page 30, he thus describes the Devonian: «To the west it extends through the southern part of the state of New York, forms the whole contour of Lakes Erie and St. Clair,» etc. Now the extension of those rocks occupying southern New York, and along the shore of Lake Erie, to form its «whole contour,» comes thence into Ohio, not by any identification or parallelism, by lithological or fossil affinities, but by absolute continuity. Yet our author describes first his Devonian as forming the contour of Lake Erie, and afterwards represents the same beds, the bituminous shale and Waverly sandstones of Ohio, as carboniferous,—these very rocks themselves forming the southern contour of Lake Erie.

We have thus run over the work to the 33d page, and here leave it. One point only we will notice. The sandstone of Lake Superior is classed as the *New Red*, notwithstanding *all the labors* of Logan, Owen, Foster and Whitney, and *others*, who have *agreed* in considering it *lower Silurian*.

We will say nothing of our author's attempts to systematize our mountain chains, if *we needed a parody* on Elie de Beaumont and his systems of mountains, we have it here.

Mr. Marcou laments the want of accurate topographical maps, and because he has not such guides, he does not lay down on his map any mountain chains, but has «written *near* the places occupied by the different chains of mountains, the names of those chains.» For the *same reason* we suppose, or some other *equally cogent*, he has given no lines of States, but has written the names of the various states *somewhere near* the places occupied by them respectively. This allows the limits of the various geological formations to be laid down *any where near* the places they occupy, without giving the pupil or the critic *the means of determining their accuracy within many miles*, a device perhaps *convenient* for the *author*, but not so for the *student*.

The map in its geology is *little more* than a *reproduction* of that published by Lyell in 1845, and in many respects it is *inferior* to that. As we have remarked respecting the text, the sandstone of Lake Superior is represented as the *New Red*, or of the age of that of the Connecticut, New Jersey, etc. But besides this, he continues a belt of the same formation across from the *head* of Lake Superior, by the sources of Red river to the *head of the Coteau des Prairies*. In that direction he again takes up the *same formation* in the Wind River chain of mountains. In both these instances, there is not the *slightest authority* for supposing such belts of sandstone formation, and particularly any of the age of the *New Red*.

Without the slightest reason or authority, and in the face of facts, he runs a belt of lower carboniferous from the coal field of Michigan to the northeastern part of the Illinois coal field, and another from the eastern side of the Illinois coal field to the northwestern side of the Alleghany coal field. The latter is a worse error than the former, for he positively traces it across a broad belt of Silurian rocks which are a prolongation of those to the north of Cincinnati, and which are clearly followed northeastward to the lake shore and the islands west of Sandusky.

« other pen than ours called attention to Mr. Marcou's *poor caricature* of a geological map of North Ame-« rica, and showed that both the map and the accompanying text are full of errors and mis-statements, « calculated to *give foreign readers most erroneous ideas*, not only of the state of American science, but « of the *true geological* structure of the country. We recall this with *more regret*, because we observe « that Sir R. I. Murchison was *deceived* by Mr. Marcou's pretensions, and lent to the map a *certain sanction* « in the pages of *Siluria*, before he was *apprized of its worthlessness*. The fact that Mr. Marcou is a com-« parative *stranger* in our country may explain *his ignorance* though not *his presumption*; but we regret « to say that no such excuse can be urged in behalf of the author whose name appears at the head « of this article. Etc. ».

As Hall, his assistant Whitney, and his other friends, appear to be uneasy about Murchison's use of my first Geological Map of America; I will say for their gratification, that at the time of the publication of the first edition of *Siluria*, I had no relation of any kind with its illustrious author, and Murchison was induced to use my book at the special suggestion of de Verneuil. I find in a letter written to me by de Verneuil from Paris, 15 January, 1854, and received at San Francisco in March of the same year, the following passage: « Murchison m'écrivait dernièrement pour me « demander si le N° X de Mr. Rogers doit réellement être mis dans le terrain Dévonien, comme « vous le proposez. J'avoue que je ne me rappelle plus assez qu'elle est la nature des roches et « celle des fossiles de cet étage N° X, et *je lui ai conseillé de vous suivre en tout* ».

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(Extract from the *Silliman's Journal of Science*, second series, vol. XXII; N° 66, p. 383 etc. November, 1856. New Haven.)

Review of a portion of the Geological Map of the United States and British Provinces by Jules Marcou; [a])

by William P. Blake.

Geological maps of the United States published in Europe and widely circulated among European geologists, are necessarily regarded by us with no small degree of attention and curiosity. This is more especially true, when such maps embrace regions of which the geography has only recently been made known and the geology has never before been laid down on a map with any approach to accuracy.

The recent geological map and profile by M. J. Marcou, which has appeared in the *Annales des Mines* and in the *Bulletin of the Geological Society of France*, presents us, in addition to the geology of the Atlantic States, a view of the geology of the broad and comparatively unknown region between the Mississippi and the Pacific. Representing regions *which have not been visited by the person making it*, such a map is necessarily a work of *compilation*, inference and generalization, and in the present state of our knowledge, some errors are to be expected. I will not undertake to say how far the *author has faithfully used the means in his power* for making a good geological map, but as there are errors *too important* to pass unnoticed, I will *simply* point out those which are *most glaring* and most likely *to mislead foreign geologists*. I shall confine myself solely to the western part beyond the Mississippi. [b])

Commencing on the Pacific coast, the peninsula of San Francisco is represented as composed of erupted and metamorphic rocks, being colored the same as the Sierra Nevada and Appalachians. The rocks of that peninsula, and on both sides of the Golden Gate, are chiefly sandstone and shale, and

[a]) Carte géologique des Etats-Unis et des Provinces Anglaises de l'Amérique du Nord par Jules Marcou. *Annales des Mines*, 5e Série, T. vii, p. 329. Published also with the following:

Résumé explicatif d'une carte géologique des Etats-Unis et des provinces anglaises de l'Amérique du Nord, avec un profil géologique allant de la vallée du Mississippi aux côtes du Pacifique, et une planche de fossiles, par M. Jules Marcou. *Bulletin de la Société Géologique de France.* Mai, 1855, p. 813.

[b]) A former map by M. Marcou, published at Boston a little over two years since, was reviewed in vol. xvii, of this Journal. The present map is in part open to the same criticisms.

sufficient evidence of the presence of Jurassic formations, and the Llano and other plateaux referred to that age are *not Jurassic*, but *Cretaceous*.

The evidence brought forward to show the presence of the Jurassic, consists of one species of *Gryphæa* and one of *Ostræa*. They were obtained from the upper strata of Pyramid Mount — one of the mounds separated from the Llano Estacado by erosion. The Gryphæa is said to have the greatest analogy with *G. dilatata* of the Oxford clay of England and France, and was provisionally called *G. Tucumcarii*. The Ostræa is reported to bear much resemblance to *O. Marshii* of the inferior Oolite of Europe [a]). In the text accompanying the map the species are announced as identical, one with *G. dilatata*, the other with *O. Marshii*. Even if this identity be admitted, it does not authorize the conclusion that the strata are beyond question Jurassic; or if it did, the occurence of Jurassic at that one point on the Canadian, would not authorize us to conclude that the formation extends for more than a thousand miles on both sides of the mountains. The genus *Gryphæa* in America is eminently characteristic of the Cretaceous formation, and species which very closely resemble *G. Tucumcarii*, if not in fact identical with it, are very abundant in Alabama and New Jersey in the Cretaceous formation. Moreover, all the species are found with many variations according to the locality. The abundance and variety of the species of this genus render it unsafe to regard *G. Tucumcarii*, however much it may resemble *G. dilatata*, conclusive evidence of the presence of oolitic formations. Specimens of the *Gryphæa* are found in the government collection, but there are none of the *Ostræa*.

Some of the evidences of the Cretaceous age of the Llano may now be presented. If *we follow* the strata in which the *Gryphæa* was procured, westward, *we find* them extending across the mountain chain, through the passes, into the valley of the Rio Grande, and here near the summit of the table-lands just south of Santa Fé, Mr. Marcou reports the presence of Cretaceous fossils. Farther west, at Poblazon near the Puerco, Lieutenant Abert obtained several specimens of *Inoceramus* [b]) from horizontal strata. The topography at *this point is the same as along the valley of the Canadian*, the strata are at *nearly* the same elevation, and their *mineral characters are similar*. Numerous specimens of *Inoceramus* have also been obtained by Simpson [c]), Wislizenus and others along the valley of the Canadian river not far from Pyramid Mount, where the *Gryphæa* was procured. Farther east on the False Washita and near the Canadian, the Cretaceous fossil *Gryphæa Pitcheri* occurs in abundance and near the great beds of gypsum. Leon Spring, in the southern part of the Llano, has afforded abundance of Cretaceous fossils, and this place is represented on the map as Jurassic. Cretaceous fossils were also obtained by Capt. Pope from the bluffs of the Llano at the Sulphur Springs of the Colorado and from the surface of the plateau near the Sand Hills [d]). The Llano of Texas is well known and is undoubtedly the continuation of the Llano Estacado. The bluffs are filled with Cretaceous fossils already described by Ferdinand Rœmer. They are correctly represented as Cretaceous on the map.

The map displays a most remarkable relation of position between the Cretaceous and the «Jurassic» along the valley of the Rio Grande between El Paso and the mouth of the Pecos. The river has cut its valley downwards through the horizontal formations of the Llano which form bluffs on each side. On the map we find the valley of the stream colored as Cretaceous, while the higher strata of the Llano, are colored as Jurassic. Thus, according to this representation, the Jurassic strata *overlie* the Cretaceous. This conclusion is *unavoidable* unless we are ready to believe that the Cretaceous strata were deposited *since* the erosion of the valley of the Rio Grande. The same alternative is presented to us along the

[a]) See Resumé of a Geological reconnoissance, etc. Report of Lieut. A. W. Whipple, U. S. Top. Engrs., H. Doc. 129, chap. vi.

[b]) Described and figured by Prof. Bailey — Report by Lieut. J. W. Abert, U. S. Top. Engrs. of an Examination of New Mexico.

[c]) Report and Map of the Route from Fort Smith, Arkansas, to Santa Fé, by Lieut. J. H. Simpson, U. S. Top. Engrs., Washington, 1850.

[d]) Report on the Geology of the Route surveyed by Bvt. Capt. Pope, U. S. Top. Engrs., 4to. Washington, 1856. [Pacific R. R. Exp. and Surveys.]

Upper Missouri; the highest table-land is colored as Jurassic, and the Cretaceous is made to crop out lower down nearer the river and rests directly upon the formation called Trias.

But the most striking feature of the map remains to be noticed. We find an area equal to that of all the States east of the Mississippi colored as Triassic. The section also represents this formation as enormously thick, and with four divisions corresponding to those in Europe. The color is extended on the map along the whole course of the Missouri down to Council Bluffs, and south into Texas, and is carried east so as to reach and border the southern shore of Lake Superior. The basis of this representation is chiefly the occurrence of red gypseous strata along the False Washita and Canadian rivers. The upper limit of the formation is considered to be at the base of the so-called Jurassic strata of the Llano, and its lower upon the Carboniferous.

The representation of this broad area as Triassic is made *without the evidence* of a single characteristic fossil, the principal support for it being the *position* and *mineral characters* of the strata. It is said that they are like those of Windsor and Plaister Cove, N. S., which were supposed to be Triassic but have since been shown by Mr. Dawson to be Carboniferous *). Hence the similarity *indicates a Carboniferous age* rather than Triassic. The limit of the formation above or below, although perhaps well defined at one point, may not be at others, or may be very different; the red color of the strata — *the only guide* — being the result of *chemical changes* and not of *original deposition*. The lower limit is not *clearly* defined, and there are *no outcrops* or *uplifts* of the strata sufficient to *reveal the whole series*. The thickness, therefore, cannot be *accurately* stated.

The entire absence of fossils from these strata, so far as known, and our slight knowledge of the line of separation between them and those of known age, and the *impossibility* of determining their thickness, render it *premature*, at least, to assign them to the age of the Trias, and to *partition* them into groups corresponding to those of the formation in Europe. We may with *equal reason* call the strata Jurassic, Liassic, Triassic and Permian, or either of them, as Triassic *alone*. It would *be most in accordance* with the *indications to refer them to the Cretaceous and Carboniferous*, the two adjacent formations above and below.

But even if the gypseous strata along the Canadian were proved to be of Triassic age, it does *not follow* that those along the Upper Missouri, a thousand miles away, are of the same period. According to published reports the strata along the river are Cretaceous, and there is *no evidence* of the presence of the Trias. Neither is there any evidence of the *extension* of the Lake Superior sandstone *across* Wisconsin into Iowa and out to the Missouri, as if the formation occupied an east and west valley in the granite. Such a representation is *at variance* with *published* records, and these surely should be regarded in the absence of *personal observation*. It is hardly necessary to state that the sandstone of Lake Superior has been examined by three separate geological corps, — Messrs. Whitney and Foster with the assistance of Prof. James Hall, by D. D. Owen, and by Sir W. E. Logan knight of the Legion of honour of France — and after several years of exploration in that region, all arrive at the *conclusion* that the sandstone *is not* the *New Red*, but *is the equivalent of the Potsdam sandstone* of New York. Prof. James Hall has announced the conclusion also in a notice of a former map by Mr. Marcou.

There is here a *disregard* of *published results*, and an *audacious attempt* at generalization, which has *seldom been equalled*. The fact that Mr. Marcou's map is *widely circulating* in Europe just *such American Geology* as this, has made it the *duty of the science of the country to protest against its being accepted abroad*, notwithstanding its publication under the sanction of the Geological Society of France.

*) Acadian Geology, by J. W. Dawson. Edinbourgh, 1855.

The motives that produced the above criticisms of Hall, Whitney, and Blake, and led James D. Dana to publish them in the *American Journal of Science and Arts*, are too evident to require an answer. Hall was not so courageous as his two assistants, preferring the shelter of the

anonymous, according to his usual custom. Besides I should be wrong to complain; he has treated far better geologists than I am, in the same manner, and his conduct toward Sir Charles Lyell, Professor Eb. Emmons, and other geological celebrities, is well known in the scientific world.

In giving the above criticisms at length, I have had in view rather to show the varying opinions upon difficult questions in American geology, than the good taste and literary capabilities of my adversaries. The ill humour of Messrs. Hall & Co. is of little import as to the advance of geology, but I am glad to see these savants give quite decided opinions, *diametrically* opposed to mine, upon several questions relative to the age of the strata of some formations, at Lake Superior, in Virginia, the Prairies, Texas, the Rocky Mountains, etc.

This will enable the geologists who study these questions to decide between us; and if I have not succeeded in my determination of the rocks that I regard as *New Red Sandstone*, *Jurassic*, *Neocomian*, and *White Chalk*, I can only say that I have tried my best to do my duty as a travelling-geologist.

CHAPTER IX.

A SYNOPSIS OF THE HISTORY OF THE PROGRESS AND DISCOVERIES OF GEOLOGY IN NORTH AMERICA.

All books of voyages and travels in North America, as well as more historical works, contain indications and notions concerning the mineral wealth of this continent, even as far back as the *History of the World*, by Sir Walter Raleigh, published in London, in folio, 1614: *L'histoire véritable et naturelle des mœurs et productions du pays de la Nouvelle France, vulgairement dite le Canada*, by Pierre Boucher; Paris, 1640: *Les voyages du Baron de la Hontan dans l'Amérique Septentrionale*, Paris, 1688: *L'histoire de la Nouvelle France*, by P. F. Xavier de Charlevoix: *The History of New Hampshire*, by Jeremy Belknap; Philadelphia, 1784: etc., etc.

The geological observers, however, did not make their appearance till the 19th century. The first pioneers were: Dr. Adam Seybert, a pupil of Werner; Godon, a French geologist; Colonel Gibbs, a pupil of the French mining school at Paris; Dr. A. Bruce; Prof. P. Cleaveland; Benj. Silliman; and above all William Maclure.

American geology may be said to have commenced with the publication of the *Geological Map of the United States*, in 1809, by William Maclure, who has been justly called the «William Smith» of America, and the *Father of American Geology*.

Maclure [1]), a pupil of Werner began in 1806 a regular survey of the United States, and uniting to his own observations those of his contemporaries before mentioned, he published in January 1809, at Philadelphia, the first attempt at a Geological Map of the United States.

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1) William Maclure, born at Ayr in Scotland, in the year 1763, emigrated to New York at the age of nineteen, and became a merchant. After having been very successful in his commercial enterprises, and having acquired a large fortune, he returned to Europe, where he devoted his time and fortune to studying, travelling, and collecting objects of natural history. Geology especially occupied his attention, and after having visited two thirds of Europe, he resolved to undertake a *geological survey of the United States*. Having returned to America in 1806, «he commenced his herculean task. He went forth with «his hammer in his hand and his wallet on his shoulder, pursuing his researches in every direction, «often amid pathless tracts and dreary solitudes, until he had crossed and recrossed the Alleghany mountains no less than fifty times. He encountered all the privations of hunger, thirst, fatigue and exposure, «month after month, and year after year, until his indomitable spirit had conquered every difficulty, «and crowned his enterprise with success. Mr. Maclure's observations were made in almost every State «and Territory in the Union, from the river St Lawrence to the Gulf of Mexico; and the Memoir, which

I give here a *fac simile* of the map — Plate IX — and the author's memoir, as the starting point for the history of the progress of American geology.

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(Extract from *Transactions of the American Philosophical Society*, held at Philadelphia, for promoting useful knowledge, vol. VI, page 411 etc.)

Observations on the Geology of the United States, explanatory of a Geological Map.
— see plate IX *) — by William Maclure.

Read January 20th, 1809.

Necessity dictates the adoption of some system, so far as respects the classification and arrangement of names the Wernerian appears to be the most suitable, First, Because it is the most perfect and extensive in its general outlines, and secondly, The nature and relative situation of the minerals in the United States, whilst they are certainly the most extensive of any field yet examined, may perhaps be found to be the most correct elucidation of the general exactitude of that theory, as respects the relative position of the different series of rocks.

Without entering into any investigation of the origin or first formation of the various substances, the following nomenclature will be used.

Class 1st. Primitive Rocks.

1. Granite,
2. Gneiss,
3. Mica slate,
4. Clay slate,
5. Primitive Limestone,
6. Primitive Trap,
7. Serpentine,
8. Porphyry,
9. Sienite,
10. Topaz-Rock,
11. Quartz-Rock,
12. Primitive Flinty-Slate,
13. Primitive Gypsum,
14. White-Stone.

*) Want of color indicates that the common boundary is not ascertained, the two classes of rocks being somewhat intermingled; or that such portions of the United States have not been examined.

« embraced his accumulated facts, was at length submitted to the American Philosophical Society, and « printed in their Transactions for the year 1809 ». (See: *A Memoir of William Maclure, Esq.*; by Dr. Samuel George Morton, page 11; Philadelphia, 1841.)

Maclure continued to extend and complete his geological survey, and in 1817, he published: « *Observations on the Geology of the United States of North America; with remarks on the probable effect that may be produced by the decomposition of the different classes of rocks on the nature and fertility of soils: applied to the different States of the Union, agreeably to the accompanying Geological Map. With two Copper-Plates.* — Read May 16th 1817 ». (In the *Transactions of the American Philosophical Society*, vol. I, new series; Philadelphia, 1818.) This was only a revised edition of his first work published in 1809. He was one of the first members and early chosen President of the Academy of Natural Sciences of Philadelphia, and was one of the most active and liberal supporters of the social scheme established by Robert Owen at New Harmony. To this western wilderness, in a country where society consisted of backwoodsmen and trappers, Maclure transported in 1824 the most splendid library on Natural History then existing in North America, and gathered round him a distinguished circle of naturalists, among whom were Thomas Say, C. A. Lesueur, C. S. Rafinesque, Dr. Gérard Troost, Robert Owen himself and his interesting family. The celebrated David Dale Owen, the true successor of Maclure in the geology of the Mississippi valley, was then a boy, and has probably derived his love and knowledge of geology from his early association with this celebrated company of savants. The later years of Maclure's life were passed in Mexico, where he died, at San Angel, the 23d day of March 1840, in the seventieth year of his age.

