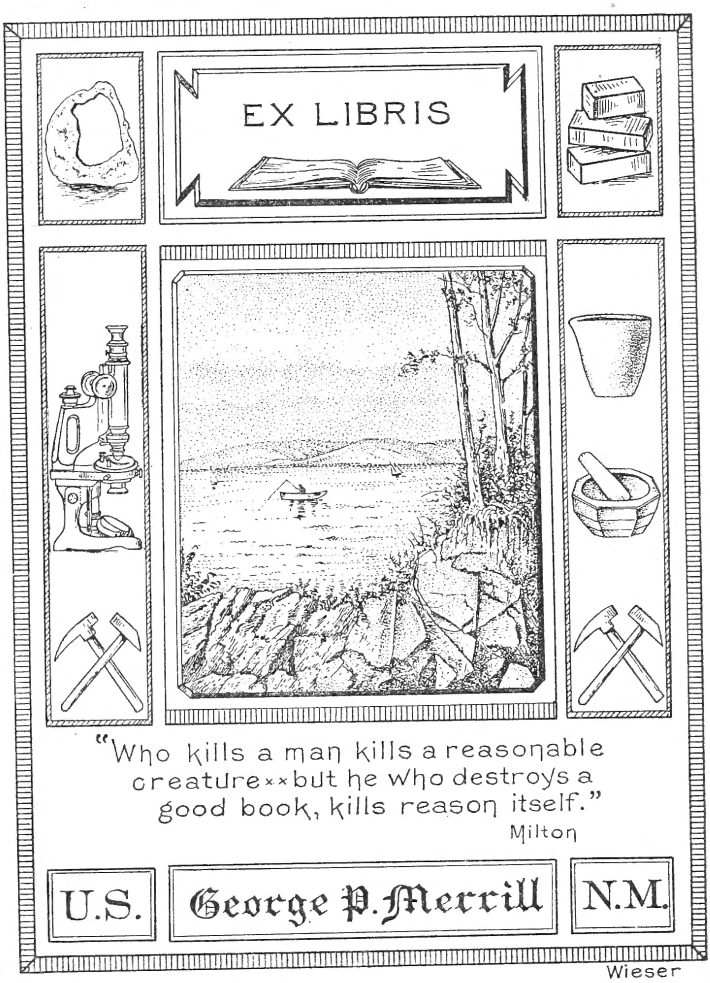

U. S. GOVERNMENT PRINTING OFFICE: 1930 J4651

TRANSACTIONS

OF THE

GEOLOGICAL SOCIETY

OF

PENNSYLVANIA.

VOL. I.

PHILADELPHIA:
JAMES KAY, JUN. & BROTHER, 122 CHESTNUT STREET.
PITTSBURGH: JOHN I. KAY & CO.
1835.

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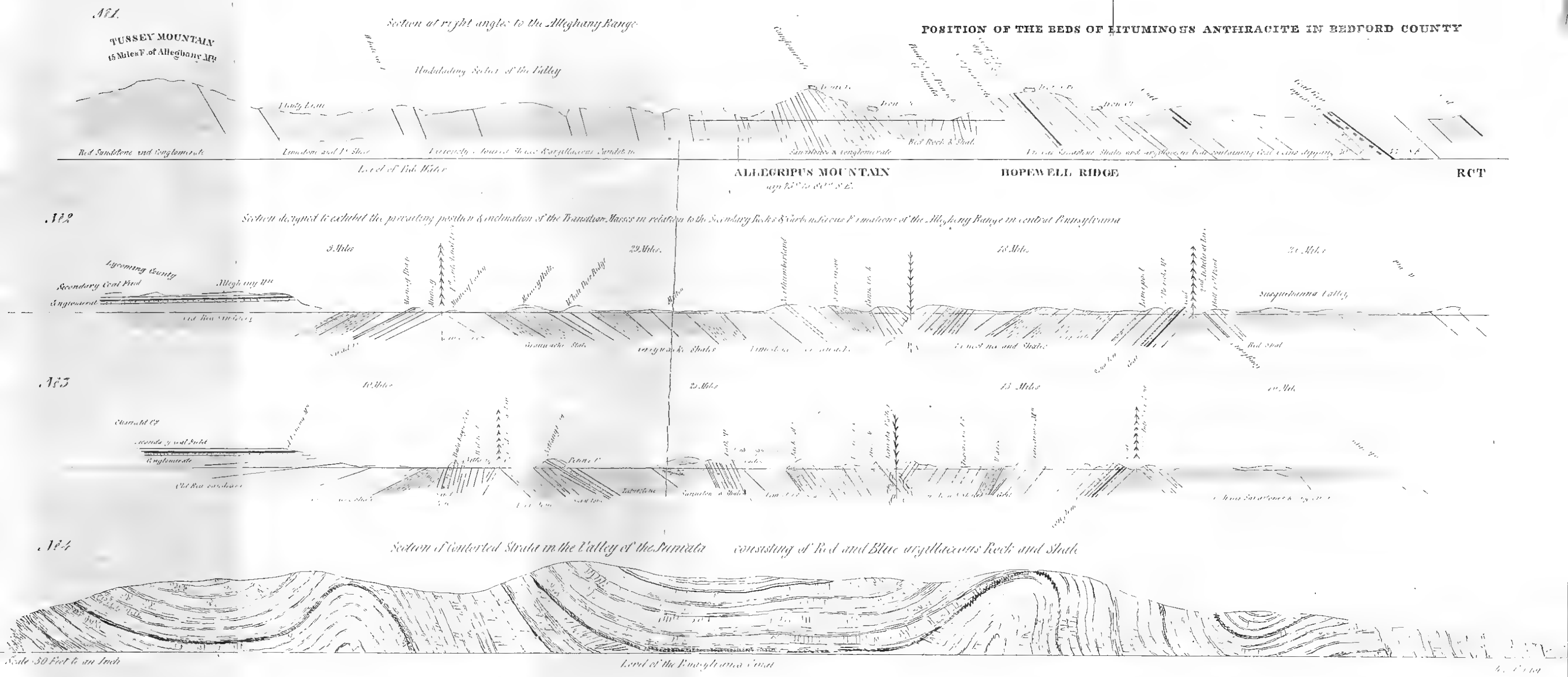
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TRANSACTIONS

OF THE

GEOLOGICAL SOCIETY OF PENNSYLVANIA.

VOL. I.—PART II.

ON THE RELATIVE POSITION OF THE TRANSITION AND SECONDARY COAL FORMATIONS IN PENNSYLVANIA, AND DESCRIPTION OF SOME TRANSITION COAL OR BITUMINOUS ANTHRACITE, AND IRON ORE BEDS NEAR BROAD TOP MOUNTAIN, IN BEDFORD COUNTY, AND OF A COAL VEIN IN PERRY COUNTY, PENNSYLVANIA. WITH SECTIONS.

By Richard C. Taylor, Fellow of the Geol. Soc. of London; Associate Fellow of Inst. Civ. Eng. London; Member of the Geol. Soc. of Pennsylvania; of the Acad. Nat. Sci. Philadelphia; and of the Albany Institute, New York.

In the "Report of the Committee of the Senate of Pennsylvania upon the subject of the Coal Trade," under the article describing "the Bituminous Coal Field of Pennsylvania," page 33; the writer describes this coal field as passing eastward in advance of the Alleghany mountain, and as including the coal of the western parts of Bedford and Huntingdon counties; adding that "it seems most probable that Wills', or Evett's, or possibly Sideling mountain, there forms the boundary of this de-deposit," thus carrying the line of division between the grauwacke and the secondary groupe, thirty miles in front of the Alleghany range.

In the same valuable report, which combines a greater mass of useful practical information on the subject of Pennsylvania coal than has ever before been presented to the public, the writer of the article Number 27 in the Appendix, at page 122, appears to have formed the same conclusion, in classing the coals of Cumberland, Wills' creek, and the Round Top (Broad Top?) mountain, on the Raystown branch of the Juniata, with the secondary bituminous coals of Clearfield and Lycoming.

Having had some opportunities of investigating the relative ages and geological order of position in most of the deposits referred to, I feel no hesitation in assigning the Bedford county coals, particularly the veins in the Broad Top mountain, to their true position among the grauwacke, or, as they are commonly denominated, the transition rocks; and in referring in all cases, from the Potomac to the Susquehanna, the boundary between the secondary coal field and the transition series containing the older coal beds, to the main range of the Alleghany mountains.

In every part where I have examined this mountain, from its base upwards, the order of superposition is so apparent, so constant, and so well defined, that it precludes all room for doubt. If there is one case in the entire system of North American rocks, distinguished from the rest by the absence of ambiguity, this is that one.

The old red sandstone (for as a group it were well to retain a long known characteristic nomenclature) is every where seen supporting the almost horizontal secondary carboniferous formations, whose compact quartzose grits and conglomerates, form the crest of the Alleghany ridge, and the solid platform by which its highest table land is maintained.*

* In referring the old red sandstone to a position corresponding with its place in the series of European rocks, and to which the American group

The oldest or lowest members of the red sand stone group, consisting of various coloured shales, pass insensibly into the upper dark shales and limestone shales of the grauwacke group below, whose beds are so much tilted as often to be perpendicular. To the first limestone parallel succeeds a vast series of highly inclined undulating and contorted strata; including granular and crystalline quartzose rocks, calcareous, siliceous, and schistose conglomerates, limestones and marbles, slates and shales; comprehending within them numerous beds of glance coal, bituminous anthracite, graphitic anthracite, radiated and conchoidal anthracite, and several varieties of iron ore. There are also distinctive characters about most of these rocks, familiar to those who have studied them, independent of their order of position, by which they may be recognized. Their organic remains are peculiar and useful guides.

The foregoing remarks will be best illustrated by the diagram, pl. 8, fig. 6. It is constructed from existing data, but being necessarily contracted in the longitudinal scale, the secondary and transition coals are brought more closely together than a correct scale would exhibit.

Before quitting this section, let me advert to one remarkable feature in it, which must be more minutely examined hereafter. I refer to the sudden change of inclination in the whole mass of stratified rocks, secondary as well as transition, about ten miles in advance of the Alleghany mountain; by which circumstance they dip in opposite directions, not in a limited space, but through a wide area. So extensive is the result of this fracture, whether proceeding from a central upheaving

bears in many respects a close resemblance, I find myself differing from an authority deservedly high amongst our continental geologists. Mr M'Clure has seen reason to place the old red sandstone on the east side the area occupied by the transition, while I recognize it on the west side.

prolonged to an unknown distance, or from contraction and consequent subsidence on either side—that, with the exception of some cases of unconformableness in the contorted limestones and undulating soft shales, I have observed its influence has been exerted over a breadth of thirty miles on one side of the anticlinal line, and from twenty-five to thirty miles on the other. I have reason to conceive, further, that on the west side this anticlinal line the strata uniformly dip to the west under the secondary formations, and on the east towards the primitive region; that this line ranges parallel with and is co-extensive with the entire Alleghany mountain range, in its passage across central Pennsylvania from Maryland to Luzerne county in this state; and if so, it forms one of the most interesting features in American geology. Much remains to be be done ere this supposition is confirmed in its contemplated extent: at present I shall only state, as the basis upon which the opinion is founded, that I have traced this line of fracture running for the space of one hundred and fifty miles, equidistant from the Alleghany mountains.

Below Newport on the Juniata, and at Montgomery's Ferry on the Susquehanna, a break occurs in the arrangement of the strata, which extensively influences the physical features of this district. Here then we discover a second anticlinal line traversing the Juniata and Susquehanna in a S. E. course, parallel with the Alleghany mountain. To the north of this line numerous grauwacke rocks, gritstones, coal shales, and carboniferous sandstones of the transition class, conglomerates and variously coloured shales, chiefly those of a chocolate colour, dip to the north at angles varying from 25 to 70°, for a breadth of fifteen to twenty miles. To the south of the same line of elevation another extensive suite of red contorted shales, red and white sandstones and silicious conglomerates, some of them perhaps identical with the former, dip at 25 to 75° to the south, across an uncertain breadth, but not less than twenty miles in that direction. We are not yet acquainted with the longitudinal extent of this fracture. But we are nevertheless in possession of the interesting fact that two great disrupted lines of elevation range through central Pennsylvania, the first at a distance of ten miles in front of the Alleghany mountain, and the second in the same parallel, at the distance of fifty to fifty-five miles in front of the same mountains. Both these lines range along chains of valleys and not on hills or ridges. The point where the two planes of lifted or tilted strata rest against each other on their lower sides is not equidistant between the two anticlinal lines, but in the proportion of fifteen to eighteen miles breadth from the south line, and twenty-five to twenty-nine miles breadth from the north or first line of elevation, measuring at right angles to those lines. These results are obtained from four sectional lines at the distance of fifty-five, one hundred, and one hundred and thirty miles from each other. From two of these I have prepared the sections, pl. 7, fig. 2 and 3, roughly traced for the present purpose of illustrating the foregoing notice.

It is also a circumstance of some interest, that this line of depression between the two uplifted planes, passes westward from the foot of the Mahanoy mountain across the Susquehanna, and along the south foot of the Shade mountain, in the bottom of the trough described by me in a former article in this volume, pp. 6 to 15, where this deep valley is filled partly by the Juniata, and partly by numerous beds of fucoides. Pursuing the same line of fracture, as it sweeps round to the south west, we find that for the space of thirty miles it forms the bed of the Juniata, which so far avails itself of the trough produced by the intersection of these vast planes; and we thus obtain an interesting elucidation of the cause of this remarkable deflection in that river, obvious to all who cast a glance at the map of its course, in the same manner as the first anticlinal line occasions a corresponding deflection of ten miles, higher up the same river, between Alexandria and Williamsburg.

We have also a solution of the originating cause of a remarkable group of contorted rocks which line the banks of the Juniata along a space of thirty miles in Mifflin county. From among many sketches of flexuous strata occupying the sides of this river, I have selected one which has been exposed by the excavations for the Pennsylvania canal. Pl. 7, fig. 4. In a previous communication, p. 11, I have adverted to these twisted rocks as forming a characteristic feature in the geology of the Juniata valley, for which I was then unprepared to account. I there observed that here was displayed "a continued series of contorted stratified masses, rolling and heaving like the waves of a stormy ocean."

A reference to the sketch of part of this trough of the Juniata, pl. 4, fig. 6, and of its transverse section, fig. 7, exhibiting the converging of the oppositely inclined masses, will save unnecessary repetition here.

Having subsequently examined a wider range of this central area, and traced its geological features in connection with this portion, the circumstance which produced this crushing and twisting of the rocks, in the line of junction of two vast disrupted planes, now becomes sufficiently intelligible. All that on the present occasion I mean to convey, as the result of much local examination, however inadequate to the perfect elucidation of the whole, is—

That within a breadth of seventy miles, forming the western zone of the transition rock series, and independent of innumerable minor disturbances of their separate parts, there are two great anticlinal lines, (that is longitudinal lines, from which descend the strata on either side) which hold a course apparently parallel with the Alleghany range for an undefined extent; and one great line of depression, at the junction of their inclined planes, occasioned by subsidence from the saddles of those planes.

It is only by enlarged researches, and by the accumulation of more facts in this intricate region, that the precise limits of the configuration, which I have indicated, may be fully defined.

Returning now to the controverted subject of the eastern boundary of the Bituminous Coal Field. The parallel of Sideling mountain, ascribed by the author of the report we have quoted, as the supposed eastern limit of this coal field, is the same as Path mountain in Centre county, being apparently an extension of that ridge; and if the same geological parallel be pursued to the north east, it would include all the anthracite of Nescopec, Wilkesbarre and the vicinity of the North branch of the Susquehanna. On the contrary, it has been shown that the secondary formations do not cross the older rocks nor pass the Alleghany ridge; which must therefore be held as the frontier line between the bituminous coal field and the deposits comprehended under the general denomination of the grauwacke groupe. In the five detailed sections of different parts of this ridge, constructed by myself, and in that recently sketched by Mr E. Miller, the true structure of this great mountain range and its relative connection with the older rock formations, are completely elucidated, and one uniform arrangement is proved to prevail. Pl. 8, fig. 6.

Much confusion, at various parts of the eastern vicinity of the Alleghany range, has arisen by conferring that name upon many of the parallel transition ridges in advance of it. By some these longitudinal ridges have, with equal impropriety, been styled *spurs* of the Alleghany; an appellation which their internal structure forbids, and which their external features proclaim to be inapplicable. The geologist will cease to confound the lofty escarpment of the old red sandstone, and of the secondary coal formation, with the inferior ridges of the older or preceding series of rocks. Vide pl. 7, No. 2 and 3.

The sectional line of Bedford county, of which a part is herewith communicated to the Society, pl. 7, fig. 1, crosses the Alleghany ridge at right angles to its course, in order best to exhibit the outcrop of its masses; passing over Tussey mountain, the Raystown branch of the Juniata, and the region of coal and iron adjoining Broad Top mountain. The nearest coal vein here rises to the surface at twenty miles eastward of the Alleghany mountain.

Tussey mountain is an elevated ridge composed of coarsely laminated red and white sandstones and conglomerates, whose beds incline from the Alleghany mountain. From thence to the Allegripus mountain is a series of undulations and low longitudinal ridges, composed of innumerable shales and sandstones, whose inclination varies from 40 to 80° to S.E. Allegripus ridge is of inferior elevation and magnitude to Tussey mountain. It contains coarse quartzose conglomerate and many other silicious rocks, as well as shales, and a bed of bituminous shale with impressions of ferns. All these strata dip eastward from 50 to 65°. Succeeding these is a series of red shales, clays, marly rock and red sandstones, which are cut through by the Raystown branch. This river, in consequence of its many windings, likewise intersects the conglomerate rock of Allegripus mountain six times in about as many miles. Further eastward we traverse an irregular mountain district composed of carboniferous shales and sandstones, conglomerates and gritstones, and comprising several veins of coal, the whole arrangement forming an inclination of from 30 to

45° S.E., exclusive of a few points, where the silicious rocks are thrown up almost vertically.

The section of this coal region has been constructed from superficial data, as very little has been done hitherto in exploring or working the minerals in this direction.

Within a mile of Hopewell Furnace, on the Raystown branch, a five feet vein of promising coal has been put in work. Its dip is about 45° to the S.E. This is a glance coal; possessing bitumen in sufficient quantity to burn well; convertible into coke; of a deep black colour; fracture exhibiting a brilliant jet polish, little affected by the atmosphere; burning to a white ash. The glance cleavage of this coal, as in some other varieties of anthracite, crosses the original laminated planes of deposit at every possible angle; presenting numerous sections of convex and concave faces. The interposition and intersection of these polished cleavages have greatly modified its original arrangement, and obliterated to a great degree the original structure. It is remarkable for the intense blackness and brilliant lustre of its planes. It burns freely at first with a bright flame, which after a while decreases and a strong white heat succeeds. Pieces of the smallest size ignite readily; and probably the most suitable mode of using it is in broken pieces of small size. For the purpose of burning in open grates, it is not improbable that this description of coal may be held in some estimation, after its properties have been fairly proved. In a grate, even of the most common construction, it affords a cheerful fire; emitting nearly the same quantity of flame, attended with certainly less smoke than the ordinary bituminous varieties; and leaves not more than the usual amount of ashes than those kinds.

Specific gravity, 1.700.

Since writing the above I have submitted specimens of this coal to T. G. Clemson, Esq., who has favoured me with the following analysis and observations. It is proper to premise that the coal with which I furnished him was obtained at an early stage of the opening of the vein, near the outcrop, and consequently the result may be expected to exhibit a larger proportion of earthy matter than actually exists in the vein.

"This substance is formed of parallel layers, making different angles with the natural surfaces of the mass: they having a vitreous, shining, black lustre. Its fracture in two senses is lamellar, with a very pure brilliant black lustre: in a cross direction it is imperfect conchoidal, with a grey black metallic appearance. Powder dark brown; fragments indeterminate, angular. Not fragile, and does not soil: free from the sulphuret of iron: gives a voluminous fine coke, and burns with a long bright yellow flame, with much smoke: ashes free from carbonate of lime, and having a blue grey colour."

Composition.

Carbon, ...	52.7
Volatile matter (bitumen, water and gas), .	16.9
Ashes, ...	30.4
	100.0

Three miles north of the Hopewell coal vein, is another called Riddle's Bank, which has been opened thirty years, but not extensively worked. The adit appears to be drifted in a fault or derangement of the strata at this point. Thickness of coal worked is five feet three inches. It is a dry hard coal, with little waste in mining, having a good roof and a convenient situation for working, so far as that operation has advanced: but from its peculiar position in an undulation of the vein, it must be limited to small breadth and a change of inclination must take place from almost horizontal to a dip of 45° south east. It is also a deep glossy jet-black coal, like the Hopewell vein, but its fracture is more angular, its original lamina less deranged by cross cleavage, and it contains bitumen in a considerable degree.

Specific gravity, 1.700.

Mr Clemson has favoured me with the following analysis.

"This coal has a brilliant black colour; a shining vitreous lustre; when reduced to powder brown black; easily broken, without being fragile, the pieces having a laminated structure. This compact fine combustible is clean, not soiling, and free from pyrites or other foreign matter. Its cross fracture is conchoidal and retaining an equal lustre to that shown upon any other of its surfaces. It burns easily, and with a long bright flame, giving the substances that are usually obtained from the distillation of other bituminous coals. In its nature it is fat, melting and swelling out with a fine voluminous coke. The cinders were of a blue grey, and did not effervesce when submitted to the action of an acid."

Composition.

Carbon, ...	70.1
Volatile matter (bitumen, water and gas), .	16.7
Cinders (chiefly argillaceous, with a little oxide of iron), ...	13.2
	100.0

There are in this vicinity several other coal veins, some of which are crossed by our section. One of these is stated to be a five feet vein, but I have not examined the quality. Another is three feet at the outcrop, and I have observed two others of eighteen inches each at the crop; one two and a half, and another three feet, under the like circumstances. It is impossible to say whether these are separate veins, or whether some of them are repetitions of others.

Coal, approaching to the quality of the Hopewell coal, has for many years been dug in Trough valley, which leads into the Raystown branch, fourteen miles from Huntingdon. This is not so good: contains sulphuret of iron; does not break into lustrous flakes like the Hopewell coal. With a blast, as in a smith's forge, it will yield smoke and flame, and even forms an inferior coke.

There are points around the north part of Broad Top mountain where coal is obtained; but the quality is not held in any estimation. I examined some of this coal in February 1831 and in October 1833, and found it earthy, sulphurous, and difficult of ignition. It was formerly in occasional use among the blacksmiths, before the facilities of procuring the better kinds of bituminous coal from the other side the Alleghany mountain were established.

It seems therefore that the quality of the Broad Top mountain coal depreciates as it advances northward. It does not appear that any of these veins cross the Juniata, or even reach its banks. At present no decided vein of workable coal has been proved between the Juniata and the Susquehanna, a circumstance which is singular; because, in a geological sense, I know no cause for the absence of carbonaceous deposits within that extensive area; and have reasons, which acquire strength with renewed observations in that quarter, for conceiving that they will ultimately be found there.

It must not be overlooked that within the last year researches have been made with some perseverance by Dr Martin, in Perry county, near the southern extremity of the region to which I refer, on the west side of the Susquehanna and nine miles above the confluence of the Susquehanna and Juniata rivers, in a prolongation of Berry's mountain which forms the southern boundary of Lyken's valley.

This coal occurs with the usual carboniferous deposits, shales and conglomerates, in Mount Patrick, the ridge immediately north of the second anticlinal parallel; and the same vein, apparently, has been found below Millerstown on the Juniata. Being a small vein, it was not thought expedient to proceed with the working at either position. Vide pl. 7, No. 2 and 3.

As the quality of this coal is somewhat peculiar, more approaching to the Bedford county coal than to that of Pottsville, its prevailing characters may be noticed.

It breaks into thin flakes and irregular lamina, with a shining glance cleavage; colour dark leaden, moderately brilliant; contains some small quantity of sulphuret of iron and much bitumen; gives a bright white flame; softens and swells when heated, forming a hollow fire having its smaller particles adhering or caking together; yields a thick smoke; leaves a black coke and a brownish ash. It is highly approved of by the blacksmiths for their purposes. On comparison with Karthaus coal yields as much flame and a brighter light, being less smoky and impure. When tried with the best Lyken's valley coal, the following differences were observable. When the blast is first applied, or when the fire is commenced, the Lyken's valley coal decrepitates, a circumstance not occurring with the Mount Patrick coal. The former yields much less flame, and that little is chiefly of a blue flickering unsteady quality, soon passing wholly off. It does not burn to a cinder, but leaves a white slaty ash, and gives out very little smoke.

I am happy to append the remarks subsequently furnished by Mr Clemson, and as they were made under different circumstances to my own, though arriving at the same result, I have not suppressed any portion of either.

" This coal has a homogeneous aspect; is of a grey black, and a shining metallic lustre. Its transverse fracture is very unequal and difficult; in another sense it is conchoidal schistose. The fragments assume a splint-like form, and have sharp angular edges. Its powder is brown; is free from pyrites and other foreign matter. Burns with a bright flame and much smoke. Does not soil, and is reduced to powder with comparative difficulty. Is not fat; softens and agglomerates in the fire, the pieces frequently retaining their form. It gives a dense coke, which has a high metallic lustre of a steel grey colour. The ashes were free from carbonates, and of a blue brown colour. The relative proportions of volatile matter, bitumen, &c. on analysis of this coal, are eleven parts to thirty-one parts of carbon."

The Society is indebted to Dr Martin for a splendid series of fossil coal plants, from this mine. Dr Harlan, who has examined them attentively, thinks they can be referred to *Knorria imbricata*, tab. xxvi., *Lychopodiolites dichotomus*, tab. ii., and *Striaticulmus* (species not identified), figured by Sternberg. The specimens, which are all flattened, vary from a few inches to a foot in breadth, and were obtained in pieces of from two to five feet in length. Dr Martin, who paid much personal attention to the examination of this mine and its products, informs us, that these "vegetable remains" lay all parallel to the walls of the vein, which is inclined at an angle of 60 degrees; but there were others also which crossed it, and these had retained their cylindrical form, although they were somewhat distorted. An explanation of the phenomenon has been offered; viz. that the pressure of the walls of the vein, being applied to the sides of the trunks, which lay parallel, would flatten them, while that effect would not be produced upon those which were placed transversely, since they would receive the pressure in the direction of their length, or from their ends. Be this as it may, the transverse cylindrical trunks were identical with the others, being of similar texture, and having precisely the same external impressions. The substance of the fossil plant is a dark compact slate, similar to that in which the coal is imbedded. The coal vein, so far as was penetrated, was irregular as to thickness, ranging from five inches to as many feet.

Our notice of the Hopewell section, would be incomplete without adverting to its iron ores.

Haematitic iron ore of great richness occurs in the limestone valley on the east side of Tussey mountain.

Hydrate of iron exists abundantly at the several points indicated in the map and section, and has supplied the neighbouring iron works for many years. It occurs under a variety of circumstances and situations, lodged on the summits of ridges or accumulated on their slopes, at all elevations. For many years the supply of ore for the Hopewell Iron Works was derived from the summit of a ridge upwards of 600 feet high. The present supply for the same establishment is derived from the east side the Allegripus ridge, at a height of about 100 feet. Like most of these ores, it is lodged in variegated clays, in nests, in irregular seams, in dispersed angular fragments, or in the form of ochreous incrustations and nodules. These clays are commonly covered to the depth of ten or twenty feet with alluvium. Two other adjacent deposits of this mineral also furnish ore to the same furnace, and produce pig and bar iron of first rate quality. These deposits are situated on the flank of a thick series of red shale and red marly rocks, containing much oxide of iron. It is therefore probable that these hydrates result from the decomposition of the ferruginous strata.*

It is a prevalent opinion, for which, from my own observation, there seems some foundation, that the richest and most extensive depositions of this mineral occur on the *eastern* sides of the ridges.

* The yield of iron at the Hopewell Furnace is forty per cent on the raw ore, and twenty-eight and a half per cent after torrefaction.

Balls of rich *argillaceous* iron ore, stratified in beds of shale, alternate with the coal measures here, attaining to the weight of eighty pounds, and they will probably be found co-extensive with some of the coal veins. The value of this description of ore is unknown here, where there exists such an abundant supply of the other varieties, attainable at a cheap rate. I observed continuous beds of this ore, some of them of excellent quality, others of a much poorer description, in situ, at four or five points, both above and below coal.

A geological examination of these vast deposits of hydrates and haematites, and a collection and exposition of practical facts relative to the numerous manufactories of iron in their vicinity, are desiderata. The small district crossed by our section is a part of that extensive system of ferruginous depositories which stretches parallel with the Alleghany through Pennsylvania, Virginia and Tennessee.

In central Pennsylvania, among the most prolific depositories of this mineral, the continuous limestone valleys of Warrior Mark and Nittany must be enumerated. The average level of the former valley is probably more than 200 feet above the transverse or lateral valley of the Little Juniata by which it is intersected, and about 1100 feet above tide water. Its surface is very undulating, the subsoil chiefly consisting of tenacious clay, intermixed with sand and fragmental sandstone debris, reposing upon a limestone base. Amongst this accumulation of detrital remains no traces of secondary rocks are observable; no transported boulders derived from the coal region, whose eastern margin approaches within ten or twelve miles.

Angular fragments of fine-grained sandstone, beds of sandy grit, and deposits of white chalky marl, which slakes like lime on exposure to the atmosphere, and is used in that state for the purpose of white-washing buildings, exist abundantly in most of the ore banks of this range. Amongst this detritus no limestone fragments occur, from which circumstance we infer that the hydrates of iron were not derived from the destruction of any calcareous formations. Iron ores are very irregularly and unequally distributed in these alluvial clay beds, and occur under a variety of forms and gradations; from an ordinary sandstone traversed by ferruginous veins, to a pure hydrate of a stalactitical structure, as pipe ore, or as a radiated and mammillated hæmatite. The ore is sometimes worked in open pits, and often in shafts of from fifteen to twenty-five feet depth.

In the Nittany valley, to the north of Bellefonte, are numerous workings of these ores. Amongst the best and most extensively worked of these "ore banks," as they are provincially termed, is that of Gatesburg. This open pit is about one hundred feet deep, and has yielded many thousand tons of pipe ore, being, it is said, the most productive in the state, with the exception of one near Harrisburg. The disseminated ore is almost as abundant on the surface as at the greatest depth to which the pit has been excavated. The situation of this and some other pits is upon a slightly elevated alluvial ridge, within the principal longitudinal valley. This ore is remarkable for being more easily melted than any other variety, yielding a high per centage of iron. The quality of the metal is in high reputation, being excellent malleable iron, adapted not so much for castings, as for bars, rods and smith's work. Numerous establishments for its manufacture exist in this vicinity.

I had commenced this paper with the intention of limiting myself to the notice of the coal of Broad Top mountain, and had affixed that title at the head of this article; but I have been somewhat discursive, and it is time to put a stop to my wanderings.

NOTICE AS TO THE EVIDENCES OF THE EXISTENCE OF AN ANCIENT LAKE, WHICH APPEARS TO HAVE FORMERLY FILLED THE LIMESTONE VALLEY OF KISHACOQUILLAS, IN MIFFLIN COUNTY, PENNSYLVANIA. By Richard C. Taylor, F.G.S., &c. &c.

Several years have elapsed since my attention, whilst crossing this valley during a deep snow, was attracted to the singular arrangement of certain long horizontal and parallel lines which appear on both its sides at the same uniform height, occupying an elevated and conspicuous position on the mountain slopes, and extending as far as the eye can reach towards both extremities. Subsequent opportunities have enabled me to examine these remarkable features at various points, and the result is sufficiently interesting to form a separate article in the Geological Transactions.

Kishacoquillas valley, geologically situated in the centre of a transition district of great interest, ranges from N. W. to S. E., in a direction perfectly parallel to the Alleghany mountain range, from which it is distant thirty miles eastward. It is now in high cultivation, comprising some of the best limestone land in the state. It varies from three to five miles in breadth; includes two inferior sandstone ridges called Knobs, and is bounded on the north by Path mountain and on the south by Jack's mountain. In reality it is a deep trough between these two lofty ridges, having the outlet of its present drainage nearly in its centre, through the gorge or defile of Jack's mountain, from whence its waters pass into the Juniata river at Lewistown. From this gorge Jack's mountain stretches thirty or thirty-five miles to the N. E., and twenty-seven miles to the S. W., where it is cut through

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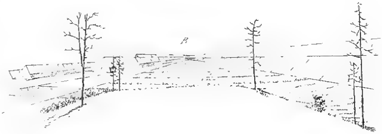
Fig. 1

... looking N. E. shewing the parallel Ridges covered with Snow and ... the ... Lake Shore line

Fig. 2

... looking ... Mountain at the right with its ancient Beach line ... the ... at the left and the ... Barrier or termination of the Original Lake at B



Jack's Mountain Fig. 3

... of the Gorge of the ... creek through Jack's Mountain looking ... from the central Limestone hills —
a a ... of Jack's Mountain at opposite sides of the gorge 800 Feet above the bed of the Creek
b b Ancient Water line or Beach line
c c ... Subordinate Limestone hill

Fig. 4

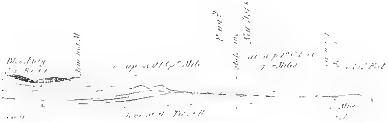


Fig. 5

Fig. 6

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by the Juniata, at the Long Narrows below Huntingdon; and thence it pursues its way fifteen miles further in the same course. The northen ridge, called in different localities Path mountain, Stony mountain, and other names, ranges almost entirely from the river Susquehanna to the Juniata, a space of sixty-five miles, then resuming its course after passing that river, it stretches uninterruptedly for a like distance to the states of Maryland and Virginia.

There is very little difference in the elevation of these singularly prolonged and uniform ridges. When clothed with the deciduous vegetation of summer, and probably under any circumstance except while they are covered with snow, nothing peculiar would be observed in the aspect of their slopes into the valley we are describing. Under the latter circumstances the traveller is struck, when viewing it from the central road by which it is crossed, with the appearance of a singular dark, horizontal, level line, running longitudinally along the southern slope of Path mountain, at about two thirds of its height, or about three hundred feet below the crest of that ridge. On turning himself towards the opposite side of the valley, he distinctly observes a corresponding line stretching as far as the eye can discern, both up and down the valley, until it becomes a mere slender thread, finally vanishing in the distant perspective. On nearer investigation, he will ascertain that this remarkable, this long, dark and apparently thin line is rendered distinguishable by a zone of pine trees, occupying an elevated horizontal shelf or bench of table land. The number and thick growth of evergreens in such a position, particularly when viewed nearly on a level with the observer's eye, is thus strongly contrasted with the snow covered sides and thinly scattered vegetation of the rocky slopes both above and below. From the level of the bench downwards, the mountain is furrowed by innumerable small ravines, descending transversely, and forming slight grooves or depressions, at intervals, in the otherwise uninterrupted horizontal line.

On either side the same character is seen to prevail, to whatever point the observer directs his view. The same black delicate fringe may be traced, pursuing its horizontal course, as far as it can be followed by the eye, with a regularity that at first sight would seem to be the result of art.