Class 2d. Transition Rocks.

1. Transition Limestone,
2. Transition Trap,
3. Grey Wacke,
4. Transition Flinty-Slate,
5. Transition Gypsum.

Class 3d. Flœtz or Secondary Rocks.

1. Old Red Sandstone or 1st Sandstone Formation,
2. First or Oldest Flœtz-Limestone,
3. First or Oldest Flœtz-Gypsum,
4. 2d or Variegated Sandstone,
5. 2d Flœtz-Gypsum,
6. 2d Flœtz-Limestone,
7. Third Flœtz-Sandstone,
8. Rock-Salt Formation,
9. Chalk Formation,
10. Flœtz-Trap Formation,
11. Independent Coal Formation,
12. Newest Flœtz-Trap Formation.

Class 4th. Alluvial Rocks.

1. Peat,
2. Sand and Gravel,
3. Loam,
4. Bog iron ore,
5. Nagel fluh,
6. Calc-tuff,
7. Calc-sinter.

To the east of Hudson's river, the primitive class prevails, both in the mountains and the low lands, decreasing gradually as it proceeds south; it is bounded on the side of the ocean by the vast tracts of alluvial formation which skirt the great granite ridge, while it serves as a foundation to that immense superstructure of transition and secondary rocks, forming the great chain of mountains that occupy the interior of the continent to the westward.

The primitive to the eastward of Hudson's river constitutes the highest mountains, while the little transition and secondary that is found; occupies the low grounds. To the south of the Delaware, the primitive is the first rock, after the alluvial formation of the ocean, the lowest step of the stair, that mounts gradually through the different formations to the top of the Alleghanys.

To the eastward of the State of New-York, the stratification runs nearly north and south, and generally dips to the east, looking up to the White Hills, the most elevated ground; in New-York State, and to the southward and westward, the stratification runs nearly N. E. and S. W. and still dips generally to the east. All the rivers east of the Delaware, run nearly north and south, following the stratification, while the southern rivers incline to the S. E. and N. W. direction.

Throughout the greatest part of the eastern and northern States, the sea washes the foot of the primitive rock; commences the deposition of that extensive alluvial formation at Long-Island, increasing in breadth to the south, forming a great part of both the Carolinas and Georgia, and almost the whole of the two Floridas and Lower Louisiana. The coincidence of the Gulf-stream, with all its attendant eddies, depositions, etc. etc. rolling along this whole extent, from the Gulf of Mexico to Nantucket, may create speculative ideas on the origin of this vast alluvial formation, while the constant supply of caloric [b]), brought by that sweeping current from the tropics, may perhaps account for the sudden and great change in the temperature of the climate, within the reach of the Atlantic.

The great distance occupied by the same, or similar substances, in the direction of the stratification, must strike the observer; as in the primitive rocks, the beds of primitive limestone and Dolomite (containing in some places crystallized felspar and tremolite) which are found alternating with Gneiss, for ten miles between Dover, State of New-York, and Kent, State of Connecticut, appear forty miles north, at Stockbridge, Connecticut, and eigthy miles south, between Singsing and Kingsbridge, New-York; where, after crossing the Hudson river and dipping under the trap and sandstone formation in New-Jersey, they

[b]) About 100 miles S. E. of Nantucket, in the month of September, Fahrenheit's thermometer in the sea stood at 78°, while the air was only 66, and the sea in soundings 61.

most probably re-appear in the marble quarries, distant from twelve to fourteen miles N. W. of Philadelphia, — a range of nearly 300 miles.

There is a bed of magnetic iron ore, from eight to twelve feet thick, wrought in Franconia, near the White Hills, New-Hampshire; a similar bed in the direction of the stratification, six miles N. E. of Philippstown, on the Hudson river; and still following the direction of the stratification, the same ore occupies a bed of nearly the same thickness at Ringwood, Mount-Pleasant, and Suckasunny, in New-Jersey, losing itself as it approaches the end of the primitive ridge, near Blackwater, — a range of nearly 300 miles.

Instances of the same occur in the transition and secondary rocks; as the Blue ridge from the Hudson river to Dan river, consists of rocks of much the same nature, and included in the same formation.

That no volcanic productions have yet been found east of the Mississippi, is not the least of the many prominent features of distinction between the geology of this country and that of Europe, and may perhaps be the reason why the Wernerian system, so nearly accords with the general structure and stratification of this continent.

It is scarce necessary to observe, that the country must be considered of the nature of the *first* rock that is found in place, even should that rock be covered with thirty or forty feet of sand or gravel, on the banks of rivers, or in valleys; for example, the city of Philadelphia stands on primitive rock, though at the Centre-square, thirty or forty feet of sand and gravel must be penetrated, before the Gneiss rock, which ascertains the formation, is found.

Beginning at the bay of Penobscot (to the northward and eastward of which most probably the primitive descends through a gradual transition to the secondary, and thus into the Independent coal formation, found in such abundance in Nova Scotia); and proceeding south, the sea coast is primitive to Boston, where the transition covers it as far as Rhode-Island.

ALLUVIAL FORMATION.

On the south east side of Long-Island the alluvial begins, occupying more than the half of that island; its western and northern boundaries are marked by a line passing near Amboy, Trenton, Philadelphia, Baltimore, Washington, Fredericksburg, Richmond, and Petersburg in Virginia, a little to the westward of Halifax, Smithfield, Aversborough and Parker's Ford on Pedee river, in North Carolina, west of Cambden near Columbia, Augusta on the Savannah river, Rocky Landing on the Oconee river, Fort Hawkins on the Oakmulgee river, Hawkinstown on Flint river, and running west, a little southerly, across the Chatahouchee, Alabama and Tombigby rivers, it joins the great alluvial bason of the Mississippi a little below the Natchez.

The ocean marks the eastern and southern limits of this extensive alluvial formation, above the level of which it rises considerably in the southern States, and falls to near the level of the sea, as it approaches the north.

Tide water in all the rivers from the Mississippi to the Roanoke stops at a distance from thirty to one hundred and twenty miles short of the western limits of the alluvial; from the Appomatox to the Delaware, the tide penetrates through the alluvial, and is only stopped by the primitive ridge.

The Hudson is the only river in the United States where the tide passes through the alluvial, primitive, transition, and into the secondary, in all the northern and eastern rivers, the tide runs a small distance into the primitive formation.

Through the whole of this alluvial formation, considerable deposits of shells are found; and a bank of shell limestone beginning in North Carolina, and running parallel to, and within the distance of from twenty to thirty miles of the edge of the primitive through South Carolina, Georgia, and part of the Mississippi Territory; in some places this bank is soft, with a large proportion of clay, in others, hard, with a sufficiency of the calcareous matter to be burned for lime, large fields of the same formation

by, or rather appears to cover a tongue of transition, which occupies progressively a diminishing width as far south as Dan river.

This secondary formation is interrupted after it passes Frederickstown, but begins again between Monocasy and Seneca creeks, the north eastern boundary crossing the Potomac, by the west of Centerville, touches the primitive near the Rappahannok, where it finishes. On the north west side it is bounded by the primitive, from some distance to the westward of Hartford, passing near Woodbury, and recommencing south of the Hudson, passing by Morristown, Germantown, etc. to the Delaware; after which it continues along the transition, by the east side of Reading, Grub's mines, Middletown, Fairfield, to near the Potomac, and recommencing at Noland's ferry, runs along the edge of the transition to the westward of Leesburg, Haymarket etc. to near the Rappahannock.

All this secondary appears to be the oldest red sandstone formation, though in some places about Leesburg, Reading etc. the red sandstone only serves as cement to a pudding, formed of limestone of transition, and other transition rock pebbles, with some quartz pebbles. Large beds of greenstone trap and wacke of different kinds, cover in many places this sandstone formation, and form the small hills, or long ridges which occur so frequently in it.

The stratification in most places runs from an east and west to a north east and south west course, and dips generally to the N. W. at an angle most frequently under 45 degrees from the horizon, covering both the primitive and transition formations, at every place where their junction could be examined; and in some places, such as the east side of the Hudson (where the action of the water had worn away the sandstone) the smooth water-worn primitive was covered with large rolled masses of greenstone trap to a considerable distance, the hardness and solidity of which had most probably survived the destruction of their sandstone foundation; may not similar derangements be one of the causes of the broken and unconnected state of this formation?

Prehnite and zeolite are found in the trap of this formation; considerable *deposits of magnetic iron ore* at Grubb's mines are enveloped, and have their circular layers intersected by greenstone trap, on a ridge of which this extensive cluster of iron ore appears to be placed.

Grey copper ore has been found in the red sandstone formation near Hartford and Washington in Connecticut; at Scheuyler's mines in Jersey, *copper pyrites* and *native copper* have been found. The metallic veins on Perkiomen creek, containing *copper pyrites*, *blende*, and *galena*, are in the same formation; running nearly north and south, across the east and west direction of the red sandstone; a small bed from an half to three inches thick of *brown* or *tile copper ore* is interspersed and follows the circular form of the iron beds at Grubb's mines.

Besides the sandstone formation, there is included within the described limits of the primitive, a bed of transition rocks, running nearly S. W. from the Delaware, to the Yadkin river, dipping generally to the south east 45 degrees or more from the horizon; its width is from two to fifteen miles, and runs from the west of Morrisville, to the east of Norristown, passes Lancaster, York, Hanover, Fredericktown, Bull run mountain, Milton, foot of Pig river, Martinsville, and finishes near Mount Pilot, between the Delaware and Rappahannock; it is partially covered by the red sandstone formation, and is in the shape of a long wedge, the thick end, touching the Delaware, and the sharp end, terminating at the Yadkin.

This range consists of beds of blue, grey, red and white small grained transition limestone, alternating with beds of *Grey wacke* and *Grey wacke-slate*; with granular quartzose rocks, and a great variety of transition rocks, not described or named in any treatise yet published; much of this limestone is intimately mixed with *Grey wacke-slate*, other portions of it contain so great a quantity of small grained sand, as to resemble *Dolomite*, and perhaps might with propriety be called the *transition Dolomite*, in many places veins and irregular masses of silex, variously coloured (mostly black) run through it, and considerable beds of fine grained white marble, fit for the statuary, occur.

Limestone spar runs in veins and detached masses, through the whole of this formation, both it, and the *grey wacke-slate* contain quantities of *cubic pyrites;* galena has likewise been found near Lancaster, and many veins of the *sulphate* of *barytes* traverse this formation, which runs about 25 to 30 miles south east, and nearly parallel to the great transition formation. A similar formation, about fifteen miles long, and two to three miles wide, occurs on the north fork of the Catabaw river, running along Linville and John's mountains, near to the Blue ridge; a bed of transition rock, commencing on Green pond mountain, Jersey, runs through Suckasunny plains, increasing in width as the primitive range decreases, until it joins the great transition formation between Easton and Reading. — On the west side of this partial transition formation, from the Potomac to the Cataba, between it and the great western transition range, a series of primitive rocks intervenes, something different from the common primitive, having the structure of *gneiss;* with little *mica*, the scales of which are detached and not contiguous; much *felspar,* rather granular than crystallized; *mica-slate*, with small quantities of *scaly mica*; clay-slate, rather soft and without lustre, the whole having a dull earthy fracture, and gritty texture, partaking of transition and primitive, but not properly belonging to either; this rock is always found on the edge of the primitive, before you come upon the transition, but no where in such quantities as in this range; there are many varieties of it, so that it imitates almost every species of the common primitive rocks, but differing from them, by having a dull earthy fracture, gritty texture, and little or no crystallization.

About ten or twelve miles west of Richmond, in Virginia, there is an *independent coal formation*, twenty to twenty five miles long, and about ten miles wide, it appears to be not far distant from the range of the red sandstone formation, it is situated in an oblong bason accompanied by whitish *free-stone, slaty clay*, etc. with *vegetable impressions,* as well as most of the other attendants of that formation; this bason lays upon, and is surrounded by primitive rocks. It is more than probable that within the limits of so large a mass of primitive, more partial formations of secondary rocks may be found.

A great variety of mineral substances is found in this primitive formation, such as *garnets* in the *granite*, from the size of a pin head to the head of a child; *staurotide*; *andalusite; epidote* in great abundance; *tremolite*; all the varieties of *magnesian rocks*; *emerald*, touching *graphic granite* and disseminated in the *granite* of a large extent of country; *adularia*; *tourmaline*; *hornblende; sulphate* of *barytes*; *arragonite* etc.

From the number already found, in proportion to the little research that has as yet been employed, there is every reason to suppose, that in so great an extent of crystalline formation, almost every mineral which has been discovered in similar situations on the ancient continents, will be found on this.

The metallic substances which are found in this primitive, are generally extensive like the formation. *Iron pyrites* run through vast fields, principally of *gneiss*, and *mica-slate*; *magnetic iron ore* forms vast beds, from ten to twelve feet thick, generally in a *hornblende* rock, occupying the higher elevations, as at Franconia, high lands of New-York; the Jerseys; Yellow and Iron mountain, in the west of North Carolina, etc. etc. Black, brown, and red *hematitic iron ores* are found in Connecticut and New-York, etc. *Crystals* of *octahedral iron ore* are disseminated in *granite* (some of which have polarity, as at Brunswick) and in many varieties of the *magnesian genus*; *black lead* exists in beds from six to twelve feet wide, traversing the States of New-York, Jersey, Virginia, Carolina, etc. *Native* and *grey copper ore* occur near Stanardsville and Nicholson's Gap, disseminated in a *hornblende* and *epidote rock*, bordering on the transition; *molybdena* is found at Brunswick, Maine; Chester, Pennsylvania; Virginia; North Carolina, etc. *Arsenical pyrites* have been discovered in large quantities in the district of Maine; *rutile*, and *menachanite* exist in a large bed, on the edge of the primitive near Sparta, in Jersey, having a large grained marble, with *menachanite* and *negrine* imbeded in it on one side, and *hornblende* rock on the other; this bed contains likewise large quantities of *blende*; *detached* pieces of *gold* have been found in the beds of some small streams in North Carolina and other places, apparently in a *quartz* rock. *Manganese* has been found in New York, North Carolina, etc. Near the confines of the red sandstone and primitive formations, a *white ore* of *Cobalt* has been worked above Middletown on the Connecticut river, and it is said near Morristown in New-Jersey.

The general nature of metallic repositories in this formation appears to be in beds, disseminated or lying in masses: when in beds (as the *magnetic iron ore*, and *black lead*) or disseminated as the *iron pyrites*, *octahedral iron ore*, *Molybdena* etc. they occur at intervals through the whole range of the formation; veins to any great extent have not yet been found in this formation.

TRANSITION FORMATION.

This extensive field of transition rocks, is limited on the S. E. side from a little to the eastward of lake Champlain, to near the river Alabama, by the N. W. boundary prescribed to the primitive rocks; on the N. W. side it touches the S. E. edge of the great secondary formations, in a line, that passes considerably to the westward of the dividing ridge, in Georgia, North Carolina, and part of Virginia, and runs near it in the northern part of that State, and to the eastward of it in the States of Pennsylvania and New-York.

This line of demarkation runs between the Alabama and Tombigby rivers, to the westward of the north fork of the Holstein river, until it joins the Alleghany mountains near the sulphur springs, along that dividing ridge to Bedford county in Pennsylvania, and from thence N. E. to the east side of the Catskill mountains on Hudson's river. This line of separation of the transition and secondary formations, is not so regularly and distinctly traced as in the other formations, many large valleys are formed of horizontal secondary limestone, full of shells, while the ridges on each side consists of transition rocks, etc. the two formations interlock, and are mixed in many places, so as to require much time and attention to reduce them to their regular and proper limits. It is however probable, that to the N. W. of the line here described, little or no transition will be found, although to the S. E. of it, partial formations of secondary may occur.

The breadth of this transition formation is generally from 20 to 40 miles, and the stratification runs from a north and south to a north east and south west direction, dipping generally to the N. W. at an angle in most places, under 45 degrees from the horizon. On the edge of the primitive; it, in some places, deviates from this general rule, and dips for a short distance to the south east. The most elevated ground is on the confines of North Carolina, and Georgia, along the S. E. limits to Maggotty Gap, descending towards the N. W. until it meets the secondary; from Magotty Gap; north easterly, the highest ground is on the north west side, sloping gradually towards the primitive, which ranges along its south east boundary.

The outline of the mountains of this formation, is almost a straight line, with few interruptions, bounding long parallel ridges of nearly the same height, declining gently towards the side, where the stratification dips from the horizon, and more precipitous on the opposite side, where the edge of the strata comes to the surface.

This formation is composed of a small-grained transition limestone, of all the shades of colour from white to dark blue, and in some places it is red, intimately mixed with grains of *grey wacke slate*, also of *lime spar* in veins, and disseminated; *siliceous flinty* veins and irregular masses, in many places there is an intimate mixture of small sand, so as to put on the appearance of *dolomite*, this is in beds from 50 to 5000 feet in width; it alternates with *grey wacke*, and *grey wacke slate*, a siliceous aggregate, having particles of a light blue colour, from the size of a pin head to that of an egg, disseminated, in some places in a cement of a slaty texture, and in others in a quartz cement; a fine sandstone cemented with quartz in large masses, often of a slaty structure, with small detached scales of *mica* intervening, and a great variety of other rocks, not described or named by any author, which from their composition and situation cannot be classed but with the transition.

The limestone, *grey wacke*, and *grey wacke slate*, generally occupy the vallies; the quartzose aggregates, the ridges; amongst which is that called the *millstone grit*; this must not be confounded with another rock, likewise denominated the *millstone grit*, which is a *small grained granite*, with much quartz, found in the primitive formation; there are many and extensive caves in the limestone of this formation, where the bones of many animals are found, as well as the remains of marine insects and shells.

Beds of *coal-blende*, accompanied by *alum slate* and *black chalk*, have been discovered in this formation on Rhode Island; the Leheigh and Susquehannah rivers; (a large body of *alum slate* which occurs on Jackson's river in Virginia is perhaps only a part of a similar formation;) *powerful* veins of the *sulphate* of *barytes* cross it, in many places it is granular, as that near Fincastle; or slaty, as in Buncomb county, North Carolina.

Iron and *lead* have as yet been the principal metals found in this formation; the *lead* in the form of *galena*, in clusters, or what the Germans call *stock-werck*, as at the lead mines on New river, Wythe county, Virginia; the *iron* is disseminated in the form of pyrites; hematitic and *magnetic iron ores*, and considerable quantities of the *sparry iron ore* occur in beds and they are likewise disseminated in the limestone.

SECONDARY FORMATION.

The south east limit of this extensive formation is bounded by the irregular border of the transition, from between the Alabama and Tombigby rivers, to the Catskill mountains. On the north west side it follows the shore of the great lakes, and loses itself in the alluvial of the great bason of the Mississippi, occupying a surface from 200 to 500 miles in breadth.

Its greatest elevation is on the south east boundary, from which it falls down, almost imperceptibly, to the north west and mingles with the alluvial of the Mississippi, having an outline of mountain, straight and regular, bounding long and parallel ranges of a gradually diminishing height as they approach the N. W. limits. An almost horizontal stratification, or the strata waving with the inequalities of the surface, distinguishes this from the two preceding formations.

Immense beds of secondary limestone, of all the shades from light blue to black, intercepted in some places by extensive tracts of sandstone and other secondary aggregates, appear to constitute the foundation of this formation, on which reposes that great and valuable formation, called by Werner the *independent coal formation*, extending from the head waters of the Ohio, with some interruptions, all the way to the waters of the Tombigby, accompanied by its several usual attendants, *slaty clay* and *freestone* with vegetable impressions etc. but *in no instance* that I have seen or heard of, is it *covered* or does it *alternate* with any rock resembling *basalt*, or indeed any of those called the newest *flœtz trap formation*.

Along the S. E. boundary, not far from the transition, a *rock-salt* and *gypsum* formation has been found; on the north fork of Holstein not far from Abington, and on the same line south west from that in Green county and Pidgeon river, State of Tennessee, it is said considerable quantities of *gypsum* have been discovered; from which, and the numerous salt licks and salt springs which are found in the same range, as far north as lake Oneida, it is probable, that this formation is on the same great scale, which is common to all the other formations on this continent: at least rational analogy supports the supposition, and we may hope one day to find, in abundance, those two most useful substances, which are generally found mixed or near each other in all countries that have been carefully examined.

The metallic substances which have been already found in this formation, are *iron pyrites*, disseminated, both in the coal and limestone; *iron ores*, consisting principally of *brown*, *sparry* and *clay iron stone*, in beds; *galena*, whether in veins or beds is not acertained. The large deposits of *galena* at St. Louis on the Mississippi, have been described as detached pieces, found covered by the alluvial of the river, of course not in place; all the large specimens which I have seen, were rolled masses, this rather confirms the opinion, that they were not found in their original places.

On the great Kanawa river, near the mouth of Elk river, there is a large mass of black (I suppose vegetable) earth, so soft, as to be penetrated by a pole from 10 to 15 feet deep; out of the hole thus made, a stream of *hydrogene gas* frequently issues, which will burn for some time. In the vicinity of this place there are *constant streams* of that *gas*, which it is said when once lighted will burn for weeks, a careful examination of this place, would probably throw some light on the formation of coal and other combustible substances, found in great abundance in this formation.

From near Kingston on lake Ontario, to some distance below Quebec (as far as I can recollect, not having my note-book here) it is principally primitive; and from all the information I could collect, that great mass of continent, lying to the north of the 46th degree of latitude, for a considerable distance to the west, consists mostly of the same formation; from which it is probable, that on this continent, as well as in Europe and Asia, the northern regions are principally occupied by the primitive formation.

The foregoing observations are the result of many former excursions in the United States, and a knowledge lately acquired by crossing the dividing line of the principal formations, in 15 or 20 different places, from the Hudson to Flint river; as well as from the information of intelligent men, whose situation and experience, make the nature of the place near which they live familiar to them; nor has the informations that could be acquired from specimens, when the locality was accurately marked, been neglected, nor the remarks of judicious travellers.

Notwithstanding the various sources of information, much of the accuracy of the outlines of separation between the formations, must depend on rational analogy; for instance, between Maggotty and Rockfish Gaps, a distance of upwards of sixty miles, I found in six different places which were examined, that the summit of the blue ridge divided the primitive and transition formations: I of course concluded, that in places where I had not examined (or which from their nature could not be examined) the blue ridge from Maggotty Gap to Rockfish Gap, was the boundary of the two formations.

The map of the United States on which those divisions are delineated, though I believe the best yet published, is exceedingly defective in the situation and range of mountains, courses and windings of rivers etc. but as the specimens which I collected every half mile, as well as the boundaries of the different formations, are from the positive situations of the different places, the relative arrangement of the map cannot change them, but must become more exact, as the geographical part is made more accurate.

In adopting the nomenclature of Werner, I do not mean to enter into the origin or first creation of the different substances, or into the nature and properties of the agents which may have subsequently modified or changed the appearance and form of those substances; I am equally ignorant of the relative periods of time in which those modifications or changes may have taken place; such speculations are beyond my range, and pass the limits of my inquiries. All that I mean by a formation, is a mass of substances (whether adhesive, as rocks; or separate, as sand and gravel;) uniform and similar in their structure and relative position, occupying extensive ranges, with few or no interpolations of the rocks belonging to another series, class, or formation; and even where such partial mixtures apparently take place, a careful examination will seldom fail to explain the phenomenon without shaking the general principle, or making it a serious exception to the rule.

In the account of the metals and minerals, it is not intended to give a list of the number, extent and riches of the metallic and mineral repositories; the nature of the ore or mineral, with a description of its relative position, in regard to the surrounding substances, is the principal object of geology, which cannot be understood by microscopic investigation, or the minute analysis of isolated rocks and detached masses; this would be like the portrait painter dwelling on the accidental pimple of a fine face: the geologist must endeavour to seize the great and prominent outlines of nature; he should acquaint himself with her general laws, rather than study her accidental deviations, or magnify the number and extent of the supposed exceptions, which most frequently cease to be so when judiciously examined.

Should this hasty and imperfect sketch, call forth the attention of those possessed of more talents and industry for the accurate investigation of this interesting subject, the views of the writer will be fully accomplished.

N. B. — The map referred to in page 127, is that published by Bradley, a reduction from which was intended to be engraved for this volume. Owing to the absence of the author of the memoir, a drawing of Lewis was used, which was compiled from materials prior to those used by Bradley — in which the mountains are more erroneously laid down, but which still sufficiently illustrates the memoir.

Maclure translated his important memoir into French, and it was published by his friend, the mineralogist J. C. Delamétherie, in his *Journal de Physique, de Chimie, d'Histoire Naturelle, et des Arts*, tome LXIX, p. 201; Paris, Septembre an 1809, accompained by a letter from the Author, which is as follows.

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(Extrait d'une Lettre de M. William Maclure, Membre de la Société Philosophique de Philadelphie, à J. C. Delamétherie, sur la Géologie des Etats-Unis.)

Monsieur et cher ami!

Je vous ai écrit par le navire *le Mentor*, et vous ai envoyé des observations sur la géologie de ce pays; je vous ai adressé en même temps une petite caisse de minéraux de ces cantons, avec la Carte Géologique sur laquelle j'ai enluminé, en diverses couleurs, les différentes natures de terrains jusqu'à Pénobscot dans le Nord. Au-delà, depuis le Saint-Laurent et les Lacs, jusqu'au flux et reflux de la mer, tout le terrain est *de formation primitive*; car sur ce continent, comme sur celui de l'Europe, les roches primitives occupent la plus grande partie des régions septentrionales.

La variété confuse et fatigante des diverses roches dans presque toutes les parties de l'Europe où j'ai eu l'occasion de les examiner, lasse la patience, et met en défaut toutes conjectures; au lieu que sur ce continent-ci, on peut raisonner *a priori*, et conclure, sans grand risque de se tromper, qu'en tel et tel lieu, telles et telles roches se trouveront.

Il me paraît que par l'arrangement des substances sur ce continent, elles ont toutes les caractères qui prouvent qu'elles sont des dépôts formés originairement par les eaux dans un état de repos; et que les eaux courantes, ni aucuns autres agens actifs, tels que le feu ou l'air sous la forme de volcans ou de tremblements de terre, n'ont jusqu'à présent changé ou dérangé matériellement l'ordre de cette disposition tranquille.

Nos rivières (quoique leurs sources ne sont pas si éloignées que celles d'Europe) sont remplies de chutes (ou cataractes) et d'obstructions, jusqu'aux bords même de l'Océan, et ne paraissent pas avoir eu un cours suffisamment long pour s'être formé des lits.

Nos montagnes conséquemment ne présentent pas ces précipices escarpés, si communs aux élévations européennes. Nous n'y trouvons pas non plus autant de profondes et étroites vallées formées par les torrents, vallées qui sont le séjour des goîtres et des cretins. Cette maladie, quoique encore rare, existe dans les vallées qui ont été les premières habitées; la nature y a eu le temps de joindre aux imperfections locales, les imperfections héréditaires. Comme j'ai trouvé le *goître* dans presque toutes les vallées étroites et profondes de tous les pays où j'ai été, excepté l'Espagne, je conclus qu'aussitôt que nos vallées des pays montagneux seront habitées, nous l'aurons de même, mais non pas peut-être au même degré d'intensité, ni si fréquemment que dans d'autres pays où les vallées sont plus profondes et plus étroites.

Quoique nous ayons d'immenses étendues de houille (ou charbon de terre) derrière notre calcaire secondaire, et qui occupent quelques-unes de nos landes calcaires, dont beaucoup approchent, si elles ne sont pas entièrement semblables à ce que M. Werner nomme la formation de houille indépendante (*independent coal formation*), néanmoins aucunes des roches d'une origine douteuse, décrites par Werner, comme se trouvant dans cette formation, n'ont encore été trouvées dans les formations de houille des Etats-Unis. Point de *grunstein* (cornéenne), comme il le nomme, avec l'augite (volcanite Delamétherie) et l'olivine. Point

d'amygdaloïde ni de thon-porphyré, dont l'origine cause l'une des grandes disputes entre les neptuniens et les vulcanistes.

Toute cette série de roches décrites par Werner, sous la dénomination de la dernière formation *trappéenne (flœtz-trapp)*, manque dans ce pays; pas un seul morceau de vrai basalte n'a encore été trouvé en-deçà du Mississippi, ni même à plusieurs centaines de milles à l'ouest de cette rivière. Nous n'avons donc point de ces roches dont la formation occasionne la dispute entre les Neptuniens et les Plutoniens; par conséquent rien, d'après les opinions des uns et des autres, d'origine volcanique. Quelques morceaux de *scories* et de lave poreuse ont été apportés des montagnes qui divisent les eaux du Mississippi et ces rivières qui se versent dans la mer Pacifique. On a trouvé de la pierre ponce près la source du Mississippi. Il est probable que cette partie de cette grande chaîne est volcanique, et il n'est pas sans vraisemblance que ces montagnes soient une continuation de celles du Mexique et des chaînes de l'Amérique méridionale.

A l'ouest des Monts Alleghanies, le grand bassin du Mississippi est secondaire (*alluvial*) d'alluvion, et la chaîne de montagnes qui sépare les eaux du Mississippi d'avec les rivières sur l'Atlantique, est principalement composée de calcaire secondaire avec coquillages.

Comme l'étude de la géologie commence un peu à passer de mode chez vous, à cause de la différence dans la structure des diverses chaînes de montagnes qui ont été examinées, je me suis attaché à donner mes *vues* actuelles sur cet objet, parce qu'elles sont fondées sur mes propres observations, jointes à l'examen que j'ai fait d'échantillons rapportés par d'autres; et quoiqu'en général j'aie mis beaucoup d'exactitude dans mes descriptions, néanmoins on trouvera sans doute des exceptions locales nombreuses, quand on fera un examen plus particulier et plus précis de ces contrées; mais ceci doit être le résultat du temps. Je suis cependant porté à croire dans ce moment, que sous peu d'années nous aurons une connaissance plus complète de la géologie de ce continent, que vous n'en avez de celle du continent de l'Europe.

This memoir is the starting point for American geology; the observations commenced so successfully by Maclure, have been continued and completed by others, and the geology of the United States is now nearly as well known as that of two thirds of Europe.

It would not be without interest to the reader, could I notice in detail all the geological memoirs that have been published on North America; but the limits of this *Synopsis* forbid such an extension; and besides it must be remembered that several of the improvements upon Maclure's classification have been recognized as erroneous; for example, several geologists have pointed out the existence of the Jurassic formation in the western part of the State of New York, in Ohio, Tennessee, the valley of the Connecticut river, New Jersey, Virginia, and North Carolina. For these reasons I shall only give the dates of those discoveries that I consider certainly established.

The first change in Maclure's classification was made by Edward Hitchcock, who, as far back as 1820, identified the Red Sandstone formation of the Connecticut river valley with the *New Red Sandstone* epoch (See: *The American Journal of Science and Arts*, vol. II, page 146: New Haven, 1820; and vol. VI, page 39, New Haven, 1824.). About the same time Edwin James, the geologist of Major Long's expedition to the Rocky Mountains, also recognized the New Red Sandstone formation in the Prairies, along the Canadian and Arkansas rivers, calling it: *Red Sandstone* and *Argillaceous or Grey Sandstone*, and synchronizing it with the *Rothetodtliegende* and *Bunter Sandstein* of Germany; but he considered it as *inferior* to the *Coal strata*, as Weaver and other English geologists did at that time (See: *Expedition to the Rocky Mountains during the years* 1819 *and* 1820, *under the command of Major S. H. Long*, compiled by Edwin James; vol. II, p. 399. 1823, Philadelphia.). Thus Hitchcock and James were the *first* to recognize the *New Red Sandstone* in North America.

The knowledge of the geographical extension of the *New Red* is due to several geologists: to Dr. Charles T. Jackson and Francis Alger — Nova Scotia, 1828 —; to Colonel F. H. Baddeley, Royal Engineers — the Magdalen Islands and Bryons Island, 1831–32 —; to Dr. D. Houghton — Lake Superior, 1843 —; to J. W. Dawson — Prince Edward's Island, 1848 —; and finally to Prof. Emmons — North Carolina, Virginia, and New Jersey: 1855–57.

The second modification of Maclure's classification was made in 1828 by L. Vanuxem[1]). Maclure considered all the rocks covering the Atlantic coast of the United States as forming but a single deposit, and belonging to one age, the *Alluvial*. Vanuxem was the *first* to perceive the confusion existing upon this subject, and American geology owes to him the distinction between the Secondary, Tertiary, and Quaternary rocks, and also the discovery of the Cretaceous rocks.

I give below Vanuxem's *diagram*, or *Tabular view* of these three formations; arranged, as he says, «according to what I believe to be their *relative geological position*».

Modern Alluvial.	Vegetable mould. River Alluvium.
Ancient Alluvial.	White siliceous sand. Red earth.
Tertiary.	Beds of Ostreæ. . . . . . . Mass of Limestone, Buhrstone, Sand and Clay.
Secondary.	Lignite. Marl of New Jersey and Delaware.

«*Secondary formation.* — None of the characteristic fossil shells of this formation — Marl of New Jersey and Delaware — have ever been found in the overlying Tertiary deposits of the Southern States; nor have they been observed to characterize any formation in Europe more modern than the chalk; the shells — *Terebratula*, *Gryphæa*, *Exogyra*, *Ammonites*, *Baculites*, and *Belemnites*[a]) — therefore being generically analogous to those of the *chalk*, the *two formations* are to be considered as *contemporaneous*».

«*Tertiary formation.* — This great region — from the Island of Nantucket to the southern part of the Peninsula of Maryland — is characterized by *littoral* shells, *analogous* to those of the *Tertiary deposits of the Paris and English basins*: unlike the Secondary, this formation contains a vast number of genera — *Ostrea*, *Pecten*, *Arca*, *Pectunculus*, *Turritella*, *Buccinum*, *Venus*, *Mactra*, *Natica*, *Tellina*, *Nucula*, *Venericardia*, *Chama*, *Calyptrea*, *Fusus*, *Panopæa*, *Serpula*, *Dentalium*, *Cerithium*, *Oliva*, *Lucina*, *Perna*,

[a]) «I have examined the extensive collection of the characteristic fossil shells of New Jersey and Delaware, in «the collection of Dr. Morton, as well as my own collection from the same localities, and consider them as affording unequivocal evidence of the correctness of the geological position which *I have assigned* to this formation. I «refer to Dr. Morton's paper (which follows this) for the specific descriptions of these fossils». — L. Vanuxem.

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1) Lardner Vanuxem was born at Philadelphia, where his father was an eminent merchant. He was a pupil at the mining school at Paris, in 1817 — 18 and 19, where he heard the lectures of Cuvier, l'abbé Hauy, and Alex. Brongniart. His training under such teachers accounts for his subsequent success as a geological discoverer, and it is easy to see in his *Tabular view* of the Secondary, Tertiary, and Alluvial rocks of the United States, and also of the Transition rocks of New York, the effect of the lessons of Cuvier and Brongniart on the *Géologie des environs de Paris*. Vanuxem died the 25th January, 1848, at his farm near Bristol, Pennsylvania.

etc. — of which few or none are extinct; indeed, very many of the species differ but little from the littoral shells now existing on various parts of the American coast».

« In fact, so strikingly different are the fossil reliquiæ of the two formations of which we have spoken, that it is much to be wondered at that they have ever been considered as contemporaneous, especially since the study of fossil conchology has afforded so many additional facilities for collecting and comparing geological facts. In truth, the Secondary and Tertiary formations of America appear to have no analogous features: the former is remarkably homogeneous in its earthy mass, and contains very few genera and species of shells, which are all of the *Pelagii* class. Its fossils, wherever observed, whether in New Jersey or in South Carolina, have hitherto been found not only generically, but even specifically the same, and there can be no doubt, that, wherever it is penetrated, its productions will be found characterized by the same remarkable simplicity. On the contrary, the shells of the Tertiary, as we have remarked above, are vastly abundant in genera and species, all of which are *littoral*, and disposed in a matrix which presents almost every variety of earthy composition».

« *Alluvial formation.* — This consists of two depositions, which may be designated as the *Ancient* and the *Modern Alluvial*».

« The first of these, or the *Ancient Alluvial*, is chiefly composed of *Red earth*. This earth is pretty uniform in its characters, consisting of sand, with a minute portion of clay, coloured by red oxide of iron: its inferior parts often contain pebbles, etc».

« This deposition occupies the highest elevations above the Secondary and Tertiary classes, and consequently could not have been formed by our existing rivers. It is entirely unmixed with the Tertiary, and destitute of the fossils which characterize the latter; it must therefore be considered as distinct from it, at the same time that it is unlike the *modern* alluvial, whose origin is clearly attributable to the overflow and inundation of our rivers.»

« The *Alluvial proper*, or *Modern Alluvial,* is well characterized in the Southern States, in consequence of its being thrown up against some one of the masses already spoken of, and there appearing as the *débris* of the rivers which traverse those States; the greater part of which, even at this period, contribute largely to this deposition. The two alluvials of the Northern States are not so well defined, in consequence of the similarity of their products; for there is great difficulty in distinguishing even between the Ancient Alluvial and the Tertiary in those States where the *Red earth* is replaced by other matter, unless shells are present. — Finally, it is *certain that all the bones of mammoth*, and other mammiferous terrene quadrupeds found in this region, *belong to the two Alluvials*». (Extract from *Geological Observations on the Secondary, Tertiary, and Alluvial formations of the Atlantic Coast of the United States of America. Arranged from the Notes of* Lardner Vanuxem, *by* S. G. Morton. — Read before the Academy of Natural Sciences of Philadelphia, January 8, 1828.)

Dr. Morton never claimed the honor of being the first discoverer of the Cretaceous formation in America; his only merit was the arrangement of the materials collected by Vanuxem; and in a note at the foot of the first page of the memoir just cited, Morton says; « The friends of Mr. Va- « nuxem are aware that he lately passed a few days in this city (Philadelphia), prior to his em- « barkation for Mexico: during that period, his time was so engrossed with preparatory arrange- « ments, and with the publication of a chemical essay, that *he requested me to arrange the materials* « *of the following paper.* After I had finished the manuscript, we examined it together, and it is now « published as corrected by the *author*. — S. G. M. — January 5, 1828. »

Morton's celebrated *Synopsis of the Organic Remains of the Cretaceous group of the United States*, Philadelphia, 1834; begins as follows: « *Ferruginous Sand.* Mr. Vanuxem was the *first* to detect the « analogy between this deposit and the chalk formation of Europe; etc.» (See page 7.)

Say, Morton, Conrad, Lea, and others, have described the Cretaceous fossils of North America, and shown the justice of Vanuxem's views, but they only extended his discoveries without materially changing them. It was Vanuxem, an excellent practical geologist, who pointed out the difficulties, and the others followed the path that he was the *first* to indicate and explore. The additions made to Vanuxem's divisions have not always been very successful; thus Morton and Conrad divided the Cretaceous rocks into three parts, the *Upper*, *Middle*, and *Lower*; but Lyell has proved that the Upper division of Morton, embracing the White Limestone of South Carolina and Georgia, and the Numulitic Limestone of Alabama, belongs to the Eocene period of the Tertiary formation. Since Vanuxem, Sir Charles Lyell is the practical geologist who has contributed the most towards the perfection of the classification of the Cretaceous, Tertiary, and Quaternary strata, and the true limits of these rocks in the States bordering on the Atlantic, will be found in his memoirs entitled: *On the Tertiary formations and their connexion with the Chalk in Virginia and other parts of the United States* (See: *Proceedings of the Geological Society of London*, vol. III, page 735. London, 1842.). — *On the Cretaceous strata of New Jersey and other parts of the United States bordering the Atlantic. — On the Miocene Tertiary strata of Maryland, Virginia, North and South Carolina. — On the White Limestone and other Eocene or older Tertiary formations of Virginia, South Carolina, and Georgia.* (See: *The Quarterly Journal of the Geological Society of London*, vol. I, 1845.)