On exploring further into this curious phenomenon, some interesting facts are presented for the consideration of the geologist, who will now perceive that it is even more extensive and upon a more gigantic scale than he had anticipated. He will discover that this slight line, which, but for the contrast produced by the snow, would never perhaps have been noticed, is a broad platform or ledge, varying in width from a quarter of a mile to more than half a mile, and is occupied by a dense mass of pines and hemlocks. He will perceive that this platform, though commonly possessing a small inclination towards the valley, is at times nearly level, and occasionally is even inclined inwards to the mountain, the surface being probably thus modified by the action of comparatively recent drainage. Extending his researches, he will learn, that the entire waters which arise within the area enclosed by these lines, comprising a length of thirty-five miles, and an area of more than one hundred square miles, have their outlet, not at the extremities of the trough, but near the centre, through one of its sides, by means of a fracture or ravine of comparatively late date, cutting a channel, eight hundred feet deep, transversely across highly inclined quartzose rocks: that were this gorge again closed, the waters would form a lake, rising to the height of the longitudinal benches we have described; and that they could reach no point of exit before they had attained an elevation approaching to their original level, when they would again be discharged at one or both extremities of the trough.

The conclusion, therefore, to which he would necessarily arrive is, that these interior horizontal lines mark the ancient beach of this lake.

In its present state the valley of Kishacoquillas is a deep elongated basin, having no other outlet for its waters but at this gap on its southern side; for it requires to be stated that, notwithstanding the enclosing ridges are prolonged many miles further to the east and west, the trough is filled up to the height of several hundred feet, at the positions marked A and B in the accompanying map, pl. 9, fig. 1, by sandstone ridges and subordinate hills. Beyond these points, A and B, it will be seen that the waters now drain in opposite directions: on the west into the Juniata; on the east into the Susquehanna. It is probable that this long continued drainage action, for even during the existence of the lake something like a similar action would be going on longitudinally, has led to the degradation of these internal barriers, and they have evidently been lowered and modified in a considerable degree. The west end of the basin is somewhat confusedly crowded with subordinate hills, swells and undulations, their present configuration being influenced by the rapid descent of the surface waters, which have there a fall of upwards of three hundred feet into the Juniata. Near A the valley terminates in a mere wedge, being effectually closed by a ridge of white gritstone, and the limestone is hollowed out to the depth of a hundred feet. It may be remarked here, incidentally, that at this western extremity, beyond A, a great change occurs in the inclination of the rock formations. Instead of a southerly dip, they now incline to the N. W. at as high an angle as 60 to 65°, gradually diminishing, and again rising in a basin form at the distance of five or six miles to the north west, towards Huntingdon. By this arrangement a basin of red sandstone and red shale is placed parallel with a part of Kishacoquillas valley, on the north side of Stony mountain.

I have accompanied this article with a variety of illustrations, because the case before us may be taken as an example of similar phenomena occurring in the transition ranges of this country. There is reason to believe that other ancient lakes and systems of lakes have existed, and have been similarly drained of their contents; that great modifications of surface have been effected among the deposits of that age, even after they had acquired their present position; and that more than one of the now empty basins and deep fertile valleys, enclosed between some of these long parallel ridges, were at one period filled with water. Penn's valley, the most elevated limestone valley in Pennsylvania, and considerably the largest in this part of the state, shows indications of having been formerly filled with water to a great height, such waters having subsequently effected their escape by two strongly defined outlets. We shall probably have occasion to return to this subject hereafter.

The illustrations prepared for this article are—

1st. A map of Kishacoquillas valley and its vicinity. Pl. 9, fig. 1.

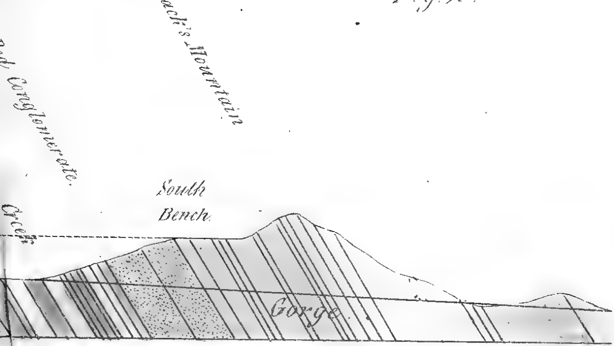
2d. A transverse geological section across its centre. Pl. 9, fig. 2.

3d. Pl. 8, fig. 3. A view from the small central limestone eminence looking east, showing the eastern termination of the ancient lake, at the point B, shown also in the map pl. 9, where the interior ridges unite with Jack's mountain, on whose side is traced the shelf formed by the ancient beach. It also illustrates a very characteristic feature in this country, showing the conical hills, called gables, being the truncated or transverse sections of some of those numerous parallel ridges which range through central Pennsylvania.

Pl. IX.

Fig. 1.

Fig. 2.



MAP AND SECTION OF KISHACOQUILLAS VALLEY

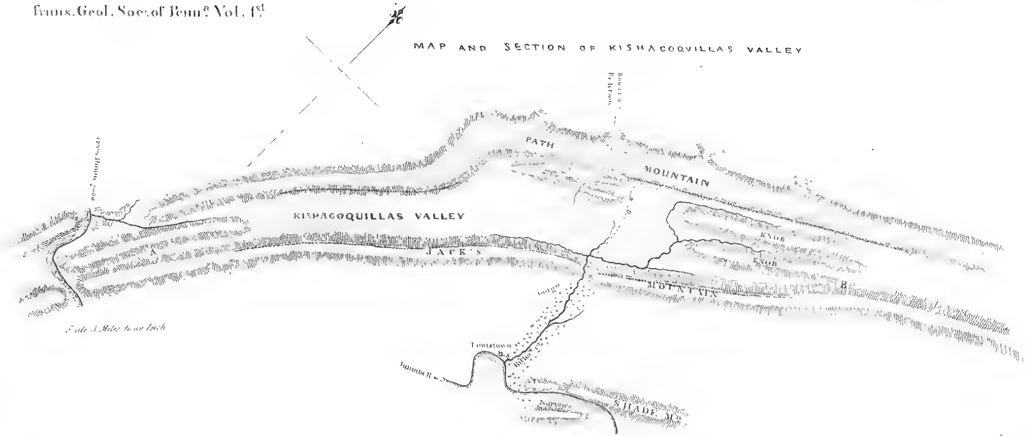
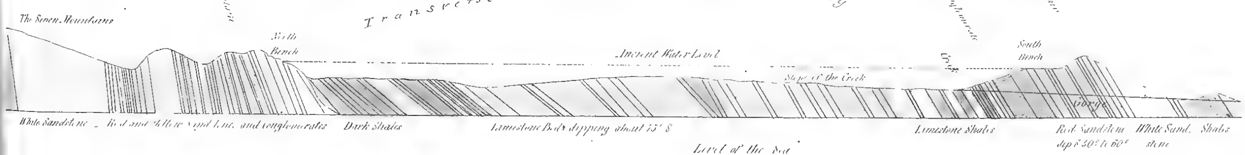


Fig 1

Fig 2

Transverse Section of Kishacoquillas Valley



4th. Pl. 8, fig. 1. Sketch looking to the south west, of the north side of the valley, showing a corresponding shelf or line of beach on the south or inner slope of Path mountain.

5th. Pl. 8, fig. 2. View of the north side looking towards the north east, exhibiting the knobs or parallel ridges, and the line of beach ranging along Path mountain.

6th. Pl. 8, fig. 4. View of the gorge of the Kishacoquillas creek, through Jack's mountain, looking south, from the subordinate hills of central limestone.

These outline views were all taken with the camera lucida, at the time of a deep snow, and the perspective is therefore correctly exhibited.

In the map we have included a few geological memoranda southward of Kishacoquillas valley, to explain its position with reference to the beds of Fucoides, described by the writer in your Transactions,* and also of an interesting deposit of fossil shells, which will probably be the subject of a future communication. This extension is also useful in showing the direction taken by the waters discharged from the lake, indicated by the assemblage of detritus on the low lands between the gorge and the Juniata. With regard to the section pl. 9, fig. 2, it will be seen that all the beds comprised within its limits incline one way, pointing to the south, their direction or courses running parallel with the ridges. These ridges consist of a numerous series of white, yellow and red sandstones, and of red conglomerates. The northern half of Jack's mountain is red sandstone and red conglomerate, while its southern slope comprises the white sandstones. The division line between these two formations or deposits runs exactly along the crest of the ridge; the prevailing dip being 50 to 60° degrees south.

* Ante, page 5.

A series of dark argillaceous shales and limestone shales intervenes between the conglomerates and the blue transition limestones of the valley, all which preserve a general inclination of about 45° degrees to the south. Another series of dark shales separates this limestone from the numerous beds of sandstones and conglomerates of Path mountain and the contiguous elevated region called the Seven mountains. Here the strata assume a highly inclined position, forming an angle of 70 or 80°, and even in several instances approach to verticality.

Organic Remains.

These are not numerous. In the red sandstones of Jack's mountain are some beds containing an undescribed fucoides. Amongst detrital fragments apparently washed out of the gorge, some white sandstones exhibit Fucoides Alleghaniensis. Near the foot of Path mountain are beds of the obscurely developed Fucoides figured by me in a former article. Trans. G. S., pl. 2, fig. 3. In the white gritty sandstone of the same mountain occur Fucoides Alleghaniensis and some others—and a few producta are distributed among the same rocks. Amongst the dark shale beds, at the north foot of Jack's mountain, are seams of from one to four inches in thickness, composed almost wholly of crinoidal (pentacrinital) remains. These chiefly consist of detached joints, which are not more than from the one-twentieth to the one-thirtieth part of an inch in diameter. Occasionally columns of eight or ten joints occur, and the whole are commonly much decomposed. The limestone seems to be almost destitute of fossils.

Minerals.

Hydrates of iron, chiefly in the form of rich pipe ore, occur in this valley contiguous to the limestone. Haemetites also exist in the same situations. Another variety has been found on Jack's mountain, near the Juniata narrows. The two former varieties are manufactured at furnaces situated within this valley.

Having disposed of these details, it only remains to revert to the supposed lake, and to consider the circumstances attending the emptying of its ancient basin.

From our previous description, and by consultation with our accompanying illustrations, may be ascertained, that the waters occupied this trough to the depth of three hundred feet in the centre, and gradually shoaled off towards the extremities, as the bottom ascended in those directions. The deepest part is immediately in front of the gorge, where the beach line appears to be four hundred and fifty feet above the present water level of Kishacoquillas creek. Supposing the basin to be refilled, it is obvious that the greatest pressure would be at the precise point at which the creek now discharges itself.

I cannot however view this as a case of sudden bursting or breaking down of a barrier by overpowering pressure, as in some instances is said to have occurred. Here the outlet and point of fracture is on one *side* of the trough, and the barrier is no less than a ridge eight hundred feet high and nearly two miles broad; whose highly inclined and compact silicious beds have been cut down to the very base, and that at right angles to their direction. We have illustrated this in the section by the line C D.

I see difficulty also in admitting this to result from the slow and gradual action of discharging waters. The transverse slopes of the ravine are probably, in its deepest part, at as high an angle as 40 or even 45°, notwithstanding the immense quantity of fallen debris. It is quite obvious to an observer that this transverse section is of a very different age; that is, of much later origin, than the ridge itself, whose sides are for the most part covered with soil and therefore are capable of sustaining vegetation; whereas the gorge presents all the characters of a fissure whose faces are chiefly covered with a talus of naked rock fragments.

Had a gradual wearing down, or hollowing out, of the ravine taken place, there would necessarily have been a corresponding slow reduction in the level of the lake, which the circumstance of a single strongly defined beach line negatives.

So decided is the character of this bench in agreeing with the wave-worn margin of a lake, that a carriage road from Lewistown has actually for some time been conducted over the mountain, its projectors having availed themselves of this favourable natural feature, to pass for many miles westward along this elevated bench. It must be admitted that no remarkable comminution of rocks, or distribution of rolled pebbles, as upon the surface of a long worn beach, can be observed; nor can it be expected, in a position where the detritus of the ridge is constantly descending upon its surface, from an elevation of three hundred feet. For the most part the surface stones are of moderate size, and occasionally sand prevails.

I am inclined to attribute the sudden drainage of this lake to a fracture or fissure of its margin; occurring transversely to the direction of the ridge, and occasioned by some such power as an earthquake, or by one of the many causes of contraction, subsidence and final disruption, in the previous arrangement of the subjacent rocks. Perhaps this fracture may have extended much farther than simply as exhibited in Jack's mountain, as something like corresponding and continuous depressions, on a smaller scale, are observable for several miles, both to the south and the north, in the same line. When once a fracture or fissure had been made across the barrier the pressure of a hundred square miles of water several hundred feet deep, would rapidly enlarge the passage; and the outburst of the lake would sweep along with its waters the debacle torn from its side, to distances proportionate to the volume and force of the moving power. In accordance with this hypothesis, such effects are now visible in the accumulation of bouldered and transported fragments, spread over the flats below the gorge, indicating at the same time both the origin and the direction and force of the escaping waters, and traceable uninterruptedly for eight or nine miles into the Juniata. The course of this detrital deposit we have shown in the map.

On consideration, the view here taken of the phenomenon described in the foregoing pages, and the reasoning by which I have accounted in some measure for the conversion of a deep lake into a deep and fertile valley, would seem to be sufficiently conclusive.

Should it be thought that we have dwelt too long on a matter of local interest, let it not be overlooked that it forms one link in the extended chain of research now before us, a part of that immense field of investigation, the frame work and physical structure of this vast country, now inviting our individual and our united exertions.

ON THE MINERAL BASIN OR COAL FIELD OF BLOSSBURG, ON THE TIOGA RIVER, TIOGA COUNTY, PENNSYLVANIA. By Richard C. Taylor, F.G.S., &c. &c.

The valley of Blossburg is 1330 feet above the level of tide water, and forms a kind of central point or area, from whence diverge irregularly a number of smaller valleys and deep ravines, descending from the elevated edges of the surrounding basin at the height of 2000 to 2250 feet above the sea. All these ravines, to the number of twelve, rise with a rapid inclination above the level of this area, until they intersect the mineral strata of the surrounding mountains; the respective elevations of their points of intersection varying, in different situations, from 200 to 500 feet, and the height of table land being 700 to 900 feet; above the bridge of Blossburg. Coal and iron ore of various qualities prevail at the above mentioned elevation of 200 feet and upwards, and when thus intersected by ravines, occur under favourable circumstances for mining by drifts in the almost horizontal strata. Almost every valley to which we have referred is capable of maintaining its separate branch rail-road, and of conveying its contribution of the important products of the district to a central line of transport. We shall briefly advert to these in succession.

Five miles up the Tioga, this river is joined by Lower Fellows's creek, which traverses a section of this coal district from the north east. The upper part of this creek is crossed by thick beds of silicious conglomerate or puddingstone, and carboniferous gritstone, causing three falls in the creek, amounting to one hundred feet, in an eighth part of a mile. Coal and iron occur above this conglomerate at the height of 450 feet, and below it are indications of the same minerals. Several smaller streams descending into this branch, and another falling into the Tioga further to the north east, contain also traces of coal and iron.

On the east side of the Tioga, nearer Blossburg, are the four principal ravines of East creek, Bear creek, Coal run, and Moore's run, whose head waters arise in the Armenia mountain. There are two or three other ravines in the same direction, where the coal is approachable.

On the west are the three ravines of Smith's creek, Boon's creek, and Johnson's creek, and one or two inferior valleys, deep enough to intersect the coal measures.

On the south and south east, they are penetrated by Flower run, Mile and Half run, Taylor's creek, Carpenter's run, Manganese run, Saynisch's run, and some smaller ravines and tributaries without name.

The first coal vein that was opened and applied to use in this country, was discovered only a few years ago by Mr Bloss, an early settler.

In 1832, when I undertook the first mineral examination of this district, the prevailing opinion among the few miners that were then employed there, was that the strata were horizontal. Nothing had been proved to the contrary; and so far as the coal workings had been extended, the workmen had noticed no material inclination. Since then, by pursuing an extensive series of actual levels up most of the ravines, a material departure from horizontality has been proved, and the whole area, with the exception of the western extension, with whose limits and details I am at present unacquainted, is decidedly shown to be arranged in a *basin* form, rising from the centre towards all parts of the circumference. Whether this coal tract be detached, forming an independent basin, or it be united with, and a prolongation of, the great western coal field, I have not fully decided.

I know, however, that the western beds dip towards the centre at Blossburg, and that it is wholly unconnected with any other coal district, along at least five sixths of its external margin. The northern edge of this basin rises to the summit of the Armenia mountain, and the southern margin caps the Elk mountain; and so insulated in fact is the geological arrangement prevailing throughout, that convenience suggests the adoption of the term I have thought proper to apply to it.

Northward of this mineral district it would be in vain to search for these coal strata; for independent of the geological character of that country being dissimilar, consisting almost wholly of the old red sandstone, there is no ground lofty enough to contain them in that direction, unless in the case of another insulated basin, which the structure of the whole region negatives. Sufficient data are also at hand, wherewith to form a decisive estimate of the relative position of the coal measures of Blossburg and the northern rock formations; and to show that as the dip of stratification is, almost without exception, towards the south, there must be an enormous elevation of land indeed in the north, ere it could be capped with the carboniferous deposits.

A rapid recital of some of these data, in a sectional line from the south to the north, will render this position more intelligible.

Beginning at Blossburg, the upper coal series of Bear creek is found to be about 130 feet lower than the same beds in East creek, to the north; the rise in that direction is here therefore 80 per mile.

Three miles below Blossburg, the Tioga running north, there is a regular dip, at the rate of 260 feet to the mile to the southward, which increases until, at 17 miles distance, it is about 500 feet in a mile, and then decreases to 200 feet per mile, to the distance of 26 miles at the state line between Pennsylvania and New York. Consequently, if we take the mean of these observations, on a meridian line of 22½ miles, there must be added 4050 feet to the absolute descent of the Tioga river, and to the thickness of several hundred feet of the carboniferous formation. Thus there would need be a total height of mountain of 5125 feet, at the state line, to contain the coal measures; whereas the hills there are only 500 to 700 feet in their greatest altitude. This calculation is entered into with a view of showing the futility of the expectation, not uncommonly expressed, of tracing these coal beds in a northerly direction beyond the limits at which they are at present discoverable.

If we pursue this examination for the sake of a more extended view of this great geological disposition to the southward, our position will be remarkably strengthened.

Thus, at 33 miles below Blossburg, the southern dip continues at 198 feet in each mile; and at 38 miles, near the Painted Post, is 130 feet per mile. At 42 miles, at the Chimney narrows, near the entrance of the Chemung Feeder, the dip is now flattened to about 100 feet per mile; making the aggregate southern depression of the strata of old red sandstone about 1050 feet more, to be added to 70 feet, the descent of the river to this point. Uniting, therefore, these sums with that observed in the Pennsylvania division of our section, the altitude of any land or mountains near the Chemung river, capable of containing the veins of the Tioga coal field, must be more than 6000 feet, whereas they do not commonly exceed 600 feet: or, by reversing the position, the stratum of rock on a level with the river at the Chimney narrows, if prolonged on an average plane of descent to near Blossburg, would be about 6275 feet below the summit of the surrounding hills of the Tioga basin.

I may add, that after having carried the examination of the same series of rocks 60 miles further, or more than 100 miles north and north east of the Blossburg coal basin, a general observation may be made, that wherever a horizontal position (which often prevails apparently) is not maintained throughout this parallel, there exists a depression pointing towards this coal district. Consequently, there is no probability that the mineral beds are prolonged to the north; and as has been before suggested, we must continue to regard this area as the termination, in this direction, of the great bituminous coal region.

The subjoined diagram illustrates the geological circumstances to which I have alluded, and the prolongation of the old red sandstone group, which is here 6 or 7000 feet thick, from beneath the Tioga coal basin. Pl. 8, fig. 5.

A large portion of these red sandstones, and the lower red argillaceous red sandstones and shales, are crowded with producta and crinoidal remains; and occasionally fucoides and caryophyllea, pectens and spirifera are interspersed.

IRON ORES

(*Argillaceous Carbonate of Iron*)—Occur in several beds, under different modifications, instratified as usual with coal, fire clay, and the common carboniferous rocks. They comprehend the three varieties, known to miners under the denominations of, *veins*, or continuous parallel seams; *pins*, or kidney-shaped concretions; and *balls*, or larger detached, oval, flattened masses, of from one to two or three hundred weight, sometimes irregularly dispersed in the *mine ground*, but commonly in *courses*. Those of the first description are the least, and of the third mentioned the most prevalent. The kidney ore (the siderose or lithoid spathic iron of Mr Clemson) is, I believe, commonly the leanest, though readily convertible into fine melting iron; the veins are the most silicious and infusible; and the balls (sphero sidereit) are the richest, producing a bright grey iron, suitable for puddling. The general character of these ores appears to assimilate to the Welsh and Staffordshire ores; and the time is not far distant, when iron, manufactured on the same principles as in Europe, will be made in this hitherto profitless region.

At the present time little has been done in the way of mining the ores of this district. No iron has yet been made there, and we only know of the existence of the beds containing this mineral, by their exposure in the sides of deep ravines and rocky cliffs. In Bear creek are two of these sections, exhibiting courses of good ball ore. Coal run intersects iron ore courses, of different qualities, at several elevations, and here is the only position where it has been worked. About 350 tons of the kidney ore have been mined, and now remain on the bank. The specific gravity of this ore averages 3.411; its weight per cubic foot 211 pounds, and the gross produce or weight per acre, of a bed one foot thick, is 4122 tons. In the lower part of this ravine is a thick bed of red ferruginous clay and shale, containing much oxide of iron, but insufficient for mining purposes—specific gravity 2.514. There are also two veins of ponderous silicious iron ore in the same ravine, of near 190 pounds to the cubic foot. One vein is from 15 to 18 inches thick, specific gravity 3.135; the other is somewhat thinner, specific gravity 3.196.

Large masses of silicious ore, washed in the bed of the Tioga, at different elevations, indicate the presence of one or more similar deposits in this valley. Good argillaceous ore is washed in the bed of Taylor's creek, and in Upper and Lower Fellows's creeks.

Boon's creek has an exposed face of shale containing excellent balls of ore, which might be mined with the superincumbent coal vein.

Johnson's creek may be remarked for numerous courses and detached masses of this mineral, occurring in a thickness of 200 feet. Some of the balls are strong rich ore, ten or twelve inches thick, weighing 600 weight or more. Specific gravity 3.999; weight per cubic foot 250 pounds; and yielding 4850 tons per acre for a foot in thickness.

Another rich bed of ball mine occurs in Morris's run, consisting of four to six courses; some of the balls being four feet and upwards in length.

Specific gravity of this ore, 3.440.

Weight per cubic foot, 215 pounds.

Weight per acre, for one foot thick, 4200 tons.

The produce of this bed might probably amount to 5000 tons per acre.

The highest position, in this immediate neighbourhood, in which I have traced good ball ore, is at the height of 420 feet above the Tioga, towards the summit of Bear creek; and the lowest is about 180 feet above the same river at Coal run. Allowing for the rise of the strata in that direction, the range of beds containing iron is about 130 feet thick, which is similar to that shown in the Coal run section.

In the stream called Saynisch's run, on the north slope of Elk mountain, six miles east of Blossburg, I found a seam of argillaceous ore accompanied with a thin coal vein, at an elevation of 520 feet above the Tioga at Blossburg; and there were traces of coal as high as 800 feet above the same point.

Hydrate of Iron, in small quantities, has been found within this basin.

MANGANESE.

A bed of black oxide of manganese occurs within this coal region, on Elk mountain, at a height of about 700 feet above Blossburg bridge. Thickness not proved.

BITUMINOUS COAL.

All the Tioga coal comes strictly under this denomination, and is wholly within the limits of the secondary deposits. There are several qualities of coal here.

Hitherto the amount supplied to the public from this quarter is very insignificant, owing to the difficulty and expenses of conveyance. The existence, even, of the greater part of the coal veins, their localities, and their adaption to numerous uses, are only now attracting notice. As soon as the means of transportation are effected, there will be a large demand for this coal in the state of New York, for the salt works, distilleries, smith's use, and private consumption, extending from lakes Erie and Ontario to the Hudson.

I have enumerated many small streams which converge into the Tioga, all of which intersect beds of coal.

Bear creek.—Small quantities are here annually mined. In quality this strongly resembles the coal of Clearfield county, possessing an imperfect crystalline arrangement, easily breaking with exposure to the atmosphere; of a a deep shining black colour, and traversed occasionally by veins of sulphuret of iron.

Specific gravity, 1.398.

Weight per cubic yard, 1 ton and 119 pounds.

Thickness of the vein 3 to 3¼ feet.

Gross produce of an acre about 5000 tons.

This description applies to the coal called Clements's.

Bloss's coal vein is good for coke, giving out a strong heat and bright flame, softening and expanding with heat, and exhibiting a good proportion of bitumen. Contains little sulphur or pyrites.

Specific gravity averages 1.405.

Weight per cubic yard, 1 ton and 131 pounds.

Thickness 3 to 3¼ feet.

Weight per acre about 5000 tons.

Eight veins are traced here comprehended within the space of 153 feet of strata; only two of which have been opened, and a small vein occurs 100 feet higher in the series, making the range of carboniferous deposits 253 feet.

Coal run.—Coal, resembling the foregoing, is here mined on a small scale.

Specific gravity, 1.371.

Weight per cubic yard, 1 ton and 1 cwt.

Weight or produce per acre, 4500 to 5000 tons.

Thickness worked, somewhat less than 3 feet, but varying from $2\frac{1}{2}$ to $3\frac{3}{4}$ feet.

The above notes on the quality of these coals were made in 1832, since which little or no progress in mining has been made.

Here is also a vein called pitch coal, which may be worked with the kidney ore. It is of a very pure and inflammable description, but contains occasional small seams of sulphuret of iron.

Specific gravity, 1.500.

Weight per cubic yard, 1 ton and 289 pounds.

Thickness $1\frac{1}{4}$ feet.

Produce of an acre, 2115 tons.

The lowest vein in Coal run is of a peculiar character, approaching somewhat to the cannel coal of England. In conchoidal fracture like anthracite, almost as capable of receiving a polish, and burning with intense heat, but distinguished from it by the quantity of bitumen and the brightness of its flame. It is in no way depreciated by long exposure to the atmosphere. The fragments from which the analysis was made were collected from the bed of the run, where they had evidently lain many years.

Specific gravity of one specimen, 1.716; of a purer variety, 1.750.

Weight per cubic yard, 1 ton and 596 pounds; of a purer variety, 2953 pounds: being 27 per cent heavier than the other bituminous coals of this field.

I have not recognised out of this district a species of bituminous coal that possesses the properties of density and gravity to such a degree.

In all, nine veins may be traced here, varying in thickness from 1 to 3 feet; and included within the space of 144 feet. Only one vein has been explored and put in work. Taking these veins at the thickness exhibited at their respective outcrops, amounting to four yards, as they vary from 1 to 3 feet, and supposing they could all be worked, there would be a gross weight per acre of 20,000 tons of coal existing at this locality. Perhaps not more than half this amount could be obtained to advantage here.

Johnson's run.—The *splint* or hard coal of this locality has an imperfect resemblance to the cannel coal, and suffers little change from exposure to the atmosphere. There are three veins here, showing about a foot and a half thickness at the outcrop, and a fourth below them is a three feet vein. No coal has been yet mined, as there is no road up the ravine where it is exposed. This quality is of the kind denominated "open burning coal."

Specific gravity, 1.493.

Weight of a cubic yard, 1 ton and 255 pounds.

Gross weight per acre of the 3 feet vein, 5442 tons.

East creek.—Traces of a similar quality of coal occur here, where seven veins of different sizes and qualities are perceived, but not a single vein has been proved.

There are indications of coal at as high an elevation as 550 feet above the Tioga river.

Morris's run.—The only other bed to which I shall particularly advert, was proved, by a vertical section of the vein, in 1832, to be 6 feet 6 inches in the face. During the winter of 1834-5, a drift has been made several yards into this vein, and it appears that both in quality and thickness it has not justified the expectations which were previously entertained of it, but it is still, I believe, in operation. Three other beds are known in this ravine.

Elk mountain.—A few weeks were devoted by me, in the spring of the past year, to the examination of this, the south eastern limit of this coal basin; but many natural difficulties in this remote and wild region, occurred to prevent its complete and satisfactory exploration. Traces of coal veins occurred at elevations of from 550 to 800 feet above Blossburg, and it appears that the carboniferous beds wholly crop out to the south, on the southern crest of this mountain.

LIMESTONE

Is found two miles below Blossburg, within the limits of the old red sandstone. I have traced this calcareous bed during its course of many miles along the north slope of the Armenia mountain, upon whose summit the coal basin ultimately crops out. It is here a species of calcareous conglomerate, but occasionally is homogeneous and crystalline. Colour greenish gray; mottled; burns to grey sandy lime. Occurs stratified, several feet thick, at the height of 300 feet above the Tioga. It approximates to the "cornstone" of the English red sandstone. It is a prevailing rock in the old red sandstone of this country. There are few places in the area where this formation prevails, that this grey limestone is not accessible. Lycoming and Bradford counties abound with it, under the coal measures. Mr Miller's section shows that it occurs at the same depth below the coal measures, at the Portage Railroad, on the Alleghany mountain, at the distance of 150 miles from the Tioga.

Specific gravity of this limestone, 2.667.

Weight of a cubic yard, 2 tons and 20 pounds.

I am favoured with an analysis of the purest quality of this stone, by J. W. Alder, Esq.

Carbonate of lime,	89
Silex,	7
Alumine,	3
Iron,	1
	100

The trial was made on 415 grains of the limestone; the separate parts of which were reserved dry, with only a loss of $1\frac{1}{2}$ grains; so that the decomposition must have been very complete. By this, and a previous experiment affording nearly similar results, it appears that this limestone of Blossburg is more pure, and contains less silex, than was anticipated. Its applicability as a flux for making iron has not yet been tested, but it is proposed to employ it for that purpose here and at the projected iron works of Lycoming creek.

A specimen of this limestone being handed to Mr Clemson, he has furnished the following remarks:

"It consists of amorphous masses of a dirty grey colour, and appears much mixed with foreign matter. Its composition per cent is—

Water,	3.2
Argil, sand, &c., insoluble residuum,	53.8
Precipitate with lime water (no iron),	12.2
Carbonate of lime, by difference,	30.8
	100.0"

The discrepancy between these analyses, arises, probably, from variation in the nature of different portions of the conglomerate limestone.

FIRE CLAY

Is coextensive with this mineral district, from the Elk mountain to the opposite heights of the Armenia mountain; in beds of 1 to 3 feet thick.

SILICIOUS CONGLOMERATES AND MILLSTONE GRIT

Occur high up in the carboniferous series, but their position is not uniform in all parts of the Blossburg coal field. For instance, at Coal run, the conglomerate bed occurs of the thickness of 18 feet at the height of 387 feet, covering all the mineral beds. In Morris's run, a mile and a half only distant, it is also 18 feet thick, but is at the bottom of the coal series, at the height of 302 feet. In Fellows's run, it reaches the height of 418 feet, and its thickness is 48 feet, also below the coal measures. On Elk mountain it reaches, by estimation, to the elevation of 900 feet.

The difference in elevation at these localities is, of course, materially influenced by the inclination of the strata. In this region, therefore, the conglomerate rock is sometimes placed below and sometimes occurs above the coal measures. Judging from the masses of this rock, which every where cover the highest points, and which are also sometimes seen in situ, I am led to conclude, that there were originally two deposits of conglomerates over a great part of this area. There are certainly two at Elk mountain in situ, and three on the hills south of Blossburg, and the opposite or north side of the basin appears to have an original covering of this rock, which is for the most part washed away, leaving its detritus upon the eminences above the coal formation. On the Armenia mountain is a platform of this puddingstone and gritstone, each bed being about 10 feet thick, overlying the carboniferous beds.

I cannot close this article without adverting to the remarkable variations or differences in the strata, at different localities within this district. The sections of these ravines are dissimilar, in the number, position and thickness of the mineral beds, and the nature of the accompanying rocks. In some situations the silicious rocks prevail; in others, the argillaceous. Sometimes six or eight coal veins exist in one locality, and two or three only appear in another. The quality of the coal, too, is different at different points. These discrepances can only be explained by more extensive and detailed investigations.

ESTIMATION OF THE QUANTITY OF COAL WITHIN THE BLOSSBURG OR TIOGA COAL BASIN.

The area of land beneath which we have evidence of the existence of coal, within the limits of what I have denominated for the present the mineral basin of Tioga, comprises thirty-five square miles, or upwards of twenty-two thousand seven hundred acres. Should it hereafter prove that the mineral beds are continuous farther to the west and unite with the great western bituminous coal field, which I do not expect, the following estimates will, of course, be materially increased.

It has been stated, that in the numerous ravines by which this coal basin is intersected, there are traces of from four to nine veins of coal. So little has been effected in determining the real thickness of these, except at two or three points, that I am unwilling to risk a calculation of their maximum value. We know, however, that in nearly every valley, one vein at least has been proved of the thickness of 3 to $3\frac{1}{4}$ feet, and in one instance of 6 feet. I think it will be perfectly safe to found an estimate on the presence of a single vein of about 3 feet, which will yield about five thousand tons to each acre.

In computing the above mentioned area, it was limited to mineral lands alone, their boundaries having been sufficiently defined for our purpose; while the valleys, ravines, and the area of land below the coal measures, are excluded.

To escape all risk of exaggeration, and to allow for vacant, waste, unprofitable or inaccessible ground, we will deduct six thousand seven hundred acres, or upwards of one-fourth; and another fourth nearly we will take upon an estimate of produce reduced to three thousand tons per acre. From these data we obtain the following result: eleven thousand acres yielding five thousand tons per acre; five thousand acres yielding three thousand tons per acre; six thousand seven hundred acres unprofitable.

The gross amount is seventy millions of tons, which will furnish one hundred and forty thousand tons per annum, during five hundred years, and require the average annual working, to obtain that supply, of about thirty acres.

The following table represents the comparative specific gravity, cubical contents, weight, and gross produce per acre of the principal varieties of coal, iron, and stone referred to in the foregoing article :—

COAL.	Specific Gravity.	Weight of one Cubic Yard.			Thickness of the Veins.	Gross contents or weight per acre of each vein.	Tons per acre.
		tons	cwt.	lbs.	feet	tons	
Coal in Coal run	1.367	1	0	60			
Do. 2d experiment, select and pure	1.371	1	0	73	3.00	5000	
Do. 3d experiment, rather slaty	1.400	1	1	10			
Clements's coal in Bear creek, average	1.398	1	1	7	3.25	5530	
Bloss's coal in Bear creek, lighter part of vein	1.378	1	0	85	3.00		
Do. heavier part of same vein	1.432	1	1	64	to	5123	
Average of the coal	1.405	1	1	19	3.25		
Johnson's creek, splint coal, two veins	1.493	1	2	55	3.00	5442	
Cannel coal in Coal run, at the cross	1.716	1	5	96			
Do. the purest quality	1.750	1	6	41			
Big vein in Morris's run, by estimation					6.00	10,000	
Little vein of very pure inflammable coal in Coal run, under the kidney ore	1.500	1	2	65	1.25	2115	
Limestone, from Limestone hill	2.667	2	0	20			
Coarse grained millstone grit	2.505	1	17	83			
Fine silicious rock, or petrosilex, locally called marble	2.703	2	0	81			
Red ferruginous clay of Coal run	2.514						
ARGILLACEOUS IRON ORE.			Weight of one Cubic Foot.			Weight of one foot thick per acre.	
Weak ball ore, on surface, below Clements's coal	3.047		1	78		3694	
Kidney-shaped ore, or pins, raised for furnace	3.400		1	98		4083	
Do. 2d experiment	3.423		1	102		4161	
Average weight	3.412		1	100		4122	
Ball ore in the bed of Bear creek, 420 feet above the Tioga river	3.212		1	89		3908	
Ball ore in large masses at Morris's run	3.440		1	103		4200	
Ball ore in rich nodules at Johnson's creek	3.999		2	26		4852	
Vein of silicious or sandy ore in Coal run, fine-grained	3.135						
Do. 2d experiment, coarse grained	3.196		1	86		3850	6000

EXAMINATION AND ANALYSIS OF SEVERAL COALS AND IRON ORES, ACCOMPANYING MR R. C. TAYLOR'S ACCOUNT OF THE COAL FIELD OF BLOSSBURG. By T. G. Clemson, Esquire.

No. 1.

Clements's Coal, Bear creek, Blossburg.

This combustible is jet black, with a wax-like lustre; is formed of parallel layers; is fragile, the fragments assuming a trapezoidal form; is not entirely free from pyrites; the sulphate of iron showing itself in efflorescence. Its powder is black, with a shade of brown. When submitted to heat, gives off bitumen, &c., leaving a coke not much swollen, hard, and rather difficult to pulverize. When incinerated, leaves an ash of a dirty white, free from lime.

The composition of this coal per cent, is

Carbon, ...	73.74
Volatile matter, ...	15.00
Cinders, ...	11.26
	100.00

No. 2.

Coal from Bloss vein, Bear creek.

This coal has a very great resemblance to that which we have just examined (No. 1). What we have said of its mineralogical history, is applicable to this.

Carbon, ...	73.00
Volatile matter, ...	15.60
Cinders, ...	11.40
	100.00

No. 3.

Splint Coal from Johnson's creek.

Has a grey black colour; very little lustre; fracture uneven; powder black, slightly brown; burns easily, and is not fat; free from pyrites; gives a hard dense coke, very little swollen, leaving cinders of a dirty white, free from carbonates.

Carbon, ...	69.3
Volatile matter, ...	14.6
Cinders, ...	16.1
	100.0

No. 4.

Pitch Coal vein, Coal run,

Has sometimes a high vitreous lustre, at others is of a dead black; is zoned; the divisions being frequently formed of mineral charcoal; fracture in one sense is lamellar, in another conchoidal: free from pyrites. Its powder is brown. Burns freely, with much flame and smoke; is very fat, and swells out into a voluminous coke, which, on incineration, leaves a white brown ash, free from carbonates.

Carbon, ...	54.26
Cinders, ...	27.24
Volatile matter, ...	18.50
	100.00

This analysis is scarcely derived from a fair average specimen, being a portion of the outside of the vein, to which some slate adhered. The bituminous matter is peculiarly abundant, and the fracture resembles pitch.

No. 5.

Cannel Coal, Blossburg.

This combustible has a dead black colour, with a light tinge of lead grey; is compact, clean and dense; breaks with a large conchoidal fracture; cuts with a knife, and receives a polish. This property combined with its waxy tenacity, enables it to be manufactured into various-shaped ornaments. In its nature it is perfectly homogeneous, burns with difficulty, giving off little bitumen, and a coke slightly deformed. Its powder is brown. The residuum or ash, after incineration, contains no lime.

Carbon,	33.4
Volatile matter,	8.4
Ashes,	58.2
	100.0

Iron Ore, from Morris's run, Blossburg.

The specimen of iron ore before us, appears to be a portion of a large globe or kidney. It is intersected by cavities, upon the sides of which are found groups of small rhomboidal crystals of carbonate of iron. Its fracture is uneven, conchoidal, and has a dark black colour, giving a greyish white powder. When cold, does not effervesce, but when aided by a gentle heat, the action is lively. There is a precipitate of carbonaceous matter to which the colour of the mass may be attributed. An abundant precipitate of the oxide of iron is thrown down by the addition of an alkali.

Kidney Ore, from Blossburg.

In form and colour this ore differs from the preceding. Its shape is that of a rounded lenticular mass, and is covered by a thin coating of bituminous shale. Its internal fracture is conchoidal, and the colour reddish brown. The addition of an acid, when aided by a slight heat, causes a lively effervescence, and like the preceding variety, a black organic powder is left, which entirely disappears when acted on by nitric acid. The ferrocyanite of potash throws down from its solution, a voluminous blue precipitate.

Silicious Iron Ore, from Blossburg.

This ore has a dark brown colour; when pulverized, its powder is dirty white. The fracture is rough and uneven. The action of the acids upon this ore is followed by effervescence, the precipitation of bituminous matter, and an insoluble silicious residuum. We should here observe, that these iron ores, as well as others that we have examined from different parts of the Pennsylvania coal fields, contain little or no lime. It was my intention to have furnished a quantitive analysis of these ores, as my friend Mr Taylor desired; but my late visit to the gold region of Virginia having detained me longer than I expected, I am under the necessity of giving this imperfect account, which, however vague, I hope will suffice to give some idea of the nature of these iron ores.

No. 6.

Coal Mine, Coal run.

Has a semivitreous lustre; is black, and very brittle; fracture uneven, and yielding a black powder. This coal is very fat, burns with a long fuliginous flame, leaving a voluminous coke, which, when incinerated, yields a grey ash, free from lime.

Carbon, ...	75.4
Volatile matter, ...	16.4
Cinders, ...	8.2
	100.0

ON THE PENTREMITES REINWARDTII, A NEW FOSSIL; WITH REMARKS ON THE GENUS PENTREMITES (SAY), AND ITS GEOGNOSTIC POSITION IN THE STATES OF TENNESSEE, ALABAMA AND KENTUCKY.

By Gerard Troost, M.D., Professor of Chemistry, Mineralogy and Geology in the University of Nashville, Tennessee; Member of the Geological Societies of France and Pennsylvania, &c. &c.

The organic remains which form the subject of this memoir, we place for the present in the genus Pentremites, established by our worthy countryman Thomas Say, although it differs perhaps in some essential points from that genus, but its fossil state (it being entirely changed into calcareous spar) makes it difficult to ascertain its minute organs.

It is composed, like that genus, of five ambulacra, radiating from the summit and terminating about the middle of the intermediate fields or scapulæ. No visible sutures separate the pelvis from the scapulæ, nor is the pelvis or base divided into different parts, but a suture runs from the tip of the scapula to the lower extremity of the pelvis.

The ambulacra are not lanceolate as in the other already described species, but they are rounded at the base; nor are the pores placed in the same manner on the tentaculæ. We annex a magnified representation of an ambulacrum (see pl. 10, fig. 11), from which it appears that a zigzag line divides it longitudinally in two parts. Striæ in a more or less inclined direction run in an alternating order from this line to the margin, and a small pore is visible half way between the line and the margin. This representation gives at the same time the form of the ambulacra. No aperture is visible where these ambulacra join together at the summit. Nor are the five

Fig: 1.

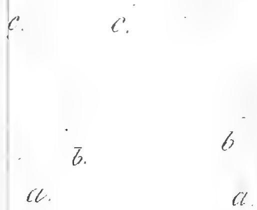


Fig. 2.

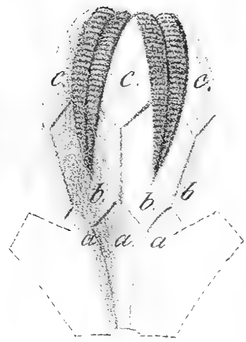


Fig: 3.

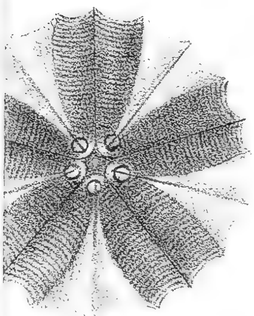


Fig: 4.

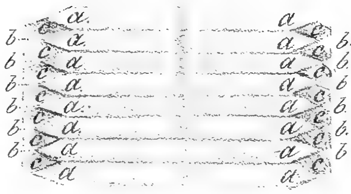


Fig: 6.

Fig: 7.

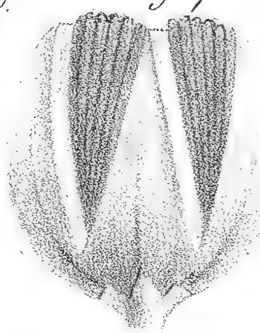
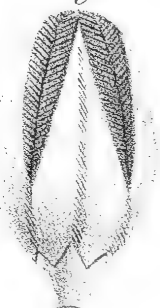
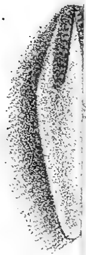


Fig: 8.



Fig



of Pentremites Florealis showing the Starshaped aperture
five holes with their Septa.
tes the Ambulacrum being removed. Showing the
d Furrows.
tes pyriformis. Say.

Pentremites Reinwardtii

Fig 3. Summit of Pentremites Florealis showing the Starshaped aperture and the five holes with their Septa

Fig 7. Pentremite. the Ambulacrum being removed Showing the edges and furrows

Fig 8. Pentremites pyriformis Say

holes, which in other Pentremites surround this aperture, visible in our specimens, but although no traces of them are to be seen in the present state of our fossil, they may have existed during life and have disappeared by their fossilification, the summit in my specimen being more or less obliterated.

There seems to be no doubt that these animals were fixed by an articulated column, but in the perfect one I possess, the base is only perforated in the centre, showing the aperture of the alimentary canal, but no radiating surface as is generally the case in that genus.

The size of the largest I found, if entire, would be about 1 inch in length. The only one that I have perfect is about half of an inch long, and one-fifth of an inch in its greatest diameter.

They occur in Perry county, Tennessee, about two miles west from Tennessee river, imbedded in an argillaceous limestone containing here and there green earth, which renders this rock susceptible of disintegration. This stratum lies below the coal measures, so that it must be considered as belonging to the upper transition. They are associated with trilobites, Calceola sandalina, calamopora, terebratula, spirifer, producti, &c.

An excursion performed during last spring was principally undertaken to ascertain the geognostic position of this interesting genus. We obtained some specimens of it imbedded in limestone with an oolitic structure; and having in our several rambles in every direction over the state never found the true *oolite formation*, as described by Messrs Phillips and Conybeare, and which prevails particularly in some parts of England, we became more anxious to ascertain the nature of the strata in which they occur, and we have now satisfied ourselves not only of the geognostic position of the strata in which they are inclosed, but also of the real construction of the remains themselves.

We will first communicate the results of our observations upon the fossil itself, and point out in what particulars it differs from those published by naturalists. Mr Say (see Journal of A. N. S., vol. 4, page 292) says that the aperture in the summit, where the ambulacra join, is angular; and Dr Goldfuss (Goldf., Petrefacta, page 160) says that it is pentagonal. Such is the fact, the form of this aperture varies much according to the more or less perfect state of the fossil, but in perfect individuals its form is a star with five rays.

Dr Goldfuss speaks of an arrangement of pores on the ambulacra which I cannot see on our specimens, and I have anatomised some in order to detect it. The doctor says (loco citato): "they" (*ambulacrorum areæ*) "are divided by a smooth longitudinal furrow, transversely, narrowly striated, and their tentacula have pores which are placed in pairs. These pores are close to one another, the outer row immediately on the border of the area, indeed in the very identical furrow itself, but the inner one is on the extremities of these transverse striæ of the ambulacra themselves; at the first glance, the large pores of the external row are only perceptible, and those of the inner row are so small that they can be seen only by a magnifying glass." We examined several specimens and, as already mentioned, we dissected some also (we have some in our cabinet, the different parts of which may be separated), and we have not been able to discover this arrangement of pores. The pores placed at the end of the transverse striæ, which Dr G. says are very small, do not exist; but the large ones placed in the furrow formed by the ambulacrum, and the margin of the continuation of the pelvis or scapula, are very perceptible. When the ambulacrum is removed, the whole mystery of these pores is cleared up; we then see that each of these transverse striæ terminates in the form of an arrow head, and joins with its point the border of the scapula, which has also transverse ridges (these transverse ridges are only perceptible when the ambulacrum is removed). The extremity only of the striæ being in contact with the upper part of the ridge, a vacuum must remain between the striæ and the margin of the scapula; it is this interval which, though not round, has the appearance of a pore. I have endeavoured to render this structure intelligible by some drawings. Pl. 10, fig. 5, is an ambulacrum showing its indented edge or arrow-shaped striæ: fig. 4, these striæ, much magnified, touching, with their extremities *a*, the ridges of the scapula *b b b*. The interstices forming the pores are marked *c c c*. The striæ, when magnified, show a longitudinal furrow in its middle, and some of them have often depressions on their ends which indeed have more or less the appearance of pores, but it is only occasioned by a kind of suture which is visible in some. Fig. 6 represents such an ambulacrum; we see that the striæ are only near the margin, and terminate at the line *a a*, which is undoubtedly a suture; the middle part has no transverse striæ, but only a longitudinal furrow. The interior of this ambulacrum is longitudinally furrowed, forming a number of channels which fit in similar channels of the interior of the body.

It is said by Mr Say and Dr Goldfuss, that the summit has five rounded apertures (ovaries of Mr S., or apertures through which the body takes in water, of Dr G.). These openings are more complicated than our authors mention. It seems that the specimens from which they have drawn up their description were not as perfect as those which I found. Each of these five openings in perfect specimens is divided into two parts by a septum, which is connected with the tip of the scapula and runs thence towards the central aperture. This septum is very delicate, and has generally disappeared during fossilification; but so far as I have been able to ascertain, it continues in connection with the scapula downwards to the *pelvis*. (See pl. 10, fig. 3.)

They are constructed of several pieces, the sutures of their junctions are visible in some, while in others they are entirely obliterated, but I had the good fortune not only to find specimens in which these sutures were very plain and could be separated, but I found also separate parts imbedded in the rock. Mr Say, in concurrence with Mr Miller, says, (loco citato) "the pelvis is composed of three pieces, two pentagonal and one quadragonal." Neither the form of the scapula nor that of the interscapula is given by these authors; it is only said "they are large, and deeply emarginated for the reception of the ambulacra, and truncated for the junction of the subrhomboidal interscapular." Nor is the description published by Dr Goldfuss and M. de Blainville correct, according to our specimens. The result of our observations shows that the whole surface of the animal, not including the ambulacra, is composed of thirteen pieces. The base, or as it is called the pelvis, contains three pieces, one pentagonal, and two heptagonal, having a re-entering angle. We have endeavoured to show these several pieces, which we found isolated, imbedded in the rocks, in pl. 10, fig. 1 and 2; the pieces alluded to are marked *a a a* in the two figures. Five pieces which receive the tips of the ambulacra, having more or less the form of a horse shoe, fig. 1 and 2, *b b b*; and five pieces having four sides of a subtriangular shape, fig. 1 and 2, *c c c*.

Seven species seem to be known of this genus.

1. Pentremites globosa, Say, supposed to have been found at Bath in England. We have found it in Alabama, at Mount Sano and vicinity; Tennessee, Crab Orchard mountain; and Illinois.

2. P. pyriformis, Say. Tennessee near Sparta,

Sequasha valley; Alabama, Mount Sano; Kentucky, between Springfield and Nashville, Tennessee.

3. P. florealis, Say. Tennessee, Jasper, Sequache valley, between Sparta and Crab Orchard, rare in the limestone near Nashville; Alabama, Mount Sano, abundant; in several places on the base of the different spurs of the Cumberland mountains, Kentucky, between Springfield and Nashville; and, according to Mr Say, also on the margins of the Mississippi.

4. P. ovalis, Goldfuss. Transition limestone at Cromford near Ratingen, Dusseldorf, Europe.

5. P. derbensis, Sowerby. Zool. Journ. vol. 2, page 317, pl. 2, fig. 3.

6. P. ellipticus, Ibid., page 318. Encrenites Godoni, Defr. Dict. des Sc. Nat., tom. 14, page 467.

7. P. Reinwardtii nobis.

The figure given by Dr Goldfuss of the P. florealis, tab. 4, fig. is an excellent representation of the fossil. The largest specimen in our cabinet of that species is from Cumberland mountain, it is one inch long and seven-tenths of an inch wide. A specimen of the P. globosa in our possession discovered in Illinois, is one inch high and one inch wide. P. pyriformis, of which I subjoin a figure, pl. 10, fig. 8, was found on the western base of the Cumberland mountains, in Warren county; it is represented in its natural size, one and three-tenths inches long and four-fifths of an inch wide. Such are the dimensions of the largest in our cabinet, but they are rarely found of that size, we have them from the size of a grain of pepper to the sizes mentioned above. They are often silicious, but in some localities entirely changed into calcareous spar.

Not much has been published respecting the geognostic position of this fossil. Dr Goldfuss says that P. ovalis occurs in transition limestone. In the United States they characterise the upper strata of that (transition) formation; they are of rare occurrence in the strata of limestone in the vicinity of Nashville, which are characterised by orthoceratites, conotubulares, Bellerophon triulcus, cocinopora, calamopora, spirifer, producti, and terebratula ; and we doubt whether they exist at all in the limestone which alternates with grauwacke, which is found towards the east of this state.

It will appear from our geognostic description of the state of Tennessee, that the strata in the vicinity of Nashville are covered with a series of strata composed of alum slate, sandstone and limestone, which are lost under the Cumberland mountains, where they are covered by the coal strata ; they are analogous to the mountain limestone of the English ; it is in the upper strata of that series, the limestone of which has often an oolitic structure, that the pentremites are found associated with stylines, catenopora, syringepora, &c., but particularly with a reticulated fossil, resembling the Gorgona antiqua of Goldfuss as to its reticulated expansions, but differing much from all the genera that have been described, as well as from those of which I expect soon to prepare a description.

The limestone which forms the base of the Cumberland mountains is particularly characterised by it. In Alabama, in Mount Sano, they are found in a stratum of limestone which lies immediately below the coal ; but in some of the lower strata, where the limestone in some places is oolitic in small grains, they become more abundant, and particularly a few miles from where the coal stratum crops out, and where the limestone is covered with a stratum of sandstone abounding in the usual lithophites. Wherever the limestone which forms the base of the Cumberland mountains assumes an oolitic structure we may expect to find the pentremites, but often so intimately incorporated with the rock that it is with difficulty we obtain specimens. The most interesting localities are Mount Fletcher and Mount Sano in Alabama ; near Jasper and Crab Orchard in Cumberland mountain, and Sparta and Henlopen, western declivity of Cumberland mountain, Tennessee. I never found any above the coal, nor in strata alternating with coal measures; so that we must consider it as one of the fossils that characterise the upper transition limestone of the interior of America.

DESCRIPTION OF A NEW SPECIES OF FOSSIL ASTERIAS (ASTERIAS ANTIQUA). By G. Troost, M.D.

This description is extracted from a partial report on the geology of the state of Tennessee, which was read in the house of representatives, at the session of 1832.

Naturalists speak in a doubtful manner, whether the Asterias is found in a fossil state. Alexander Brongniart, in his valuable geognostical description of the environs of Paris, mentions two places in which some fragments of *Asterias* were found; the one in the upper chalk (see page 15, 2d edition, *Des articulations qui par leur forme cuboide paraissent avoir appartenu a une espece voisine de l'Asterias aurantiaca*). The second seems to have been found in strata having some analogy with the Calcaire grossière of Paris, and was sent to Brongniart from the vicinity of Ghent (see page 196, *Portions ou Articulations d'Asterias*). I suppose it is on the authority of Brongniart, that Defranc enumerates amongst the *Stellerides*, one *Asterias* in the fossil state, and as being doubtful whether it occurs posterior to the chalk. (*Defranc*, *Tableau des Corps Organises Fossiles*, page 102.)

Our fossil belongs to the division with a radiated body, as established by Lamarck, and is composed of five rays, having a longitudinal groove, which in our species is narrow. These rays, five in number, are in proportion shorter than those in the *A. spinosa*, which it resembles, as to its external form. Our specimen measures from extremity to extremity of two opposed rays, two and two-fifths inches; the rays from the disk to its extremity measure one inch. The *A. spinosa*, which has served for comparison, measures from tip to tip of two opposed rays four inches, and from the disk to the tip one and three-fifths inches. It is very probable that the *A. antiqua* was furnished in its living state with movable spines, like the generality of those belonging to this division, but these spines have disappeared in our specimen, it being imbedded, in fact partly incorporated, in a solid granular limestone, and has only come to light by the wearing of the rock, by which are also obliterated most of its specific characters. Not only the spines are worn off, but it seems that also the epidermis has disappeared. We see from the figure, (see plate 10, fig. 9), that the margin which encloses the groove is composed of two different parts, the outer part being composed of articulations or pieces of a parallelopipedon shape, except the first, placed nearest to the disk, which has the form of an equilateral triangle, one of the sides placed against the disk. The internal part of the margin is narrower than the external one, and is composed of a double row of triangular points, placed in such manner, that the groove seems surrounded by white triangular points placed close to one another, while the intervals form a row of black triangles. Perhaps this appearance is partly owing to the effect of fossilification—or must these be considered as the internal structure of the animal? In the latter case, it differs widely from those that are living on our shores. I have, in order to see whether I could produce a similar appearance, cut up a dry *Asterias spinosa.* Having removed the spines, I have successively worn down the whole animal to the cavity in the rays, and I was not able to produce any thing similar to the fossil species.

I am not acquainted with the internal structure of the articulated species mentioned by naturalists. Perhaps its structure may be similar to ours. As the whole of its external surface has disappeared, it is impossible to determine its specific characters, and consequently whether it will form a distinct species; and as for the same reason, it cannot be ranked among the known species, I have denominated it *Asterias antiqua.*

I discovered it near Big Harpeth river, Davidson county, Tennessee, on a water-worn part of a stratum of granular blackish-grey limestone, which is quarried there for marble. The same fragment of rock, as we perceive in the drawing, contains fragments of polypiferes, which also have come to light. They seem to belong to the Ceriopora, Goldf., and Calamopora, Goldf., with some bivalves, spirifer and terebratula. Such remains are also found amongst the disintegrations of this stratum. This stratum is the lowest one of that section of country and is the same as those in the vicinity of Nashville, and consequently belongs to the upper transition series.

Whether this *asterias* is abundant or not, I cannot say, because I do not believe that it would be recognisable in fractures of the rock, as the object is too intimately incorporated with the rock. It is the only one that I have seen.

When I presented this report to the legislature of the state of Tennessee, I was not acquainted with the third part of the valuable work of Dr Goldfuss, *Petrefacta Musei Regiæ Borussicæ, &c.*, which, at that time, was not yet published. Dr Goldfuss describes in it ten species of *Asterias*, but none of them resemble our fossil; and it remains as interesting as it was before, as it belongs to one of those few animals which are found from the lowest fossiliferous strata through the intermediate formations, and are found living at present in the ocean. Those described by Dr Goldfuss are: first, the *A. lumbricalis, Schloth.* It occurs in the upper strata of the Lias sandstone, at Walzendorf, near Coburg, and at Lichtenfels, in Bambergen. The second, *A. lanceolata, Goldf.*, same locality as the first. Third, *A. obtusa, Goldf.*, associated with articles of the *Encrinitus moniliformis*, in the conchyliferous limestone (*Muschelkalk*) of Friedrickshall, at Marbach, near Villingen, in Wurtemberg. Fourth, *A. areniola, Goldf.*, in the superior oolitic sandstone strata of the Jura limestone formation of *Porta Westphalica*, and on the Jacobsberg, the right bank of the Weser, near Minden. Fifth, *A. quinqueloba, Goldf.*, from the chalk formation of Northfleet, England, Maestricht, Netherlands, and Rinkerode, near Munster. Sixth, *A. Iurensis, Munster*, in the oolitic argilite, between the Jura limestone and Lias sandstone, in Bairuth, also near Nattheim, in Wurtemberg and Stuttgarden. Seventh, *A. tabulata, Goldf.*, in the superior argillaceous strata of the Jura limestone of Baruth, near Streitberg. Eighth, *A. scutata, Goldf.*, same locality. Ninth, *A. stellifera, Goldf.*, same locality. Tenth, *A. prisca, Goldf.*, from the Lias sandstone of Wasseralfingen, in Wurtemberg. From the above list, it appears that they have been found from the conchyliferous limestone, as the *A. obtusa, Goldf.*, to the chalk formation, as *A. quinqueloba, Goldf.* So that our *Asterias* is separated from them by the varigated sandstone, the zechstein, copperslate, old red sandstone and the coal.

I found five other species of free Asterites: one of them occurring in a lower stratum than that in which the *A. antiqua* is imbedded; and the four others in higher situations; all nevertheless, below the coal; but which, for want of having any body to draw them, must for the present remain undescribed.

ON THE LOCALITIES IN TENNESSEE IN WHICH BONES OF THE GIGANTIC MASTODON AND MEGALONYX JEFFERSONII ARE FOUND. By G. Troost, M. D.

[Continued from page 146.]

Big Bone cave is situated on the county line which separates White from Warren county; in fact the line runs over it. Its entrance is in White county, about a mile south of Ross's road, and three miles from Rock island in Cany fork. It is in a spur of the Cumberland mountain, or rather in the continuation of the north western slope of that mountain, which lies to the east of Sparta, and runs thence after several meanders towards M'Minville. This spur forms a narrow ridge which separates the two mentioned counties, offering to the spectator, placed on its summit above the cave, a beautiful view over part of Warren county.

The entrance of this cave is about half way up the mountain. It is of a low, semicircular form, about 9 feet high and 30 feet wide on the floor; it is excavated in limestone, and contains two principal wings or routes. The left one, I am told, pierces the whole ridge, and forms in Warren county what is called the Arched cave; the right wing has never been traversed to its end.

Piloted by one of the neighbouring inhabitants, who had been employed a long time in preparing saltpetre from materials procured from this cave, I penetrated several miles into the right wing. I went in several directions through it, and returned by different roads towards the same entrance. These roads, which are sometimes so narrow that two persons could not go side by side, form at other places large excavations which are called rooms, or have some fantastical name; and in fact the whole resembles the other caves so numerous in the western country. Being situated in the upper part of the limestone strata, where the sandstone begins to make its appearance, and therefore the fluids which may penetrate into it not being charged with carbonate of lime; it is natural to suppose that no stalactites embellish its roof nor stalagmites incommode the traveller; in fact, we were not troubled by drippings as is often the case in similar caves; every thing here was dry, but black, occasioned by the burning of resinous pine wood which is used for light by those that worked the saltpetre materials.

As these caves have been formed by subterraneous currents of water, and as the rocks are not of an uniform solidity to resist the action of water, it is natural to suppose that we travelled over a remarkably unequal and tortuous road. We met with several precipices; sometimes we found small openings through which we passed with some difficulty, and again large spacious excavations; it was in one of these excavations or rooms, which was several feet below the general level of the cave, and into which nobody could descend without a ladder, that the bones of the Megalonyx were found. I have spoken with several of the old settlers, and they all agree that the bones in question were discovered in this low excavation; but the number or the kind of bones I could not ascertain, and several marvellous stories respecting these remains are in circulation. Thus it is said, that ribs were found 7 feet long; there seems to be no doubt that a great number of bones were found there; and, in my opinion, those purchased by Mr Price Wetherill, and described by Dr Harlan, really came from this place. Squire Fisk, one of the first, and one of the few early settlers that came here with a finished education, and being also a good observer, mentions in a letter to me "that once a full barrel of newly discovered bones was sent to Mr Clifford." He believes that the saltpetre made there was chiefly sold to Mr Clifford.

The room in which the bones are found is situated a great distance from the entrance; it is therefore not probable that the animal came there alive: but if he came, he must certainly have fallen into the excavation and perished, because, as I have already observed, it requires a ladder to descend into it. Nor is it probable that it was dragged there by carnivorous animals; I do not believe that they would have dragged their prey for a mile and more to devour it (I had penetrated the cave, according to my guide, about 3 miles). It seems therefore that it was drifted in by the current which formed these subterraneous fabrics, and that it is very probable that the whole carcass was there, because we have fragments of the extremities and of the pelvis.* These bones were covered from 3 to 4 feet deep with the earth from which the nitrate of lime for the preparation of saltpetre is extracted.† Whether this must be consi-

* Squire Fisk mentions in a letter to me, speaking of a large claw he sent to the late Dr Barton: "Flakes had been scaled off at and near the point of the claw, by which means it had evidently been shortened; but its original length, I am confident, was not less than 15 inches. It measured around the heel or base of the ball, which was a bone of the most indurated kind, and well preserved, 12 inches."

† In a correspondence with Professor Reinwardt, of Leyden, an eminent naturalist, and who no doubt investigated, during his residence in the East Indies, the sources from which, in India, saltpetre is drawn, that philosopher says, that it would be interesting to investigate the causes by which this salt is produced in America; he seems of opinion that its origin must be attributed to the decomposition of organised matter. I do not believe that saltpetre is produced by the decomposition of animal and vegetable matter, in the caves of the interior of America; they have already produced large quantities, and still abound in that salt. I have been very attentive in investigating this matter, and examining the materials which have been lixiviated, and those that are yet in their unaltered state in the caves; and I have always found them more or less similar to the disintegration of the rocks in which the caves were excavated, and somewhat analogous to the soil which is found in its vicinity, making abstractions of the vegetable matter which is found in the latter, and the first containing a larger proportion of carbonate of lime. I

dered as an old alluvion, deposited while the cave was a subterraneous stream or river, or as a disintegration of the rock which is daily in progression, we are not prepared to say; but however it may be, it can in no manner elucidate the geological nature of the surrounding country.

found no water worn pebbles nor any fragments of other rocks. The bones which were found (and the earth which contained the bones was dug up to the very floor), are very few compared with the large quantity of saltpetre produced. I was told that sometimes more than 400 men at one time were engaged in it, and of course the decomposition of the flesh of these few animals could not have produced the nitrogen necessary for the nitric acid; there are besides found large numbers of quills of porcupine, as I am told, but even these are not so abundant, because I found not a single one. But is organic matter absolutely necessary to produce nitrogen in such a state that it enters in combination with oxygen? Nascent nitrogen, it is said, combines with oxygen and forms the acid; but why should not nitrogen, when in favourable circumstances, enter into combination with oxygen, though not exactly at the moment it was produced? Here in our caves, every thing seems favourable to this combination.

Although the wind, when we entered the cave, blew in such a direction that it ought to have entered through the Arched cave in Warren county, and consequently have blown out of the entrance by which we went in, nevertheless we did not meet any current of air; on the contrary the air was rushing in through the same aperture. We had at first some difficulty to keep our lights burning; but when we had advanced some distance, the draught diminished very much, and we soon felt no current of air at all, our lights burnt quiet and bright, and, though apparently stagnant, the air was pure, delightful and invigorating; the workmen told me it was the most healthy occupation they ever were engaged in. It had frozen early in the morning, and was still very cold when we entered the cave; of course we found the temperature of the interior very agreeable. We remained several hours in it, the sun was near the meridian and the atmosphere quite warm when we came out, but still the air rushed into the cave and was very perceptible when we began to approach the entrance, even before we could perceive daylight; so the rushing in of air could not be attributed to a dilatation or condensation of it by the difference of temperature. The air was dry, but sufficiently moist to make the earth feel damp, and was not dusty; though the earth contained much saltpetre, I no where saw efflorescences of that salt; the earth was loose, light, and, independently of the saltpetre, which is dispersed through it in very irregular proportions, is composed of silex, carbonate of lime, and a small proportion of alumine and magnesia. But the earth from the floor is not preferred by the workmen; they often take the lower part of the sides of the cave, even peeling off about an inch deep from the rock, which they say is more productive.

Inasmuch then, as the air in the cave was stagnant, or apparently so, and as we found nevertheless that a constant current of air was flowing in, it follows that an absorption or decomposition of the air must take place in the cave.

In order to give an adequate idea of the geognostic situation of this cave and the surounding country, and which, as we have already mentioned, stands in no relation with the subject of this memoir, we will communicate an extract from a general geognostic description which was contained in a report to the legislature of Tennessee, delivered two years ago, and which we expect soon to offer to the public.

The lowest strata that prevail in Tennessee, west of Cumberland mountains, are limestone, and are visible in the vicinity of Nashville, and in some other counties. These strata are composed of granular and compact limestone of various shades of grey, from light ash grey to blackish grey. They lie horizontally, and are characterised by the following organic remains—several species of orthoceratites, conotubularis, Bellerophon hiulcus, isotelus, stromatopora: but particularly the Calamophora gothlandica, and several species of terebratula, spirifer and producti (which are all considered as characterising the upper transition series), are found in our lower strata; and there seems to be no doubt that they

In the caves in which there is a constant current of air, as I have seen some in the Smoky mountains, from the opening of which rushes always a current of air, no saltpetre is formed. Could not this air furnish the constituents of the nitric acid, which combines with lime and forms part of the saltpetre materials? Besides we know from actual experiments, made first by Dr Priestley, and afterwards repeated by Cavendish, Gilpin and Davy, that when the electric fluid is made to pass through atmospheric air or any mixture of nitrogen and oxygen, the two elements combine in the proportion to form acid.

I believe it is easier to account for nitrogen in the production of nitric acid, than for the oxygen which it requires. We know that atmospheric air is composed of from 21 to 23 per cent of oxygen, the remainder being nitrogen; or nearly, to take round numbers, as 1 of oxygen to 3 of nitrogen; and nitric acid is composed of $2\frac{1}{2}$ of oxygen to 1 of nitrogen. So that if all the oxygen of the air combines with the necessary proportion of nitrogen to form nitric acid, the remains of the air must be nitrogen gas, and of course we would find an atmosphere in such caves not calculated to support animal life: and even if the nitrogen was offered, by the decomposition of vegetable or animal matter, in a nascent state, to the atmosphere, it would make it unfit for respiration. We must conclude then with saying, that the formation of saltpetre is still surrounded with mystery.

rest upon the grauwacke series, which prevails to the east of the Cumberland mountains; one of the uppermost of the above mentioned strata, is nearly wholly composed of Strophomenes rugosa. These strata containing organic remains alternate with strata which contain no fossils, and are on our high lands, covered with a stratum of a species of alum slate, which, in a mineralogical point of view, resembles that variety in which, in Westrogothia, the Agnostus pisiformis is found. I have compared our slate with a specimen from the above mentioned European locality, which is covered with the A. pisiformis; and I found it similar. Some parts effervesce a little with acids; other parts do not possess that quality. This shale, which is mostly perfectly black, straight, foliated, without lustre, passes sometimes into a glossy slate with curvated and distorted foliated structure. We never found any organic remains, vegetable nor animal, in it; it lies in a conformable stratum upon the limestone series already described. It is sometimes bituminous, and contains even small seams of coal, which, though bituminous, resembles in its external appearance anthracite. It contains also nodules and particles of pyrites.

Upon the stratum of alum slate follows a stratum of limestone, which often contains green earth; it is mostly of a sublamellar texture, in some places remarkably fetid, and characterised by several genera of encrenites. I found also different genera of trilobites, Spirifer caspidatus and large hamites. This stratum may be traced over a large extent of ground, as in Davidson, Williamson, Maury, Smith, White, Overton, and several other counties, lying always in the same geognostic position, that is covering the alum slate. The fossils which it contains, particularly the radiaria, are very numerous (sometimes the whole stratum is made up of them), and are sometimes calcareous and often entirely changed into silex.

This encrenitic stratum is followed by a very interesting silico-calcareous one, or a stratum, which is at some places entirely calcareous, at other places entirely silicious, and at other places again, the silicious and calcareous strata alternate with each other; the silicious parts have sometimes the appearance of hornstone or chert, sometimes of sandstone, and have often an earthy aspect resembling tripoly, but whether calcareous or silicious, the whole stratum, which is from 200 to 300 feet thick, is characterised by some reticulating polypifers, resembling the Gorgonia antiqua, Goldf., G. infundibuliformis, Goldf.; also the Retepora cancellata, R. prisca, both of Goldf. I have specimens, the calcareous parts of which are entirely made up of them, and I have also silicious specimens which are similarly composed. It is this stratum which contains our rich deposits of hydrate of iron; even the cavities which are in the ore, are sometimes filled with the above mentioned Gorgonia and Retepora, in a silicious state.