Since the discoveries of Vanuxem and Lyell, the geologists who have done the most to make known the geographical extension of the Cretaceous and Tertiary rocks, are: Thomas Nuttall — Alabama, Arkansas, and the Great Bend of the Missouri, 1832 —; Dr. Pitcher, U. S. A. — Alabama, Louisiana, Texas, and Arkansas, 1832-33 —; Nicolet — Upper Missouri, 1842 —; Ferdinand Roemer — Texas, 1848-49 —; Evans — Mauvaises Terres of Nebraska, 1849 —; Tyson and Dr. Trask — California, 1853-54 —; Dr. F. V. Hayden — the Dacota country, 1855.

Maclure regarded the Old Red Sandstone and the Carboniferous formation as belonging to the Secondary rocks, but in this he was mistaken, and we have seen also that his *Old Red* was recognized by Hitchcock as *New Red*. It is true that at that time, 1809, the Paleozoic strata were entirely unknown, and there were only a few notions relating to the *Mountain Limestone* of Derbyshire, England (See: *A Delineation of the Strata of Derbyshire*, by White Watson; Sheffield 1811; and also; *Figures and Descriptions of Petrifications collected in Derbyshire*, by William Martin; Wigan, 1793.).

Thomas Nuttall, the learned botanist, recognized the *Mountain Limestone* throughout the great calcareous platform of the Mississippi valley, as early as 1820 (See: *Observations on the Geological Structure of the Valley of the Mississippi*, Philadelphia, 1821.); and Eaton, in publications ranging from 1818 to 1832, tried to classify the sedimentary rocks of New York State; although he was generally not very successful in his determination of the relative ages of the strata, his works have contributed much to the development of American geology. It is, however, still to Vanuxem that we are indebted for the knowledge that the *Secondary* rocks of Maclure are *Transition* or *Paleozoic* rocks, and he more than any other geologist has helped to analyze and class them in their natural order. Vanuxem says in his *First Annual Report of the Geological Survey of the fourth district of the State of New York*, pages 189 and 190; Albany, 1837: «In 1827 and 1828, I travelled over a part «of Western New York, and a considerable portion of the States of Ohio, Kentucky, Tennessee, «and Virginia. The extensive collection of fossils, rocks, and minerals I then made, fully satis-

«fied me as to the greater geological antiquity of all our great horizontal western region than had «been given to it. This opinion was communicated to Professor Cleaveland, and was published «in *The American Journal of Science and Arts*, — vol. XVI, p. 254 — for 1829. Since then, all other in- «formation collected of the parts examined, has only tended to strengthen my conviction of their «*Transition* characters.»

Four years after, George E. Hayes of Buffalo recognized the correctness of Vanuxem's views, and in his *Remarks on the Geology of Western New York*, he says: «I cannot resist the conclusion, «that all these rocks are older than the Secondary formation, and owe their origin to that train «of causes, whatever they were, that produced the *Transition rocks.*» (See: *Silliman's Journal*, vol. XXXI, page 242; New Haven, 1837.)

Some years later, Vanuxem, together with Conrad, Emmons, and Mather, classed in detail all the Paleozoic or Transition strata of the State of New York; but I will speak of this, in connexion with the *Geological Survey* of New York.

The *Old Red Sandstone* was not recognized with certitude in America until later than 1831, and Richard Cowling Taylor, a pupil of the celebrated «*Strata Smith*», was the first to point out the true position of the *Old Red Sandstone* of Pennsylvania, *underlying* the *Coal Measures*. (See: *On the Carboniferous series of the United States of North America, as to the actual position of the Old Red Sandstone in America. — Philosophical Magazine.* London.)

The Carboniferous rocks have been studied chiefly by Eaton, Hitchcock, Silliman, Hildreth, and Taylor,[1]) who from 1825 to 35 published numerous and important documents on the Coal Measures of Pennsylvania and Ohio. Since then many geologists have studied this gigantic American formation, and the labors of Captain Bayfield, in New Brunswick, Nova Scotia, and Newfoundland; Richard Brown, in Cape Breton Island; Dawson, in Nova Scotia and New Brunswick; Gesner and Logan, in New Brunswick; Hitchcock and Jackson, in Massachussets and Rhode Island; Henry Rogers and Lesley, in Pennsylvania; William Rogers, in Virginia; D. D. Owen, in Illinois, Indiana, Iowa, Missouri, Kentucky; Troost and Safford, in Tennessee; Tuomey, in Alabama; Swallow and Shumard, in Missouri and Arkansas; etc., are too well known to need further mention.

The Jurassic formation is the last of the principal geological groups that has been found in the United States; see what is said of its discovery, pages 17, 18, and 19 of this work.

Geology is so well considered and appreciated in North America, that the Civil Authorities of the States and Provinces, and even the Federal Government, have instituted *Geological Surveys.* The first one was undertaken by North Carolina, in 1824 and 25, and was under the charge of Prof. Olmsted. Since then almost all the States, Territories, and the British Provinces, have organized surveys, some of which are completed, and others are still in the course of execution. The two most remarkable, both for their results and the difficulties surmounted, are: the *Geological Survey of*

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[1]) Richard Cowling Taylor was born at Hinton, Suffolk, England, 18th Jan. 1789; he was a prominent mining engineer, and had the good fortune to be engaged in some engineering with the *Father of English Geology*, William Smith. Taylor went to reside in the United States, near the year 1829, and until his death at Philadelphia, in 1851; he was occupied especially in Coal mining. The chief work of R. C. Taylor is his celebrated „*Statistics of Coal*", published in 1848, which has become a standard work of reference.

the State of New York, made under Legislative Authority; and the *Geological Survey of Wisconsin, Iowa, and Minnesota*, made by order of the United States Treasury Department. The survey of New York was accomplished between 1836 and 1842, and that of the Upper Mississippi region between 1839 and 1851. When the survey of the State of New York was commenced, the Transition strata were not known in detail; Vanuxem considered all the stratified rocks in this State as belonging to the Transition epoch; and Taylor had found the Old Red Sandstone in the environs of Blossburg, Pennsylvania; this was the state of knowledge on that subject. The mission, then, of this survey was to make known the Transition strata of the New World in detail. The State of New York was divided into four districts; the first including the City of New York and the town of Schoharie; the second, the northern part of the State, with the villages of Potsdam and Chazy; the third, the Mohawk valley, with Trenton falls and Utica; and the fourth comprehending the western part of the State, with the falls of Seneca, Rochester, and Niagara. The four geologists appointed in 1836, were: William W. Mather for the first district, Professor E. Emmons for the second, T. A. Conrad for the third, and Lardner Vanuxem for the fourth. The FIRST ANNUAL REPORT was dated 11th Febr. 1837, and in the part relating to the *third district*, by T. A. Conrad, the following divisions are found (see, page 158, etc.):

Gneiss.

Section I.
1. *Calcareous sandstone* of the Mohawk valley, or *Calciferous sandrock* of Prof. Eaton.
2. *Bastard limestone*, or *sparry limestone* of Prof. Eaton.
3. *Gray sparry limestone* of the Mohawk valley.
4. *Blue fœtid limestones and shales of Trenton falls.*

Section II.
1. *Gray sandstones and shales of Salmon river.*
2. *Red or Variegated sandstone of Niagara river.*
3. *Red oxide of iron and associated strata*, or *ferriferous slate* of Professor Eaton.

Section III. *Onondaga limestone series.*

Section IV. *Shales of the superior series*, or *pyritiferous rocks* of Professor Eaton.

In the reports of the first, second, and fourth districts, there is no attempt at the classification of strata, although it is probable Vanuxem had already classed in a series the rocks of the fourth district. In 1837, a change was made in the arrangements for the survey, Conrad was named paleontologist for the whole State, Vanuxem took charge of the third district, and was replaced in the fourth by James Hall, who had hitherto been employed by Professor E. Emmons as an assistant in studying the *iron ores* of the northern district.

The SECOND ANNUAL REPORT, dated Albany Febr. 20th 1838, contains in the part devoted to the *second district*, by Emmons p. 214 etc., the first description and denomination of the *Potsdam Sandstone*, where it is called *Sandstone of Potsdam* of St Lawrence County. In that of the *third district*, now under the charge of Vanuxem, page 282 etc., is the following series, beginning with the lowest in the ascending order:

Gneiss.
Calciferous sandrock.
Birdseye limestone.
Trenton limestone.
Black shale.
Green shale and its sandstone.
Millstone grit. ☞

☞ *Protean group.*
Red shale.
Water limes.
Upper limestone.
White sandstone.
Pyritiferous rock.

In the report of the *fourth district*, then under the charge of Hall, the following series is found, page 294 etc.,

Red marl and Sandstone.
Argillaceous and Calcareous shales of the Genesee and Niagara rivers.
Argillaceous iron ore.
Calcareous shale.
Geodiferous and Bituminous limestone.
Gypseous marl and slates.
Carboniferous or Mountain limestone.

which only reproduces in part the series of Conrad published the year before for the *third district*.

The THIRD ANNUAL REPORT is dated Albany Febr. 23[d], 1839, and in the *Paleontological Department*, by T. A. Conrad, is *the first complete tabular view* of the strata of the State of New York, page 62 and 63. I copy it here *verbatim*.

TABLE OF FORMATIONS, SHOWING THE ORDER OF SUPERPOSITION, AND SOME CHARACTERISTIC FOSSILS OF THE TRANSITION STRATA.

10.	Carboniferous strata, (in Pennsylvania,)	*Euomphalus catillus; Delthyris trigonalis, D. cuspidatus; Producta scotica, P. sulcata, P. scabricula, P. hemispherica; Goniatites minuta, G. Henslowi; Calamopora polymorpha; Amplexus coralloides.*

ROCKS OF NEW YORK.

OLD RED SANDSTONE GROUP, (*Murchison.*)

9.	*Old Red Sandstone?* Olive Sandstone, (organic remains undetermined, except a few land plants, very rare.	
8.	Dark and coloured shales, ...	*Dipleura Dekayi; Cryphæus Boothii; Calymene Rowi; Pterinea fasciculata, P. concentrica; Posidonia lirata; Delthyris distans;* (Sow.) *Lima macroptera; Cyrtoceras maximum.*
	Black slate, ...	*Posidonia.*

MEDIAL SILURIAN STRATA.

7.	Gray Brachiopodous sandstone, ...	*Atrypa elongata; Delthyris arenosa.*
	Helderberg sandstones, ...	*Fucoides cauda-galli.*
	Helderberg limestones, ...	*Asaphus micrurus, A. selenurus; Calymene bufo; Cryphæus calliteles; Calymene anchiops; Atrypa prisca, A. aspera, A. Wilsoni; Pileopsis tubifer; Strophomena rugosa, S. tuberulifera; Atrypa concentrica; Calamopora fibrosa; Cyathophyllum ceratites, C. helianthoides.*
	Second Pentamerus limestone, ...	*Pentamerus Knightii; Euomphalus profundus.*
6.	Gypseous shales, ...	*Eurypterus remipes.*
	Rochester shales, ...	*Asaphus caudatus; Platynotus Boltoni; Trimerus delphinocephalus; Orthis elegans; Strophomena elliptica; Delthyris lineatus; Caryocrinus loricatus, C. ornatus.*
	Pentamerus limestone, ...	*Pentamerus elongatus, (P. oblongus?)*
5.	Green slate, lenticular iron ore, etc. . . .	Undetermined.
4.	Niagara sandstone, (red,)	*Fucoides Harlani; Dictuolites Beckii; Lingula cuneata.*

Lower Silurian System.

3.	Salmon river sandstone, olive.	*Pterinea carinata*, Conr. *P. plumiata*, *P. modiolaris*; *Cyrtolites ornatus*.
	* Green slate.	*Agnostus pisiformis*.
	Gray crystalline limestone	Group of the Trenton limestone.
2.	Trenton limestone and slate. . .	*Cryptolithus tessellatus*, *Trinucleus*, *Asaphus tuberculatus*, *Calymene Blumenbachii*, *Isotelus Gigas*, *Orthis testudinaria*, *Strophomena alternata*, *Pleurotomaria cordiformis*, *Orthoceras striatum*, *Trocholites ammonius*, *Columnaria alveolata*, *Trematis*, *Fucoides* ... Graptolites.
	Mohawk limestone	*Orthoceras* ...
	Gray limestone with quartz veins	*Fucoides demissus*.
	Gray calciferous sandstone	*Lingula acuminata*.

Cambrian System. Taconic.

1.	Olive sandstone and slate	*Fucoides* ... Brong.
	Variegated sandstone, Potsdam sandstone of Emmons	*Dictyolites* ...

Primary.

Gneiss, etc.

* The position of the rock with Agnostus was determined by Mr. Vanuxem.

In this report, Vanuxem employs for the first time the denominations, *Oriskany Sandstone*, p. 272; *Seneca Limestone*, page 275; *Tully Limestone*, page 276. Hall, in his report of the fourth district, employs for the first time the denominations, *Marcellus Shales*, page 296; *Ludlowville Shales* and *Moscow Shales*, page 299; and *Chemung Group*, page 302.

Finally, in the FOURTH ANNUAL REPORT, dated Albany, Jan. 26, 1840, Mather describes and names the *Hudson Slate Group*, page 254 etc., and Vanuxem gives the following series of strata, etc., page 380 and following:

Potsdam sandstone.
Calciferous sandrock.
Fucoidal layer.
Mohawk limestone.
Bird's eye limestone.
Trenton limestone.
Black slate or shale.
Frankfort slate.
Pulaski shales.
Salmon river sandstone.
Medina sandstone.
Oneida conglomerate.
Protean group.
Onondaga salt group.
Manlius water lime group.
Pentamerus limestone.
Delthyris shaly limestone.
Encrinal limestone. ZZ
ZZ *Oriskany sandstone.*
Fucoides Cauda-galli.
Schoharie grit.
Onondaga limestone.
Corniferous limestone.
Seneca limestone.
Marcellus shales.
Upper shales of Marcellus.
Skaneateles shales.
Hamilton group.
Moscow shales.
Tully limestone.
Genesee slate.
Sherburne flagstone.
Ithaca group.
Chemung group.
Montrose sandstone.

This series of strata in the *third district*, is a *more complete classification* of the sedimentary Transition rocks than had until that time been made.

Hall gives, pages 453, 454, and 455, a *table* showing the series of rocks in the *fourth district*, but as this table is almost wholly a reproduction of those previously published by Vanuxem and Conrad, it is needless to repeat it here.

By comparing their observations, the geologists and the paleontologist for the State of New York agreed upon the following series for the *final classification* of the Paleozoic strata of New York, which was published in the FINAL REPORT, edition in 4°; Albany, 1842.

II. Taconic system.

III. New York system.	1. *Potsdam sandstone.*	De Verneuil's Synchronism.)
	2. *Calciferous sandrock.*	
	3. *Black river limestone group.*	Lower Silurian.
	4. *Trenton limestone.*	
	5. *Utica slate.*	
	6. *Hudson river group.*	
	7. *Gray sandstone.*	
	8. *Oneida Conglomerate.*	
	9. *Medina sandstone.*	
	10. *Clinton group.*	
	11. *Niagara group.*	
	12. *Onondaga salt group.*	Upper Silurian.
	13. *Water lime group.*	
	14. *Pentamerus limestone.*	
	15. *Delthyris shaly limestone.*	
	16. *Encrinal limestone.*	
	17. *Upper Pentamerus limestone.*	
	18. *Oriskany sandstone.*	
	19. *Cauda-Galli grit.*	
	20. *Schoharie grit.*	
	21. *Onondaga limestone.*	
	22. *Corniferous limestone.*	
	23. *Marcellus slate.*	Devonian formation.
	24. *Hamilton group.*	
	25. *Tully limestone.*	
	26. *Genesee slate.*	
	27. *Portage group.*	
	28. *Chemung group.*	

IV. Old Red system or Old Red Sandstone.

V. Conglomerate of the Carboniferous system.

This classification is certainly a very remarkable work, and although the strata are very regular and almost horizontal, much labor and research was required in order to group them, and to recognize their respective positions. More detailed study will probably modify certain parts of this series, but without changing its meaning or general results.

I have entered somewhat fully into the history of this classification of the Paleozoic rocks of the State of New York, chiefly on account of its importance, since by its means the Transition

strata of America were disentangled; and also because in many geological works, published in America and in Europe, this classification is attributed *mostly* or *wholly* to James Hall. This is not only *false* in itself, but a *great injustice* to the true discoverers of this series. Vanuxem was the *first* to recognize the *Transition* character of the New York strata; Vanuxem and Conrad classified the *greater* part of them; then come Emmons aud Mather; and of the whole five, James Hall is the one who contributed the *least* to this important work.

The *Geological Survey of the Upper Mississippi* required more time than that of the State of New York, on account of the vast extent of country it embraced, being more than four times as large as New York State. The Federal Government entrusted it to David Dale Owen, a very competent and gifted geologist for such an arduous task. Owen the pupil of Maclure, Say, Lesueur, and Troost, has nobly continued the work of those first geological pioneers of the Ohio valley, and has extended to the borders of the Mississippi and Missouri the researches that Maclure and Vanuxem had made with such success in the States bordering the Atlantic. Owen was assisted in his gigantic work by Dr. J. G. Norwood of Madison, one of the best American geologists; J. Evans, the first explorer of the *Mauvaises Terres* of Nebraska, and geologist of Steven's expedition; Dr. B. F. Shumard, one of the best paleontologists; Richard Owen, now Professor at Nashville; J. B. Meek, a geologist and paleontologist of great talent; C. Whittlesey and A. Litton. The following is his classification of the Paleozoic rocks of the States of Wisconsin, Iowa, and Minnesota, published in 1851.

(Extract from the *Table of Colors* of the *Geological Map of Wisconsin, Iowa, and Minnesota: exhibiting, also, the extension of the Iowa Coal-field into Missouri, and its relation to the Illinois Coal-field;* by David Dale Owen. Washington, 1851.)

Formation of South Western Iowa.	F. 6.	. . . . .	*Coal Measures.*
Formation of the vicinity of the «des Moines», Rapids of the Mississippi.	F. 5.	Upper series. Lower series.	*Carboniferous Limestone.*
Formation of Cedar valley, . .	F. 4.	c. Upper Coralloid limestone. b. Middle shell beds. a. Lower Coralline beds.	*Devonian Period.*
Upper Magnesian Limestone of Iowa and Wisconsin.	F. 3.	c. Coralline and Pentamerus beds. b. Lead bearing beds. a. Shell beds.	*Upper Silurian Period.* *Lower Silurian Period.*
Upper Sandstone of Minnesota and Wisconsin. Lower Magnesian Limestone of Iowa and Wisconsin.	F. 2.	c. White sandstone. b. Magnesian limestone with veins of quartz. a. Magnesian limestone with oolitic layers.	*Lower Silurian Period.*
Lower Sandstone of Wisconsin and Minnesota.	F. 1.	f. With intercalations of Magnesian limestone. e. Soft fine sandstones. d. Upper *Trilobite* beds. c. Coarse *Lingula* grits. b. Lower *Trilobite* beds. a. Red sandstone of Lake Superior.	*Lower Silurian Period.*

This *Tabular view* is certainly, next to the classification of the Paleozoic strata of New York, the best thing that has been done for the grouping and superposition of the Transition strata of America. There is only one subdivision that appears to me to occupy a false position, namely the *Red Sandstone of Lake Superior*. The most remarkable discovery of David Dale Owen is that of the *Primordial Fauna* in his group of the *Lower Sandstone of Wisconsin and Minnesota* F. 1. Until then, Emmons had only found *Lingula* in the *Potsdam Sandstone*, and it was only in 1847 between the falls of St Anthony and the mouth of the Wisconsin, that Owen discovered the first *Trilobite*, and the next year several species and even genera of *Trilobites*, *Lingula*, *Orbicula*, *Orthis*, and *Crinoidea*, were found in the same group. Almost at the same time Barrande made his discovery of the *Primordial Fauna* of Bohemia, and Angevin that of his Fauna of the *Regiones* A., *Olenorum*; and B., *Conocorypharum*, of Scandinavia. Thus Emmons had the honor of *first* recognizing the *Potsdam Sandstone*, but Owen was the *first* to find the *Primordial Fauna* in the strata of this Group.

These two geological surveys are much the best of all that have been undertaken in America, and serve as models for those in process of execution. I should mention, however, as well executed, the *Geological Survey* of Massachussetts, by Ed. Hitchcock; that of Lake Superior, by C. T. Jackson; of Alabama, by Tuomey; of Tennessee, by Safford; and of Missouri, by Swallow, Shumard, and Meek. As to the survey of the two Canadas, it was honored at the two Great Universal Exhibitions of London 1851, and Paris 1855, with medals, decorations of the Legion of Honor, and even with a Knight's title from the Sovereigns of England and France, and its Director General W. E. Logan, aided by T. Sterry-Hunt, mineralogist of the survey, has shown to the scientific world, with so much modesty and talent, the *grand results and discoveries* of their joint survey, that nothing remains for others to say, but to express their admiration and gratitude for the half dozen hieroglyphical pamphlets they have published, under the title of *Report of Progress of the Geological Survey of Canada.*

The first comparison of the American Paleozoic strata with those of Europe, was made by Conrad in 1839, 40, and 42. Hall also made an attempt in 1840 and 43; and Daniel Sharpe, while studying the fossils collected by Charles Lyell during his first visit to America, also attempted a detailed comparison of these strata (See: *Quart. Journ. of the Geol. Soc. of London*, vol. IV, p. 145; London, 1848.). Vanuxem had in 1829 recognized the similarity of the western formations to those of New York, and James Hall, in an excellent and interesting memoir, entitled: *Notes explanatory of a Section from Cleveland, Ohio, to the Mississippi river, in a south-west direction; with remarks upon the identity of the western formations with those of New York*; and published in 1843 in the *Reports of the Association of American Geologists and Naturalists*, page 267 etc.; Boston; has made a very remarkable comparison between the Paleozoic rocks of the State of New York and those of the States of Ohio, Kentucky, Indiana, and Missouri. But de Verneuil first truly synchronized the Paleozoic strata of America with the great European divisions of the same period, and his comparison has been generally accepted. De Verneuil made a rapid excursion through America as far as the Upper Mississippi, during the summer of 1846, and on his return to Europe he presented to the Geological Society of France, 19 April 1847, his memoir entitled: *Note sur le parallélisme des roches des dépôts Paléozoïques de l'Amérique Septentrionale avec ceux de l'Europe* (See: *Bulletin de la Soc. Géol. de France*, 2ième série, tome IV, page 646 etc.; Paris, 1847.). In this memoir, which may be

considered as decisive for the principal sections and the grouping of the American Paleozoic rocks, de Verneuil has accomplished for this part of geology what Lyell had done, in 1842, for the classification of the Tertiary rocks bordering the Atlantic.

Paleontology has been very successfully cultivated in America; the first who devoted themselves to this science were, Lesueur, Harlan, Jefferson, Say, Green, Bigsby, Rafinesque, Troost, Morton, Redfield, Lea, and Hitchcock; but Conrad has contributed more than any to the development of American paleontology. An excellent zoologist as well as a good geologist, Conrad has very well described a great many of the fossil mollusca of the New World. After having passed several years in the careful study of the Paleozoic fossils of the State of New York, ill health obliged him unfortunately to abandon his work, and another, who is not at all his equal in learning, has succeeded him. Leidy is, next to Conrad, the best paleontologist in the United States, and his memoirs on the fossil Vertebratæ has caused him to be justly called the Richard Owen of America. The young paleontologists of the present day are numerous, and the most prominent are, Dr. Shumard, Holmes, Newberry, Meek, Wyman, Billing, etc.

The *Paleontology of the State of New York*, by James Hall, of which two volumes have already appeared, is a very useful work, but the determination and description of species are not very satisfactory; compared with publications of the same nature, such as the beautiful memoirs of Barrande, de Koninck, M^c^ Coy, Milne Edwards and Jules Haime, de Verneuil, Sandberger, Angevin, etc., *the Paleontology of New York* appears quite inferior, — the best part of it being the plates drawn by Mrs. Hall, and also the geological order.

In terminating this *Synopsis of the Progress of American Geology*, I repeat that my design was not to give a *complete* history, but only some *land marks*, by citing the *exact dates* of discoveries, and attributing them to their *true authors*. Maclure, Vanuxem, Hitchcock, Taylor, Conrad, Emmons, Lyell, de Verneuil, and David Dale Owen, are the *only discoverers*; other geologists have extended and detailed the just views and grand ideas that these illustrious savants were the first to divulge.

CHAPTER X.

LIST OF MAPS AND MEMOIRS ON THE GEOLOGY OF NORTH AMERICA.

LIST OF GENERAL GEOLOGICAL MAPS RELATING TO NORTH AMERICA.

(The following list refers chiefly to Geological Maps of the whole of North America, or of a great portion of the continent — two States at least.)

1809 — **Maclure**, William — *A Map of the United States of America; colored geologically;* accompanying: Observations on the Geology of the United States. (Trans. of the Amer. Phil. Soc., vol. VI.) *Philadelphia.*

1811 — **Maclure**, William — *Carte des Etats Unis de l'Amérique-Nord, pour servir aux observations géologiques;* accompanying: Observations sur la Géologie des Etats-Unis. (Journ. de Phys., de Chim., d'Hist. Nat. et des Arts, par J. C. Delamétherie, vol. LXXII.) *Paris.*

1817 — **Maclure**, William — *Map of the United States of America; designed to illustrate the Geological Memoir of William Maclure Esq.;* accompanying: Observations on the Geology of the United States, etc, (Trans. of the Amer. Phil. Soc., new series, vol. I.) *Philadelphia.* Reproduced, in 1822, by P. Cleaveland, as frontispiece of: An Elementary Treatise on Mineralogy and Geology; second edition, *Boston;* and also, in 1843, by Charles Moxon, as frontispiece of: The Geologist for the year 1843. *London.*

1822 — **James**, Edwin — *Map of the Country drained by the Mississippi; western section;* by Major S. H. Long; accompanying Maps and Plates, of: An account of an Expedition from Pittsburgh to the Rocky Mountains, performed in the years 1819 — 20. *Philadelphia.* In that Map, Ed. James, the Geologist of the Expedition, has drawn quite accurately the limits of several geological formations of the Prairies east of the Rocky Mountains.

1842 — **Lawrence**, Byrem — *Geological Map of the Western States.* Cincinnati?

1843 — **Hall**, James — *Geological Map of the Middle and Western States*; accompanying: The Survey of the Fourth Geological District of New York, vol. IV. *Albany.*

1844 — **Owen**, David Dale — *Geological Chart of part of Iowa, Wisconsin, and Illinois;* plate N° 2 and N° 3; and *Chart of the Great Illinois Coal Field*, plate N° 4; in: Report of a Geological Exploration of part of Iowa, Wisconsin, and Illinois, made in the autumn of the year 1839. *Washington.* Despatched from New Harmony, Indiana, to the Department at Washington, 2 April, 1840; but revised before going to press, June 11, 1844.

1845 — **Boué**, Ami — *Essai d'une Carte Géologique du Globe Terrestre*, Paris. An English translation with additions and corrections has appeared in: The Physical Atlas of Natural Phenomena, by A. K Johnston; *Edinburgh*, 1848; and also in the edition of 1856, under the title of: *The Geological Structure of the Globe*, by J. P. Nichol. An American edition has appeared under the title of: *Outline of the Geology of the Globe*, by Edward Hitchcock. *Boston*, 1853.

1845 — **Lyell**, Sir Charles — *Geological Map of the United States, Canada*, etc.; accompanying: Travels in North America in the years 1841 — 42; *London* and *New York* — English and American edition —. A second English edition appeared in 1855; and a German translation has been made under the title: *Geognostische Karte der Vereinigten Staaten, Canada*, etc.; accompanying: Charles Lyell's Reisen in Nordamerika. Deutsch, von Dr. Emil Th. Wolff. *Halle*, 1846.

1846 — **Owen**, David Dale — *Geological Chart of the Ohio valley*, to illustrate: On the Geology of the Western States of North America; in the postponed papers of the second volume of: The Quarterly Journal of the Geological Society of London; plate XIX. — Communicated by Mr. Lyell; read November 2, 1842. *London.*

1848 — **Owen**, David Dale — *Provisional Geological Map of Part of the Chippeway land district of Wisconsin, with part of Iowa, and of Minnesota Territory*, to illustrate: Report of a Geological reconnaissance of the Chippewa land District of Wisconsin; and, incidentally, of portion of the Kickapoo country, and of a part of Iowa, and of the Minnesota Territory. *Washington.*

1848 — **Vislizenus**, A. — *Geological Sketch*, accompanying: Memoir of a tour to Northern Mexico in 1846 and 1847. *Washington.* Translated into German and printed in: Geographisches Jahrbuch zur Mittheilung aller wichtigern neuen Erforschungen, von Dr. Heinrich Berghaus; *Gotha*, 1850: under the title of: *Dr. A. Vislizenus, geologische Skizze seines Reisweges von Independence durch das nördliche Mexico bis zur Mündung des Rio Grande del Norte.*

1850 — **Grewingk**, C. — *Karte zur Abhandlung über die Geogn. und Orogr. beschaffenheit der N W.-Küste Amerika's und der anliegenden Inseln, mit Zugrundelegung der Karten des Hydrogr. Dep. des See-Ministeriums zu Petersburg*, 1849; accompanying: Beitrag zur Kenntniss der orographischen und geognostischen beschaffenheit der Nord-West-Küste Amerika's mit den anliegenden Inseln. (Verhandl. der Russ.-Kaiserl. Mineral. Gesellschaft zu S[t] Petersburg: Jahrgang 1848 und 1849.) *St. Petersburg*, 1850.

1851 — **Richardson**, Sir John — *Map on the Physical Geography and Geology of the Arctic Regions*; accompanying: Arctic searching Expedition; a Journal of a boat-voyage through Rupert's land and the Arctic sea, in search of the discovery ships, under command of Sir John Franklin. *London.*

1852 — **Owen**, David Dale — *Geological Map of Wisconsin, Iowa, and Minnesota; exhibiting, also, the extension of the Iowa Coalfield into Missouri, and its relations to the Illinois Coal field* the map is dated 1851, but appeared only in 1852 — accompanying: Report of a Geological Survey of Wisconsin, Iowa, and Minnesota and, incidentally, of a portion of Nebraska Territory. *Philadelphia.*

In the same Report is found a *Geological Map of parts of Minnesota and Wisconsin, designed to show portions of the rock formations now concealed by Drift*; by J. G. Norwood.

1853 — **Marcou**, Jules — *Geological Map of the United States and the British Provinces of North America*; accompanying: A Geological Map of the United States and the British Provinces of North America, with an explanatory text, geological sections, and plates of the fossils which characterize the formations. *Boston*, July 1853. A French translation has appeared under the title: *Carte Géologique des Etats-Unis et des Possessions Britanniques de l'Amérique du Nord*, d'après Jules Marcou (Voyage dans l'Amérique du Nord en 1853 et 1854, par Guillaume Lambert.). *Bruxelles*, Mars 1855.

1853 — **Hitchcock**, Edward — *A Geological Map of the United States and Canada*; accompanying: Outline of the Geology of the Globe, and of the United States in particular. *Boston*, October 1853.

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1855 — **Dawson**, John William — *Geological Map of Nova Scotia, Prince Edward Island, and part of New Brunswick*; accompanying: Acadian Geology; an account of the geological structure and mineral resources of Nova Scotia and portions of the neighbouring provinces of British America. *Edinburgh.*

1855 — **Logan**, Sir William E. — *Carte Géologique du Canada*; accompanying: Esquisse géologique du Canada, pour servir à l'intelligence de la Carte Géologique et de la collection des minéraux économiques envoyées à l'exposition universelle de Paris. *Paris*, août 1855.

1855 — **Isbister**, A. K. — *Geological Sketch Map of the Northernmost parts of America*; accompanying: On the Geology of the Hudson's Bay Territories, and of portions of the Arctic and North-Western Regions of America (Quarterly Journal of the Geol. Soc. of London; vol. XI, page 497.). *London*, November 1855,

1856 — **Marcou**, Jules — *Carte Géologique des Etats-Unis et des Provinces Anglaises de l'Amérique du Nord*; accompanying: Résumé Explicatif d'une Carte Géologique des Etats Unis et des Provinces Anglaises de l'Amérique du Nord, avec un profil géologique allant de la vallée du Mississippi aux côtes du Pacifique, et une planche de fossiles (Extrait du Bull. de la Soc. Géol. de France, 2e série, tome XII, p. 813, séance du 21 Mai 1855.). *Paris*, Mars 1856. This Geological Map appeared simultaneously in the: Annales des Mines, 5e série, tome VII, pag. 320; accompanying: Esquisse d'une classification des chaînes de montagnes d'une partie de l'Amérique du Nord. *Paris.*

1856 — **Rogers**, Henry D. — *Geological Map of the United States and British North America*; published the 1st of July 1856; in the new and enlarged edition of: The Physical Atlas, by A. K. Johnston. *Edinburgh.* Rogers has presented an original copy of that map, at the meeting of the: British Association for the Advancement of Science, held at Glasgow, in September 1855 (Report of the 25th Meeting, page 95: On the Geology of the United States.).

LIST OF MEMOIRS ON THE GEOLOGY OF NORTH AMERICA.

A great number of Memoirs on the Geology of North America having been published in the Scientific Journals, I refer the reader to these collections; in their tables of contents are the titles of these memoirs, and the names of their authors. I give, however, the titles of some of the memoirs which have been published in scientific journals; because they have been printed separately, and also on account of their importance in relation to the progress of American geology.

Transactions of the American Philosophical Society; old and new series, 4°. Philadelphia.
Transactions of the American Academy; 4°. Boston.
Transactions of the Literary and Historical Society of Quebec; 8°. Quebec.
Transactions of the Geological Society of Pennsylvania; 8°; vol. I and II. Philadelphia, 1834—1838.
Transactions of the Geological Society of London, first and second series; 4°. London.
Mémoires de la Société Géologique de France; première et seconde séries, 4°. Paris.
Transactions of the Albany Institute; 8°. Albany.
Transactions of the Academy of Science at St. Louis; 8°. St. Louis, 1857.
Proceedings of the Boston Society of Natural History; 8°. Boston.
Proceedings of the Academy of Arts and Sciences; 8°. Boston.
Proceedings of the American Philosophical society; 8°. Philadelphia.
Proceedings of the Academy of Natural Sciences of Philadelphia; 8°. Philadelphia.
Proceedings of the American Association for the Advancement of Science; 8°. 1847—1856.
Proceedings of the Geological Society of London; 8°. London.
Proceedings of the Elliot Society of Natural History; 8°. Charleston S. C. 1856.
Proceedings of the California Academy of sciences; 8°. San Francisco, 1854.
The American Mineralogical Journal, by A. Bruce; 8°. I vol. New York, 1814.
The American Journal of science and arts; by B. Silliman; 8°; first and second series. New Haven.
The American Quarterly Journal of Agriculture and Science; by E. Emmons; 8°. Albany.
Journal of the Academy of Natural Sciences of Philadelphia; old and new series; 8°. Philadelphia.
The Monthly American Journal of Geology and Natural science; by G. W. Featerstonhaugh; 8°. 1 vol. Philadelphia. 1831—1832.
Atlantic Journal; by C. S. Rafinesque; 8°. 1 vol. Philadelphia, 1832—1833.
The Canadian Journal of Industry, Science and Art, old and new series; 8°. Toronto.
Western Journal and Civilian. St Louis.
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Reports of the first, second, and third Meetings of the Association of American geologists and naturalists; 8°. Boston, 1843.
Report of the Superintendent of the Coast Survey for the years 1849—50—51—52—53—54—55; 8° and 4°; by A. D. Bache. Washington.
Smithsonian Contributions to knowledge; 4°. Washington.
Annual Reports of the Board of regents of the Smithsonian Institution; 8°. Washington.
The Mining Magazine; 8°. New York.
The Quarterly Journal of the Geological Society of London; 8°. London.
Bulletin de la Société géologique de France; première et deuxième séries; 8°. Paris.
Zeitschrift der deutschen geologischen Gesellschaft; 8°. Berlin.

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1809 — **Maclure,** William. — *Observations on the Geology of the United States, explanatory of a Geological Map;* (Trans. of the Amer. Phil. soc. vol. VI), Philadelphia. — Reproduced *verbatim*, in the present volume. — French translation, under the title: *Observations sur la géologie des Etats-Unis, servant à expliquer une carte géologique;* (Journal de phys.. de chim. et d'hist. nat.: tome LXIX, septembre 1809), Paris. A second french translation, more complete, under the title: *Suite aux observations sur la géologie des Etats-Unis;* (Journ. de phys., de chim. et d'hist. nat.; tome LXXII, février, 1811), Paris. Revised edition, under the title: *Observations*

on the Geology of the United States of North America; with remarks on the probable effects that may be produced by the decomposition of the different classes of rocks on the nature and fertility of soils: applied to the different States of the Union, agreably to the accompanying Geological Map. With two copper plates; (Trans. of the Amer. Phil. soc.; vol. I, new series, 1818); Philadelphia. A corrected reprint of this last edition was made in Philadelphia, 1817, in 8°. form.

1816 — **Cleaveland,** P. — *An Elementary treatise on Mineralogy and Geology*; 8°. Boston. Second edition, 2 vol. 1822.

1818 — **Eaton,** Amos. — *Index to the Geology of the Northern States;* 12°. Leicester; second edition, 1820. Troy.

1819 — **Rafinesque,** C. S. — *Travels and discoveries in the West;* 8°, Pittsburgh.

1820 — **Hayden,** H, H. — *Geological essays; or an inquiry into some of the geological phenomena to be found in various parts of America, and elsewhere*; 8°. Baltimore.

1821 — **Nuttall,** Thomas — *Observations on the Geological structure of the valley of the Mississippi* (Extract from the Journal of the Academy of Natural sciences of Philadelphia; vol. II, Part. I, pag. 14). 8°. Philadelphia.

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1825 — **Van Rensselaer,** J. — *Lectures on Geology;* delivered in the New York Athenæum; 8°. New York.

1828 — **Eaton,** Amos — *A geological nomenclature for North America*; 8°. Albany.

1828 — **Vanuxem,** L., and **Morton,** S. G. — *Observations on the Geology and organic remains of the Secondary, Tertiary, and Alluvial formations of the Atlantic coast of the United States of North America* (Extract from the sixth vol. of the Journ. of the Acad. of Nat. sci. of Philadelphia); 8°. Philadelphia.

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1831 — **Rafinesque,** C. S. — *Enumeration and account of some remarkable natural objects*, etc.; 8°. Philadelphia.

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1833 — **Lea,** Isaac. — *Contributions to Geology;* 8°. Philadelphia.

1833 — **Finch,** J. — *Travels in the United States of America and Canada, with notices of their Geology and Mineralogy;* 8°. London.

1834 — **Morton,** S. G. — *Synopsis of the organic remains of the Cretaceous group of the United States. To which is added an appendix, containing a tabular view of the Tertiary fossils hitherto discovered in North America;* 8°. Philadelphia.

1836 — **Comstock**, J. L. — *Outlines of Geology*; second edition, 8°. New York.

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1843 — **Koch**, A. C. — *Description of the Missourium Theristocaulodon*; 8°. Dublin.

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1847 — **Verneuil**, Ed. de — *Note sur le parallélisme des roches des dépôts paléozoiques de l'Amérique Septentrionale avec ceux de l'Europe* (Extrait du: Bulletin de la Soc. Géol. de France, 2ᵉ série, tome IV.); 8ᵛ. Paris.

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1852 — **Warren**, John I. — *The Mastodon Giganteus of North America*; 4°. Boston.

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1852 — **Leidy**, Joseph — *Description of an extinct species of American Lion* (Extract from: Trans. of the Amer. Phil. soc.; vol. 10). 4°. Philadelphia.

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1853 — **Andrews**, I. D. — *Report on the trade and commerce of the British North-American colonies, and upon the trade of the Great Lakes and Rivers*; 8°, atlas. Washington.