This stratum is covered, towards the west of Tennessee river, by strata of sandstone, which contains lignite and immense beds of marly limestone, which contains Ostrea falcata, Exogyra costata, Gryphæa convexa, G. mutabilis, all of which have been described by Dr Morton and others, and which stratum will be described more minutely in my geognostic description of the state, but our present intention is to follow up the stratification towards the Big Bone cave.

The silico-calcareous stratum, with Gorgonia, &c., described above, and which forms the high, but level part of Davidson, Williamson, Maury, Rutherford, Warren and White counties, is in the eastern parts of the two latter counties, Warren and White, covered with a different series of strata. It is an alternation of different strata of limestone: some black, resembling the black marble of Dinant and Nameur, in the Netherlands;

others of different shades of grey, from light ash grey to blackish grey, also of different textures; some granular, others compact, but most of them exhibiting an oolitic structure: the oolitic limestone is always light, sometimes nearly white. Some of these strata are without any organic fossils, while in others they are densely accumulated. This series, which belongs to an old deposition, as it is always below our coal strata, is not known, I believe, to exist in Europe. It is particularly characterized by several species of pentremites, stylines, calamopora, and some other which no doubt will constitute some new genera.

This formation, which I have traced from near Huntsville, Alabama, to near the Cumberland river, Tennessee, and which must be considered as the base of Cumberland mountain, is lost, at an elevation of about 1600 feet above the sea, under the coal strata which form the summit level of Cumberland mountain.

It is in the above described formations of oolitic limestone, which I have nowhere found above the coal or alternating with it, that Big Bone cave is situated.

DESCRIPTION OF SOME ORGANIC REMAINS CHARACTERIZING THE STRATA OF THE UPPER TRANSITION WHICH COMPOSES MIDDLE TENNESSEE. By G. Troost, M. D.

Hamites.

The fossil under examination coincides in some respects with the *Hamites funatus*, Brong., but its ribs are not quite as oblique as represented in the figure given in Descriptions Geologiques des Environs de Paris, 2d edit., pl. 7, fig. 7. In this respect it is intermediate between the H. rotundus, Sow., and the H. funatus; but its transversal section is in the form of an ellipsoid. In our specimen the diameter of one of the extremities is much larger than that of the other, which seems not to be the case with the one represented by Brongniart. In only a few places of it has the shell been preserved, which seems to have been very thin, so that the greatest part of it must be considered as a cast.

I have not been able to learn what size those found in Europe generally have, and cannot therefore say whether our Hamites is uncommonly large, as I am rather inclined to believe. If we can rely on the names, the H. gigas, Sow., is a gigantic species; I am not acquainted with its size, but the H. maximus of the same naturalist must, no doubt, be the *largest* that Sowerby has observed. I find it has 10 lines in diameter and 2 inches in length; ours has, from one extremity to the other, measuring outside, 19½ inches, and both extremities are much mutilated; but one can form a more correct idea of its size by stating that the circumference of its larger extremity is 10¾ inches.

If the above mentioned characters are sufficient to separate it from the H. funatus, I propose the name of

HAMITES HAANII.

I found it in a stratum of a granular spathose limestone which lies below the shale near the Harpeth river, in Davidson county, where this stone is quarried for tombstones, &c. I do not know whether the Hamites have been found in any strata below the chalk. Those mentioned by Brongniart, in the above mentioned work (see pages 83, 95, 96 and 99), were found in "*la craie tufau et de la glauconie* of Rouen, of La Perte du Rhone, near Bellegarde, and in the mountains of Fis and Sales, in the Alps of Savoy. According to Mantell, Buckland, Phillips, Desnoyers, Sowerby, Hoenighaus, Risso, and Defranc, it occurs in similar strata, chalk and green sand, consequently in the upper secondary strata. Defranc mentions of the 15 species, only one as doubtful whether it occurs anterior to the chalk; De la Beche places 20 species in the list of organic remains of the cretaceous group, and not a single one in the lists which he gives of inferior groups, whereas it occurs here below the coal strata, and is associated with Turbinolia mitrata, Goldfuss, which, according to Schlotheim, occurs in the upper transition.

TURBINOLIA MITRATA, Goldfuss.

Goldfuss has subdivided the genus Turbinolia of Lamarck, and has formed of it his genus Cyathophyllum. The characters laid down by Goldfuss for the Turbinolia are: "a simple, free, turbinate, or inverted conical, stellated, lamellar polyp cell, composed of vertical lamellæ joined together in the centre, forming on the upper part a single terminating star, and projecting on the side like small ribs. The sides of these lamellæ are covered with warts. The latter character is not mentioned by Lamarck, and brings most of the fossils of our state, which I heretofore considered as Turbinolia, into the genus Cyathophyllum. I found nevertheless two species which I consider as belonging to the genus Turbinolia, the one approaching the *T. mitrata*, and the other the *T. cuneata*, Goldfuss.

Turbinolia mitrata is inverted, conical, with a bent base; the lamellæ are thin and externally grown together, forming only shallow ribs; these lamellæ are covered with projecting points, by which they are in contact with one another.

They are calcareous, and occur associated with the above described Hamites, bivalve shells and spirifer, in the same locality.

Turbinolia cuneata, Goldfuss.

It is compressed, and has an obtuse base. The lamellæ are thicker on the outside, and grown together, to form a compact cover for the deep intermediate spaces of the star. These lamellæ become thinner in the interior, where two of them grow together, forming a single one. They reach alternately a grate-shaped partition, which runs longitudinally through the middle of the star.

It is found in the same locality as the preceding, associated with the same fossils; also, in the lower stratum, associated with encrenites.

Cyathophyllum ceratites, Goldfuss.

These organic remains form a single, free, inverted conical, horn-shaped stem, curvated at the base. The young are externally more or less smooth, or indistinctly longitudinally striated; but the old and larger ones exhibit longitudinal striæ, protuberant transversal rings, and a loose border of prolifying cells. The cup-shaped terminal cell has an extended border, and numerous uniform and more or less notched lamellæ.

The description given by Goldfuss is applicable to our fossil. They are not unfrequently found in the limestone of Davidson county, but still more frequently in the glades near Tennessee river, in Perry county. They are of the size of one half to four inches in length, and are converted into quartz.

The geological position mentioned by Goldfuss "in soil on transition limestone near Bensberg," corresponds thus with that of ours.

ON THE ORGANIC REMAINS WHICH CHARACTERIZE THE TRANSITION SERIES OF THE VALLEY OF THE MISSISSIPPI, &c. By G. Troost, M. D. In a letter to Dr Harlan of Philadelphia. [Extracted from his manuscript Report to the Legislature of Tennessee as Geologist of the State.]

I will commence with a list of the fossils which I found in the transition strata, including the mountain limestone of the English geologists. I must do so, because, in a zoological point of view, our carboniferous limestone is characterized by the same organic remains which in Europe are found in the grauwacke group—and our grauwacke is without fossils, except a few of the upper strata. The lowest fossil that I have found, is the Maclurites bicarinata, Lesueur. They occur in a stratum of black limestone near the Holston river; they are abundant near Kingsport, where they are associated with the Conotubularia Cuvieri. The next fossils are some Encrenites and Polypiferes, which are so much incorporated with the rock, that I was not able to distinguish them. The next series is the carboniferous, which I considered distinct from the coal measures. The lowest strata are characterized by a genus which I have christened Conotubularia, and we have C. Cuvierii, C. Brongniardii, C. Goldfussii.

2. Several species of Orthoceratites.

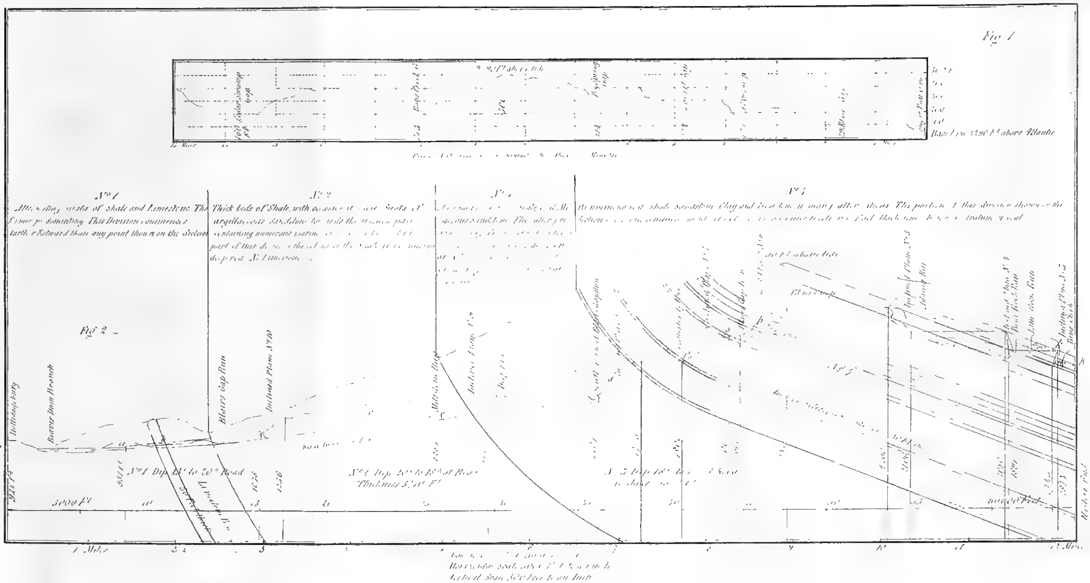
3. Isotelus planus. 4. Astrea tessellata, nobis. 5. Cyathophyllum ceratites, Goldf. 6. Cyathophyllum vermiculare, Goldf. 7. Stromatopora concentrata, Goldf. 8. Stromatopora verrucosa, nobis. 9. Coscinopora infundibuliformis, Goldf. 10. Catinipora mæandrina, nobis. 11. Calamopora maxima nobis. 12. Columnaria diver-

gens, nobis. 13. Columnaria sulcata, Goldf. 14. Manon Piziza, Goldf. 15. Eschara ovatopora, nobis. 16. Escaria reticulata, nobis. These 16 species are found in the lowest strata—the intermediate strata of the same group contain:

17. Astreas antiqua, nobis. 18. Hamites Haanii, nobis. 19. Turbinolia cuneata. 20. Aulopora serpens, Goldf. 21. Scyphia Neesii, Goldf. 22. Scypia stellata, nobis. 23. Sarcinula costata, Goldf. 24. Astrea alveolata, Goldf. 25. Calamopora spongites, Goldf. 26. Calamopora hemispherica, nobis. 27. Calamopora alveolaris, Goldf. 28. Calamopora basaltica. 29. Calamopora favosa, Goldf. 30. Calamopora gothlandica, Goldf. 31. Calamopora milleporacea, nobis. 32. Astrea porosa, Goldf. 33. Syringopora ramulosa, Goldf. 34. Catenipora escharoides, Lam. 35. Catenipora labyrintica, nobis. 36. Aulopora tubæformis, Goldf. 37. Achilleum cheirotonum, Goldf. 38. Madrapora complanata, nobis. 39. Cyathophyllum gracile, nobis. 40. Cyathophyllum secundum, Goldf. 41. Cyathophyllum plicatum, Goldf. 42. Cyathophyllum excentricum, Goldf. 43. Cyathophyllum helianthoides, Goldf. 44. Cyathophyllum plicatum, Goldf. 45. Linipora rotunda, nobis. 46. Turbinolia mitrata, Goldf. 47. Cnemidium remulosum, Goldf. 48. Achilleum fungiforme, Goldf. 49. Tragos sphæroides, Goldf. All the above mentioned remains are intermixed with several Crinoidea which I have not yet determined, and Trilobites of which I have called one Asaphagus megalopthalmus.

The Molluscæ are very numerous, but before I have received the Mineral Conchology of Sowerby, I am not able to mention them. I know, for the present, Calceola sandalina, Turbo bicarinatus, Bellerophon hiulcus, Strophomene rugosa, Raf., Producti, Spirifer, Terebratula and others.

The upper strata of the same group (always below the coal) are characterised by Pentremites (see my memoirs). There are still many fossils which I can not enumerate as yet, not having determined them.



Section of the Allegheny Mountain

E.M.

Lehman & Duval Lith.

XI.

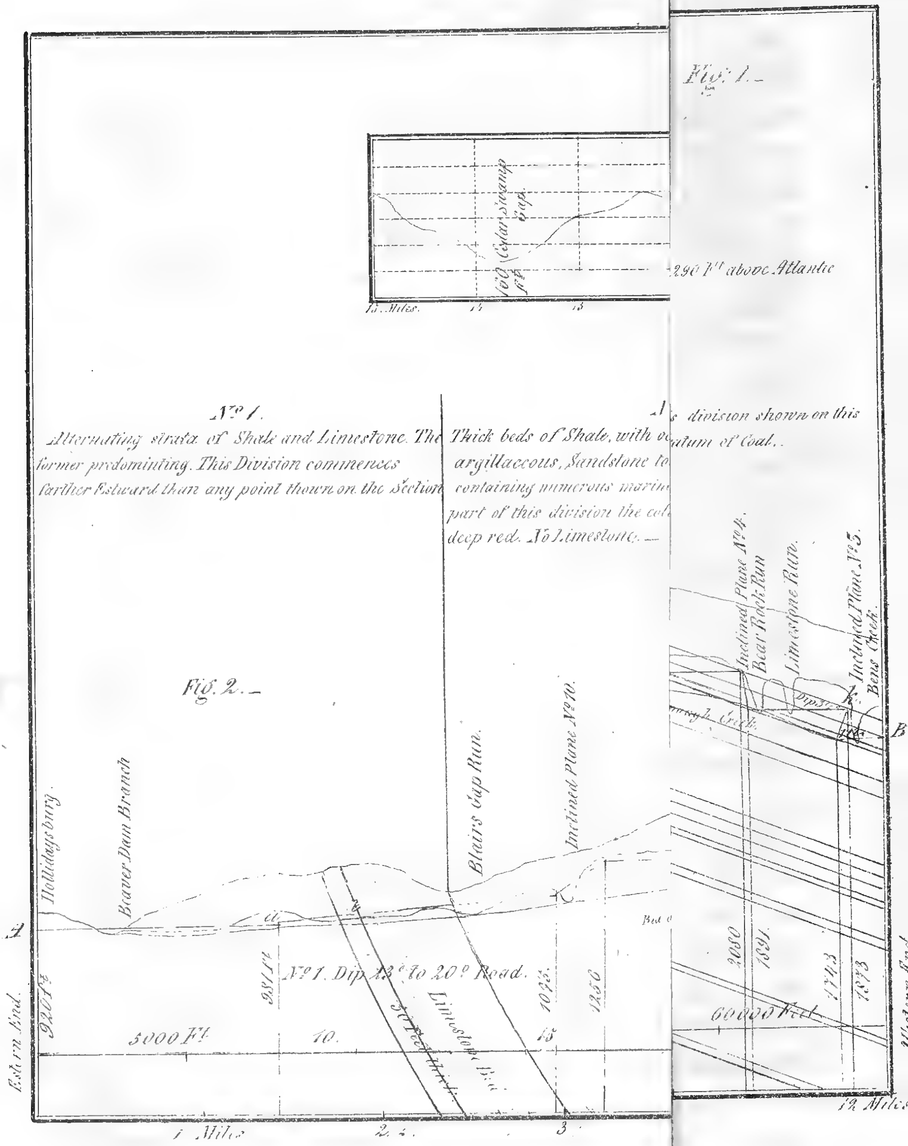


Fig: 1.
Cedar Swamp Gap.
500 Ft
290 Ft above Atlantic
13 Miles.
14
15
No. 1.
Alternating strata of Shale and Limestone. The former predominating. This Division commences farther Estward than any point shown on the Section
Thick beds of Shale, with oc argillaceous, Sandstone to containing numerous marin part of this division the col deep red. No Limestone.
s division shown on this atum of Coal.
Fig. 2.
Hollidaysburg
Beaver Dam Branch
Blairs Gap Run.
Inclined Plane No. 10.
Inclined Plane No. 4.
Bear Rock Run
Limestone Run.
Inclined Plane No. 5.
Bens Creek.
Dip 3°
Estern End.
920 Ft
5000 Ft
981 Ft
No. 1. Dip 13° to 20° Road.
Limestone
1075
1250
10.
15
2080
1891
1743
1873
60000 Feet
1 Miles
2
3
12 Miles

Z. M.

GEOLOGICAL DESCRIPTION OF A PORTION OF THE ALLEGHANY MOUNTAIN, ILLUSTRATED BY DRAWINGS AND SPECIMENS. By Edward Miller, C. E.

As a recreation from duties of a more arduous character, I have for some time past employed myself, during hours of leisure, in collecting information concerning that part of the Alleghany mountain which is crossed by the Portage Railroad; and this memoir, and the drawings which accompany it, contain some of the results of my observations. The deep excavations made for the Portage, and the bold ravines and gorges with which the mountain is serrated, afford every opportunity which can be desired for an examination, and I have endeavoured to procure results which may be depended upon as accurate, so far as they extend. The dip and bearings of the various strata were ascertained by proper instruments; and the topographical details from correct manuscript maps, and other data belonging to the state, and now in the engineer's office at Johnstown.

The sheet of drawings contains an outline map of a part of the mountain (about 200 square miles) on a scale of 1 mile to an inch. It comprises portions of Cambria, Bedford and Huntingdon counties. The summit or crest line of the mountain, which forms the eastern boundary of Cambria county, is indicated by a vermilion trace for a distance of 15 miles. The map also shows the courses of all the streams; the Portage Railroad, along which the observations were taken; the line of dip; and the line of bearing of the strata.

The map is accompanied by an elevation or profile of the crest line, drawn on the same horizontal scale as the map, and a vertical scale of 400 feet to an inch.

The section of the mountain was drawn from observations made along the railroad, but projected to a vertical plane passing through the line of dip. The base line represents the level of the Atlantic ocean. The road is shown by a red line. The section also shows the beds of Blair's Gap run and the Conemaugh; the form of the ground in the vicinity of the railroad, with the ravines and streams which cross it; and the general outline of the mountain. The horizontal scale is 3000 feet to an inch, and the vertical scale 500 feet to an inch. Allowance must of course be made for the distortion caused by so great a difference between the scales.

The section extends between the points marked A and B on the map. Along this whole distance the line of dip was taken at a great many points, and found to be singularly regular. Its direction is W. N. W., which makes the line of bearing very nearly correspond with the average course of the mountain crest. The dip does not vary materially from inclined plane No. 3 to inclined plane No. 6; for this distance it is $3\frac{1}{2}$ degrees. From inclined plane No. 6, it increases gradually as we pass eastward; and at Hollidaysburg, which is the most eastern point shown on the section, it is 23 degrees.

The drawings show strikingly the manner in which the sides of the mountain have been cut down by the action of water, which has made deep narrow valleys, sometimes destroying large quantities of coal. These denudations have been productive of one good effect however; for they have exposed some of the lower strata in the series, which otherwise could not have been worked except at great expense.

A box of specimens, with references to the section for the strata in which they were found, accompanies these papers. Rare minerals will not be looked for from this quarter, and the specimens are valuable only as illustrations of an interesting formation.

ERRATA.

P. 252, *line* 9, *for* 3000 *read* 6000.

P. 252, *line* 10, *for* 500 *read* 1000.

P. 253, *line* 22, *for* 5 feet and 1–10th *read* 5710 feet.

At the foot of Plate XI., for 3000 *read* 6000; *and for* 500 *read* 1000.

The section is divided into four principal spaces, distinguished by different colours, and by the numbers 1, 2, 3, 4.

No. 1 commences farther eastward than our section extends, and is composed of alternating strata of shale or slaty clay and limestone, the former predominating. One limestone bed marked *b*, is about 50 feet thick, and does not show many traces of organic remains, except where it has been weathered. Vide specimen 3, locality *b*. Some of the limestone strata are not more than 1 inch in thickness, and are filled with shells of various kinds. Vide specimens 1, 2, locality *a*.

No. 2 has, I believe, no limestone. It consists almost entirely of shale, but has towards the western extremity occasional strata of argillaceous sandstone of small thickness, alternating with and passing into the shale. Sometimes the sandstone contains many impressions of shells, and other marine remains. Specimens 4, 5, 6, locality *c*. Towards the western part of this division, the shale has an uniform deep red colour. The thickness of the rocks comprised in this division, measured perpendicularly to the dip, is 5 feet and 1-10th.

No. 3 is composed of alternating strata of shale and sandstone. Whole thickness 3370 feet. The sandstone predominates greatly; it is micaceous, and is readily quarried in thin tabular plates of large dimensions. Specimen 7, locality *d*. Towards the eastern part of this division, the colour of the rocks is a deep red, but it gradually changes to green, as we advance westward. I could not discover any traces of organic remains.

No. 4. The coal measures. I have chosen to consider them as commencing at the point *e*, because there is at this place a decided change in the character of the rocks, and we find, for the first time, sandstone containing vegetable remains of a kind which, I believe, is never found except in the immediate vicinity of coal. It appears in a thick bed at *e*, and above this alternates with micaceous sandstone and shale. No. 8 is a specimen of this sandstone, with the impression of a large terrestrial plant, locality *g*. The vegetable remains contained in it are frequently converted into charcoal. At *f*, is a bed about 30 feet thick of limestone, containing so large a proportion of silex, that it forms good mortar without any admixture of sand. It is exceedingly hard, and full of irregular seams and fissures. Specimen 9, locality *f*. At *g* the first coal appears, it is only a few inches thick. A short distance above it, iron ore of a fair quality is found. Specimens 10, 11, locality *g*. From this place, we find the usual strata which form the coal measures of England. Bituminous coal, shale, sandstone, clay and iron stone, in many varieties and numerous alternations. The coal strata are numerous, from one inch to six feet in thickness, and very various in quality; differing materially sometimes in the same stratum. I have designated all that I am acquainted with, which occur within the limits of the section, by black lines. Some of those shown are too small to be worked advantageously, and there are probably several which have escaped observation.

Iron stone is abundant, and similar to the varieties found in similar situations in England.

I send a fair specimen of the coal and of the coke produced from it. Specimens 12, 13. The best of the mountain coal produces 84 bushels of coke from 60 of coal. Some of the strata contain a substance strongly resembling wood charcoal in grain and lustre, and occasionally a woody fibre is plainly perceptible. Specimens 14, 15, locality *i*.

The most interesting specimens found in this quarter, are in the deep cuttings at the head of inclined plane No. 3, locality *k*. A stratum of good coal 2 feet thick is found at this place, having a roof of black shale 4 feet thick, upon which is an unstratified bed of argillaceous rock, containing a great variety of shells and other marine remains, with sulphuret of iron and balls of iron stone. The upper part of the stratified shale also contains marine impressions, and some of the more delicate remains have been replaced by sulphuret of iron. In breaking these rocks to pieces to facilitate their removal, great numbers of shells were loosened and fell out. Specimens 16 to 24, locality *k*.

The only limestone I have found in that part of the coal measures shown in the section, is the silicious bed at *f* previously described, and a stratum 3 feet thick of a light blue colour, which shows itself in the ravine of Ben's creek, at *m*, and also in that of Limestone run, which obtains a name from it. The sandstone is very various in appearance and quality. Where it crops out, the strata are frequently so much broken by seams and fissures, as to be unfit for building purposes. The best quarries are usually found in the water courses; the same causes which swept away the softer strata not having been sufficient entirely to carry off or destroy the sandstone, which remains in large blocks on the surface of the ground.

NOTICE OF FOSSIL VEGETABLE REMAINS FROM THE BITUMINOUS COAL MEASURES OF PENNSYLVANIA, BEING A PORTION OF THE ILLUSTRATIVE SPECIMENS ACCOMPANYING MR MILLER'S ESSAY OR GEOLOGICAL SECTION OF THE ALLEGHANY MOUNTAIN, NEAR THE PORTAGE RAILWAY. By R. Harlan, M. D. &c.

Pecopteris obsoleta.

Geological position—Shaly sandstone of the bituminous coal measures.

Loc.—Vicinity of Johnstown, Pennsylvania, western base of the Alleghany mountains.

Cab. of Geol. Soc. of Pennsylvania. Also, Cab. Acad. Nat. Sc. of Philadelphia, from the anthracite coal measures of Wilkesbarre, Pa.

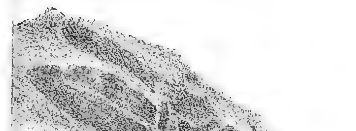
This specimen forms part of the series of illustrative specimens which accompanies the valuable essay of Mr E. Miller on the geology of the Alleghany mountain at the Portage Railway. In several respects, this species bears considerable analogy with the Pecopteris cistii, Ad. Brongniart, Hist. des Veg. Foss., pl. 106, with the following characters: "P. foliis lanceolatis bipinnatis; pennis elongatis obtusis, abrupte desinentibus, pinnula terminali brevissima elliptica vel subrotunda; pinnulis ellipticis vel suboblongis, basi connatis vel usque ad basin discretis, etiamve basi paululum contractis; pinnula infirma rachi pennarum inserta, vix alteris majori; nervo medio valde notato; nervulis arcuatis bis furcatis, distantibus, tenuissimis." With this description it will be only necessary to draw the distinctive characters of the present species, which consists of a single specimen 4 inches long in the stalk, and 1½ inches wide between the extremities of the leaves, Pl.XIV.

Fig: 1.

Fig. 4.

Fig. 3.

Fig. 2.



Lehman & Duval Lith^{rs} Philad^{a}

Fig. 1

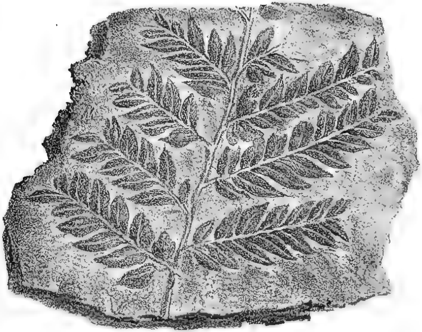


Fig. 4.

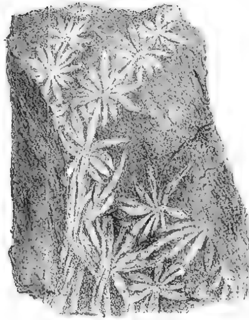


Fig. 5

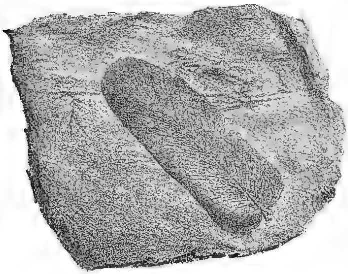
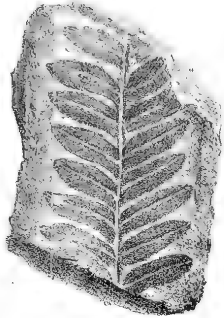


Fig. 2



On Stone by G. Lehman

Lehman & Duval Lith.rs Philad.a

each separate leaf being seven-eighths of an inch long by two-eighths broad—approximate, though separate, throughout their length: those of the P. cistii being occasionally united at base. The length of the leaves in the latter species is not quite double their breadth, whilst these organs are in length three times their breadth in the "obsoleta;" but what would appear to distinguish the P. obsoleta from all other species of this genus, is the interruption of the basil attachment of the upper half of the leaf, which appears unconnected with the stem in many instances. All vestige of nervures is totally obliterated from the leaves of the "obsoleta," which, in other respects, is a bold and well relieved specimen. Vide pl. 14, fig. 2.

Pecopteris Milleri.

P. pinnulis obliquis, rectis, linearibus elongatis, vix distinctis; nervulis simplicibus, valde obliquis.

Geological position and locality the same as the preceding species. This most perfect specimen, which appears as if sculptured on the accompanying rock, consists of a fragment of a stem 3½ inches in length, displaying alternate curvatures, with four branches 2 inches long on either side, alternating with each other, each bearing from fifteen to twenty leaves half an inch long and two-eighths of an inch broad, separate from each other, obovate, linearly curved, and at their distal extremity pointed; with numerous simple oblique nervures.

This species is allied to the *Pecopteris Beaumontii* of Brongniart—Hist. des Veg. Foss. pl. 112—from the coal measures of the Alpine Lias, but is distinguishable by the simplicity of the nervures (those of the latter being dichotomous), also by the form of the leaf.

We have dedicated this species to our valuable associate Mr Edward Miller, author of the geological memoir alluded to above, and to whom the Society has been recently indebted for an interesting illustrative series of fossil shells and vegetables. Vide pl. 14, fig. 1.

Neuropteris.

Among the illustrative specimens above alluded to, are a number of vegetable fossils, numbered from 30 to 39; they include several masses of bituminous shale, inclosing numerous impressions of leaves, of which we have enumerated five distinct layers on the surface of a single piece, which displays also on the reverse side impressions of finely fibrous wood. These impressions of leaves are very distinct, and readily referable to the genus Neuropteris, and are distinguished from all other species of this genus by the extreme minuteness of the nervures, being almost invisible without the aid of a glass, seen through which, the entire leaf appears to consist of nervures.

In other respects this species bears no remote resemblance to the Neuropteris macrophylla, and N. flexuosa, of Ad. Brongniart, Hist. des Veg. Foss. pl. 65.

We are informed by Mr Miller, that these fossils occur on the top of the Alleghany mountains, lying immediately on the surface of a bed of bituminous coal, and that marine shells were found both above and below them.

The anthracite coal measures of the Lehigh and Schuylkill, Pennsylvania, are generally referred by geological observers to the grauwacke series; and the bituminous coal measures of Alleghany, Ohio, &c. to the secondary formations—the rocks would lead us to the former opinion, the fossils, in some instances to the latter, at least so far as they have been examined from both localities.

I have been indebted to our associate Dr J. L. Martin, for an interesting collection of fossil plants, consisting principally of Lycopodiolites of Sternberg, Striaticulmus, &c., from his coal mine, in the western termination of the Schuylkill coal measures, situated on the western or right bank of the Susquehanna river in Perry county, Pennsylvania, together with a more remarkable specimen covered with the impressions of leaves, which appear to have fallen promiscuously from trees growing in the vicinity of muddy shale. Similar specimens, I have been informed, are very common in our transition coal measures. These impressions of leaves may be compared to those of the *Lycopodiolites dichotomus* of Sternberg. Vide "Essai d'un Exposé Geognostico-Botanique de la Monde Primitif, tab. 2." Vide pl. 14, fig. 3.

DESCRIPTION OF A NEW FOSSIL PLANT FROM PENNSYLVANIA OF THE GENUS EQUISETUM. By R. Harlan, M.D., &c.

Equisetum stellifolium. Pl. 14, fig. 4.

E. *Caule* erecto, simplici, lævi, cylindrico, diametro 1-8 poll., subæquali; *ramulis* 10, 12, ad articulationes caulis verticillitis, stelliformibus; *articulis* vix distinctis, versus basim distantibus, superne approximatis; *vaginis* indistinctis.

Geological position—Coal measures, bituminous shale.

Loc.—Pennsylvania, Schuylkill anthracite coal mines. Cabinet of the Geological Society of Pennsylvania.

This beautiful and delicate little plant has left its image in a strong and vivid impression on a piece of densely foliated shale, 5 by 3 inches in size, and rather less than half an inch in thickness, displaying exceedingly minute and numerous particles of mica intimately incorporated.

So beautiful and symmetrical in appearance is this impression, that I conceived on first view the idea of an artificial production, but its true character is easily recognisable by observing similar impressions in the different laminæ throughout the specimen, some of which I have uncovered from the vicinity of both surfaces.

The principal and most perfect stalk of these impressions is about three inches in length, destitute of striæ, strongly but unequally divided into five separate but continuous pieces, by an equal number of knots or articulations, the pieces diminishing in length in ascending, the first being seven-eighths of an inch, the second five-and-a-half-eighths, the third four-and-a-half-eighths, the fourth four-eighths, &c. The stalk, originally cylindrical, has been subjected to forceable pressure; its present greatest diameter is one-eighth of an inch; from each articulation spring 8, 10 or 12 leaves, which radiate from the centre to the circumference, forming a pretty symmetrical star at each articulation, which diminishes in size as we approach the superior extremity of the stalk, the leaves varying from two-eighths to half an inch in length, and being one-sixteenth of an inch in breadth, the terminal star being reduced to a mere tuft. The articular sheaths which exist in all the recent species of this genus are barely visible in this fossil specimen; they may possibly have been destroyed by pressure; remnants of the sheath are however visible, more particularly at the antepenultimate joint of the upper portion of the principal stalk.

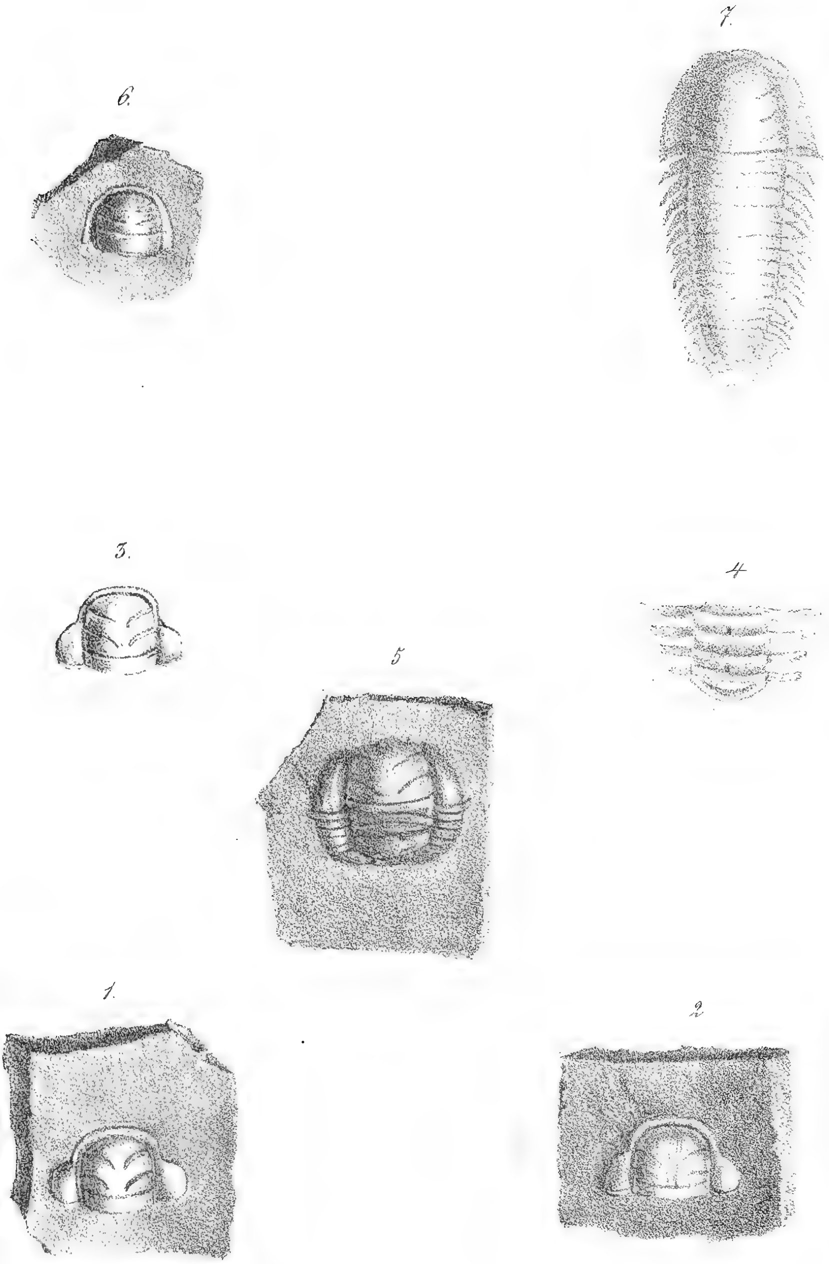
Species of the genus Equisetum have been discovered growing in all parts of the globe, with the exception of New Holland; yet very few fossil species have as yet been found, and hitherto none in America.