1854 — **Morton**, S. G.; **Agassiz**, Louis; **Nott**, J. C.; and **Gliddon**, G. R. — *Types of Mankind*; 4°. Philadelphia.

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1856 — **Nott**, J. C. and **Gliddon**, G. R. — *Indigeneous races of the Earth;* 4°. Philadelphia.

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1857 — **Owen**, Richard — *Key to the Geology of the Globe;* 8°. New York.

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1858 — **Fröbel**, Julius — *Aus Amerika* (Geol.); 8°. 2 vol. Leipzic.

HUDSON'S BAY TERRITORIES, RUSSIAN AMERICA AND ARCTIC REGIONS.

1814 — **Steinhauer** — *On the Geology of Labrador* (Extract from Trans. of the Geol. Soc. of London. vol. II), 4°. London.

1819 — **Mc culloch,** John — *Voyage for a Northwest passage*, by John Ross. Appendix on the rock-specimens. 4°. London.

1823 — **Jameson,** Robert — *Journal of a voyage to the Northern whale Fishery, including Researches and Discoveries on the East Coast of Greenland*, by W. Scoresby; Geological appendix. 8°. Edinburgh.

1823 — **Richardson,** Sir John — *Narrative of a Journey to the Shores of the Polar Sea, in the years* 1819, 20, 21, *and* 22; by John Franklin; Appendix N° 1; Geognostical Observations, 4°. London.

1824 — **König,** Charles — *A Supplement to the Appendix of Captain Parry's voyage for the discovery of a North-West Passage, in the years* 1819–20; Rock specimens; 4°. London.

1826 — **Jameson,** Robert — *Journal of a third voyage for the discovery of a North-West Passage, from the Atlantic to the Pacific;* by William Edward Parry; Appendix; Notes of the Geology of the Countries discovered during Captain Parry's Second Expedition; and: Notes on the Geology of the Countries visited during Captain Perry's Third Voyage; 4°. London.

1828 — **Richardson,** Sir John — *Narrative of a Second Expedition to the Shores of the Polar Sea, in the years* 1825, 26, *and* 27; by John Franklin. Appendix N° 1; Topographical and Geological Notices; 4°. London.

1829 — **Bayfield,** H. W. — *Outlines of the Geology of Lake Superior* (Extract from: Trans. of the Lit. and Hist. Soc. of Quebec, vol. I.); 8°. Quebec.

1829 — **Baddeley,** F. H. — *On the Geognosy of a part of the Saguenay Country* (Extract from: Trans. of the Lit. and Hist. Soc. of Quebec, vol. I.); 8°. Quebec.

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1839 — **Buckland,** W.; **Belcher,** Ed.; and **Collie,** A. — *The Zoology of Capt. Beechey's Voyage to the Pacific and Behring's straits, performed in the years* 1825, 26, 27, *and* 28. Appendix: Geology; 4°. London.

1850 — **Grewingk**, C. — *Beitrag zur Kenntniss der orographischen und geognostischen Beschaffenheit der Nordwest-küste Amerika's mit den anliegenden Inseln.* (Extract from: Verhandlungen der russisch-kaiserlichen mineralogischen Gesellschaft zu St-Petersburg. — Jahrgang 1848 und 1849). 8°. St-Petersburg.

1850 — **Agassiz**, Louis — *Lake Superior: its Physical character, vegetation and animals;* 8°. Boston.

1851 — **Richardson**, Sir John — *Artic Searching expedition: A journal of a boat-voyage through Rupert's land and the Aretic Sea, in search of Sir John Franklin.* 2 vol. 8°. London.

1852 — **Sutherland**, P. C., and **Salter**, J. W. — *Journal of a voyage in Baffin's bay and Barrow straits, in the years* 1850—51, *performed by H. M. Ships « Lady Franklin » and « Sophia », under the command of William Penny.* Appendix; Geology. 2 vol. 8°. London. See also, in: the Quart. Journ. of the Geol. Soc. of London; vol. IX, 1853; two memoirs entitled: *On the Geological and Glacial Phenomena of the Coasts of Davis' Strait and Baffin bay*, by Sutherland; and *On Artic Silurian fossils*, by Salter.

1852 — **Rink**, H. — *Om den geographiske Beskaffenhed af de danske Handelsdistrikter i Nordgrönland tilligemed en Udsigt over Nordgrönlands Geognosi.* (Extract from: Trans. Roy. soc. Danemark). 4°. Copenhagen. Also: *De Danske Handelsdistrikter i Nordgrönland, deres geographiske Beskaffenhed og produktive Erhvervskilder.* 8°. Copenhagen.

1852 — **Bigsby**, J. J. — *On the Geology of the Lake of the Woods, South Hudson's Bay* (Extract from: The Quart. Journ. of the Geol. soc. of London; vol. VIII). 8°. London.

1854 — **Bigsby**, J. J. — *On the Geology of Rainy Lake, South Hudson's Bay* (Extract from: the Quart. Journ. of the Geol. Soc. of London, vol. X). 8°. London.

1854 — **Kane**, E. K. — *The United States Grinnel Expedition in search of Sir John Franklin;* 8°. New-York.

1855 — **Belcher**, Sir Edward; **Salter**, J. W., and **Owen**, Richard — *The last of the arctic voyages; being a narrative of the expedition under the command of Capt. Sir Ed. Belcher, in search of Sir John Franklin, during the years* 1852—53—54. Appendix: Account of the Arctic Carboniferous fossils; and Note on some remains of an Ichthyosaurus. 2 vol, 8°. London.

1855 — **Isbiter**, A. K. — *On the Geology of the Hudson's Bay Territories, and of portions of the Arctic and Nord-Western Regions of America; with a coloured Geological Map* (Extract from the Quart. Journ. of the Geol. Soc. of London; vol. XI). 8°. London.

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1842 — **Bonnycastle**, Sir R. H. — *Newfoundland in 1842: considered in its Geological and Statistical relations.* 2 vol.; 8°. London.

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1845 — **Bayfield**, H. W. — *On the junction of the Transition and Primary rocks of Canada and Labrador.* (Extract from the Quart. Journ. of the Geol. Soc, of London; vol. I). 8°. London.

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1846 — **Gesner**, Abraham — *Report on the Geology of Prince Edward island.*

1847 — **Gesner**, Abraham — *New Brunswick; with notes comprehending Geology*, etc.; 8°. London.

1848 — **Dawson**, J. W. — *On the New Red Sandstone of Nova Scotia.* (Extract from the Quart. Journ. of the Geol. Soc. of London ; vol. IV). 8°. London.

1848 — **Dawson**, J. W. — *Report on the Coalfields of Caribou Cove and River Inhabitants, Cape Breton.* 8°. Pictou.

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1849 — **Gesner**, Abraham — *The Industrial resources of Nova Scotia; comprehending Geology*, etc.; 8°. Halifax.

1849 — **Logan**, Sir William E. — *Rapport sur le rivage septentrional du lac Huron.* Exploration géologique du Canada; 8°. Montréal.

1851 — **Jackson**, Charles T. — *Report on the Albert Coal Mine* (New Brunswick); 8°. New York.

1852 — **Logan**, Sir William E., and **Owen**, Richard — *On the foot-prints occuring in the Potsdam Sandstone of Canada.* (Extract from the Quart. Journ. of the Geol. Soc. of London ; vol, VIII). 8°. London.

1853 — **Bigsby**, J. J. — *On the Geology of Quebec and its Environs.* (Extract from the Quart. Journ. of the Geol. Soc. of London; vol. IX). 8°. London.

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1855 — **Dawson**, J. W. — *Acadian Geology; an account of the Geological structure and mineral resources of Nova Scotia, and portions of the neighbouring provinces of British America;* 8°. Edinburgh.

1855 — **Logan**, Sir William E., and **Sterry-Hunt**, T. — *Esquisse géologique du Canada;* pour servir à l'intelligence de la Carte géologique et de la collection des minéraux économiques envoyées à l'exposition universelle de Paris, 1855. 12°. Paris.

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1810 — **Godon**, S. — *Observations minéralogiques, faites dans les environs de Boston, pendant les années* 1807 *et* 1808. (Extract from: Annales du Muséum d'histoire naturelle. Tome XV) ; 4°. Paris.

1819 — **Hitchcock**, Edward — *Remarks on the Geology and Mineralogy of a section of Massachussetts on Connecticut River, with a part of New-Hampshire and Vermont.* (Extract from the American Journ. of sci.; vol. I); 8°. New-York.

1824 — **Hitchcock**, Edward — *Geology and Mineralogy of the Connecticut valley.* (Extract from the American Journ. of sc.; vol. VI). 8°. New Haven.

1833 — **Hitchcock**, Edward — *Report on the Geology, Mineralogy, Botany and Zoology of Massachussetts.* 8°. Amherst. Second edition; 1835. Amherst.

1834 — **Hitchcock**, Edward — *Plates illustrating the Geology and Scenery of Massachussetts;* 4°. Amherst.

1834 — **Mather**, Wm. W. — *Sketch of the Geology and Mineralogy of New London and Windham counties in Connecticut.* 8°. Norwich.

1837 — **Shepard**, Charles U. — *A Report on the Geological Survey of Connecticut.* 8°. New Haven.

1837/40 - **Jackson**, Charles T. — *Reports on the Geology of the State of Maine.* 3 parts. 8°; and 4° Atlas of Plates. Augusta.

1838 — **Jackson**, Charles T. — *Second Annual Report on the Geology of the Public Lands, belonging to the two States of Maine and Massachussetts.* 8°. Augusta. Second edition. Boston, 1838.

1838 — **Hitchcock**, Edward — *Report on a re-examination of the Economical Geology of Massachussetts.* 8°. Boston.

1840 — **Jackson**, Charles T. — *Report on the Geological and Agricultural Survey of the State of Rhode-Island*, made under a resolve of Legislature in the year 1839. 8°. Providence.

1841 — **Jackson**, Charles T. — *First Annual Report on the Geology of the State of New-Hampshire.* 8°. Concord.

1841 — **Hitchcock**, Edward — *Final Report on the Geology of Massachussetts, with Catalogue of the specimens in the State Collections.* 2 vol. 4°. Amherst.

1842 — **Percival**, James G. — *Report on the Geology of the State of Connecticut.* 8°. New-Haven.

1842 — **Jackson**, Charles T. — *Second Report of the State Geologist, giving the condition of the Geol. Surv. of the State of New-Hampshire.* 8°. Concord.

1844 — **Jackson**, Charles T. — *Final Report on the Geology and Mineralogy of the State of New-Hampshire; with contributions towards the improvement of agriculture and metallurgy.* 4°. Concord.

1844 — **Hitchcock**, Edward — *Explanation of the Geological Map of Massachussetts.* 12°. Boston.

1845/48 - **Adams**, C. B. — *First Annual Report on the Geology of the State of Vermont; Second An. Rep.; Third. An. Rep.; Fourth An. Rep. on the Geological Survey of the State of Vermont.* 8°. Burlington.

1848 — **Thompson**, Zadock — *Geography and Geology of Vermont;* 12°. Burlington.

1853 — **Thompson**, Zadock — *Appendix to the History of Vermont* (Geology); 12°. Burlington.

1853 — **Hitchcock**, Edward — *Report on certain points in the Geology of Massachussetts.* Boston.

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1802 — **Jefferson**, Thomas — *Notes on the State of Virginia;* 8°.

1807 — **Godon**, S. — *Observations to serve for the Mineralogical Map of the State of Maryland.* (Trans. of the Amer. Phil. soc., vol, VI). Philadelphia.

1814 — **Akerly**, S. — *Geological account of Duchess County, N. Y.* (Extract from the American Mineralog. Journ. vol. I); 8°. New York.

1814 — **Mitchill**, S. L. — *On the Geology of Long Island* (Extract from the Amer. Mineral. Journ. ; vol. I) ; 8°. New York.

1814 — **Akerly**, S. — *On the Geology and Mineralogy of the island of New York.* (Extract from the Amer. Miner. Journ.; vol. I); 8°. New York.

1819 — **Pierce**, James — *Discovery of Native Cristallized Carbonate of Magnesia on Staten Island, with a notice of the Geology and Mineralogy of that island.* (Extract from the Amer. Journ. of sc. ; vol. I) ; 8°. New York.

1820 — **Akerly**, S. — *The Geology of the Hudson river and the adjacent regions;* 12°. New York.

1820 — **Bigsby**, J. J. — *On the Geology of Genesee county.* (Extract from the Amer. Journ. of sc.; vol. II); 8°. New York.

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1824 — **Eaton**, Amos — *A geological and agricultural survey of the district adjoining the Erie Canal in the State of New York;* 8°. Albany.

1830 — **Morton**, Samuel G. — *Additional observations on the Geology and Organic remains of New-Jersey and Delaware.* 8°, Philadelphia.

1831? — **Taylor**, Richard C. — *On the Carboniferous series of the United States of North America, as to the actual position of the Old Red sandstone in America.* (Extract from: The London Philosophical Magazine). 8°. London.

1832 — **Morton**, S. G. — *On the Analogy which exists between the Marl of New-Jersey, and the chalk formation of Europe.* 8°. Philadelphia.

1834/35/36 — **Ducatel**, J. T., and **Alexander**, J. H. — *Report on the New Map of Maryland* (Geol.). 3 vol. 8°. Baltimore.

1834 — **Taylor**, Richard C. — *Memoir of a section passing through the Bituminous Coal field near Richmond, in Virginia.* (Extract from the Trans. of the Geol. soc. of Pennsylvania, vol. I); 8°. Philadelphia.

1835 — **Taylor,** Richard C. — *Notice of certain fossil acotyledonous Plants in the secondary strata of Fredericksburg, in Virginia.* (Extract from the Trans. of the Geol. Soc. of Pennsylvania; vol. I). 8°. Philadelphia.

1835 — **Rogers,** H. D., and **Rogers,** W. B. — *Contributions to the Geology of the Tertiary formations of Virginia.* 4°. Philadelphia.

1836/42- **Rogers,** Henry D. — *Geological Exploration of the State of Pennsylvania. First Annual Report,* 1836; *second Annual Report,* 1838; *third Annual Report,* 1839; *fourth Annual Report,* 1840; *fifth Annual Report,* 1841; *six Annual Report,* 1842. 8°. Harrisburg.

1836 — **Rogers,** Henri D. — *Report on the Geological Survey of the State of New Jersey;* 8°. Philadelphia.

1836 — **Rogers,** William B. — *Report of the geological reconnaissance of the State of Virginia;* 8°. Philadelphia.

1836/40- **Dix, Mather, Emmons, Conrad, Vanuxem** and **Hall** — *Geological survey of the State of New York.* Report of the secr. of State in relation to, 1836: *First Annual Report,* by Mather, Emmons, Conrad and Vanuxem, 1837; *Second Annual Report,* by Conrad, Mather, Emmons, Vanuxem and Hall, 1838; *Third Annual Report,* by Conrad, Mather, Emmons, Vanuxem and Hall, 1839; *Fourth Annual Report,* by Conrad, Mather, Emmons, Vanuxem and Hall, 1840. 8°. Albany.

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1840 — **Rogers,** Henry D. — *Description of the Geology of the State of New Jersey, being a final Report;* 8°. Philadelphia.

1840 — **Taylor,** Richard C. — *Two Reports on the Dauphin and Susquehanna Coal Company, and on the Geological examinations of the Stony Creek Coal Estate.* 8°. Philadelphia.

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1841 — **Booth,** James C. — *Memoir of the Geological Survey of the State of Delaware: including the application of the Geological observations to Agriculture.* 8°. Dover.

1842 — **Emmons,** Ebenezer — *Geology of New York; Part.* 2, *comprising the Survey of the second Geological District.* 4°. Albany.

1842 — **Vanuxem,** Lardner — *Geology of New York; Part.* 3, *comprising the Geology of the third Geological District.* 4°. Albany.

1843 — **Mather**, William W. — *Geology of New York*; *Part 1, comprising the Geology of the first geological district*; 4°. Albany.

1843 — **Hall**, James — *Geology of New York*; *Part 4, comprising the Survey of the fourth geological district*; 4°. Albany.

1843 — **Cozzens**, I., jr. — *Geological History of Manhattan or New York Island*; 8°. New York.

1843 — **Rogers**, William B. — *On the age of the Coal rocks of Eastern Virginia* (Extract from: Reports of the Ass. of Amer. Geolog.); 8°. Boston.

1843?— **Lea**, Henry C. — *Description of some new Fossil Shells, from the Tertiary of Petersburg, Virginia*, 4°. Philadelphia.

1844 — **Emmons**, Ebenezer — *The Taconic System; based on observations in New York, Massachusetts, Maine, Vermont, and Rhode-Island*; 4°. Albany.

1847 — **Lyell**, Sir Charles — *On the Structure and Probable Age of the Coal-Field of the James River, near Richmond, Virginia* (Extract from the Quart. Journ. of the Geol. Soc. of London, vol. III.); 8°. London.

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1852 — **Lea**, Isaac — *On the Fossil Foot-Marks in the Red Sandstone of Pottsville, Pennsylvania* (Extract from the Trans. of the Amer. Phil. Soc., vol. X.); 4°. Philadelphia.

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1855/57-**Kitchell**, Wm. — *First Annual Report of the Geological Survey of the State of New Jersey, for the year 1854*; 8°. New Brunswick. *Second Annual Report on the Geol. Survey of the State of New Jersey, for the year 1855*; 8°. Trenton, 1856. *Third Annual Report on the Geol. Survey of the State of New Jersey, for the year 1856*, 8°. Trenton, 1857.

1855 — **Lea**, Isaac — *Fossil Foot-Marks in the Red Sandstone of Pottsville, Pennsylvania*; super-royal folio. Philadelphia.

1856 — **Lesley**, J. P. — *Manual of Coal and its Topography*; *or Geology of the Appalachian region of the United States of North America*; 12°. Philadelphia.

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1819 — **Rafinesque**, C. S., and **Clifford**, J. D. — *Prodrome d'une Monographie des Turbinolies du Kentucky.*

1821 — **Nuttall**, Thomas — *Observations on the Geological Structure of the valley of the Mississippi* (Extract from the Journal of the Acad. of Nat. Sc. of Philadelphia vol. II, part I.), 8° Philadelphia.

1834/38-**Troost**, Gerard — *Geological Report to the General Assembly of the State of Tennessee.* Report of Progress for the years 1834, 35, 36, 37, 38, 39, 40, 41 44, 45, and 46, 8°. Nashville.

1835 — **Hildreth**, S. P. — *Observations on the Bituminous Coal Deposits of the valley of the Ohio and the accompanying rock strata; illustrated by a Geological Map* (Extract from the Amer. Journ. of Science, vol. XXIX.), 8°. New Haven.

1835 — **Featherstonhaugh**, G. W. — *Geological Report of an Examination made in 1834 of the elevated country between the Missouri and Red Rivers*; 8°. Washington.

1836 — **Featherstonhaugh**, G. W. — *Report of a Geological Reconnaissance made in 1835, from the seat of Government, by the way of Green Bay and the Wisconsin Territory, to the Coteau des Prairies, an elevated ridge dividing the Missouri from the St. Peter's River*; 8°. Washington.

1836 — **Hildreth, Riddell, Lapham**, and **Locke** — *Report on the Geological Survey of Ohio*; 8°. Columbus.

1837/38 — **Mather**, William W. — *Geological Survey of the State of Ohio. First Annual Report*, 1837. *Second Annual Report*, 1838; 8°. Columbus.

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1838 — **Owen**, David Dale — *Report of a Geological Reconnaissance of the State of Indiana; made in the year* 1837; 8°. Indianopolis.

1838 — **Mather**, William W. — *Report of the Geological Reconnaissance of Kentucky, made in* 1838. 8°.

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1842/46 — **Owen**, David Dale — *On the Geology of the Western States of North America* (Extract from: Proceedings of the Geol. Soc. of London, vol. IV, part I, N° 92; and in the Postponed Papers of the Quart. Journ. of the Geol. Soc. of London, vol. II.); 8°. London.