Mr Ad. Brongniart (vide Hist. des Veg. Foss., 2d livraison) describes five species: one of these he states to have been found in the tertiary, two species from secondary formations, and a third, of rather a doubtful character, from the coal measures.

Our species bears some distant specific resemblance to the Equisetum Meriani, figured by Brongniart, pl. 12, fig. 13, which was found in the iridescent marl of Neuewelt, near Bale.

Martin figures three fossils, (vide Petrifacta Derbensia, pl. 20) all of different genera, under the name Phytolithus plantites (stellatus). One of these, fig. 5, bears some analogy to the present species, but is sufficiently distinct. A fine specimen of this Derbyshire fossil exists in the Steinhauer collection of Mr Wetheril, now deposited in the Acad. Nat. Sc. of Philadelphia. Fig. 4, of the plate above alluded to, is an *Asterophillites* of Brongniart, or *Annularia* of Sternberger.

There are other plants with stellate leaves, with which, perhaps, the fossil Equisetum might be confounded, as the Hippuris, Asperula, Galium, &c. But if the plant figured by Brongniart, pl. 12, fig. 13, be an Equisetum, there can be no doubt of our species.



New Species of Trilobites.

Lehman & Duval Lith^rs

NOTICE OF NONDESCRIPT TRILOBITES, FROM THE STATE OF NEW YORK, WITH SOME OBSERVATIONS ON THE GENUS TRIARTHRUS, &c. By Richard Harlan, M. D.

Having recently enjoyed an opportunity of inspecting several new species of Trilobites, in the cabinet of the Lyceum of Natural History of New York, which were obtained from Utica in that state, and which were supposed, at first view, to belong to the new genus Triarthrus, proposed by Dr Green, in order to include a peculiar species; I have been enabled to correct the erroneous impression on which this genus is constructed, and which were, perhaps, unavoidable from the imperfection of the fossil specimens of this kind which have hitherto come under the observations of authors. Among the numerous specimens above referred to, occurs one complete impression of the whole animal, from which it is clearly demonstrated that the only portion of this animal previously discovered, consisted of the *buckler* and not of the *body*. The latter having been composed of softer materials has, in most instances, been obliterated; consequently the characters which were supposed to distinguish a peculiar genus, under the name of Triarthrus (vide Green's Monograph of N. A. Trilobites, p. 86), having been drawn from the head or buckler of an individual under the erroneous impression that it constituted its abdomen and tail, cannot by any means be brought to practicable application, and the genus Triarthrus becomes obsolete.

But this is the less to be regretted in the present instance, inasmuch as by modifying and contracting the characters on which the genus Paradoxides of Brongniart or Entomostracites of Wahlenberg is constructed, it will readily include not only the present species of triarthritic reference, but also of the Paradoxides Boltoni, and P. scaraboides, which do not possess all the generic characters of Paradoxides as now extant. The above named species differ generically, in the form and proportions of the abdomen and tail, from each other and from those parts in the present species.

Generic characters in order to be practically useful, should always be brief; in accordance with this rule, the following modification of the characters of Paradoxides is offered.

Genus Paradoxides.

Buckler, destitute of oculiform tubercles, anterior border semicircular, middle lobe marked with transverse furrows or bands.

Abdomen, composed of transverse bands or articulations continuous with those of the lateral lobes.

Under such modification we are prepared to introduce the new species before us.

1. Paradoxides triarthrus. (H.) Pl. 15, fig. 5.

Buckler hemispherical, middle lobe nearly twice the width of the lateral lobes, and marked with three transverse lines, the two superior interrupted in the middle, lateral lobes plain, narrower above, subventricose. *Abdomen*, with at least four articulations, those of the middle being continuous with those of the lateral lobes, which diminish in descending order; *tail* continuous with the abdomen, inferior margin rounded.

The whole animal is rather broader than long; length of the body nearly equal that of the buckler; three or four small spines arranged transversely on the middle of the body; the specimen, like all such occurring in slate, is compressed and somewhat distorted.

Dimensions: total length of the impression rather less than five-eighths of an inch; greatest breadth rather less than six-eighths.

Locality: Utica, state of New York.

Geological series: carboniferous slate.

Cabinet of the Lyceum of Nat. Hist., New York; plaster casts in the Cab. of Geol. Soc. of Pennsylvania.

A second impression of the body without the head, occurs on the reverse surfaces of a schistose slab, more perfect and less compressed than the body with the head attached, and which is figured now for the first time. Vide pl. 15, fig. 4.

2. Paradoxides arcuatus. (H.) Pl. 15, fig. 1, 2, 3.

Several other triarthritic specimens accompanied the above from the same locality; they consist of the bucklers only, and bear some analogy with the "Triarthrus Beckii" of Green (Vide Monograph, p. 87, fig. 6, cast No. 34). The description of this species is herewith transcribed, with the necessary corrections to render it intelligible." Cauda [capite] subrotunda, bipunctata; articulis abdominis [frontis] tribus, absque lobis lateralibus consuetis, sed lobo arcuato utrinque opposito."

The P. arcuatus, however, differs from his description and figure in the greater proportional size and form of the lateral lobes of the buckler, which are fully half the breadth of the middle lobe, ventricose, and prominently arcuated on their exterior borders, narrowing above and completely surrounding the middle lobe, of which it forms the anterior border: whilst these portions in the description of the T. Beckii, are represented by the author as "forming narrow cuneiform appendages to the sides." This description does not accurately correspond with, at least, some of the impressions of this species which are represented on the cast referred to.

The figure of T. Beckii (vide pl. 15, fig. 6) is added in order to show how closely it is allied with the buckler of the *Paradoxides scaraboides* of Brongniart and Desmarest (vide Histoire Naturel des Crust. Fossil., p. 34, pl. 3, fig. 5). These authors quote as a synonyme, the Entomostracites scaraboides of Wahlenberg, who thus characterizes his species, "cæcus, capite hemispherico, antice rotundato; fronte subovata, antrorsum angustiore; cauda utrinque sinuato-tridentata." The author adds, "perfect or entire specimens are rarely found. From beds of fetid aluminous ampelite." Vide pl. 15, fig. 7.

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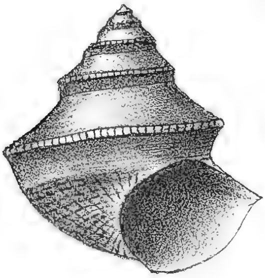

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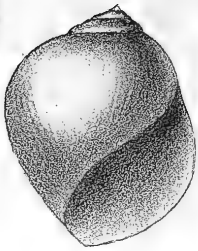

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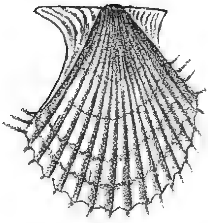

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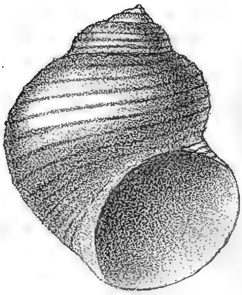

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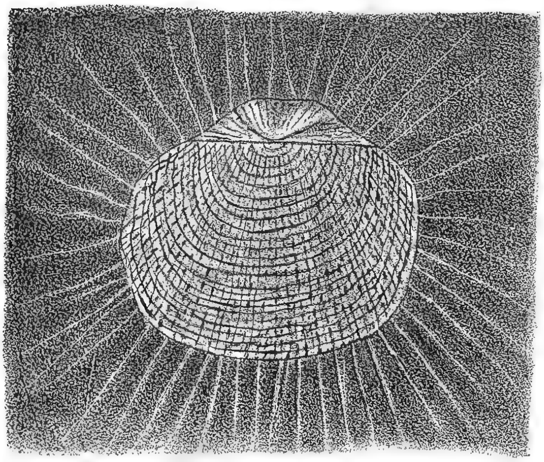


Lehman & Duval Lith[rs] Philad[a]

DESCRIPTION OF FIVE NEW SPECIES OF FOSSIL SHELLS IN THE COLLECTION PRESENTED BY MR EDWARD MILLER TO THE GEOLOGICAL SOCIETY. By T. A. CONRAD.

STYLIFER, Sow.

S. primogenia. Pl. 12, fig. 2. Shell ventricose, volutions rounded; suture well defined; aperture more than half the length of the shell; margin of the labium arcuated.

It is with some doubt that I refer this shell to the genus Stylifer of Sowerby, which has been founded on recent species alone; but it strongly resembles *S. astericola*, Sow., except that is much larger; it has however some of the characters of Paludina, and may possibly have been a fresh water shell. It varies much in outline, as the figures will show. Occurs in slate, and the shell replaced by crystallized carbonate of lime.

TURBO, Lam.

1. *T. tabulatus.* Pl. 12, fig. 1. Shell turrited; whirls of the spire each with a carinated crenulated line, and numerous spiral wrinkled raised lines; body whirl concave above, with fine revolving lines; beneath subcancellated, and with distant revolving tuberculated lines, more numerous at base.

2. *T. insectus.* Pl. 12, fig. 4. Shell turbinate, ventricose, with prominent coarse revolving striæ; whirls convex, flattened above; aperture orbicular, about half the length of the shell.

Found with the preceding fossils, and resembling them in mineral composition.

Productus, Sow.

P. confragosus. Pl. 12, fig. 5. Shell suboval, larger valve with a longitudinal sulcus; valves with numerous rugose concentric lines, and long filiform spines.

In slate, stratum K of Mr Miller's section; the shell has been replaced by pyrites.

Numbers are in a specimen of slate, all very much distorted by pressure; the perfection of the filiform spines is remarkable. In the cabinet of Richard C. Taylor, Esq., are European specimens of two species, which evidently possessed spines similar to those of the confragosus, as fragments of the spines clearly exhibit; and many other species were doubtless armed in a similar manner. On one specimen of the slate, a fern is associated with numbers of the present species of productus.*

Pecten.

P. armigerus. Pl. 12, fig. 3. Shell ovate, with angular costæ, and slender, erect, very prominent spines; ears unequal; one ear of the left valve elongated and pointed.

In slate; the interior of the left valve is the only specimen I have seen, but it is remarkably perfect and distinct.

The following fossils accompanied the shells here described:

Productus scoticus, Sow.
Productus sulcatus, Sow.
Unio, allied to U. subconstrictus, Sow.
Spirifer undulatus, Sow.
Cyathophyllum ceratites, Gold.

* The European specimens of Producta, with spines, I collected from the dark limestone shale of Berwick upon Tweed, and from a similar shale at Abersychan Iron Works, Monmouthshire. R. C. T.

Calamopora polymorpha, Gold.
Cyathocrinites pinnatus, Gold.
Orthocera, undetermined.
Nautilus, undetermined.

As a considerable number of fossils are common to the grauwacke in Europe and America, it is very desirable that an accurate list of such species should be published to assist the geological inquirer. From the tables of De la Beche I have at present merely enumerated such organic remains, adding a few which I have myself identified.

FOSSILS OF THE GRAUWACKE COMMON TO EUROPE AND AMERICA.

Zoophyta—6 species.
Radiaria—1 species.
Conchifera—10 species.
Mollusca—8 species.
Crustacea—3 species.

The geographical distribution of the strata composing the grauwacke group is exceedingly interesting, inasmuch as they are characterised by organic remains which indicate that they originated in a climate of a far higher temperature than exists at present in regions without the tropics; for at the period when these mollusca enjoyed life, the arborescent fern, and other vegetable forms now imitated by the Flora of tropical countries, shaded the soil in a burning clime, now swept by the blasts of a polar winter, and whose altered vegetation is strongly contrasted by those remains of plants indicative of the unbounded exuberance which characterised the green mantle of our globe in its earlier day.

This uniformity of temperature over so vast an extent of country, from central Alabama to the border of the arctic sea, has been variously accounted for by theoretical writers: but the hypothesis of a central heat is advocated by many geologists; and Mr Lyell has proved that a certain distribution of sea and land would go far to produce the temperature which must have existed in the carboniferous era. Others, however, deny its efficiency to produce so vast a difference, and call in the aid of central heat. It seems certain that volcanic eruptions were very frequent and widely distributed in the epoch in question; and the identity of organic remains, so remarkable in the grauwacke wherever it occurs, proves that the disturbing forces acted throughout many parts of our globe in a single geological era. The lavas being almost uniformly poured into the bed of the sea, must have greatly elevated its temperature. And who can calculate to what extent thermal springs may have modified the temperature of the shallower seas which encircled the volcanic isles?

Here, as in Europe, we find, in the strata overlying the coal, ferns and fucoides, marine and fresh water shells, and all the phenomena which tend to prove the existence of a vast ocean, interspersed with many islands; and we cannot but cherish the hope that an accurate investigation of the fossils will at some future day explain the origin of our beds of anthracite and bituminous coal, or at least exhibit the state of the earth's surface in that interesting period in which they originated.

I have ascertained that the extreme southern limit of the grauwacke group, east of the Mississippi, is at the town of Tuscaloosa, in Alabama; sandstone here forms the bed of the Black Warrior river, and it is remarkable that small masses of bituminous coal are imbedded in it in such a manner as to show clearly that they originally fell upon a very soft and yielding surface. Whether this sandstone is the result of deposition or of igneous fusion, I leave for others to decide.

ANALYSIS OF THE MINERALS ACCOMPANYING MR E. MILLER'S DONATION. By T. G. Clemson.

Among the mineral substances accompanying Mr Miller's interesting paper on the Portage Railroad, lately presented to the Society, were specimens of coal, and siderose or lithoid spathic iron ore. At this time the subject of iron metallurgy is one of great moment to the interests of this commonwealth; up to the present epoch, science has been neglected, and routine the only pillar that supported this very important industry. The present state of our iron works would serve as land marks to show the advancement of the art elsewhere. All the iron made in this state, and we may add the United States, has been by the means of charcoal, giving an article which can by no means compete with the low price of foreign iron; with us, but one mode of treatment prevails, taken from the dear purchased experience of the first establishments founded in our country. The modifications here made in the art of smelting have been trifling, because the scientific ignorance of the majority of our iron masters is proverbial. Hence the many failures in attempting to improve—the costs of such attempts are better appreciated by the iron masters. But the results could easily have been foreseen; the experiments, such as they were, always having been made upon that very precarious and delicate engine used in eliminating the metal. A general disrespect for science or theory, as it is termed, pervades the community. However, this feeling will prevail but for a moment; the iron masters are anxious for, and have discovered the necessity of legislative aid for the promotion of science. We could then compete with any nation in the world; we do not lack material; and was science duly appreciated, the advantages would be as manifest as they are in other countries. The improvements that have been made in this art, within the last few years, have been prodigious, amounting almost to a revolution: we allude more particularly to the use of bituminous coal without having been previously coked, and the introduction of heated air into furnaces. Some of our finest ores are neglected because too rich, at other times too poor, &c. Art takes no hand in changing the proportions of constituents; every thing is left to nature.

In order to justify the above remarks, we have the honour to submit to the Society the results of the chemical investigation of the following substances.

Coal from Portage Railroad, presented to Geol. Soc. by E. Miller. Marked No. 12.

This coal is of a brilliant black. Its structure is foliated in two senses, and conchoidal or uneven in another. Very fragile. The pieces assume a pseudo regular or trapezoidal appearance. The whole mass is zoned, and sometimes divided by thin layers of a fibrous black coal resembling charcoal. Its lustre is resplendent, with an occasional tinge of iridescence; in a cross sense it is black, velvety and dead. Its powder is black, inclined to brown. It ignites with facility, and burns with a bright, long, fuliginous flame, giving much smoke. Is very fat, and by distillation furnishes a light voluminous coke, much bitumen, water and gas, the latter product free from ammonia.

Composition per cent.

Volatile matter (bitumen, water and gas),	15
Ashes (argillaceous, with oxide of iron),	8
Carbon,	77
	100

Ashes free from carbonate of lime, very little iron, colour grey.

Mineral Charcoal. Marked No. 14.

This specimen of mineral charcoal, presented to the Geol. Soc, by Mr Miller, is a fibrous, pulverulent, black, combustible substance, found disseminated in the beds of bituminous coal of the coal field through which the Portage Railroad has its course; and I understand is not uncommon in other coal fields of this state. In Europe it is found at Potschapel near Dresden, and at Waldembourg in Silesia. It has sometimes been termed anthracite from its burning with difficulty; this appellation is erroneous. Mr Karsten remarks, concerning this matter, "that when a coke contains much of it, that it forms itself into masses which choke the furnace, and refuses to burn. This is explained by the fact of this substance falling with ease into a powder; and the powder of charcoal, as well as this, resists the action of the strongest blowing machines. The powder of mineral charcoal being rather more dense than that of wood, is less easily penetrated by the wind. The difficulty of burning is always more or less apparent in those bodies that are traversed with difficulty by the air."

The specimen which we examined, easily reduced to powder, which is a dead black. When calcined in close vessels, it does not materially change its aspect; by distillation gives bitumen, water and alkaline gas. It is free from pyrites, and apparently pure; the cinders were yellowish red, free from lime.

Composition per cent.

Carbon,	0.664
Cinders,	0.270
Volatile matter,	0.066
	1.000

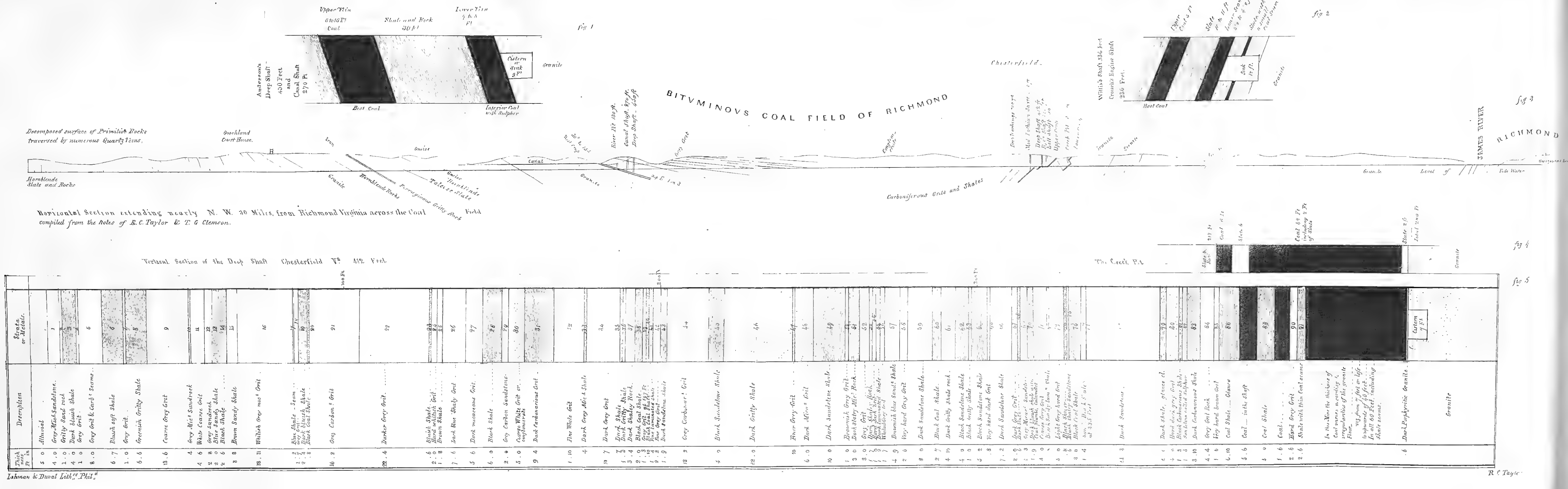
Examination of Specimen No. 32.

Specimens of siderose or lithoid spathic iron accompanied the other substances. These ores are found in nodules of different sizes, varying in form; they are known frequently as kidney ores; when broken, have a blue brown colour, conchoidal fracture. Sometimes lamellar crystals of the sulphuret of zinc are found on breaking a mass. When reduced to powder, its colour is grey; submitted to heat, developes the odour of bitumen.

The ore is composed as follows:

Carbonate of protoxide of iron (protoxide of iron 49.42, carbonic acid 30.94)	80.36
Sand and argile, ...	12.60
Carbonate of lime, ...	1.00
Carbonate of manganese, carbonate of magnesia, bitumen and water, ...	6.04
	100.00

One hundred parts of this ore, then, yield 38.2 of metallic iron.



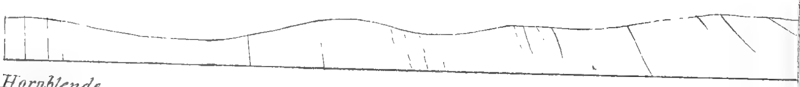
Horizontal Section extending nearly N. W. 30 Miles, from Richmond Virginia across the Coal Field compiled from the notes of R. C. Taylor & T. G. Clemson.

Vertical Section of the Deep Shaft Chesterfield V.a 442 Feet.

Anderson's

Decomposed surface of Primitive Rocks traversed by numerous Quartz Veins.

Goochland Court House.



Hornblende Slate and Rocks

Horizontal Section extending nearly N. W. 30 Mile
compiled from the notes of R. C. Taylor & T. G. Clemson.

Vertical Section of the Deep Sha

Thickness. Ft. in	Description	Strata or Metals.
5 . 0	Alluvial	
4 . 0	Grey Mic^s Sandstone	1
1 . 0	Gritty Sand rock	2
4 . 0	Dark bluish Shale	3
1 . 0	Grey Grit	4
8 . 0	Grey Grit & Carb^s Seams	5
6 . 7	Bluish soft Shale	6
1 . 0	Grey Grit	7
6 . 6	Greenish Gritty Shale	8
13 . 6	Coarse Grey Grit	9
. 4	Grey Mic^s Sandrock	10
4 . 6	White Coarse Grit	11
2 . 8	Grey Sandrock	12
2 . 0	Blue Sandy Shale	13
2 . 6	Black Shale	14
3 . 8	Brown Sandy Shale	15

Lehman & Duval Lith^rs Phil^a

MEMOIR OF A SECTION PASSING THROUGH THE BITUMINOUS COAL FIELD NEAR RICHMOND, IN VIRGINIA. By RICHARD C. TAYLOR, F.G.S., &c.

In the following pages I propose to lay before the Geological Society of Pennsylvania the result of a recent excursion, in company with my friend Mr Clemson, for the purpose of obtaining, by personal observation, some satisfactory information as to the geological position and relations of the bituminous coal field near Richmond.

Being somewhat limited as to the time necessary for the entire examination into its details, I offer the following memoir as the result of a general reconnoissance, rather than as an elaborate investigation of this singularly interesting coal region. At the same time I am led to hope that some additional mineralogical details and analyses of the coals and other mineral substances of this neighbourhood will be laid before the Society by the gentleman to whom I have referred.

Our notice of this district will be necessarily introduced by a rapid sketch of the geological character of this part of Virginia on either side the coal region. For the mineralogical details of these ancient rocks the writer is also largely indebted to the able authority before named.

Between Fredericksburg on the Rappahannoc river, and the Chickahominy, a space of 50 miles, owing to the level nature of the country, its alluvial covering, the extensive decomposition of the subjacent primitive rocks, and the absence of ravines cutting into those rocks in position, a very unsatisfactory estimate can be formed relative to the details of the geological base along this route.

To the east and west of Fredericksburg, for several miles, the Rappahannoc cuts through thick beds of horizontal sedimentary rocks, which overspread the almost vertically disposed and stratified primitive rocks.*

An examination of the character of these interesting deposits, in connection with those occurring along a sectional line passing through the gold region, in a north west direction, over a space of upwards of 70 miles, will form the subject of a future communication by Mr Clemson.

Some deposits of sedimentary character and mechanical origin, somewhat like those of Fredericksburg, are partially exhibited at Richmond on the banks of James river; both positions being probably nearly on the same level, at the head of tide water and of sloop navigation.

Feldspathic granite, containing large crystals of translucent feldspar, is laid bare by the waters of the Chickahominy; and granite rocks, highly inclined, occur in the vicinity of Richmond, forming rapids where they cross the James river.

Slaty hornblende rock is cut through by the Massapponoe river, at eight miles south of Fredericksburg.

A thick alluvial deposit, consisting of transported fragments, many of them of considerable magnitude, and much decomposed, derived from granitic, quartz and various primitive rocks, lines the sides of the James river at Richmond, covering the argillaceous and gritty horizontal beds to which we have alluded.

A considerable thickness of similar detritus covers the granite in a westerly direction.

Sienitic rocks rise to the surface about ten miles west of Richmond, ranging about north east.

Then succeeds granite with large feldspar crystals; and within an extensive depression or trough of this rock

* Vide Section from Fredericksburg to Winchester. Pl. 17, fig. 2.

reposes the bituminous coal of Chesterfield or Richmond, one of the most remarkable carboniferous deposits in the United States; to the consideration of which we propose to devote the present article.

In order, however, that the continuity of our description of this coal field may not be interrupted, it may be here expedient to proceed with the geological notes as to the western side of this region.

On passing westward, the carboniferous beds are succeeded by sienitic rocks and quartzose schist. Their inclination is only discernible at a few points, where they may be observed dipping to the eastward, that is under the coal basin, at an angle of 20 to 30°. During many miles the face of the country possesses an undulating character, and the primitive stratified rocks being here almost wholly decomposed to the depth of many feet below the surface; a thick covering of red tenacious clay is produced, to the no small embarassment and delay of the traveller in these regions.

Gneiss is next seen to occupy a breadth of two or three miles, dipping to the east as before. Hornblende slate succeeds, followed by talcose slate; then a gritty iron ore, or coarse ferruginous sand rock, inclining at an increasing angle eastward. Other beds of hornblende slates, passing into granite, appear on approaching Goochland court house, beyond which the surface is alternately striped with red clay, and a sandy or gritty soil, denoting vaguely the corresponding mineral character of the subjacent rocks. This area is traversed by numerous parallel veins or walls of quartz, whose superior indestructibility has resisted the action of the elements. Hornblende slate is again seen, accompanied by various modifications of rocks containing that mineral.

This brings us to the western division of our proposed section or diagram, pl. 16, fig. 3, and it only remains further to add that the inclination of the stratified masses, over whose edges we have crossed, appears to increase gradually, until at this point it approaches within a few degrees of verticality.

RICHMOND COAL FIELD.

The section we have thus partially described is designed to illustrate the prevailing geological features of a small yet valuable subdivision of this state, and extends north west from Richmond nearly parallel with the James river, so as to cross the coal field about at right angles in its centre, and at its widest diameter; thus exhibiting the trough or basin-form disposition of its interior beds.

By the diagram, which is sufficiently in detail for our present purpose, it will be seen that the granite declines at a great angle towards the west, on the eastern margin of the coal region, sinking to an unknown depth below it, and rising again at a gradually increasing angle, in an opposite direction, towards the western margin. The coal beds crop out immediately over this granite on both sides, evidently conforming to the configuration of that rock.

The writer by no means announces as a newly discovered fact that this coal deposit rests upon granite, without any interposing rocks, except occasionally a few inches of coal shale; but he is desirous here to add his testimony in corroboration of so interesting an occurrence. It appears the more desirable that he should do so, since an authority of deservedly high reputation in natural science, who will be quoted in another part of this article, has stated that he has found on examination, that the coal basin of Richmond is "actually underlaid with a calcareous rock of a peculiar appearance." We place before the society specimens of the granitic rock on which this coal reposes, which specimens we detached from their sites in the mines.

The western outcrop is commonly termed the "Upper seam," and the eastern the "Lower seam," under the supposition, in connection with some observed variations in quality and thickness, that they are distinct masses or beds of coal. But on careful examination of the included strata, the "measures" or "metals" as they are termed in mining phraseology, and from numerous other obvious characters, the geological continuity or conformity of the whole becomes too apparent to leave room to doubt that it is one coextensive deposit, filling up a trough of uncertain depth in the primitive rock.

On the causes or origin of this and similar basins in various parts of the world, it forms no part of the plan of this memoir to animadvert.

So rapid is the descent of this rock and consequently of the superincumbent coal beds, that the numerous collieries within its limits, instead of being distributed, form a chain of works ranging in a line along the margin, both at the eastern and western outcrops, seldom extending further into the basin than from a fourth to a third of a mile.

The Richmond coal field ranges about N.N.E.; but its precise limits at either extremity do not appear to be distinctly defined. It is understood that the extreme points where coal traces exist are about thirty-five miles apart; that is to say from the Appomattox river to the forks of the Pomunky.

Our line of section is so arranged as to intersect this basin at points where its internal structure is best defined in the numerous shafts. The greatest breadth is here ten miles. It is probable that in the direction of this transverse line is comprised the greatest thickness of coal, which thins off as it approaches the northern and southern extremities; the maximum thickness being, so far as can be proved, about the centre of the eastern side.

By comparing fig. 1 and 2, pl. 16, which represent shaft sections of the two coal veins on opposite sides of the basin, and carefully following up the examination of the intermediate stratification, little hesitation can be entertained of their perfect identity and continuity. In each section, (and several others resembling them might have been added) the upper vein, which is also the thickest, consists of the best quality of coal, while the lower vein is comparatively inferior and depreciated by sulphuret of iron.

We have further evidence of the continuity of the carboniferous strata, in the perfect accordance in their component structure, particularly the remarkable, thick series of micacious grits and conglomerates. To this may be added the testimony of the only species of fossil plant, a peculiar variety of calamite; which at Chesterfield pits occurs at the depth of 320 feet, or 60 feet above the coal, and in a similar position at Anderson's or Graham's deep mine on the opposite side of the basin.*

It will not be necessary to occupy space by recapitulating the details of the numerous beds, measures or metals, passed through in our principal section of the deep shaft, pl. 16, fig. 5, to which the reader is referred.

A classification of these beds furnishes the following result.

Forty beds, coming under the denomination of carboniferous, gritty, micacious, or argillaceous shales, comprise a total thickness of 134 feet.

Fifty-one beds, consisting of white and grey micacious grits, some of them fine, others approaching to the character of conglomerates, yet containing feldspar crystals like porphyry, amount in the aggregate to 267 feet.

* In elucidation of the relative positions indicated above, it may be stated, that the Chesterfield mines, represented in pl. 16, fig. 4 and 5, Graham's pits, at fig. 1, and Willis's and Crouche's pits, fig. 2, occupy the three points of a triangle, about ten miles apart from each other.

Two or three coal beds or seams of variable thickness comprise from 11 to 40 feet.

For the details of the respective thicknesses of these strata, and for a view of a complete suite of specimens of every bed enumerated in the section, by which means it was compiled, we are indebted to the liberality of Mr Reid, the managing proprietor of these mines.

These grits, and some of the shales, appear to have originated solely in the destruction of primitive rocks, and the whole series of these mechanically formed strata is especially remarkable for the abundant prevalence of mica, and at intervals of carbonaceous particles.*

Some unimportant variations in the quality and thickness of these superincumbent beds, as might be expected, are noticed by those who have been employed in sinking the deep shafts within this area, but the prevailing character of the whole groupe remains unchanged.

Whether any other groupe of rocks of this character exists elsewhere, particularly under similar circumstances, filling up a deep granite basin, is unknown to the writer. They are totally dissimilar to any other rocks usually accompanying coal, whether transition or secondary, that have come under the writer's observation on either side the Atlantic.†

Coal.

So great an accumulation of bituminous coal, almost in one solid seam, as is presented in the Chesterfield pits, is a highly interesting geological fact, without a parallel in this continent.

* Some of these carbonaceous white grits are quarried in large masses on the borders of the James river canal, and are conveyed down to Richmond.

† It is remarkable that they should be deemed, by so experienced an observer as M'Clure, to be allied to the old red sandstone, to none of the members of which they bear any resemblance, and whose eastern and nearest escarpment is 120 miles to the westward.

Some particulars of these veins are well worth recording.

Commencing with the north eastern part of the coal field we find the coal in two seams, amounting together to from 10 to 17 feet.

On the north western side are two veins, in Anderson's or Graham's pits, 30 feet asunder; the highest being from 6 to 16 feet, the lowest from 4 to 8 feet thick. These seams are said to come together to the north.

At the River pit on the south side of James river, in some old workings, at the depth of 130 feet, was a 20 feet seam, of a quality equal to any in Virginia. This work was suspended on account of the vein being "nipped out" by the granite.

Crossing to the east side of the coal field we find some extraordinary sections of this mineral.

Hill's pit contains three veins of 5, 6 and 25 feet.

In Mid-Lothian or Woolridge's pit the coal in one seam is worked above 30 feet, and in parts of the same mine is occasionally much thicker.

In the Maidenhead or Heath's mine I examined a gallery cut in a solid seam of splendid coal not less than 25 feet thick.

The Black Heath coal, which is reputed the finest quality in the district, is 40 feet thick.

In Mills's three pits the coal varies from almost nothing up to 40 feet, and the whole seam amounts to 60 feet, including some courses of shale. Fig. 5.

The Creek pit has one bed of 6 feet, separated only by a 6 feet bed of shale and rock from the main bed of coal which is here 48 feet, including 2 feet of shale; we have here therefore an aggregate of no less than 52 feet feet of clear coal. Fig. 4.

On account of the great geological interest excited in the development of such vast masses of this valuable mineral, I have been induced, in the sections fig. 4 and 5, to exhibit these coal seams at their maximum thickness, rather than the ordinary average.

Quality.

The coals of this region are of the white ash kind. In the purest beds its structure is imperfectly crystalline; having the conically radiated arrangement so frequently observable in the anthracite coals. Being highly bituminous, they of course burn to a coke and form a hollow fire. For domestic purposes this coal is very agreeable; burning with a yellow flame and forming a durable or lasting fire without the frequent necessity of renewal, as is the case in some descriptions of the fatter bituminous kinds. The quality of the coal is understood to vary in most of the deep veins. That of Black Heath has long commanded the highest price in the market; being esteemed superior to the Nova Scotia coal. But in all the mines there are portions of the beds, particularly towards the bottom, where the quality is inferior and sulphury; the introduction of which has injured the general estimation of the Richmond coal.*

The specific gravity of Richmond coal has been determined to be 1.246, and the weight of one bushel is 66½ lbs., according to Mr Bull.

* The upper beds of the Richmond coal are, as before observed, of the best quality.

Graham's or Anderson's, fig. 1, and adjoining pits:

Upper vein of excellent quality and decidedly superior to the lower. Has a striated crystalline texture, entirely without sulphur.

Lower vein contains sulphuret of iron, and does not make, for some purposes, so strong a fire. Somewhat slaty, but the coal itself is lighter than the top vein. It forms an excellent fuel for grates.

Willis's. Good coal, the upper vein rather superior.

Crouch's. Said to be of better quality than Willis's; the highest coal is the best.

Brown's. Upper vein eight feet, good; lower vein three and three quarter feet, inferior.

Hill's. Top vein of the best description.

These mines are not mentioned with a view to selection as being the best, but rather to show a certain conformity in quality at remote positions.

MISCELLANEOUS NOTES AS TO DIFFERENT MINES.

As may be inferred from the configuration of this coal field, the shafts are sunk to depths which are regulated by the distance from the outcrop.

North of James river.

I have memoranda as to the following works:

Brown's, above 300 feet deep; Wigham's, Randolph's, Woodward's, Tuckaho, Deep Run pits, and others.

Willis's: shaft about 130 feet; raising 600 or 700 bushels per day, by mules. Not troubled with water.

Crouch's: engine shaft 230 feet, used only for drawing off water.

There are twelve old shafts in this vicinity ranging parallel with the crop, within one mile. Three only are now worked.

Graham's or Anderson's: canal pit 270 feet; deep shaft 450 feet. Several other shafts adjoining, and working both seams; numerous old workings from the crop.

These mines are troubled with water, on account of the unnecessary number of old shafts, which, by perforating the strata, convey the surface and drainage water into the workings, from whence it is raised by mule power.

South of James River.

River pit 130 feet, abandoned for the present; Powhatan pit, Norwood pits and others, on the west side of the basin.

On the east side are Tribue's, Salley's, Black Heath, Cunliffe's, Blunt's, Heath's shafts; Maidenhead, 400 feet; Creek, 280 feet; Union; Bell, 400 feet; Rise, 400 feet; Mills's deep shaft, 412 feet; Mid-Lothian, 500 feet, and the workings, it is understood, are carried to the depth of 700 feet; Stonehenge, 400 feet; Hill, 480 feet; Rowlet's and some others extending towards the Appomattox river.

I am aware of the incomplete state of the details of many important mines, and of divers omissions: but I have not undertaken to describe all, or to particularize more than I saw, or derived from the best sources.

The Bell and Rise shafts are now troubled with water, chiefly arising from the fractured state of the superincumbent strata, and the partial falling in of the galleries in 1833. Mule power alone is employed to raise this drainage water. An engine drains the water from the Mid-Lothian mine. The Maidenhead mine is remarkably dry. The sink or cistern at the bottom of the shaft is only six feet deep, which suffices to collect all the water during twenty-four hours, and is pumped out every morning.

Brown's mine is said to be wet, and to employ steam power in pumping.

The Black Heath mine has been on fire for some time, causing a suspension of the works.

Mills's Bell shaft, or rather some of the workings there, have been on fire for twenty-five years, and it has now advanced into some of the old workings of the Rise shaft mine: but the works are still carried on, and communication with the fire is for the present stopped by walling.

It is not known how this combustion originated—whether spontaneously, by decomposition of pyrites, or by accidental causes.

Fire damp does not now prevail in the Richmond mines to an inconvenient extent. I could only hear of one trifling accident that has occurred by this circumstance.

Very little wood is employed in the working of these mines, on account of the great thickness of the veins. The weight of the roof is therefore necessarily to be sustained by pillars, which in the Chesterfield mines vary from sixteen to thirty yards square, according to the dimensions of the seam.

In these deep galleries the mode of working out the coal is upon the slope or plane, commencing with the top, or as a flight of stairs. The labour is principally performed by hired slaves, under competent direction. Mules are employed under ground to draw the wagons to the bottom of the shaft. As the shafts are chiefly sunk in solid rock, curbing is not commonly required beyond the first 50 or 60 feet.*

Of other useful mineral substances there are few traces in the Richmond basin.

In the shaft of the Maidenhead mine, 20 feet above the coal was passed through a bed, from six to eighteen inches thick, of very hard bluish-green argillaceous rock, containing some iron. This bed is much intersected by small white veins of carbonate of lime, forming septa, and resembling some of the weaker varieties of argillaceous iron ore.

Mineral charcoal occasionally prevails in the same mine.

GENERAL CHARACTER OF THE RICHMOND COAL FIELD.

The prevailing circumstances which are developed during the subterranean excavations in this remarkable mass of coal, are such as would be expected to attend the deposition of vegetable matter; or of any substance in fact, not altogether in a state of fluidity, yet capable of entering into and filling up the innumerable inequalities and minor cavities of the original granite bed, and at the

* Price of coals at the pit's mouth, at the head of the railway, twelve and a half cents per bushel of five pecks, weighing ninety pounds. At Richmond eighteen and a half cents; inferior, sixteen cents per bushel.

Contracts are, I understand, occasionally entered into on more favourable terms.

Cost of transportation on the thirteen miles of railroad to Richmond, the head of sloop navigation, six cents per bushel.

same time of maintaining in the plane of its own superior surface a certain general parallelism or level. They thus furnish a ready explanation as to the otherwise singular irregularities in the thickness of the great lower coal seam, so different from the usual characters of coal veins, as they are termed, in the secondary formations.

After this coal has been excavated, and its base has been laid bare, the floor of the mine exhibits the original undulating surface of the granite. In some few instances the eminences which protrude from this ancient surface rise entirely through the lower carboniferous bed, as on a larger scale an island rises above the waters of an ocean, and the coal, in mining phrase, is "nipped out." Occasionally these granite points or "walls" shut up all further working in that direction. Drifts may be carried round them, or by great labour and perseverance they may sometimes be surmounted, when a descent is frequently made into a body of good coal, filling a deep hollow from 40 to 50 feet. These of course are the extreme cases.

Thus the floors of the deep galleries present an irregularly undulating surface, to the inconvenience and retardation of the miners, and occasioning frequent obstacles to the formation of subterranean railroads. From the lateral galleries the coal is dragged in basket wagons by negroes, who pass over the deeper hollows on rough wooden bridges and inclined planes.

It is not always that this coal rests immediately upon the granite. Occasionally there is a foot or two of black carboniferous shale, or a seam of from one to six inches of dark porphyritic rock.

Often many square feet of the granite are laid bare, when its superior surface appears smooth, as if worn by previous attrition before the deposition of the vegetable matter had commenced.

As may readily be inferred, there exists no correspondence or parallelism between the upper and lower surfaces of the main coal seam; neither does its roof present the usual continuity of plane as is seen in ordinary stratified deposits.

But in those lower thick seams, under our immediate consideration, the roof is irregular, rising and falling, swelling and expanding, without at the same time conforming to the undulations of the granite base; the depressions in the roof occasionally descending towards elevations of the floor, and the contrary.

Amidst this irregularity, it must be observed, there is no important interruption to the parallelism of the laminæ or planes of stratification within the body of the coal itself. So far as my examination of these beds in the deep workings extended, the laminæ or their seams, of which the whole mass was made up, were of uniform thickness, parallel with each other, and with the prevailing dip of the coal.

The hard dry shale which forms this roof is not laminated or seamed like the coal shales higher up: but, wherever it has come under my observation, it possesses the polished conchoidal glance cleavage, which is more characteristic of the transition coal measures than the secondary. This is one reason, although not altogether conclusive, why I am rather inclined to assign this independent coal formation among the transition carboniferous deposits, than to the secondary class, wherein I can trace no analogy throughout the whole series of superincumbent strata.

That the alternative of bituminous or non-bituminous has no authority in determining the comparative ages of coal, I have shown in a previous article on the bituminous transition coals of Pennsylvania.

In the formation now under consideration, we perceive not a single bed, out of a series occupying 700 feet at least known to us, which represents any recognized bed of the secondary carboniferous series.

The evidence derivable from organic remains is next to be considered. With the exception of one species of calamite, the writer was unfortunately unable, during the examination of the products of fifteen shafts, to discover traces of the usual coal plants; and he was informed by the intelligent manager of the Maidenhead and Heath's new shafts, that he had not succeeded in discovering any such remains during the progress of those works, with the exception adverted to. From a valuable communication made to the Academy of Natural Sciences by Mr Nuttall, we learn that "in the bituminous slate clay, which as usual accompanies this coal, besides impressions of ferns, and the supposed equiseta, there are vestiges of some enormous flaccid-leaved gramineous plant, leaves of one of the scitamineæ similar to those of ginger, and fine casts of a palm, resembling the pennate fronds of some species of zamia or cycas. The apparent remains of fish, which also occur together in such uncommon abundance, are extremely ambiguous, inasmuch as the supposed fins alone are found."*

To the unceasing researches made during the last fifteen years, by many distinguished naturalists in the department of fossil botany, we owe the facilities, heretofore unknown, of comparing and identifying the antediluvian flora of our coal fields; and with the specimens before them, geologists will henceforth cease to employ those vague and unsatisfactory expressions which resulted from the then unsettled state of this interesting branch of natural science.

In the Chesterfield coal shafts, one of the beds, No. 70 of our section, at the depth of 319 feet below the sur-

* Journal of the Academy of Natural Sciences of Philadelphia, vol. 2, p. 36. Also Sternberg, book 3, p. 16.

face and 60 feet above the coal, consists of a dark blue micaceous shale, in which occur impressions and casts of that fine fossil plant *Calamites Suckowii.* I obtained specimens of the same fossil, apparently occurring under similar circumstances, from two or three other shafts at distant points in this coal field. M. Adolphe Brongniart, who describes and figures this calamite, in his Histoire des Vegetaux Fossils, plate 16, fig. 1, observes, that although the external surface of the Richmond fossil is indifferently preserved, he assigns it to this species as a variety, on account of its general form and the thinness of its bark. The sides are only more convex than some other varieties described by the same writer, which may be owing to a less compression; for these stems, which were probably vertical, appear to have been compressed in the direction of their length, and exhibit numerous wrinkles or folds, which seem to indicate how much their sides were thin and flexible. This specimen is even very remarkable under this point of view, and proves that the stems were fistulous like those of the living equiseta."* We may add, that this folded or wrinkled character, of which a good representation is given in the figure of M. Brongniart, is common to every specimen we have seen in this coal field. These specimens were from 8 to 12 inches in diameter near their base. From a dark micaceous grit overlying the coal of the Chesterfield pits, we obtained several specimens of impressions of smaller compressed calamites, some of them not exceeding three-fourths of an inch in diameter.

Lignites, the vegetable matter of which occurs in a carbonized form, abound in the grey and white grits overlying the coal. I have not obtained them in a sufficiently perfect form to enable me to determine the class to which these fossil vegetables belong.

* Histoire des Vegetaux Fossiles, p. 126.

We have not observed any of those bodies or fishes so abundant in the coal slates, according to Mr Nuttall, in this district. It is not improbable but their forms have been mistaken for the detached fronds of neuropteris or pecopteris.

It is not the least remarkable geological feature of this district, that throughout such repeated alternations of rock beds, gritty argillaceous and coal shales, one distinguishing character in the structure of the compact rocks may be traced through the entire series. That a great accumulation of rocky beds, of mechanical origin, clearly and solely derived from primitive rocks, should be lodged within a basin of granite, is by no means difficult to account for. But that rocks possessing this conglomerate character should be interstratified with innumerable argillaceous and carboniferous beds, which attest long and undisturbed intervals between each alternation, intervals at any rate long enough to admit of the growth of plants of considerable magnitude, suggests a remarkable duration or extension of that epoch during which those repeated supplies of similar constituents, derived apparently from a common source, continued to proceed.

What may be the greatest depth of this coal basin must, in the absence of evidence, remain purely conjectural. Like most deposits of this description, it is probable that the central beds are flattened, and for a certain space towards the centre are horizontal. We perceive, for instance, on the west side of the basin, that the declivity of the lowest beds, which was at first as great as thirty degrees, decreases even in the workings to fifteen degrees; and that at the distance of two or three miles this angle, judging from the dip of the upper beds which alone can be examined, is diminished to two or three degrees only from horizontality. Something like this is noticed in the mines on the eastern side of the basin, where the descent is stated to commence at forty-five degrees, and though partially interrupted by faults, is found to flatten towards the interior.

Of these dislocations, which are perceptible to a greater or less extent in most of the coal pits within this area, it is not now the intention of the writer to speak. Such faults are to be expected so near the outcrop of these highly inclined rocks. We will only advert to the most remarkable line of fracture, which runs along the whole eastern side of the coal field, throwing up the coal in such a position as to form a double crop; that is, two distinct outcrops of the same seam.

The Black Heath mines, the Union mine and the Deep Run pits range along the outer strip or belt of coal, and are separated entirely from the main area, by a step of granite, miscalled a hill or wall.

We have, therefore, the peculiar circumstance of a double tier of shafts and collieries, running nearly parallel with, and at no great distance from, and apparently co-extensive with the entire mineral basin, yet perfectly detached and separated by an interposing face or wall of primitive rock, against which the outer rim of coal rests. This fracture and subsidence are represented in our diagram fig. 5, as accurately as the small scale of the section and the obscurity of the data would allow.

One other feature, and that unquestionably peculiar to the Richmond coal region, remains to be adverted to. It is the lowest in position in the United States, or, for aught that is known to the contrary, in the whole continent; being already worked to the depth of from 100 to near 350 feet below the level of tide.

Combining the various circumstances which have been thus hastily and imperfectly sketched, it will be seen that this area presents one of the most remarkable features in American geology, in connection with the subject of coal.

The only parallel to which I can with probability refer it, is in the coal deposits of central France, which there repose in basins of granite and gneiss. The fossil plant of the Richmond coal measures, bears some resemblance to one of the calamites of this French coal region. But even there it remains undetermined, I believe, as to what geological period or formation the conglomerate rocks contained within these primitive basins can be referred; and as many similar species of fossil vegetables exist alike in the grauwacke series and in the newer carboniferous groupe, it does not appear that the relative ages of the beds containing them, can be determined with that precision we are frequently enabled to do, by means of animal organic remains.

For instance, in the five varieties of our Richmond coal plant, Calamites Suckowii, M. A. Brongniart describes:

The first as existing in the Newcastle bituminous coal of England; at Doutweiler near Saarbruck; in the coal mines near Liege, and near Valenciennes.

The second in the mines of Litry, department of the Calvados.

The third in the anthracite coal of Wilkesbarre, in Pennsylvania.

The fourth in the bituminous coal shale of Richmond, Virginia.

The fifth in the coal pits near Valenciennes.

Varieties of the same species are here shown to exist, in the secondary bituminous coals of England, Germany and France; in the anthracite or transition coal of Pennsylvania; and in the Virginia coal resting upon granite: deposits formed at distant and remote epochs.

Among the desiderata demanding the attention of geologists, a strict examination into the component materials of the transition and secondary conglomerates has been urged. A familiar acquaintance with the nature of these conglomerates, particularly in the secondary coal fields of America, confirms the opinion, previously suggested, that the micaceous grits and conglomerates of the Richmond coal measures have no analogy with any of the former class that have come under my inspection. Neither do they resemble any one of the innumerable members of the grauwacke and transition series.

From the remark of Mr M'Clure, in associating these grits with the old red sandstone, however I may differ on the latter point, it is evident that his impression was, the coal of this basin was older than that formation, and so far his views coincide with the writer's.

For the present, therefore, reasoning from the phenomena, scanty as they are, observable in the bituminous coal deposit of Richmond, I am inclined to refer its origin to an earlier epoch than coincides with that of the most ancient portions of the secondary carboniferous groupe of this country.

ANALYSIS OF SOME OF THE COAL FROM THE RICHMOND MINES. By T. G. Clemson, formerly of the Royal School of Mines of Paris, &c. &c.

Upon the coal field of Richmond, lately visited by my friend Mr Taylor and myself, I have no observations to make that could give additional interest to the very able paper read by that gentleman at a preceding meeting of this Society.

The superior quality of this combustible, its unique and singular position upon the granite, and the nature of the superincumbent measures, make every thing respecting this singularly interesting coal field worthy of record. The particular age of this formation is only to be ascertained by reference to the contained organic remains. The coal, as has been observed, lies upon granite, sometimes separated but by a few inches, at other times in close contact with this rock. The singular appearance and composition of the overlying strata, not apparently deposited slowly, for some of these are of a porphyritic nature, and differ from the measures that overlie the coal in other parts of the world. More recent incumbent beds are also wanting, from which, had they existed, we might have deduced something more satisfactory with regard to the age of the Richmond coal field.

We have the honour to subjoin the composition of three varieties of coal, taken from different pits sunk in this basin.

Coal from Willis's Pit, six miles north of the James River. Pl. 16, *fig.* 2.

This coal is jet black, has a shining pitchy lustre; powder, dark brown; breaks with an uneven fracture, and is very fragile; contains sulphuret of iron; is very fat, and burns with a long yellow flame, leaving a light silvery coke, which when incinerated leaves an ash free from carbonates, and of a greyish-white colour.

Composition per cent.

Carbon,	66.6
Volatile matter,	28.8
Cinders,	4.6
	100.0

Coal from the bottom seam of Anderson's Pit, in Goochland county, Virginia, on the north side of James River. Pl. 16, *fig.* 1.

Black, with a glimmering lustre; more compact, and somewhat less brittle than the preceding variety; gives a brown powder, and not free from pyrites; ignites easily, and burns with a long yellow flame, leaving a light silvery coke, which on being incinerated gives an ash of a red violet hue, free from lime.

Composition per cent.

Carbon,	64.2
Volatile matter,	26.0
Cinders,	9.8
	100.0

This is the inferior quality of coal. The coal of the upper vein is in higher estimation in the market.

Mineral Charcoal, Maidenhead mine, Chesterfield county, Virginia.

This substance is by no means uncommon in the Richmond coal beds, and resembles much in physical character similar substances found in the Pennsylvania fields.

It has a dark brown colour, giving a jet black powder. Its texture is fibrous and silky, very soft to the touch, and pulverizes into an impalpable powder with the slightest effort ; burns and incinerates with facility, leaving a lilac-coloured ash which does not effervesce.

Composition per cent.

Carbon,	83.3
Volatile matter,	10.7
Ashes,	6.0
	100.0

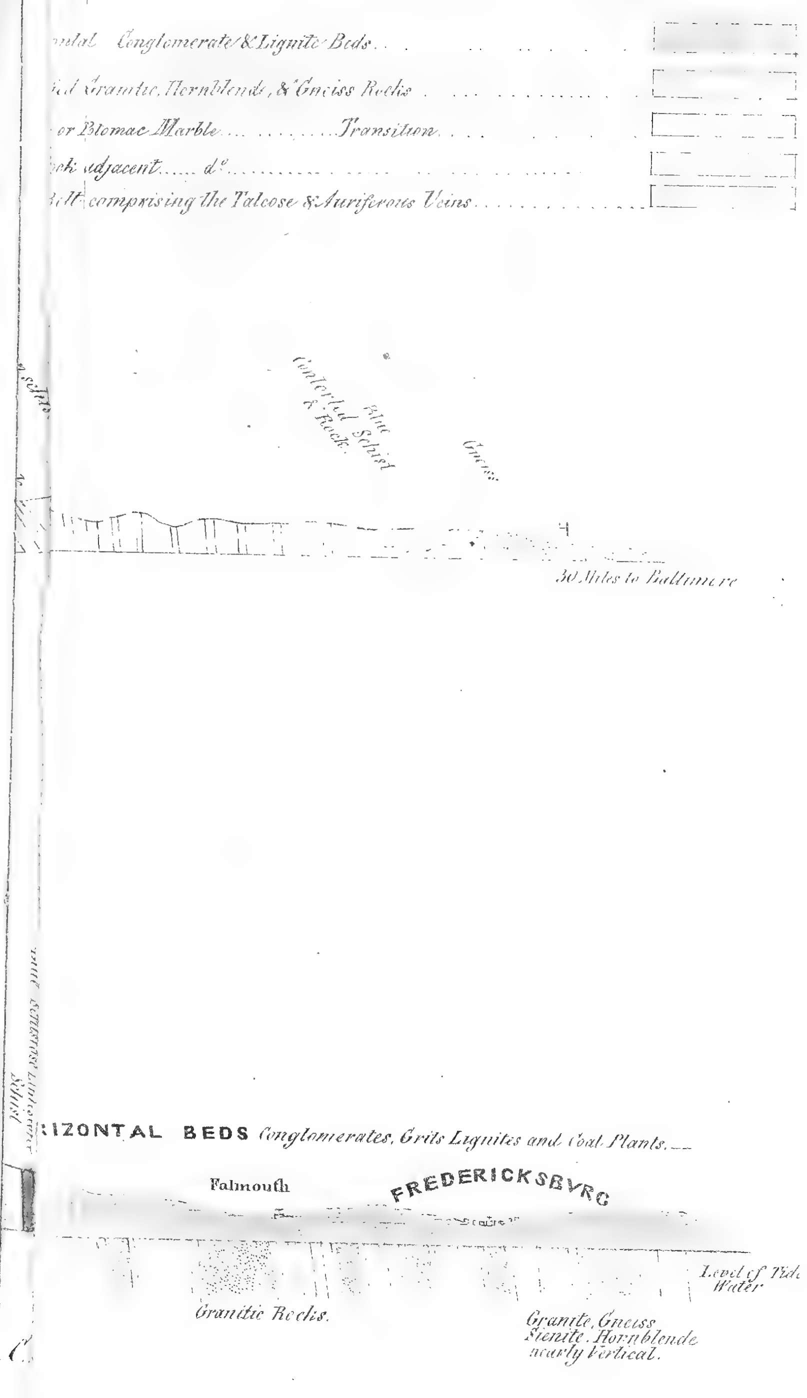
NOTICE OF A GEOLOGICAL EXAMINATION OF THE COUNTRY BETWEEN FREDERICKSBURG AND WINCHESTER, IN VIRGINIA, INCLUDING THE GOLD REGION. By Thomas G. Clemson.

My friend Mr Taylor and myself having been appointed to investigate certain portions of the gold region of Virginia, opportunity was offered us for tracing somewhat extensively, the geology of that interesting country.

Inasmuch as the history of any portion of this vast continent is not without interest, and as many have invested capital in mining operations in the region which I shall attempt to describe, I presume that the following descriptions and accompanying sections, constructed by Mr Taylor, delineating the nature, position and extent of these metalliferous and other formations will be acceptable to the Society.

Portions of North and South America, those lying west and south of the Gulf of Mexico, have long been objects of speculative interest to Europeans as well as to the inhabitants of the United States. So extended has been the scale upon which the mining operations of these countries have been conducted, and so large the interests invested, that the public have been made acquainted with the mineral resources of those distant countries by the first talents of the age. So very minutely have many of these districts been examined, that we are much better informed respecting them than we are with the environs of Madrid. Not so in the United States. Here little has been done to advance the mining and metallurgical interests.

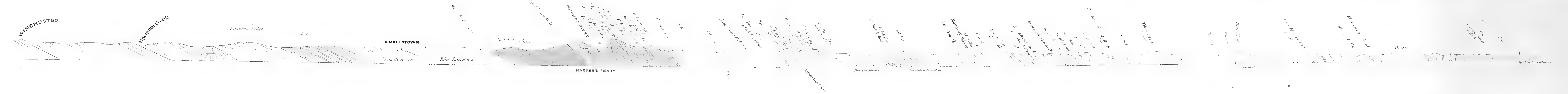
There is no business attended with more expense,



Conglomerate & Lignite Beds
Granitic, Hornblende, & Gneiss Rocks
or Potomac Marble ..... Transition
adjacent ..... d°
comprising the Talcose & Auriferous Veins
Contorted Schist & Rock
Blue
Gneiss
30 Miles to Baltimore
IZONTAL BEDS Conglomerates, Grits Lignites and Coal Plants.
Falmouth
FREDERICKSBVRG
Level of Tide Water
Granitic Rocks.
Granite, Gneiss Sienite, Hornblende nearly Vertical.

Fig. 1.

SECTION from 30 Miles West of BALTIMORE in MARYLAND to WINCHESTER in VIRGINIA.



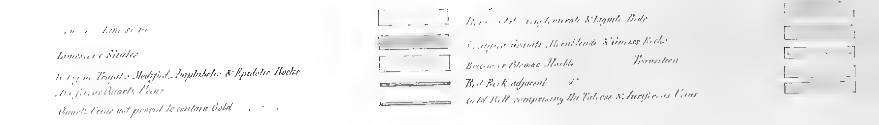
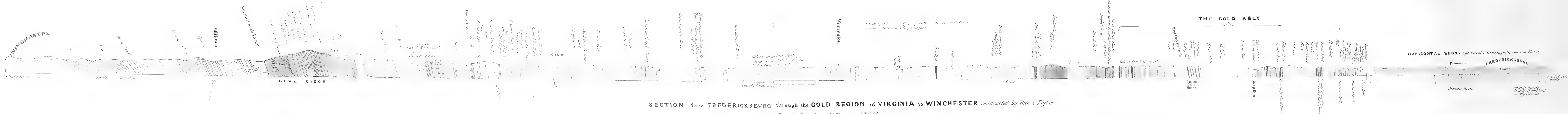


Fig. 2.



SECTION from FREDERICKSBURG through the GOLD REGION of VIRGINIA to WINCHESTER constructed by Rich. C. Taylor

From the Observations of R. C. Taylor and T. G. Clemson

none requiring more mature judgment and profound scientific information, none more exciting, or by which we may be more easily led astray, than the arts of mining and metallurgy. Few opportunities are offered to the public at large for acquiring this kind of information, and few nations have adequately valued their mineral wealth, or have placed these great primitive and delicate resources under proper auspices. We have thus cursorily endeavoured to enumerate some of the leading causes which have conspired against successful attempts at mining in this country.

In the Carolinas and farther south, much gold was procured by washing alluvial deposits on small rivers, streams or creeks, and subsequently from veins, ere public attention was finally directed to the existence of similar formations in the state of Virginia. Within a few years many companies have been organized, and charters obtained for working deposit and vein mines: with but few exceptions the mining operations here have been carried on by persons totally ignorant of the art, consequently without order or economy. Landholders and others have been more successful in washing and separating the gold from alluvial deposits by the use of mercury. Some of these deposits are found to be prodigiously rich. A certain locality yielded to the amount of 1700 dollars from one single bucket of ore. This is an extraordinary example, and by no means an average expression of the richness of the entire mine.

GEOLOGY.

Our section embraces the country, included between Fredericksburg on the Rappahannock, and Winchester, in the great valley of the Shenandoah, a distance of from 70 to 80 miles. The transition or blue limestone disappears under the last mentioned stream, which forms a line of separation between the transition and evidently altered rocks that immediately make their appearance after crossing the river, and form those highlands called the Blue Ridge. They extend on within 23 miles of Fredericksburg. The gold belt then commences and continues with but little interruption for 15 miles, when we come upon the more distinctly crystallized amphibolic and badly characterised granitic rocks, which extend on, and are covered by the horizontal and stratified formations which disappear under the tide waters of the river Rappahannock, as may be seen in the river between Falmouth and the city of Fredericksburg.

THE BLUE LIMESTONE OF THE VALLEY OF THE SHENANDOAH.

This valley has been long celebrated for the fine quality of the land that covers the transition beds. Its surface on the whole is comparatively level; taken separately, slightly undulating. Springs abound, and the water is of that variety called hard, owing to its containing the bicarbonate of lime in solution; by boiling, one half of the carbonic acid is driven off, which accounts for the incrustations or depositions observed in those vessels in which the water has been heated. The Shanendale springs are situated in this valley, in Jefferson county about six miles from Charlestown. These waters have been much resorted to for pleasure and health. In clearing out the main spring, an abundance of fine crystals of selenite were found a few feet below the surface of the ground. These crystals may have been deposited from the water, as it is known to contain this salt, with sulphate of magnesia, hydrosulphates, &c. Near Smithfield, there is a mineral water impregnated with iron, which is frequently prescribed to invalids. The limestone rock of this valley is of a variety of colours, but usually blue. It is seen frequently on the surface, and has a general dip to the east. The surface of this limestone appears to have been acted upon by running water, and by fragments kept in motion by the fluid; cavities frequently occur in the rock which resemble those pots occasionally observed elsewhere, and which have been been formed by constant agitation of mineral particles, kept in motion by the fluid. Veins of quartz traverse the beds, and much isolated quartz rock is seen on the surface of the ground. The quartz is sometimes a milky quartz, at other times it has the appearance of a fine grit, assuming various forms. In the environs of Winchester the limestone is more silicious than usual. There are seams of this rock that contain a sufficiency of insoluble matter to render the lime obtained eminently hydraulic, and of these some are coloured almost black with carbonaceous matter. Near Shepherdstown, on the river Potomac, hydraulic lime is prepared and used in the country in the construction of canals, &c. Not far from Charlestown, and near the village of Smithfield, fine marbles are quarried, but to a small extent, and only for the uses of the vicinity.

The blue limestone breaks into fragments too small to be used extensively for ornamental purposes, or where regularity in large pieces is an object.

BLUE RIDGE.

The river Shenandoah, which in the original Indian language means river of clear water, bathes the western foot of this chain, which has a parallel direction with the Alleghanies. The general dark appearance of all highlands viewed at a distance, aided with a little imagination, may make the received appellation, applied to these mountains, appropriate. The western declivity of this chain is much more precipitate than its eastern inclination.

The volcanic action (if we admit such a power to have been exerted in this case), that at some former period upheaved those mountains that have a direction through our continent from N. E. to S. W., appears to have acted in parallel lines with diminished force as we move east from the main or highest line of action—the Blue Ridge being the result of one of those forces.

Notwithstanding the altered appearance of the rocks, they are distinctly stratified, and have a dip east varying from 10 to 15°. The beds forming the main eminence approach nearer to 10°, which is about the dip of nearly all the rocks southward between this ridge and James river.

The trap rocks form dykes running parallel with the general direction of all the beds, which is from north east to south west. Some of these traps, when the amphibole becomes more abundant, are crystallized and somewhat schistose.

In a geological sense, the Blue Ridge is well defined on either side. On the east, the altered rocks make their appearance, and limit the gold belts. They are stamped with certain similar characters, that lead us to believe, all such, included between this line and the transition limestone, owe that general character to similarly and coevally acting agents. In a physical point of view, we should be led to the same conclusions. From this point, where the altered rocks appear, the ascent is gradual, yet undulating, until you reach the beautifully situated little village of Paris, on the eastern slope, which you climb before passing down into the rich valley of the Shenandoah. The eastern side of this chain is cultivated to the top: on the west the slope is much more rapid, and in an uncultivated state. As might be expected, springs are abundant and the water excellent.

ROCKS OF THE BLUE RIDGE.

As we have already observed, there is a general, prevailing character stamped upon the rocks that constitute the mountains of the Blue Ridge, and, like all other entritic groups, they have a decided crystalline structure, and are of a heterogeneous composition, which varies frequently, as the different constituents individually predominate. They penetrate and pass into each other, sometimes by slow gradations, leaving no distinct line of demarcation between two rocks materially different. Again, the passage is abrupt between rocks widely differing in physical appearance, whatever may be the analogy of composition. There is a want of continuance or permanence of mineral composition, and consequently of specific character. We shall endeavour to convey an idea of the whole, by special descriptions of some of the most prodominant rocks, and their relative positions.

VARIOLITES—ARGILO-PORPHYRIES.

In ascending the ridge from the west, a variety of grey schistose rocks and shales are crossed before arriving at a rock, which at a little distance would be taken for a conglomerate. On close examination, it will be found that the spheroidal masses that are embedded in the base consist of petro-silicious crystals, sometimes white, sometimes green. These globular masses are generally semi-crystalline. Again, the cavities are only partially filled, and the substances coating the interior have a more perfect crystalline form.

The spheroidal masses embedded, and the crystals coating the sides of the cavities, differ in colour and composition from the base of the rock, which is generally bluish-brown, reddish-grey and green, varying in intensity from time to time. The base of this amygdaloid has the appearance of being an altered argillaceous schist, and is by far the most abundant part of the rock. Rolled masses are found which, though not as beautiful, are not dissimilar to the rolled variolites that are found in the Durance, department of Drome, in France.

This rock appears to have been once in a state of semi-fusion, and the cavities formed at that period have been partially filled by the reunion of petro-silicious matter; sometimes the crystallization appears to be the effect of coeval sublimation or interior infiltration. Whatever may have been the mode of formation of these rocks, like other variolites, and argilo-porphyries, they appeared to be expressions of pre-existing rocks, modified by some cause not now acting.

PORPHYRY.

This rock appears to be a modification of the preceding; a white petro-silicious or feldspathic substance, partially crystallized, is imbedded in a compact hard homogeneous base of a brown colour. It resembles a dioritic porphyroid, rather than a perfect porphyry. The white imbedded substance exists in spheroids, with a structure semi-crystalline, and not in prisms. The embedded and embedding substances are about equal in quantity. The ovoids are from the size of a pea, down. The base of the rock has been partially penetrated by the substance forming the spheroids. In the preceding rock the ovoids sometime separate from the base, leaving cavities and protuberances. This mineral breaks with an even fracture, and the line of separation divides the spheroids and the base, without any derangement of direction. Both parts appeared to be of equal hardness, and susceptible of a fine and equal polish. The colour of the base and of the contained masses being so distinct, the effect produced by a polish is very agreeable.

TRAPPITES—EPIDOTIC ROCKS.

The summit of the Blue Ridge descending one mile to Paris, is chiefly composed of a green rock which varies much both in colour and composition. It is frequently a light leek green, or a dark green passing into an almost black homogeneous rock of the nature of trap. Veins of quartz are not uncommon. Small granular crystals of epidote are seen upon the surface, and we are inclined to think that the mass of rock is coloured by this mineral.

Between the villages of Paris and Salem, in Fauquier county, various altered rocks occur. They are similar in appearance to certain traps; again they are of the nature of grits, passing into protogine and other heterogeneous rocks, in which the quartz predominates. At the distance of about five miles from Salem, you come upon shales that are neither talcose nor argillaceous schists, but appear to be mixtures of either. Much quartz in veins traverses these beds.

At the distance of four miles from Salem, there is a green petro-silicious rock with crystals of feldspar. The base varies in colour, generally a dirty green, and the lamellar feldspar sometimes very abundant. This rock contains veins of quartz of a dark blue colour which is a very beautiful variety. The trappites hereabout have a general dark green hue. The dark blue quartz is so common, that the fences have been partially constructed with this material.

In approaching Salem, the amphibolic rocks, with repeated modifications, occur; and sometimes the amphibole nearly disappears, and you have a ferruginous grit. These amphibolic substances are not unfrequently schistose, more generally massive, compact, hard, and frequently disintegrating upon the surface, which renders it difficult to get a perfect idea of the nature of the substances which compose the mass. As you leave Salem and proceed east towards Warrenton, the modified amphibolic rocks continue until you come upon a dark, and a lighter gritty rock. Talcose slates, with quartz veins, now become common; and the whole surface of the country, from this, for several miles beyond Warrenton, is parsemated with milky quartz. Those traps already alluded to, still continue from time to time, and are seen nine miles west of the village last named. You then come upon soft shaly beds of the nature of talcose chlorites and argillaceous schists. The dip of these beds is from 5 to 10° from verticality, south east.

Near about the distance of seven miles east from Warrenton, a trap dyke or vein of a few feet in breadth is crossed. This is a conspicuous feature in this locality; it pursues a direction parallel with the prevailing stratification. Modified and amphibolic rocks occur for the distance of one and a half miles. A band of sienite, nearly a mile in breadth, is then crossed. It is seen on the river Rappahannock at Wheatley's mills, below Norway ford. This rock is almost entirely composed of amphibole, which exists in crystals of different sizes, almost black, and traversing the mass in almost every possible direction, leaving here and there a spot of the white base exposed to view. On the banks of the river near the above named mill, numerous boulders or rounded blocks of this same rock, with other rocks rounded by attrition, lie on the shores and in the bed of the stream. The gradations from one rock to the other, and the great variety of distinct rocks that are to be seen at this locality, make it particularly interesting to the student of mineralogical geology.

To the sienites succeed beds of blue chlorite slates, and blue schistose contorted limestone, traversed by veins of white carbonate of lime. These beds of limestone slates appear to have been twisted and turned in every possible manner. This limestone has been burned for lime in the vicinity of Marsh run.

In succession, a bed of chlorite schist crosses the river at Kelly's mill, below which another series of amphibolic rocks occur, which pass into a fine-grained sienite, apparently alternating with a rock that has the character of an amygdaloid. The base of this rock is purple or violet, the amygdals containing green crystals and sometimes white, and though not as prevalent as in those rocks described as argillo-porphyries, bear so great a resemblance that we cannot avoid believing them to be of similar origin.