1843 — **Hall**, James — *Notes Explanatory of a Section from Cleveland, Ohio, to the Mississippi river, in a southwest direction; with remarks upon the identity of the western formations with those of New York* (Extract from: Reports of the Association of American Geologists.); 8°. Boston.

1844 — **Owen**, David Dale — *Report of a Geological Exploration of part of Iowa, Wisconsin, and Illinois, made under instructions from the Secretary of the Treasury of the United States, in the autumn of the year* 1839; 8°. Washington.

1847 — **Yandell**, L. P., and **Shumard**, B. F. — *Contributions to the Geology of Kentucky*; 8°. Louisville.

1848 — **Christy**, David — *Letters on Geology; being a series of communications originally adressed to Dr. John Locke, of Cincinnati, giving an outline of the geology of the West and South-West; together with an Essay on the Erratic Rocks of North America*; 8°. Oxford, Ohio.

1848 — **Prout**, H. A. — *The Geology and Mineral Resources of the State of Missouri* (Extract from the Western Journal and Civilian, vol. I.); 8°. St. Louis.

1849 — **Owen**, David Dale — *Report of a Geological Reconnaissauce of the Chippewa Land, District of Wisconsin; and, incidentally, of a portion of the Kickapoo Country, and of a part of Iowa and of the Minnesota Territory*, 8°. Washington.

1849 — **Jackson**, Charles T. — *Report on the Geological and Mineralogical Survey of the Mineral Lands of the United States in the State of Michigan, made under the authority of Congress, in* 1847 *and* 48; 8°. Washington.

1849 — **Burt**, W. A., and **Hubbard**, B. — *Reports on the Linear Surveys, with reference to mines and minerals in the Northern peninsula of Michigan, in the years* 1845 *and* 1846; 8°. Washington.

1842 — **Mitchell**, E. — *Elements of Geology, with an outline of the Geology of North Carolina;* 8°.

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1846 — **Lyell**, Sir Charles — *On the newer Deposits of the Southern States of North America* (Extract from the Quart. Journ. of the Geol. Soc. of London, vol. II.); 8°. London.

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1848 — **Tuomey**, M. — *Report on the Geology of South Carolina;* 4°. Columbia.

1848 — **Holmes**, F. S. — *Notes on the Geology of Charleston, S. C.;* 8°. Charleston.

1849 — **White**, G. — *Statistics of the State of Georgia* (Geol. Map.); 8°. Savannah.

1849 — **Roemer**, Ferdinand — *Texas; mit besonderer Rücksicht auf deutsche Auswanderung und die physischen Verhältnisse des Landes, nach eigener Beobachtung geschildert.* — Mit einem naturwissenschaftlichen Anhange und einer topographisch-geognostischen Karte von Texas; 8°. Bonn.

1850 — **Tuomey**, M. — *First Biennial Report of the Geology of Alabama;* 8°. Tuscalosa.

1851 — **Bailey**, J. W. — *Microscopical Observations made in South Carolina, Georgia, and Florida* (Extract from Smithsonian Contributions to Knowledge, vol. II.); 4°. Washington.

1852 — **Agassiz**, Louis — *Extracts from the Report of Prof. Agassiz to the Superintendent of the Coast Survey, on the examination of the Florida Reefs, Keys, and Coast* (Extract from: Annual Report of the Coast Survey, showing the progress of that work during the year 1851.); 8°. Washington.

1852 — **Roemer**, Ferdinand — *Die Kreidebildungen von Texas und ihre organischen Einschüsse;* 4°. Bonn.

1854 — **Lieber**, O. M. — *A Sketch of the Geology of the State of Mississippi* (Extract from the Mining Magazine; vol. III.); 8°. New York.

1854 — **Wailes**, B. L. C. — *Report on the Agriculture and Geology of Mississippi, embracing a sketch of the social and natural history of the State;* 8°. Jackson.

1855/57 — **Tuomey**, M., and **Holmes**, F. S. — *Fossils of South Carolina;* 4°. Charleston, S. C.

1856 — **Emmons**, Ebenezer — *Geological Report of the Midland Counties of North Carolina;* 8°. New York.

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1806 — **X.** — *Abstracts of public documents relative to the late discoveries in exploring the Missouri, Red, and Washita rivers;* 8°. Washington.

1809 — **Lewis** and **Clarke** — *The Travels of Capts. Lewis and Clarke.* Performed in 1804, 1805, and 1806, by order of the Government of the United States. 2 vol., 8°. Philadelphia.

1850 — **Cross**, O. — *A Report in the form of a Journal, to the Quatermaster general, of the march of the regiment of mounted Riflemen to Oregon, from May 10 to October 5*, 1849; 8°. Washington.

1851 — **Simpson**, J. H. — *Report and Map of the route from Fort Smith, Arkansas, to Santa Fe, New Mexico;* 8°. Washington.

1852 — **Stansbury**, Howard — *Exploration and Survey of the valley of the Great Salt Lake of Utah, including a reconnaissance of a new route through the Rocky Mountains.* Appendix E. *Geology and Paleontology*, by James Hall; 8°. Washington.

1853 — **Leidy**, Joseph — *The Ancient Fauna of Nebraska: or a description of remains of extinct Mammalia and Chelonia, from the Mauvaises Terres of Nebraska* (Extract from Smithsonian Contributions to Knowledge, vol. VI.); 4°. Washington.

1853 — **Marcy**, R. B. — *Exploration of the Red River of Louisiana, in the year* 1852. Appendix D., *Geology*, by Ed. Hitchcock and Geo. G. Shumard. Appendix E., *Paleontology*, by B. F. Shumard. 8°. Washington.

1853 — **Sitgreaves**, L. — *Report of an Expedition down the Zuni and Colorado rivers*; 8°. Washington.

1854 — **Marcou**, Jules — *Sur la Géologie des Montagnes Rocheuses, entre le Fort Smith (Arkansas) et Albuquerque (Nouveau Mexique).* (Extract from: Bulletin de la Soc. Géol. de France, 2e série, vol. XI.) 8°. Paris.

1854 — **Marcou**, Jules — *Résumé d'une section géologique des Montagnes Rocheuses à San Pedro, sur la côte de l'Océan Pacifique* (Extract from: Bulletin de la Soc. Géol. de France, 2e série, vol. XI.); 8°. Paris.

1854 — **Bartlett**, J. J. — *Personal narrative of Explorations and Incidents in Texas, New Mexico, California, Sonora, and Chihuahua;* 2 vol., 8°. New York.

1855 — **Pacific Railroad Expl.** — *Report of the Secretary of War on the several Pacific Railroad Explorations.* Documents accompanying the report of the Secretary of War. V, *Report of Explorations of a route near the 38th and 39th parallels of latitude, from the mouth of the Kansas to Sevier river, in the Great Basin*, by E. G. Beckwith; also: *Report of Explorations on the line of the forty-first parallel of north latitude*, by E. G. Beckwith (Appendix: *Geological Report of the country explored under the 38th and 41st parallels of north latitude, in* 1853—54, by James Schiel.). VI, *Report of Explorations for a route near the thirty-fifth parallel of latitude, from the Mississippi river to the Pacific Ocean*, by A. W. Whipple (Chapter 6: *Résumé of a geological reconnaissance extending from Napoléon, at the junction of the Arkansas with the Mississippi, to the Pueblo de los Angeles, in California*, by Jules Marcou.). VII, *Report of Explorations of a route near the thirty-second parallel of latitude, from the Red river to the Rio Grande*, by J. Pope (Appendix; chapter 13: *Geological notes of a survey of the country comprised between Preston, Red river, and El Paso, Rio Grande del Norte*, by Jules Marcou.). 8°. Washington.

1856 — **Warren**, G. K. — *Explorations in the Dacota Country, in the year* 1855. Appendix E., *Geological note on section in ravine of l'Eau qui court river*, by W. P. Blake; *Geological notes, etc., on Nebraska*, by F. V. Hayden. 8°. Washington.

1857 — **Meek**, F. B., and **Hayden**, F. V. — *Descriptions of new species and genera of fossils, collected by Hayden in Nebraska Territory; with some remarks on the Tertiary and Cretaceous formations of the North-West and the parallelism of the latter with those of other portions of the United States and Territories* (Extract from the Proc. of the Acad. of Nat. Sc. of Philadelphia, May 1857.); 8°. Philadelphia.

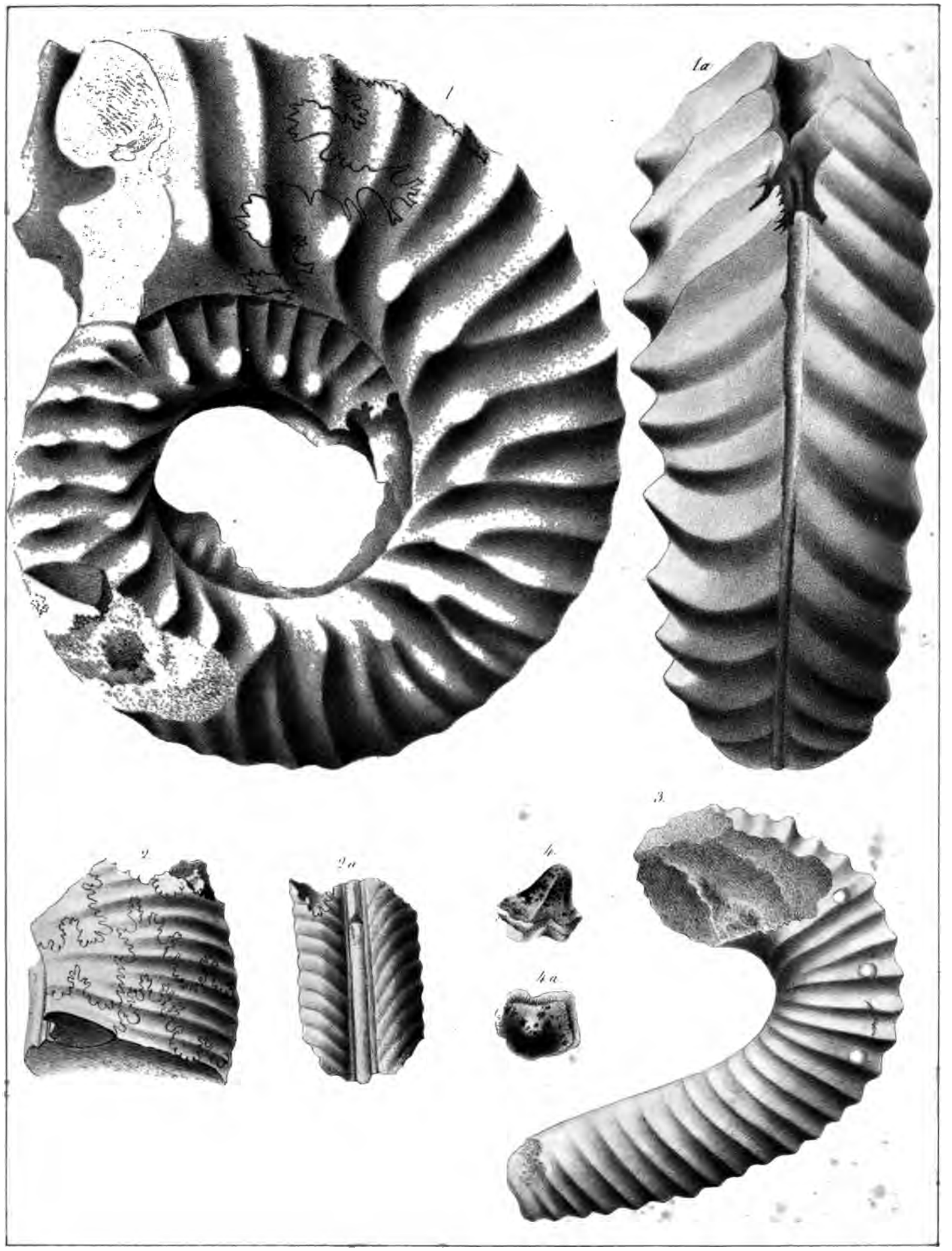
NOTE.

28th March 1858. — I have just received vol. II and III of the quarto edition of the *Reports of Explorations and Surveys, for a Railroad from the Mississippi river to the Pacific Ocean*, published by order of the Senate of the United States. Volume II, contains Captain Pope's Exploration and a Report on the Geology of his route by W. P. Blake. My preliminary Report, entitled: *Geological Notes of a Survey of the country comprised between Preston, Red river, and El Paso, Rio Grande del Norte*, published in the octavo edition, is omitted, although Capt. Pope quotes, page 36, my suggestions as to the practicability of boring Artesian wells on the Llano Estacado. Mr. Blake never quotes my Report, or gives my name, except in order to say that I am mistaken in finding on this road the *New Red Sandstone* and the *Jurassic*. I will say nothing about Mr. Blake's objections and remarks; hoping that he has been more successful than myself, and that no mistake exists in his Report.

Volume III, is devoted completely to Lieutenant A. W. Whipple's *Report of Explorations for a Railway route near the thirty-fifth parallel of North Latitude*, and contains quite an extensive *Report on the Geology of the Route*. My name appears very often in the Geological part of this volume, and the use and abuse of it will impress at once every impartial reader. I have said already twice in the Introduction of this present work, and I repeat here again: *That I decline all responsibility as to the use that has been made by W. P. Blake, J. Hall, and A. A. Humphreys of my official note-books and specimens, which for me have no existence whatever.* I do not recognize a single phrase or word of the Geology by Blake and Paleontology by Hall as *my own*; and more, I do not recognize as my work the: *Résumé and Field Notes, by Jules Marcou, Geologist and Mining Engineer to the Expedition; with an English Translation by W. P. Blake.* The only part of vol. III that I consider as my production, is the *Résumé of a Geological Reconnaissance, extending from Napoléon, at the Junction of the Arkansas with the Mississippi, to the Pueblo de los Angeles in California*; pages 165, 166, 167, 168, 169, 170, and 171; and the different quotations taken from that *Résumé of a Geol. Rec.*, by Whipple and Blake.

Mr. Blake has done his best to nullify and deny all my discoveries on this Survey. I will say nothing more to defend myself, and I hope that Mr. Blake is satisfied with his own work. I desire heartily that his *voluminous* Report may be of more service to the progress of science, and give a better knowledge of the Geology of the Expedition of which I was the Geologist, than my *concise* Résumé and my other works on the subject; but I beg all Geologists, personal friends or others, not to confound my *observations* with Mr. Blake's *opinions and comments* on their value, and to judge impartially if I am to be blamed for what I have done.

In these volumes nothing is said as to my withdrawal from the publication of the Geology of Whipple's and Pope's Explorations; this delicate subject was wisely avoided by every one, in order to cover the abuse of authority of Jefferson Davis, which was the cause of my resignation.



F. Brugger del. et lith. Imp. Lier Zurich

Fig 1 1a. *Ammonites Schumardi, n. sp*
„ 2. 2a. *Ammonites Novi-Mexicani, n. sp*
Fig. 3. *Baculites Fremonti. n sp*
„ 4. 4a. *Ptychodus Whipplei, n. sp.*

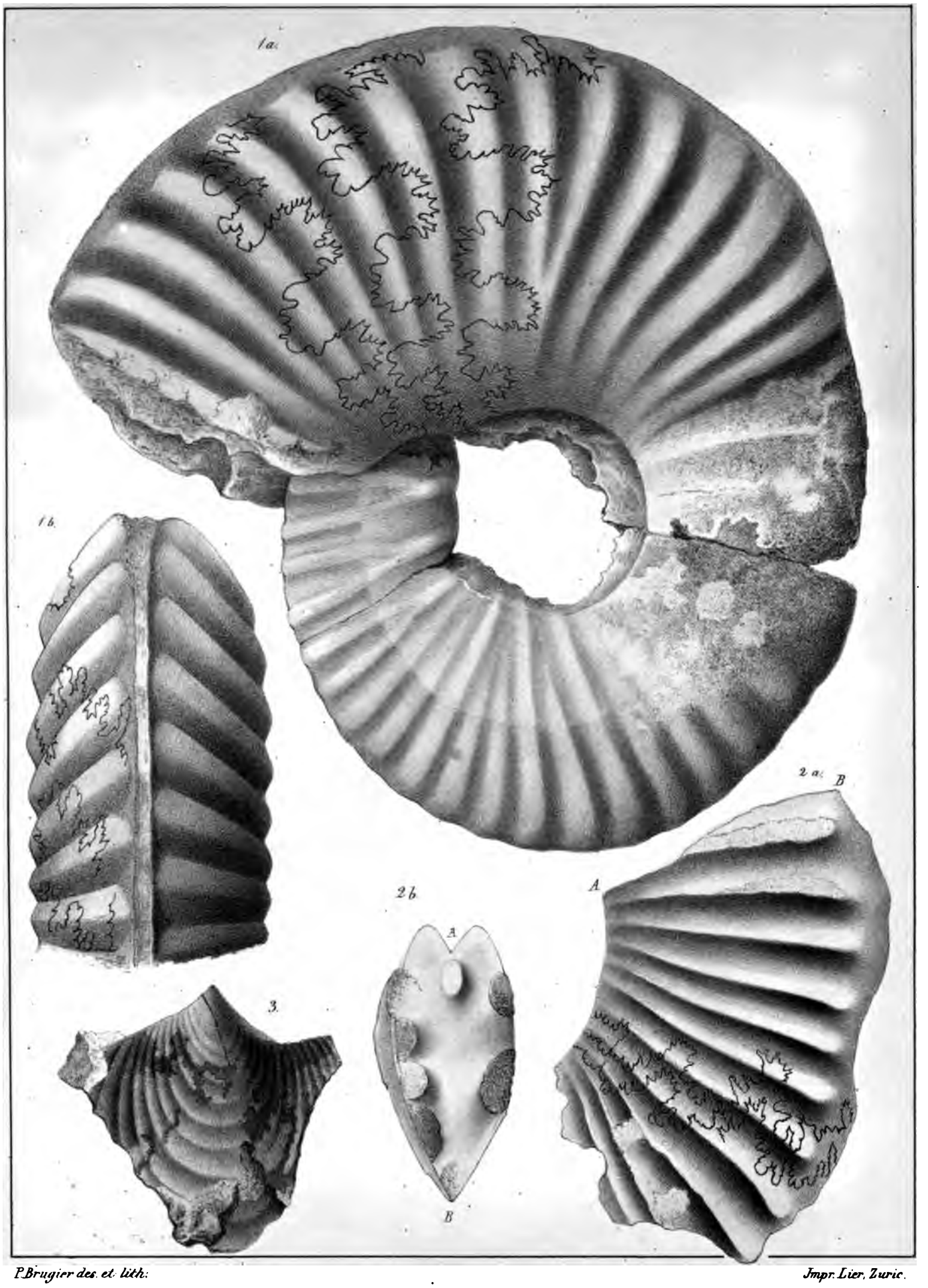


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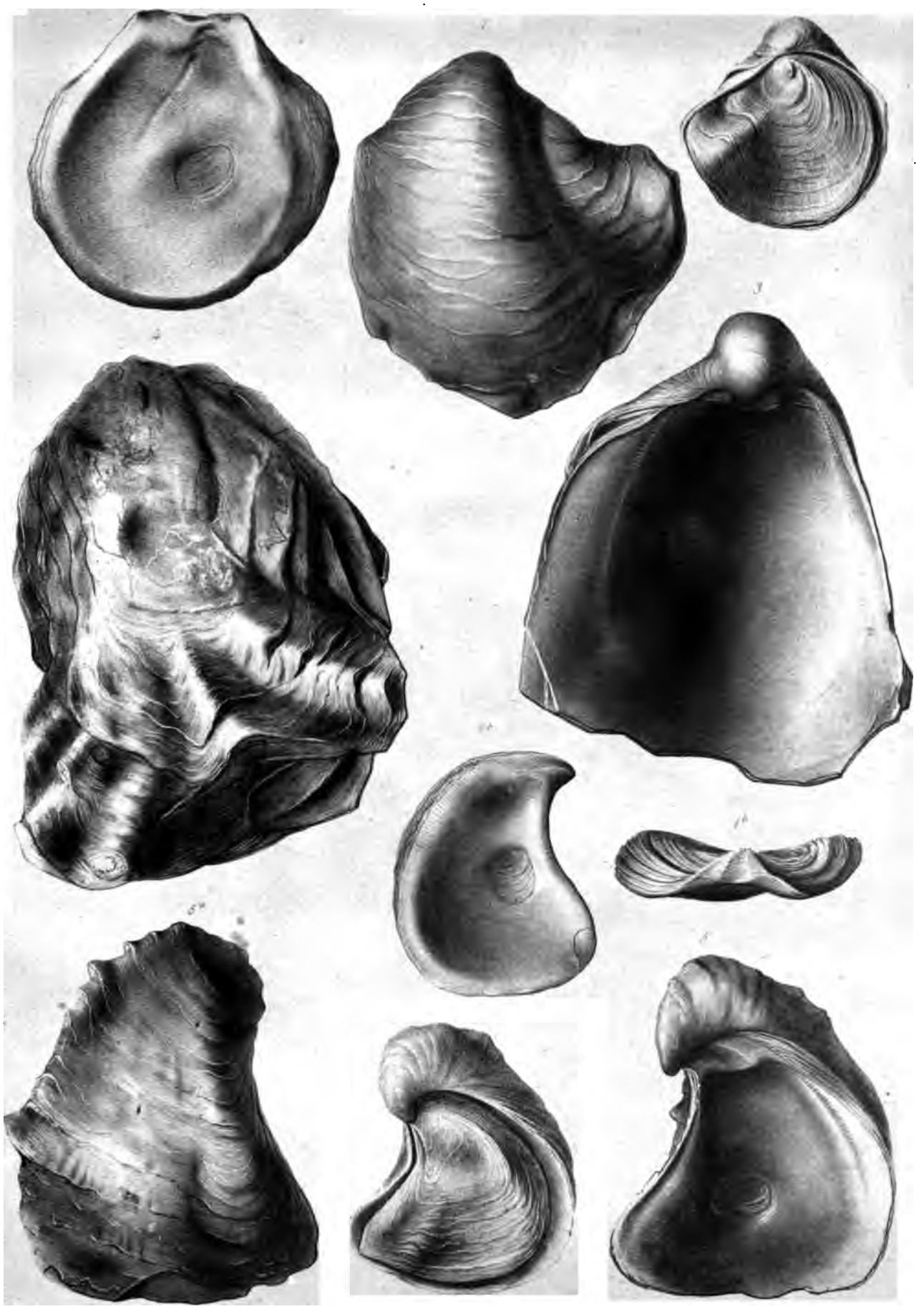
Fig. 1a. 1b. Ammonites Belknapii n. sp.
„ 2a. 2b. Ammonites Gibbonianus Lea.