In a greenish blue, slaty, altered rock at about fifteen miles from Warrenton, a trap dyke or vein juts up and limits distinctly the talcose slates of the gold region. A portion of this trap dyke is a heterogeneous mixture of specular oxide of iron, silicious grit and a petro-silicious substance of a green colour, passing imperceptibly into the homogeneous traps that bound it on either side. The talcose shales, as they approach these traps, are modified; and there being no distinct line of demarcation between the shales and the traps, we might compare this alteration to that of a stick of wood, one end of which was thrust into a fire and charred. The gradation from wood to charcoal is evident, though not sudden.

A copper mine was formerly worked not far from this spot, but to what extent we are not able to say.

In proceeding on over the talcose slates, &c. of the Gold Belt, numerous quartz veins have been observed to contain gold, when you come upon steaschiste with amianthus passing into jade. One section, then, traverses the Union Gold mining property, the minute details of the stratification of which we present in a separate and enlarged section.

From the Union mines, proceeding with our section eastward, talcose and chlorite slates, accompanied by protogine and various modifications of rocks of this character, occupy a breadth of eight miles from the Union mines. On the Rappahannock the protogine rocks occupy a breadth of nearly a mile, succeeded by a belt of this same rock passing into a sienitic granite, having quartz veins intersecting the mass.

Garnet schists, talcose schists, and the auriferous quartz veins of the Rappahannock and United States gold mining companies, follow in succession: forty veins of quartz, including those of the Union gold mining company, were counted in passing over the eight miles alluded to.

These were the most prominent, and observed as they crossed the main roads; but it is probable that a more close examination would disclose others passed by us unobserved.

This brings us to Hartwood hill, the apparent eastern boundary of the region of talcose slates and auriferous quartz. The following are the principal stratified rocks that occur in descending this hill in an easterly direction: chlorite schist, a blue gritty schistose rock, porphyritic and hornblende slates, in which there are small quartz veins, hornblende rocks, and a variety of shales; a black bituminous shale which has been bored into upwards of 100 feet, under the supposition that it was coal shale; quartz vein; thin seam of syenite; a bed 70 feet thick of decomposed feldspathic rock.

Sienitic and granitic rocks then continue to Cedar hill, where, at seven miles west of Fredericksburg, they disappear under the white horizontal conglomerates, which extend from thence past Fredericksburg towards the Potomac.

GOLD BELT.

The talcose slates which form the majority of the rocks within the gold region, are of easy disintegration under the influence of the usual atmospheric agents; hence the rounded form of the hills and the undulating character of the country. A small portion of the land overlying the shales may be considered as fit for agricultural processes, much of it having been under cultivation for tobacco, &c. until it is worn out. Ravines and valleys are deepening. Those hollows that are circumscribed by hills having no outlet, are gradually filling up from the detritus of the surrounding rocks. These clays thus deposited, are used for making bricks.

These talcose-slate lands might be much improved by the addition of lime, a bed of limestone existing near the confines of the Gold Belt.

The surface of the land being undulating, is consequently adapted to mining operations, allowing the location of adit levels, by which the mines can be drained to a limited depth. Some of the waters have a sensibly ferruginous taste. The hills are not higher than about 150 to 200 feet above the Rappahannock, and have but few precipitate faces, save on the rivers. The rocks that show themselves in the gold region of this part of Virginia, are talcose and chlorite shales, protogine, jade and steaschiste. These rocks have a direction from south west to north east. They are highly inclined, deviating from perpendicularity only a few degrees, towards the south east.

The talcose slate is here generally a red rock, dividing into long thin laminæ, with a silk-like silvery lustre, having that usual talcose or soapy touch, that characterizes magnesian rocks. They are of easy disintegration on the surface of the earth, and may be generally worked with a pick below. These rocks mix the one with the other, and give a great variety of colours within a space of a few feet. When the chlorite is most abundant, the rock is green: ferruginous matter gives a variety of tinges, from a dark to a light red. These colours do not alter the general character of the shales, which in the majority of cases may be worked without blasting, though at times the schistose structure is lost, and the rock becomes more petro-silicious, passing into a hard and compact protogine. Near the Union gold mines, steaschiste occurs with amianthus. A quarry of this rock was opened on the river Rappahannock, at Barnitz Mills. Jade also occurs, out of which the aborigines of our country shaped their axes, arrow and spear heads.

Masses of milky and ferruginous quartz are seen scattered over the surface of those lands, traversed by auriferous veins. When these masses are broken, sometimes gold is found visible to the eye. There are veins that contain gold, and others from which no gold can be extracted by the ordinary means used in this country. The veins of auriferous quartz follow the general direction of the rocks, running parallel to the Blue Ridge, and Alleghany mountains; that is to say, from nearly about south west to north east. These veins appear to be of the nature of what the Germans call "liegende stock," or, in other words, are considered to be contemporaneous with the formations in which they are found to exist, being parallel with the stratification, and having no other walls than those of the rock parallel, and between the layers of which they have their course. The dip of these veins varies with the inclination of the rocks.

Sulphuret of iron, of lead, of copper, hydrate of peroxide of iron, specular oxide of iron, native gold, native silver, &c., are the metallic substances that are found in this region. Talc, asbestos, jade, turpentine, amphibole, cyanite, varieties of quartz, and other mineral species that are common.

Some of the veins that traverse the country are barren, others contain more or less gold. This is found disseminated, and is frequently so fine as not to be discerned by the eye. It however by no means prevents the gold from being separated from the quartz by chemical means. The most economical means of arriving at this end is the great desideratum. The quartz in these veins has a general resemblance. It is sometimes white and compact; at other times it is found with a slight tinge of blue. The sulphuret of iron appears to be very abundantly diffused. This substance is, however, sometimes wanting, having left in its former place the hydrate of the peroxide of iron and native gold, which are seen coating the pseudo-morphous forms once occupied by the pyrites. Portions of the quartz are very friable, and like a sponge traversed in every direction by vacuities, once filled with the sulphuret, which from some cause has disappeared, leaving the quartz with a rugged drusy structure. This accidental appearance assumed by the quartz is usually considered to be a good indication, and is vulgarly called rotten or decomposed quartz. The quartz in some of the veins has a pseudo-regular structure, dividing into parallelopipeds. An example of this is observed in the Rappahannock mines.

Lands containing gold veins within a comparatively small area have been secured for gold mining speculations. The majority of operatives have not carried their works to any extent for the want of information. Many of the mines that have been in operation are at a stand for want of the most appropriate plan of separating the gold from the ore. The Rappahannock, the United States, and the Union gold mines are in operation. The plan of operations commenced at the Union is of the most approved practical character, and the issue of the undertaking will materially influence the general prosperity of the gold interests in Virginia. The three engines to be employed in working these mines have been imported from England. The majority of the miners employed here are from the most celebrated mining districts in Great Britain.

HORIZONTAL BEDS OF FREDERICKSBURG.

In continuing on towards Fredericksburg, the general appearance of the soil changes. Instead of the red argillaceous earth that covers the talcose slates, a bluish-white occurs, and the general contour of the hills differs. In approaching Fredericksburg from the south, at about a mile distant, is a bed of horizontal rock 50 feet in thickness. The upper portion of this bed is entirely composed of sand scarce agglutinized, which, on descending, passes into a conglomerate of the same sand with quartz pebbles varying in size from that of a millet seed to a ton in weight. This rock has a grey appearance, and the harder varieties are quarried and used for building purposes. In the county of Stafford, opposite to Fredericksburg, this formation again occurs, forming those hills which border the river. These beds must have a thickness of nearly 80 feet above the river. The lower portion is a conglomerate similar to that which occurs east, and of which we have just spoken, and disappears under the tide waters of the Rappahannock. The upper portions of these beds at this locality have a much finer texture; rolled pebbles are common, but differing from the quartz pebbles of the lower stratum. These upper beds are of a blue colour, argillaceous, and free from carbonate of lime. The imbedded pebbles appear to be portions of a similar rock rolled. They, like the mass of rock, contain many impressions of plants. Lignites are common, and large portions of this rock abound with impressions: specimens of fossil wood are found; and in the same piece you have the quartzose petrifaction, and the organic fibre not yet entirely replaced by the silex. Sulphuret of iron, though not abundant at this particular locality, is common in the environs. Portions of the upper beds of these rocks are coloured yellow with sulphur, which sometimes incrusts and forms concretions in the cavities. The sulphur is most probably the result of the decomposition of pyrites.

The mass of grey rock is overlaid by three or four feet in thickness of thin strata varying in composition and differing from the main mass; one of these strata is a blue argillaceous bed six inches to a foot in thickness, which divides easily, and displays to view fine impressions of plants; another thin layer of entirely different composition overlies this; it is red, and contains much mica. This last seam appears to be free from organic remains. These interesting rocks are covered with rolled pebbles. In the environs of Richmond a thin horizontal bed occurs, but so masked by the alluvium, that occupies a great thickness, as to prevent a minute examination. At Falmouth, two miles up the river Rappahannock, above the spot where the conglomerates disappear under the bed of the stream, granitic rocks show themselves, forming the rugged beds of the river. These granitic rocks are overlaid by the horizontal formations, which do not show the slightest evidence ulterior to their deposition; hence we learn that these beds were deposited after that great event which upheaved those mountains and metalliferous rocks which so uniformly traverse our continent in a north east direction, and which have been detailed in the foregoing pages.

REVIEW OF GEOLOGICAL PHENOMENA, AND THE DEDUCTIONS DERIVABLE THEREFROM, IN TWO HUNDRED AND FIFTY MILES OF SECTIONS IN PARTS OF VIRGINIA AND MARYLAND. ALSO NOTICE OF CERTAIN FOSSIL ACOTYLEDONOUS PLANTS IN THE SECONDARY STRATA OF FREDERICKSBURG. By Richard C. Taylor.

I contribute towards the illustrations of Mr Clemson's and my own papers on the Mineralogy and Geology of this portion of North America, four sections, which, with some investigations that are detailed but not reduced into the diagram form, exceed the extent above announced.

The southern section in the parallel of Richmond, I have already described; pl. 16, fig. 3. The central longitudinal section in the parallel of Fredericksburg, including the gold region, and extending to Winchester, is detailed in pl. 17, fig. 2. And the northern section, in the parallel of Harper's Ferry, extending towards Baltimore, is delineated in fig. 1 of the same plate. A fourth section furnishes details of the Union Gold Mining company's tract in the vicinity of the Rappahannock river.

The observations I have now, individually, to make, shall be few and condensed; and chiefly in relation to the Fredericksburg section.

Avoiding all details, I proceed to give an abstract of the four principal classes of rocks crossed by this section of seventy-one miles; commencing with the lowest, and at the east end.

I. *Primitive.*—Extends westward from near Fredericksburg twenty-one miles, being subdivided into

1. Stratified rocks, partly overlaid by horizontal secondary beds, . . .	10 miles
2. The Gold Belt—talcose slates, protogine and quartz veins, ...	11 "
	21 "

This series comprises rocks of innumerable variety in their mineral constituents, dipping seldom more than 10° from the perpendicular, towards the south east.

II. *Zone of Modified and Mixed Rocks allied to the Primitive.*—Extending from the Gold Belt towards the western base of the Blue Ridge, 36 miles.

This class is described as containing an infinite variety of amphibolic aud epidotic rocks and trapites, including also, within its limits, some bands of sienite, talcose slates, and innumerable quartz veins, which have not yet been determined to be auriferous.

Their inclination is remarkably uniform, being from 8 to 15° from verticality.

III. *Transition of later date than the preceding.*—A part only of the breadth of the great Winchester limestone valley, 14 miles.

The inclination of whose beds is from 30 to 45° from the vertical, and is somewhat disturbed and obscure near its junction with the Blue Ridge.

IV. *Secondary.*—Occupies a breadth on this section of seven miles, partly covering the primitive rocks, and therefore included in the length of Class I.

Horizontal apparently.

Total length of this section 71 miles, at right angles to the courses of the beds.

The only geological document extant with which we can compare our sections, is the map of Mr M'Clure, and with this we perceive considerable discrepancy. Taking the dimensions from that map of the respective classes of rocks which cross our line of section, and comparing them with our own, they stand as follows:

M'Clure.

Primitive, ...	30	miles
Old red sandstone, ...	10	"
Transition, ...	10	"
Primitive again to the crest of the Blue Ridge,	6	"
Transition again, ...	15	"
	71	"

T. and C.

Class I.	Primitive 10 miles, Gold Belt 11,	21	miles
II.	Modified, amphibolic and mixed,	36	"
III.	Transition, ...	14	"
IV.	Secondary overlying Class I. in part,		
		71	

The writer has elsewhere alluded to this supposed belt of old red sandstone, and pointed out the true site of that rock, 100 miles westward from the position assigned to it by the authority before cited.

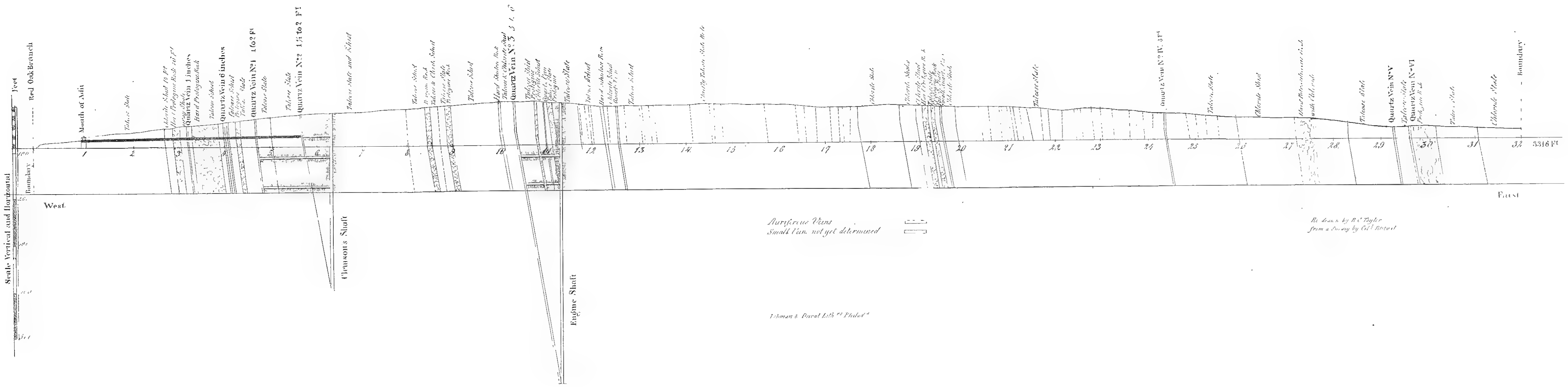
In examining the data which we have brought together, towards elucidating the geological structure of this country, we cannot but be struck with the enormous aggregate thickness of those stratified rocks, which by being placed as it were on their edges, side by side in almost a vertical position, afford the means of correctly measuring their entire dimensions, and display within a limited area a vertical depth far exceeding in amount any estimate that we have hitherto had the means of forming.

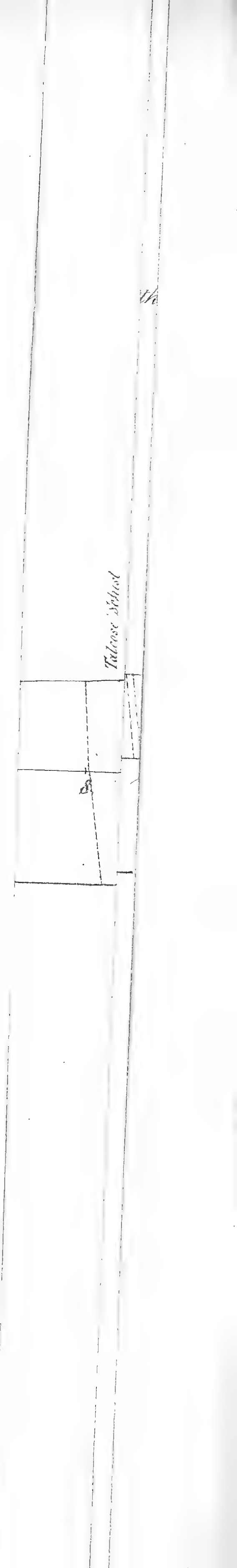
We subjoin the result.

Below Fredericksburg, the primitive rocks are obscured by more recent deposits; but having twice trav-

LONGITUDINAL SECTION *shewing the position of the* AURIFEROUS VEINS *at the Union Gold Mines* VIRGINIA

From the Observations of R. C. Taylor and T. G. Clemson May 1835




Talcose Schist

ersed and studied the same stratification in an oblique direction, between James River and the Rappahannock, we are acquainted with, and in fact have illustrated in pl. 16, fig. 2, the geological character of 40 miles more, where those rocks are prolonged till they intersect the section we are describing.

Thickness of primitive rocks passing between the parallels of Richmond and Fredericksburg, course of strata north east, not less than	15 miles
I. Primitive class, west of Fredericksburg, at right angles to the direction of the stratification, ...	7 "
The Gold Belt, ...	10 "
II. Class of altered and amphibolic rocks, and intermixed beds, extending to the west side of the Blue Ridge, . .	30 "
III. Transition beds, average dip 40° for nine miles, ...	6 "
	68 "

We have thus, in a breadth of 120 miles, the enormous thickness of 68 miles, the whole mass of which declines in one uniform direction.

The fourth section, to which the present article has reference, and shown in plate 18, is a detailed portion of the Virginia Gold Belt, near the Rappahannock. Having studied the position of the auriferous veins in this place, with more minuteness than in most others, and with professional objects, we are permitted by the proprietors of the mines to communicate to the Geological Society the section which was constructed from those examinations.

It comprises only about a twentieth part of the breadth of the Gold Belt, and the rocks partake of the prevailing character of that region; consisting of talcose slate, chlorite shales, protogine, steaschistes, jade, &c., occurring under occasional modifications not necessary to enumerate here. For the details, the reader is referred at once to the section. Within the limit of 3200 feet, comprehended by this diagram, the following veins of quartz occur, commencing from the east:

1. Small vein, showing 4 inches only in the adit, near the outcrop, auriferous.

2. Another of 6 inches, under the like circumstances, auriferous.

3. Vein proposed to be worked, varying from 6 inches to 3 feet, containing auriferous pyrites, which yield from 1½ to 2 ounces of gold per ton.

4. Averaging 2 feet, the pyrites and quartz of which yielded on experiment 1½ to 2 ounces of gold per ton.

5. From 3 to 5 feet; one-third of this vein is estimated to yield ½ ounce to 1 ounce per ton; one-third from ¾ to 1½ ounces, and the remaining third, 4 ounces to the ton.

6. From 3 to 5 feet wide; if selected in two kinds, it is calculated that one-third will yield ¾ of an ounce per ton, and the remainder 2 ounces of gold per ton.

7. Undetermined, quartz vein.

8. Another.

9. Another.

10. Vein from 2½ to 3½ feet wide, undetermined.

11. Vein not auriferous.

Of these eleven veins, six are ascertained to contain gold, which is capable of being obtained by the usual process of amalgamation or concentration.

Only the third, fourth and fifth are intended to be worked, according to the system projected for the mining operations here.

From the extraordinary development and the uniformity of position of the stratified rocks in this region, of which those of the Gold Belt form a small portion, and from the contemporaneous character of the auriferous quartz lodes, there is every reasonable probability that they descend proportionately beneath the surface, and that they will be found to continue to the lowest depth accessible to the practical miner, and therefore are only limited by the circumscribed power attending all human operations. Whether the metalliferous properties of these veins be permanent or modified, at increased depths, is a secret which time and actual proof can alone determine.

Harper's Ferry Section. Pl. 17, *fig.* 1.

It is unnecessary to make other than a brief reference in this place to the section which comprises a large portion of the country between Winchester and Baltimore, because all its details will be found inserted in that diagram, and a repetition would be superfluous. The western extremity of this line passes over 30 miles of blue limestone, and occasional beds of hydraulic limestone, which have been previously adverted to in Mr Clemson's paper. These latter rocks are crossed in the vicinity of Charlestown, dipping nearly at 45° in some positions. They are here quarried; and, after calcination, yield a hydraulic cement of considerable repute. Two varieties of this rock, together with the common blue transition limestone of this valley, have been analyzed by the above named gentleman, and the result is contained in the following note, extracted from the Journal of the Franklin Institute.*

* *Analysis of Hydraulic and Blue Limestone, from Jefferson County, Virginia.*

I analyzed two varieties of this limestone: the one was of a black colour, had a conchoidal fracture, and was susceptible of a fine polish, differing from the grey variety, inasmuch as the latter contains a greater proportion of alumina, giving the hydraulic properties, and is free from bituminous matter, the evident cause of the black colour observed in the first. These two substances being found in immediate contact with the blue limestone, I add an analysis of this rock from the same locality:—

At Harper's Ferry, and extending for 10 miles eastward, occurs a series of modified rocks, whose characters in many respects assimilate to those which we had traversed near Paris and the Blue Ridge, and which have been described in the preceding article.

Passing these we intersect the calcareous breccia known by the name of Potomac marble, and a belt of blue transition limestone. The remainder of the section consists of a variety of the inferior stratified rocks.

FOSSIL PLANTS IN THE SECONDARY HORIZONTAL STRATA OF FREDERICKSBURG.

The conglomerates, grits, and gritty argillaceous beds constituting the groupe which we have described under this appellation, have been held by one writer to be identical with the testaceous beds at Annapolis; but as those are calcareous and probably tertiary, and as their connection has not been traced, the supposition appears to be unauthorized. Opposite Fredericksburg this groupe rises to the height of 80 feet, and near Falmouth 100 feet above the river, while near its western termination it attains an elevation of probably near 150 feet above tide level. This rock is a true depository of lignites, silicified masses of wood, the fragments of large trees,

Black Limestone.		*Grey variety of Limestone.*	
Alumina,	15.2	Alumina,	32.6
Magnesia,	08.2	Magnesia,	02.6
Oxide of iron,	01.4	Oxide of iron,	02.0
Carbonic acid, water, bitumen,	39.2	Carbonic acid and water,	29.8
Lime,	36.0	Lime,	33.0
	100.0		100.0

Blue Limestone.

Alumina,	04.8
Lime,	51.2
Carbonic acid and water,	41.4
Other substances, oxide of iron, &c.	02.6
	100.0

Fig. 1

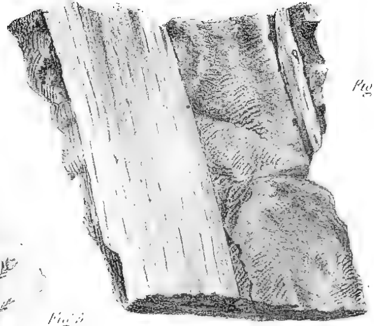


Fig. 2

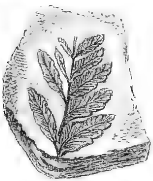


Fig. 4

Fig. 3

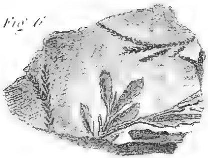


Fig. 6

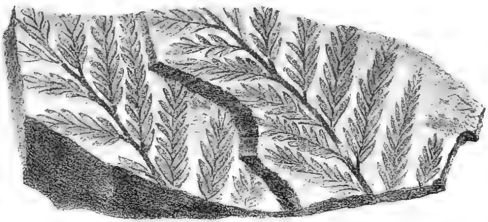


Fig. 5.

On Stone by G. Lehman

Lehman & Duval Lithrs. Philada.

Fig: 1.

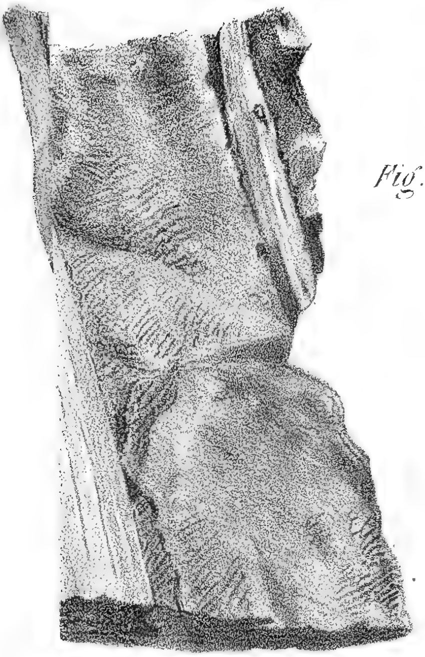


Fig. 2

On Lehman & Duval Lith[rs] Philad[a]

reminded us of those of the Portland rock. We traced these conglomerate and lignite beds to the James river, where, near Richmond, they overlie, as at Fredericksburg, the almost vertical primitive rocks.

Over the coarser conglomerates of Fredericksburg are others in which lignites, both silicified and in the state of charcoal as well as in casts, are plentiful. Above them, in numerous laminæ and seams of bluish argillo-silicious soft shale, resembling marl, but without lime, occur several species of plants. The sedimentary character of these finer beds attests the slow and tranquil circumstances attending their deposition, and affords evidence of a prolongation of time adequate to the repeated renewal of vegetation on their successive surfaces.

Our attention was first directed to these plants by Mr F. Shepherd, who at our request furnished the Geological Society with specimens. We observed no traces of mollusca or animal exuviæ among these elegant lignites. In deposits of this character they may be expected, and when found will materially assist in determining the geological age of these rocks.

Over the argillaceous beds are others of fine white grit abounding in long stems of succulent plants resembling flags. They are frequently in the form of hollow casts, which, near the surface, are filled or penetrated by the roots and fibres of existing vegetables. They are perhaps allied to

Lycopodiolithes? *Pl.* 19, *fig.* 2.

They exhibit no scales nor leaves. The longitudinal elevations or striæ are not prominent or distinct, nor are they uniformly disposed on the surface of such specimens as have reached us, which occasions the more hesitation in naming the genus of this plant.

Lepidodendron. *Pl.* 19, *fig.* 1.

From the grey argillaceous beds above the coarser grit. The characters affixed to this plant by Sternberg, in referring to Lepidodendron phlegmaria, book 2, p. 29, and pl. 17, fig. 1, dispose us to place this species among that order of plants, although we have never seen it occurring of a greater size than about double that here figured.

In the more perfect specimens, the arrangement of the surrounding leaves, the rudiments or imperfect traces of scales, and the general configuration of the branches, bear resemblance to the genus Lepidodendron. Our figure is only so much more minute than those of Sternberg. In all cases the upper extremities of the branches are covered with sharply pointed leaves, whilst in the lower and older stems they have fallen off, as is common with these plants.

We had prepared other illustrations of this fossil, as well as a more splendid specimen of the branching Sphenopteris corresponding to fig. 3, but those we have sketched are sufficiently characteristic.

Sphenopteris. *Pl.* 19, *fig.* 3.

The beautiful fossil vegetable, a fragment of which is here represented, was referred to the genus Sphenopteris with some hesitation: because in our specimen the generic characters of the leaves were obscure; and from their extreme delicacy of outline, showed, in the young pinnules, even when examined through a microscope, in their oval and lanceolate forms and in the apparent absence of nervures, more resemblance to those of the genus *Pachypteris* than to the lobated pinnules inseparable from Sphenopteris. The acquisition of some additional specimens, from the same locality, has assisted in elucidating the structure of these plants, and has removed much of the previous difficulty. Some of the latter specimens are distinctly lobated at their extremities, and obscurely so at their sides. On re-examining our figure 3, traces of the same character were faintly discerned on the older leaves, and thus one of the sources of embarrassment in naming this plant is removed. We refer to the work of M. A. Brongniart, pl. 45, for some of the characters which are partially traced in our sketch.

Fig. 6.

This fragment is probably a *Sphenopteris* of another species, whose leaves are more strongly lobated and more deeply impressed upon the stone.

Pecopteris? Fig. 4.

Something approaching to this figure occurs in pl. 97 of Brongniart. The arrangement of the nervures is here distinctly exhibited; its organization is most distinctly yet delicately defined: and the drawing accurately represents these characters.

Fig. 5.

We are unable to decide with precision upon this plant, of which several examples are found in our collection. Its structure and the arrangement of its leaves are obscurely developed in so minute a specimen. There appear some reasons for referring it, although doubtfully, to the genus *Thuytes* of Sternberg.

On looking over this imperfect list of plants, it will be seen that they all are cryptogamous, Cellulares, or Acotyledones, with the exception of Thuytes, and they belong to genera whose species are distributed abundantly amongst the coal vegetation of all parts of the world; but the present species are new to us. The most recent, but at the same time the most doubtful, genus, is that of Thuytes, a dicotyledonous plant. The four species figured by Sternberg and Brongniart occur in the oolite groupe. We should probably have been more correct had we placed this among the smaller foliaceous Cryptogami.

As relates, therefore, to the evidence which these fossil plants furnish as to the relative age of the formation wherein they are deposited, we are led to the conclusion that it is of secondary origin, perhaps coeval with the oolites. They have no resemblance to any of the plants of the Richmond coal field that have come to our knowledge, and decidedly bear the impress of a more modern character.

In this view we are confirmed by the lignites and silicified wood in some of these beds, which indicate a geological age much less remote than the coal fields of the Alleghanies, for instance, and still further removed from that of Richmond.

The large broken masses of silicified wood are unquestionably remains of vasculares or dicotyledonous plants or trees, no member of which series has yet been observed in our coal vegetation. They resemble in some respects the silicified wood of the Portland oolite of England, and like them exhibit no marks of perforation by the Teredo.

The silicified fragments found by Mr Nuttall near the James river are described as "penetrated with quartz of an opaque white colour, destitute of the resinous fracture, and easily crumbling into an almost impalpable sand." The latter character prevails in the Fredericksburg lignites, and some of them are coated with small quartz crystals.

Again, we have other lignites which are broken up and abundantly intermixed with the grits, and even in the finer argillaceous seams; which fragments occur only in the form of burnt or charred wood, not bituminous, but having their ligneous fibres preserved.

We have moreover a distinguishing evidence of the more recent character of these deposits than those of the Richmond coal field, in the friable open texture of the grits, which are no more crystalline than ordinary oolites, whereas the rocks of Richmond are compact, frequently subcrystalline and porphyritic.

It must be observed that all the genera to which we have assigned the fossil plants of Fredericksburg occur in the oolitic groupe of Europe. For this fact we have the testimony of M. A. Brongniart, Saussure, Phillips, Murchison, De la Beche, and many others. These genera have also been found, according to M. Elie de Beaumont, to a certain degree associated with belemnites and other fossils of the lias, inasmuch as those fossils are imbedded both above and beneath them. But we have seen no traces of algæ, cycadeæ, or of conifera, all of which orders occur sparingly in the oolitic series of Europe.

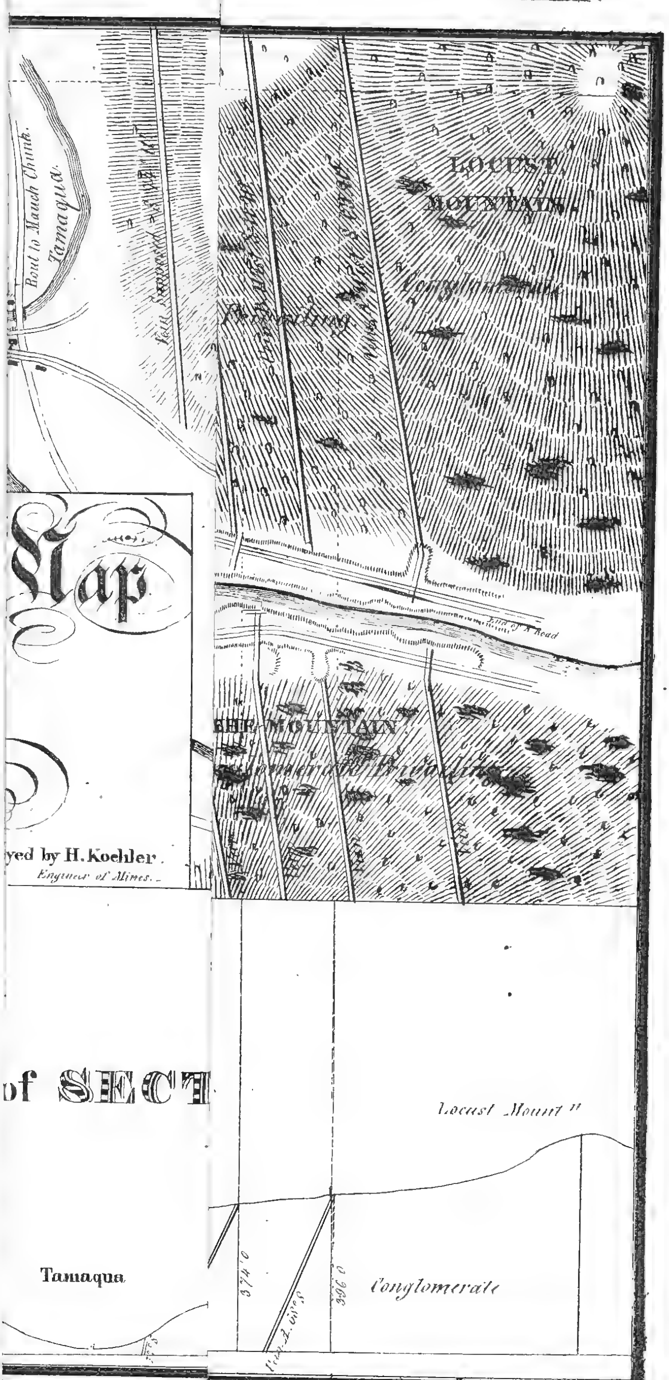
In the absence of further direct and affirmative evidence respecting the Fredericksburg secondary deposit, it will perhaps be convenient to retain for the present the local appellation we have conferred upon it.

ON THE ANTHRACITE DEPOSIT AT TAMAQUA, SCHUYLKILL COUNTY, PENNSYLVANIA, WITH A MAP AND SECTION. By H. KOEHLER, Esquire.

Plate 20.

THE anthracite region, confined between old red sandstone, both at its southern and northern limits, occupies at Tamaqua the space of one mile in breadth, and is distinctly marked by the summit of Sharp and Locust mountains, which are the highest levels of a basin, in which thirty-two large coal beds at present known, and a great number of small veins occur. Within this basin thinly stratified sandstone of greyish or darker colour prevails, and with slate impregnated with carbon and filled with petrefactions of palm stems and leaves, ferns and reeds, forms the walls of the coal veins. This sandstone and slate, frequently containing layers of small grained conglomerate, rest upon conglomerate made up of large pebbles, and forming the crests of Sharp and Locust mountains, exhibiting grotesque masses of rock. On the south side of the Sharp mountain, near the ledge of conglomerate rock called the "back bone of the coal region," commences red shell; and although some beds of conglomerate are often found alternately with the strata of the red sandstone south of Sharp mountain, no distinct coal veins have been discovered therein. On the northern declivity of Locust mountain, the red shell is again in situ, and limits the extent of the coal field on that side, at which, after a distance of about four miles north, conglomerate reappears to embrace the coal beds of the Broad mountain. The principal coal beds of Tamaqua vary from 3 to 28 feet in width. Those of the

Pl.XX.