Fig. 3. Inoceramus Lerouxi n. sp.



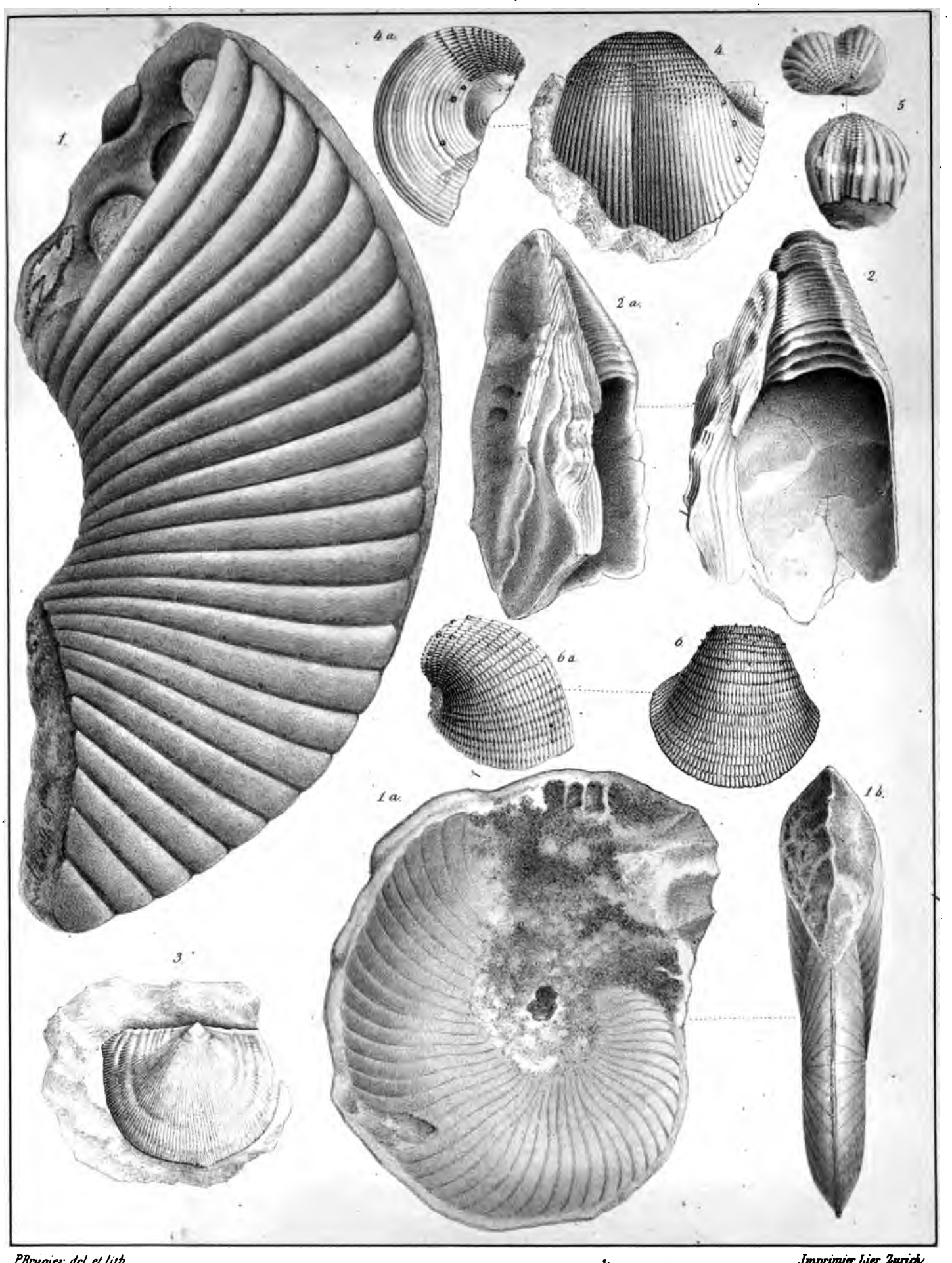


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Fig. 1. 1 a. 1 b. Ammonites peruvianus, de Buch.
" 2. 2 a. Ostrea Virginiana var. Californica, n. sp.
" 3. Productus Delawarii, n. sp.
" 4. 4 a. Productus semireticulatus, Mart.
" 5. Productus costatus, Sow.
" 6. 6 a. Productus scabiculus, Mart.

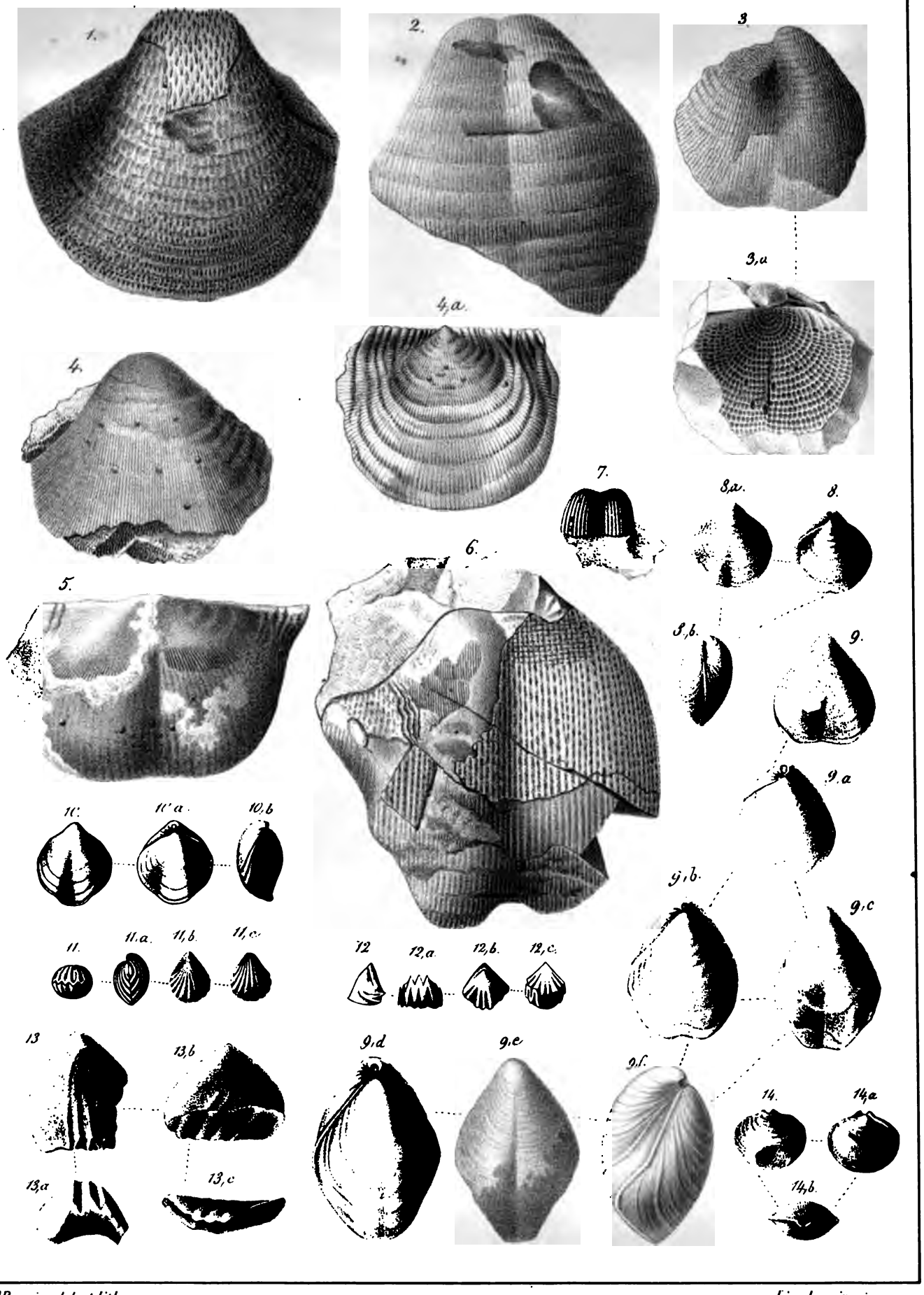

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Fig. 1. Productus pustulosus, Phill.
, 2. Productus punctatus, Mart.
, 3. 3a. Productus pyxidiformis, de Kon.
, 4. 4a. Productus Cora, d'Orb.
, 5. Productus Cora var. Mogoyoni n. sp.
, 6. Productus semireticulatus, Mart.
, 7. Productus Flemingii, Sow.

Fig. 8, 8a, 8b. Terebratula plano-sulcata, Phill.
, 9, 9a, 9b, 9c, 9d, 9e, 9f. Terebratula subtilita, Hall.
, 10, 10a, 10b. Terebratula Royssii, Lév.
, 11, 11a, 11b, 11c. Terebratula Mormonii n. sp.
, 12, 12a, 12b, 12c. Terebratula Uta n. sp.
, 13, 13a, 13b, 13c. Terebratula Rockymontana n. sp.
, 14, 14a, 14b. Orthis Pecosii, n. sp.

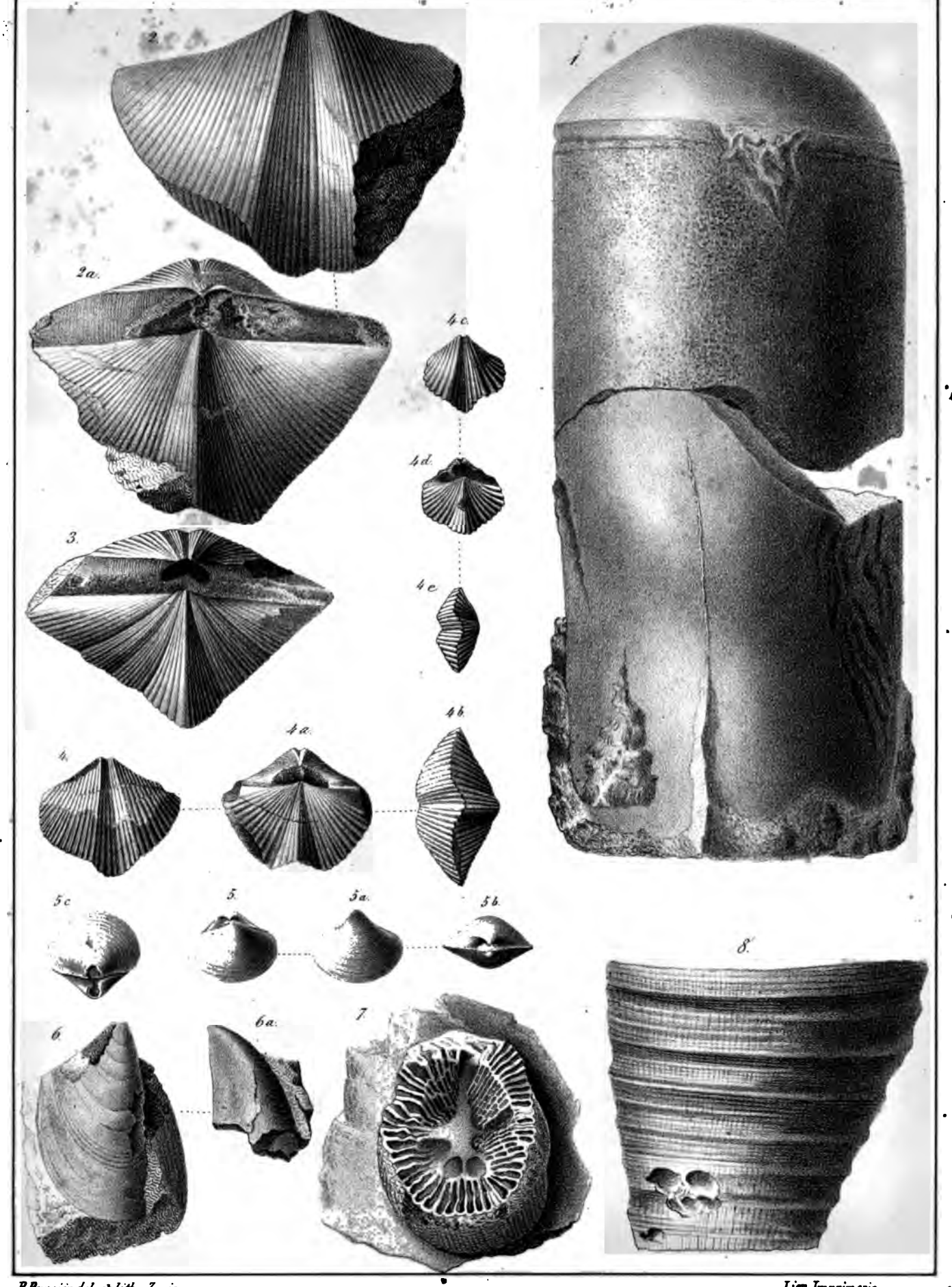

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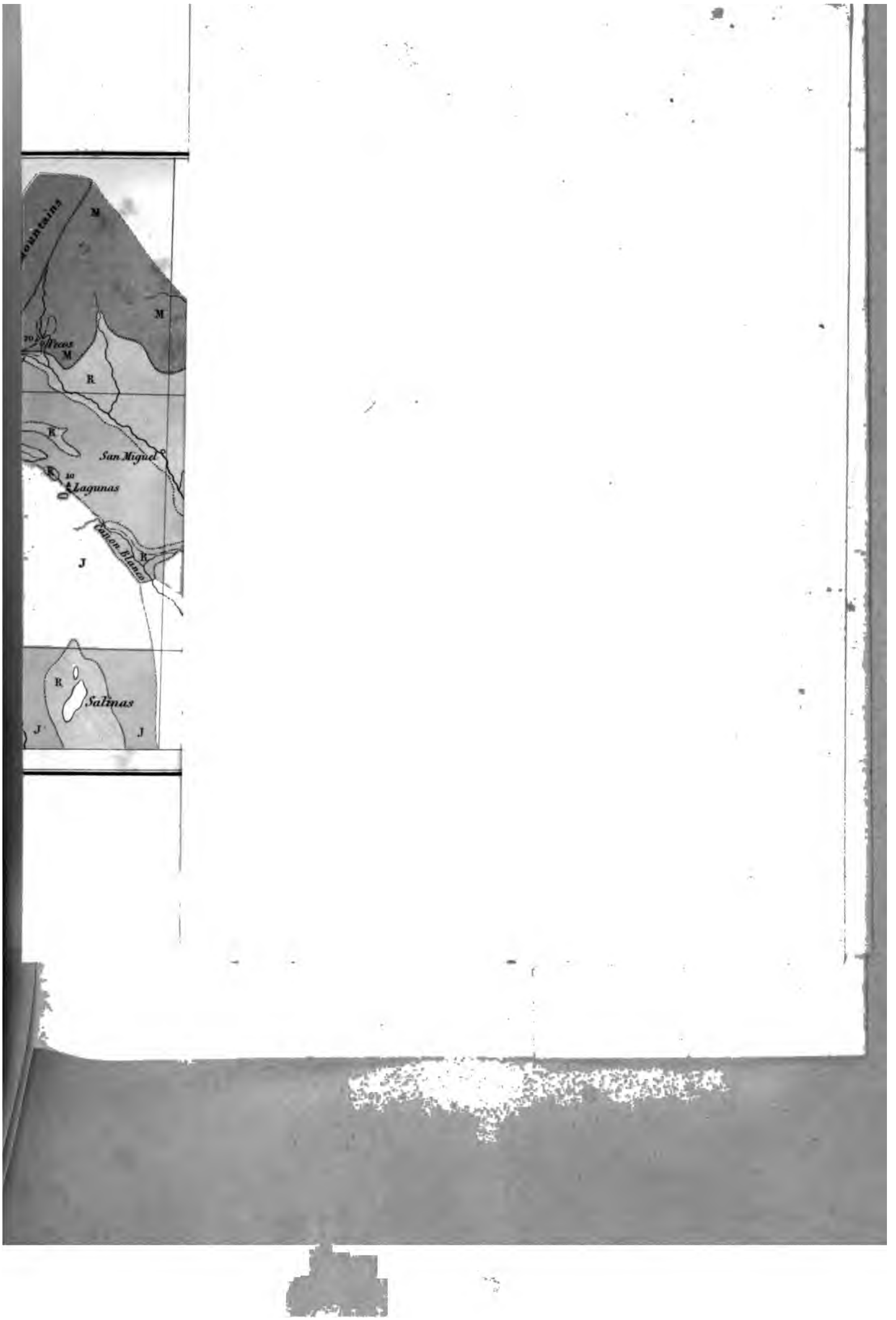
Fig. 1. Orthoceras Nova-Mexicana. n. sp.
" 2. 2 a. Spirifer striatus Mart.
" 3. Spirifer striatus var. triplicatus.
" 4. 4 a. 4 b. 4 c. 4 d. 4 e. Spirifer Rockymontani. n. sp.

Fig. 5. 5 a. 5 b. 5 c. Spirifer lineatus Mart.
" 6. 6 a. Productus Apachesi n. sp.
" 7. Zaphrentis Stansburii Hall.
" 8. Zaphrentis cylindrica Haime.


Mountains
M
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Pecos
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San Miguel
Lagunas
Canon Blanco
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Salinas
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J

BY THE SAME AUTHOR.

A GEOLOGICAL MAP OF THE UNITED STATES AND THE BRITISH PROVINCES OF NORTH AMERICA: with an Explanatory Text, Geological Sections, and Plates of Fossils which characterize the formations. 1 vol., 8°. 1853, Boston (United States). 3 dollars.

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