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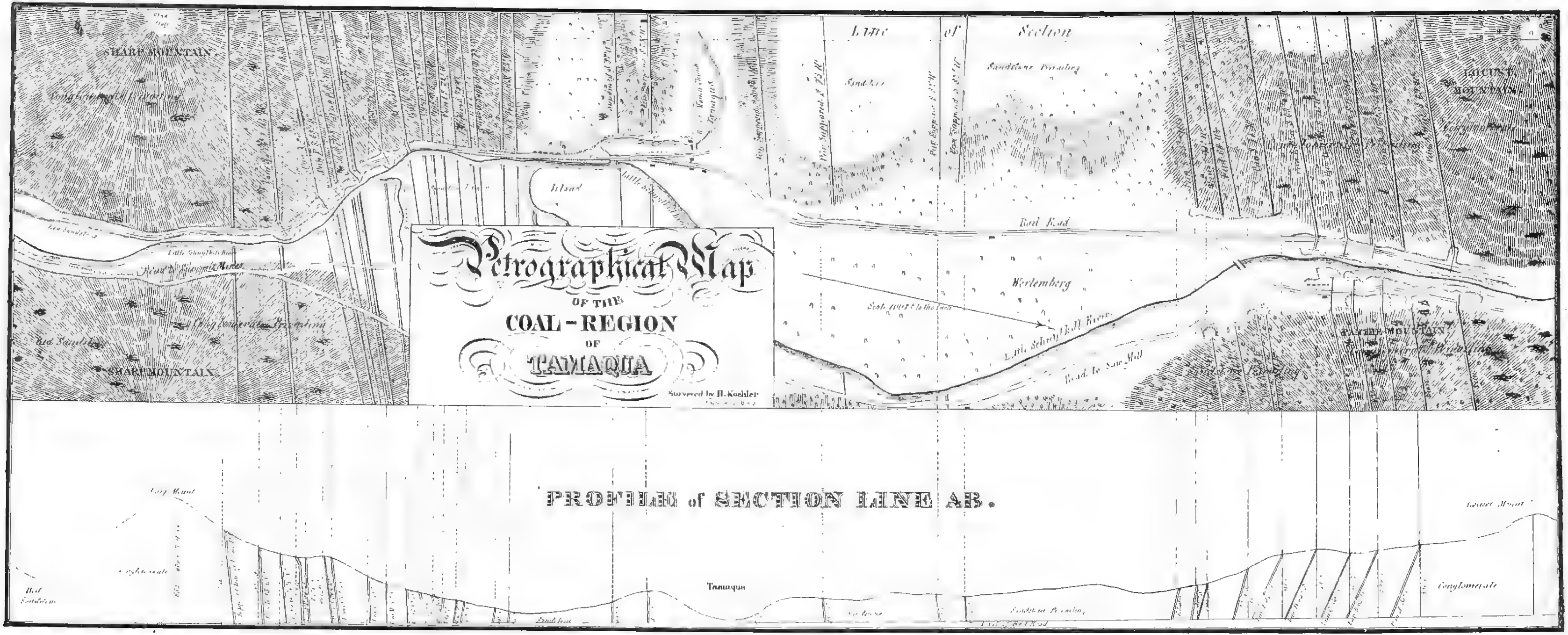


Lehman & Duval Lith^{rs} Philad^a

Sharp mountain are remarkable for their almost perpendicular dip, being from 83 to 87° north. The veins in Locust mountain dip from 60 to 70° south. In their direction, these veins, like the strata of the adjacent sandstone and slate, are nearly parallel with one another, bearing between 60 and 70° south west or north east from a given point, and parallel to the course of the higher ridges of the mountains. On the map those veins only are marked which are over 3 feet wide, and have been exposed to observation by mining operations, in which case their courses and dip are only given. It is quite certain, however, that many more coal beds exist within the extent of this map which will be opened in future times. The mining operations are all carried on by the Little Schuylkill company, who employ from 200 to 300 workmen, conveying their coal by means of locomotive engines to Port Clinton, their landing on the Schuylkill canal.

ACCOUNT OF THE TRAVERTIN DEPOSITED BY THE WATERS OF THE SWEET SPRINGS, IN ALLEGHANY COUNTY, IN THE STATE OF VIRGINIA, AND OF AN ANCIENT TRAVERTIN DISCOVERED IN THE ADJACENT HILLS. By G. W. FEATHERSTONHAUGH, Geologist to the United States, Fellow of the Geological Societies of London and Pennsylvania, &c.

IN a report lately made to government, and recently published by order of both houses of congress, I have at page 21 spoken of a rare geological phenomenon, in the valley of the Sweet Springs, Virginia; the which, as it is connected with the structure of the Alleghany ridges, I am desirous of giving a more full description of, for the transactions of the Geological Society of Pennsylvania.

The principal ridges of the Alleghany elevations have a general parallelism to each other, and coming from the north, run in a S. S. W. direction through the state of Virginia, until they blend with the table lands that are bounded by the carboniferous beds of the Cumberland mountains, in the state of Tennessee. Many of the valleys between these ridges are intersected by numerous knobs, outliers and spurs, which, at inferior elevations, are connected with the main ridge. The White Sulphur Springs, in the county of Green Briar, rise at the western foot of the main ridge, usually passing under the designations of Alleghany and Backbone mountain, on account of its being a watershed for the heads of various important streams, which empty into the Ohio river at the west, and into the Atlantic at the east.

In passing from the White Sulphur to the Sweet Springs, a distance of about 18 miles, the direct course would be nearly south, but there is a good main road, which passes somewhat obliquely through numerous romantic dells and defiles of the Backbone Ridge alluded to, into a broad valley, bounded by an inferior ridge, here called Peter's mountain, at the foot of which the Sweet Springs rise. This is the same ridge which, 50 miles to the north, is called Warm Springs mountain, the Hot and Warm Springs of Bath county bursting out at its western foot.

This valley, like many of the others, is agreeably diversified by hummocks, spurs and knobs, all well wooded, and interspersed with numerous sequestered coves, and wild looking little vales, which separate them.

I had an opportunity during the past summer of examining this part of the country, and found some important beds of anthracite coal on the eastern edge of the main Alleghany ridge, about 8 miles south of the White Sulphur Springs, and lying off 2 or 3 miles from the main road. About 14 miles from the White Sulphur, the elevations recede, the country begins to open, and a very rich bottom of land presents itself, through which the waters of the Sweet Springs flow after they have left their source. The soil here is extremely fertile, bearing luxuriant crops of corn, and indeed nothing can be more beautiful than this valley opening as the traveller advances, and bounded by Peter's mountain.

At the foot of a graceful knoll which extends about three quarters of a mile to this mountain, the Sweet Springs break out very copiously. Before they have left the spring 100 yards, they begin to deposit carbonate of lime, which has formed a regular travertin on the sides of a brook running near the enclosure of the establishment. This brook gives a stream, which, as I have before observed, runs through the rich bottom land. The stream runs for near two miles from the Sweet Springs until it reaches a fall of about 75 yards, where there is a saw mill. This fall is about 550 yards across the valley, and the people of the vicinity call it the Beaver Dam, supposing it to have been constructed by the beavers, as many logs are lying on the slope, which, without reflection, may be thought to be the remains of an ancient structure erected by these animals. On examining this fall and its broad slope, now entirely grown up with bushes and brakes, I was surprised to find that the whole slope consisted of calcareous matter of the same character as that I had observed at the Sweet Springs. It was evident, therefore, that the stream, now only a few yards broad, had once covered the whole surface of the valley; that the rich bottom had once been a pond dammed up, and that the water had been discharged as in ordinary dams, over the whole breadth of 550 yards. If this were so, it struck me that the flat land at the bottom of the slope must have been also covered by this calcareous stream. On examining it, I found it to be the case, and following it up for near three quarters of a mile over the travertin, I came at last to a cascade 42 feet high and about 6 feet broad. The stream was here projected in a very beautiful sheet upon the lower grauwacke slate, which in many places had a stalagmitic floor of travertin upon it of a foot thick. Having scrambled down to the slate, I had a front view of the cascade, with the whole ledge of travertin it was projected from, together with the infinite variety of stalactitic rods and pilasters depending from it. I observed a hemlock tree, *Abies Canadensis*, about forty years old, in full life, incrusted, all its roots and about 7 feet of the stem, with calcareous matter.

Near the foot of this wall of travertin, more than 40 feet high, were the entrances to various caverns, similar to some spacious ones I had entered in the calcareous dam I have spoken of, with depending stalactites, in some instances resembling filagree work and petrified mosses, the fretted appearance of which is caused by the spray of the cascade. And here I would remark, that mineral waters of this character deposit their solid contents most rapidly when they are in quick motion and at shallow depths, the water being then more completely submitted to the action of the sun, and rendered less capable of holding the calcareous matter in solution. This I suppose to be the cause of the broad calcareous slope which has been attributed to the ingenuity of the beavers. When these valleys of denudation were scooped out, and a deep ravine formed where this rich valley bottom now is, the stream at this place probably passed over a rapid, that breaking the water produced the deposit in question, which constantly rose in height until the aqueous volume diminished to its present size, by the filling up of the ravine with calcareous and vegetable alluvial matter, converting the bare slaty bed of the ravine into a fertile valley, capable of producing 10,000 bushels of Indian corn annually; a singular instance of the beneficent manner in which nature operates in favour of man. For here we see the springs of life not only issuing from the depths of the wilderness to restore the enfeebled constitution of the suffering southerner, but that portion of them not directly applicable to his wants, mechanically engaged, by a most happy process, in producing the means of sustaining those who here seek relief, and of embellishing every thing around them. These are amongst the charming lessons we receive from nature, and which dispose our hearts to see a divine care for us in every thing.

The following section exhibits the course of the stream.

a The Sweet Springs. *b* Fall, supposed a beaver dam. *c* Cascade.

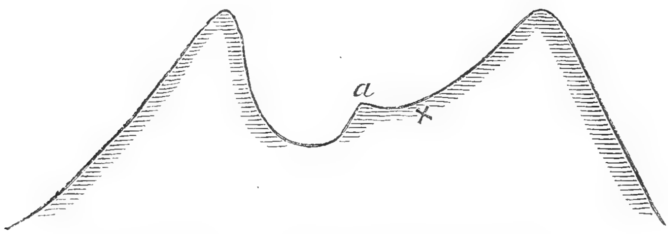
I was one day returning to my cabin, with some specimens of this travertin, when I met Mr Rogers, the landlord of the establishment at the Sweet Springs, an old inhabitant of this part of the country, and a very intelligent and worthy person. He assured me that, some years ago, when hunting deer in the hills, he had seen some rocks exactly resembling them. As he is a man of very good judgment, I proposed to him to accompany me there, and he cheerfully assented. Mounting his horse, and accompanied by myself on foot, we went about 6 miles in a north direction; but so many years had elapsed since he had casually observed the place, and the deep dells and hills, clothed with their everlasting woods, resembled each other so much, that we passed an entire morning wandering about, climbing one hill and descending another, till I began to think he had been mistaken, and told him so; but he proposed trying another hill side, called Snake Run mountain, and there I followed him. Being in advance of me, I heard him hallo, and immediately knew, from the cheerful sound of his voice, that the game was found. He approached me, holding in his hand a piece of very ancient travertin, which I recognized at once; and leading me to the brow of a hill, at least 350 feet above the level of the Sweet Spring, I saw, to my great surprise, a huge mural escarpment of travertin skirting the brow of the hill, with the weather-worn remains of old stalactites, whilst the body of the rock resembled in every particular the recent one at the cascade; abounding in large pipes of calcareous matter, which had formerly inclosed logs and branches of wood. The pendent stalactites consisted of concentric circles, and there was the complete evidence that a stream of mineral water of great breadth, containing carbonate of lime, had for a great length of time passed over this brow and formed the rock. The surface of the rock in many parts was interspersed with what are vulgarly called pot-holes, being circular perforations made in rocks by pieces of rock and gravel, kept whirling in them by streams of water, similar to those which I have seen at the summit of the lofty hills of Lake George, in the state of New York. This Snake Run mountain stood, as I found by compass, N. N. E. by E. from the Sweet Springs; and Peter's mountain, of which I could get a peep through the trees, bore east of the place where I stood.

Here was an extraordinary phenomenon! an immense deposit of travertin lying 350 feet above the level of the spring from which it probably was derived. It seems to be susceptible of no other explanation, than that the level of the valley was, at some remote period, much higher than it is now, and that the springs were at least at this level. The Snake Run mountain is a large limestone outlier from Peter's mountain, such as are constantly found in the valleys. Before these were scooped out by the retiring currents, it is probable the whole surface of the now deeply sulcated region was continuous, and that the springs issued from the bottom of the ocean. When the valleys were swept out, these knobs, hills and spurs, being hard compact transition limestone, resisted, and were left; whilst the conglomerates, shales and sandstones, were carried away: since that period, the softer parts of the formations occupying that part of the valley where the springs now are, have been gradually worn down, and a new direction given to the stream, whilst the old travertin remains a monument of the ancient level, and one of the strong geological proofs of the process of denudation.

These mountainous countries have undergone great changes. I frequently found fragments of conglomerate sandstone (old red) abounding on the slopes and in the valleys, together with slabs and pieces of encrinital limestone, which are not to be found in situ, except this last, which I found near the summit of White Rock mountain, a conspicuous eminence, a few miles west by south from the White Sulphur. The conglomerates appear to have lain above the highest existing summits, and to have been swept away.

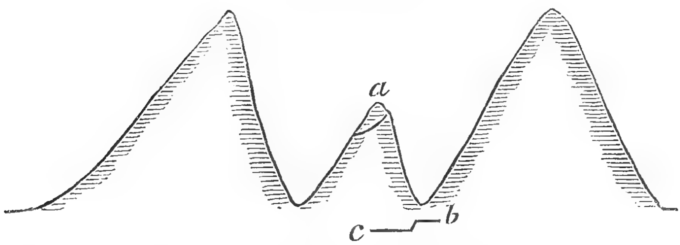
The following sections will serve to explain the ancient and present state of the valley.

1. ANCIENT.



a Travertin. × Ancient site of the springs.

2. MODERN.



a Ancient travertin. *b* Level of modern springs. *c* The cascade.

OBSERVATIONS ON A PORTION OF THE ATLANTIC TERTIARY REGION. By T. A. Conrad.

During a recent excursion through the Atlantic tertiary region, I obtained two species of shells which appear to be new, and some beautiful zoophytes, one of which I have herein described and figured.

At the village of Upper Marlborough, in Prince Georges county, Maryland, I found a very interesting deposit of the age of the eocene formation of London and Paris, and although the shells are mostly mere casts in the indurated stratum, and almost entirely decomposed in the green sands beneath, yet an attentive study of the rocks of various localities from New Jersey to Alabama inclusive, has removed all doubts from my mind relative to the age of the deposit in question. Casts of those most characteristic shells, *Crassatella alta,* and *Cardita planicosta* are abundant, and not a single specimen of either species has ever yet been found higher or lower in the scale of formations than the eocene strata. The same may be said of other species occurring abundantly in the rocks of this locality. The bank of the small stream at Upper Marlborough is high and precipitous, composed of sand and clay, with an occasional mixture of eocene green sand and indurated calcareous masses replete with fossils, the whole consisting of what has been generally termed diluvium. To the west of the village is a range of considerable hills, and on their steep acclivities are scattered abundance of the *Ostrea compressirostra* of Say, and fragments of silicious rock which is a mere aggregate of casts of bivalve shells. Perhaps the summit of the tertiary here, does not exceed 30 feet in elevation above the level of the river. The strata are nearly horizontal. The upper portion is an indurated arenaceous marl, about 4 feet thick, replete with casts of shells which generally have a chalky coating, but occasionally the shells have been replaced by silex. I have specimens of the rock enclosing great numbers of the *Turritella vetusta*, nobis, which are very perfect and beautifully mineralized. Beneath this crust is a mixture of chloritic, quartzose and micaceous sand, the former greatly predominating; it is in mineral character strictly analogous to a variety of the secondary marl of New Jersey, but widely different in its geological relations, as will be seen at a glance by one who can rightly interpret its fossils, which never for a moment bewilder or mislead the inquirer who is versed in this neglected but important collateral branch of geology. Having traced the burr stone of Georgia, the fossilliferous sands of Claiborne, Alabama, and a calcareous clay near Orangeburg, South Carolina, to a common or synchronous origin, I immediately perceived that the deposit at Upper Marlborough was a link in the interesting chain of older tertiary beds.

The only secondary species observed here, is the *Gryphæa vomer* (Morton), but as the matrix is merely the detritus of the secondary green sand, it may be entirely accidental, or it may be that the species was preserved, as the *Plagiostoma dumosum* (Morton) certainly was, having been found attached to an Ostrea in a tertiary stratum at Claiborne.

In the vicinity of the village of Piscataway, also in Prince Georges county, about 16 miles from Upper Marlborough, the same geological features are finely exhibited. The hard crust which overlies the friable chloritic sand, consists chiefly of casts of a fine bivalve described in this paper under the name of *Panopea elongata*. I was the first to publish an account of this interesting locality, and to refer it to the period of the London clay and calcaire grossier, an opinion which every subsequent discovery has tended to confirm, until it is now beyond dispute and admitted by every American geologist. To personal observation I am chiefly indebted for the knowledge and relations of every locality of the eocene hitherto described, occurring in New Jersey, Virginia, Maryland, South Carolina, Georgia and Alabama. Piscataway is situated in a beautiful valley, bounded towards the Potomac by a range of diluvial hills which repose on the horizontal strata of the eocene. From the village the creek cuts through the same formation to its junction with the Potomac at Fort Washington. It has been stated by Professor Ducatel, that green sand of the age of the New Jersey "marl" exists in Maryland, but I believe that so far as organic remains will determine the point, it will all prove to be of lower tertiary origin.

The only places where I have seen the eocene and older pliocene in contact, are in the bank of James river in Virginia, about two miles below City Point; and again a few miles further down the river at Coggin Point, the plantation of my friend Edmund Ruffin, Esq. These localities have been noticed by Professor W. B. Rogers and Mr Featherstonhaugh. The bank of the river is high and precipitous; the lower portion, having but a few feet elevation, consists of eocene chloritic sand containing abundance of *Ostrea sellæformis*, nobis. A thin seam of gypseous clay is generally interposed between the green sand and ferruginous marls, and characterized by the above mentioned *Ostrea*, which is thus brought in actual contact with the pliocene fossils, but is never intermixed with them. It was here I learned the curious fact that the *Ostrea compressirostra*, Say, was the only species of testacea destined to survive, in the same region, the revolution which destroyed all its associates of the eocene ocean. It is abundant on both the tertiary divisions.

The summit line of the lower tertiary is here much undulated, and indeed the surface of both formations in this vicinity exhibits strong marks of the action of powerful currents.

During a recent visit to Long Branch in New Jersey, in company with Mr Vanuxem, I recognised in some casts of shells in a "marl pit" near that place, a few species of the lower tertiary, such as *Voluta Sayana*, *Cardita alticostata*, *&c.*; and as no secondary species was present, I consider the deposit decidedly as modern as the Claiborne formation. It forms a marked contrast to the arenaceous fossilliferous rock at Tinton, six miles distant, where the usual groupe of cretaceous remains occurs; for the latter embraces no tertiary, nor the former any secondary fossil whatever.

In speaking of the eocene period, it may be proper to notice a subformation, which I, in common with most other writers on the subject, considered a distinct formation—the equivalent of the plastic clay of Europe; but a perusal of the third volume of Professor Lyell's Principles of Geology, convinced me of my error; and in the entire absence of fossil shells, or of any fossil whatever, except lignite, we can correctly classify these strata only when their relative position to contiguous formations, above and below, has been clearly ascertained.

The beds of clay and lignite in the United States, usually termed plastic clay, seem to have been deposited in fresh water; for no marine, nor indeed any but vegetable fossils have hitherto been detected in them. Their age has not yet been accurately determined, but as they invariably lie between the primary and tertiary formations, they appear to me to have been formed at the mouths of rivers, when the eocene ocean washed the primary rocks, and to have been converted into dry land by the same convulsions which upheaved the eocene fossilliferous strata. No reliance can be placed on the report of *mastodon* remains having been found in these clay deposits, nor has any well authenticated fact been developed, which could authorize us to consider them of more recent date than the period to which we have here referred them.

At Mr Ruffin's plantation, Shellbanks, I noticed some marl pits in strata of the older pliocene, where a marked resemblance to the English crag was obvious, in a ferruginous mixture of comminuted shells and silicious sand. The upper stratum consists chiefly of finely comminuted shells, inclosing very small, generally young, bivalves, and is about 4 feet thick. It is intersected by numerous seams of clay, without organic remains. The next stratum is of a grey colour, with fewer shells and fragments of shells, and is about 3 feet thick; and then follows a marl full of large bivalves, in a state of decomposition.

Mr Ruffin pointed out to me the singularly broken and irregular summit line of the tertiary, and remarked, that if the sand and gravel were removed, the surface would exhibit numerous deep funnel-shaped cavities. Have these been formed by eddies in the currents, which abraded the surface in the same manner that the waters of rapid rivers hollow the rocks over which they run?

In most of the pliocene marl banks, the large *Pecten Madisonius*, *P. Jeffersonius*, with *Ostrea compressirostra*, and large *Balani*, form the mass of species at the summit; but they are not confined there exclusively, occurring more rarely throughout every part of the deposits.

DESCRIPTION OF NEW FOSSILS.

TESTACEA.

Panopea elongata. *Pl.* 13, *fig.* 1. Shell oblong, produced, surface with distinct concentric irregular undulations; beaks distant from the anterior margin.

Occurs abundantly at Piscataway, Maryland, generally in casts in the indurated marl. Distorted casts of a Panopea, probably the same species, are common near Orangeburg, South Carolina.

Modiola cretacea. Pl. 13, *fig.* 2. Shell inflated, narrowed inferiorly; umbonial slope angulated.

This species is remarkable for its inflated form, which gives it a rounded contour. It is a cast from the upper division of the cretaceous series of Clark county, Alabama, whence it was received by Dr Harlan, to whom I am indebted for the opportunity to describe and figure it.

Turritella humerosa. Pl. 13, *fig.* 3. Shell turrited, subulate; whorls with fine regular revolving striæ, an obtuse slight elevation on the summit, and a shallow groove at base of each.

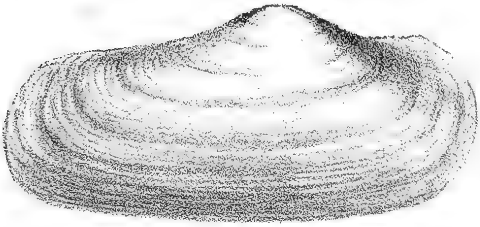
From the eocene at Piscataway, Maryland.

ZOOPHYTA.

Lithodendron lineatus. Pl. 13, *fig.* 4. Campanulate; laminæ of the rays finely crenulated; surface longitudinally and delicately striated.

A beautiful species, not uncommon in the pliocene beds of Virginia, attached to various shells.

I have rather too hastily supposed that the equivalent of Mr Lyell's miocene period occurred in this country; but I am now convinced that all above the eocene may more properly be termed older and newer pliocene. There is no gradual transition from the older to the newer tertiary, but so vast has been the change, or the period of time which elapsed between them, that a single species of testacea has alone survived it; besides, so many recent species of the Atlantic coast of North America occur in every deposit of the tertiary above the eocene,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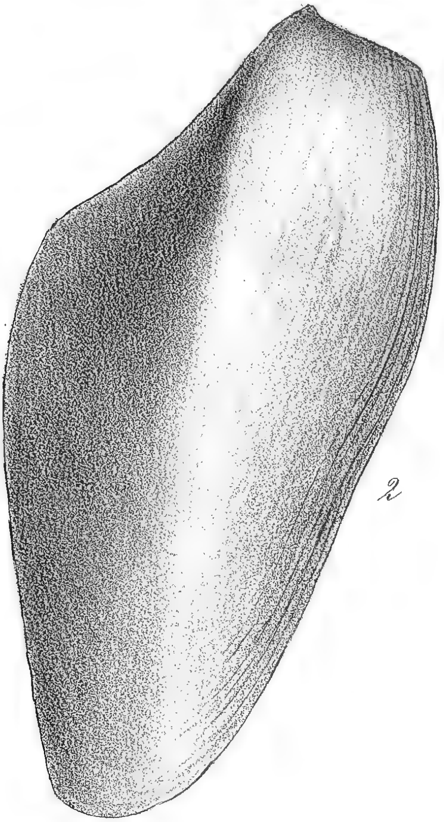
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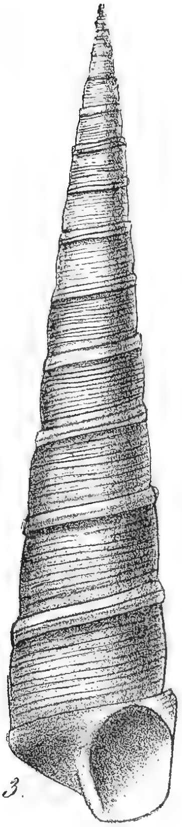
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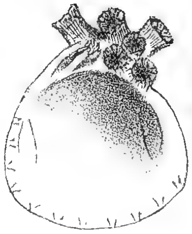
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that although the amount varies considerably in different localities, from fifteen to thirty per cent, yet I believe the discrepancy to have been caused by different depths of water, or peculiarity of situation—not difference of time in which the species existed. These remarks, however, do not apply to those deposits which are composed almost exclusively of existing species; they are certainly entitled to the appellation of newer pliocene, and occur chiefly in Maryland, North Carolina and South Carolina.

THEORY OF RAIN, HAIL, SNOW AND THE WATER SPOUT, DEDUCED FROM THE LATENT CALORIC OF VAPOUR AND THE SPECIFIC CALORIC OF ATMOSPHERIC AIR. By J. P. Espy, Esquire.

It is demonstrated by the air pump, that if air saturated with vapour is suddenly rarefied, some of the vapour is condensed by the refrigeration which is produced by the rarefaction.

It follows from this principle, that if air saturated with vapour should be made to ascend in the atmosphere, the vapour condensed in so ascending would in quantity be proportionate to the height to which it ascended; for the higher it ascended, the more it would be rarefied and cooled, and so more and more of its vapour would be condensed.

Now if any cause exists in nature to produce an upward motion of air highly charged with vapour, and to continue that motion for some considerable time, the quantity of vapour so condensed would be very great, and a rain would be thus produced which would continue as long as very moist air continued to ascend.

When it is recollected that air is lighter the more moisture it contains, it will readily be perceived that there is a cause to produce an upward motion of air, containing a large portion of vapour.

Indeed nothing is more certain than that a column of air lighter than surrounding columns would be forced to rise, and that with a velocity proportionate to the superior weight of surrounding columns.

It might be supposed that the equilibrium would soon be restored, more especially if upon the condensation of the vapour, the air containing it is condensed also, as is generally believed.

This latter, however, is not the fact: for I find by calculation that the quantity of latent caloric given out by the change of vapour to water or cloud, is sufficient to produce an expansion in the air six times greater than the contraction caused by the vapour turning to water. This calculation is founded on these three principles, which are all demonstrated by experiment. 1st. The latent and sensible heat of steam is a constant quantity, equal to 1212 of Fahrenheit. 2d. The capacity of atmospheric air is 250, that of water being 1000. 3d. The expansion of air by heat is 1-480th of the whole, for every degree of Fahrenheit above its bulk at 32°.

It follows from these facts, that whenever vapour, in an ascending current of air, begins to condense into cloud, there is an expansion of the whole mass of air as far as the cloud extends, caused by the evolution of the latent caloric of the vapour. Moreover, this evolution of caloric prevents the air in ascending from becoming cold as rapidly as it would by expanding if it was dry air.

It is known that if dry air should be made to ascend in the atmosphere, it would become one degree colder for every 100 yards of ascent, so that at the distance of ninety 100 yards high, it would be 90° colder than when it left the surface of the earth. But if saturated air should be made to ascend ninety 100 yards, it could not sink in temperature even 45° without condensing a large portion of its vapour; in some cases when the dew-point is high, more than enough to heat it 45° above what it would be by ascending to that height if no latent caloric had been given out.

It follows then, from these principles, that the higher this air ascends, the more will the equilibrium be disturbed, and that the equilibrium cannot be restored while very moist air, at the surface of the earth, continues to flow towards the ascending column.

For moist air in ascending will constantly have some of its vapour condensed and its latent caloric evolved; and thus its specific gravity diminished below that of the surrounding air. While this process is going on, the barometer will fall underneath the forming cloud, even before it begins to rain; for the air, as it expands in the region of the cloud, will spread outwards, and thus diminish the quantity of gravitating matter over the region below; and if the depression of the barometer is given, the velocity of the upward motion of the air may be calculated.

I find, if the barometer stands one inch lower under a forming cloud than it does in the surrounding regions, the velocity of the air upwards will be 230 feet per second.

This velocity will be sufficient to carry up large drops of rain after they are formed far above the region of perpetual congelation and freeze them there, and then carry them off to the sides of the ascending column and precipitate them in the form of hail.

When the dew-point is very high and the ascending column very narrow, the upward velocity will be very great, and thus water spouts, or what the French call trombes, both by sea and land, may be formed.

In short, it is believed that all the phenomena of rains, hails, snows and water spouts, change of winds and depressions of the barometer follow as easy and natural corollaries from the theory here advanced, that *there is an expansion of the air containing transparent vapour when that vapour is condensed into water.*

It is now more than three years since I formed this theory, and all the facts which I have been able to collect since, particularly with regard to water spouts and hail, have confirmed me in its correctness.

It is not my intention at present, however, to present all the coincidence in favour of this theory which I have collected; my object is to call the attention of the members of this Society, and meteorologists generally, to the importance of the subject, and to request them to turn their attention to the following queries, which are indicated by the theory :—

1st. Does the wind always blow towards the centre of a great rain in the lower part of the cloud, and from the centre of the rain in the upper part of the cloud, except as modified by the prevailing currents of wind?

2d. Do those storms which travel from the south west to the north east, always set in with the wind north east and also terminate with the wind south west, when the centre of the storm passes over the observer?

3d. If the wind does not change at the termination of one of these north east storms, is it because there is another not far distant in the south west?

4th. Is the direction of these storms determined by the uppermost current of air in our climate (which is known to be very uniform from the south west), carrying in that direction the air which rises into it, in the region of the storm?

5th. Is the prevailing direction of storms in the torrid zone towards the north west on the north of the equator, and towards the south west on the south of the equator, setting in with the wind in the opposite direction?

6th. If a storm passes to the south of us travelling eastwardly, does the wind change by the north towards the west; and if the storm passes to the north of us, does the wind change round by the south, blowing with a violence in proportion to the quantity of rain and its proximity combined?

7th. Is the direction in which a narrow storm travels, sometimes determined by a middle current moving in a different direction from the uppermost current?

8th. Do storms become more widely extended from the place of their commencement, as they travel eastwardly, or in any other direction?

9th. Does the depression of the barometer keep pace with the motion of the storm, accompanying it throughout its course?

10th. In case of a violent tornado, is the depression of the barometer very sudden and very great at the moment when the tornado passes; and at the moment of greatest depression is there no rain, the drops being carried upwards by the rapidly ascending air?

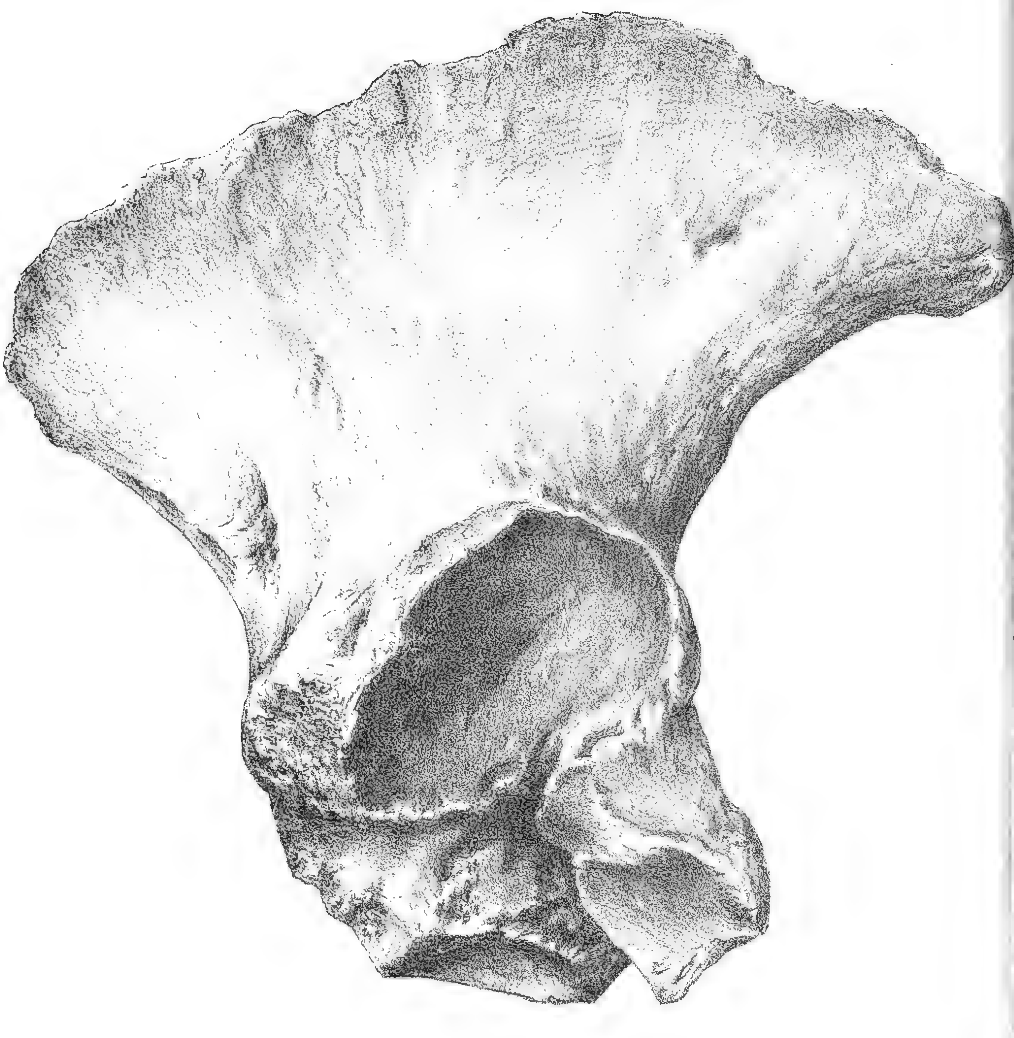
11th. Do violent tornadoes never occur only when the dew-point is very high, and are they always accompanied by violent rain or hail, more copious in the borders of the tornado than in the centre?

12th. In narrow storms or hard showers, does the air at the surface of the earth and at the upper part of the cloud move outwardly from the centre of the shower, while at the same time at the lower part of the cloud it moves towards the centre of the shower?

13th. Are there not sometimes two veins of hail at no great distance apart, both near the borders of the storm?

14th. Are hail storms always of very limited extent in width, occurring only when the dew-point is high; and more frequently in the afternoon than any other part of the day?

If these and such questions, plainly indicated by the theory, should be answered in the affirmative by observation, the theory will be established on a foundation which cannot be shaken. I hope I have shown plausibility enough in the theory, to excite the interest of observers to inquire of nature *whether these things are so.*



Os ilium of the Megalonyx.

NOTICE OF THE OS ILIUM OF THE MEGALONYX LAQUEATUS, FROM BIG BONE CAVE, WHITE COUNTY, TENNESSEE. By R. Harlan, M.D., &c.

Plate 21.

Among several portions of the skeleton of the Megalonyx, recently discovered in the above named locality, the only bone of this extinct animal, not heretofore obtained, is the *os ilium*. A notice of these remains has already been communicated to this Society, by our zealous associate, Professor Troost, and will be found at page 144 of these Transactions.

Referring to the accompanying figure for a very accurate view of this bone, we need only remark, as a curious distinguishing feature, the acetabulum. This is divided into three distinct articulating facets, by a deep crucial groove; the superior facet being nearly double the size of the two inferior. These deep and strongly marked grooves denote the former attachment of very powerful round ligaments.

The observations of Dr Troost on the locality of these fossils, render it quite probable that all the bones of this animal, hitherto described as coming from *White Cave*, Kentucky, are in reality relics from *Big Bone Cave*, Tennessee.

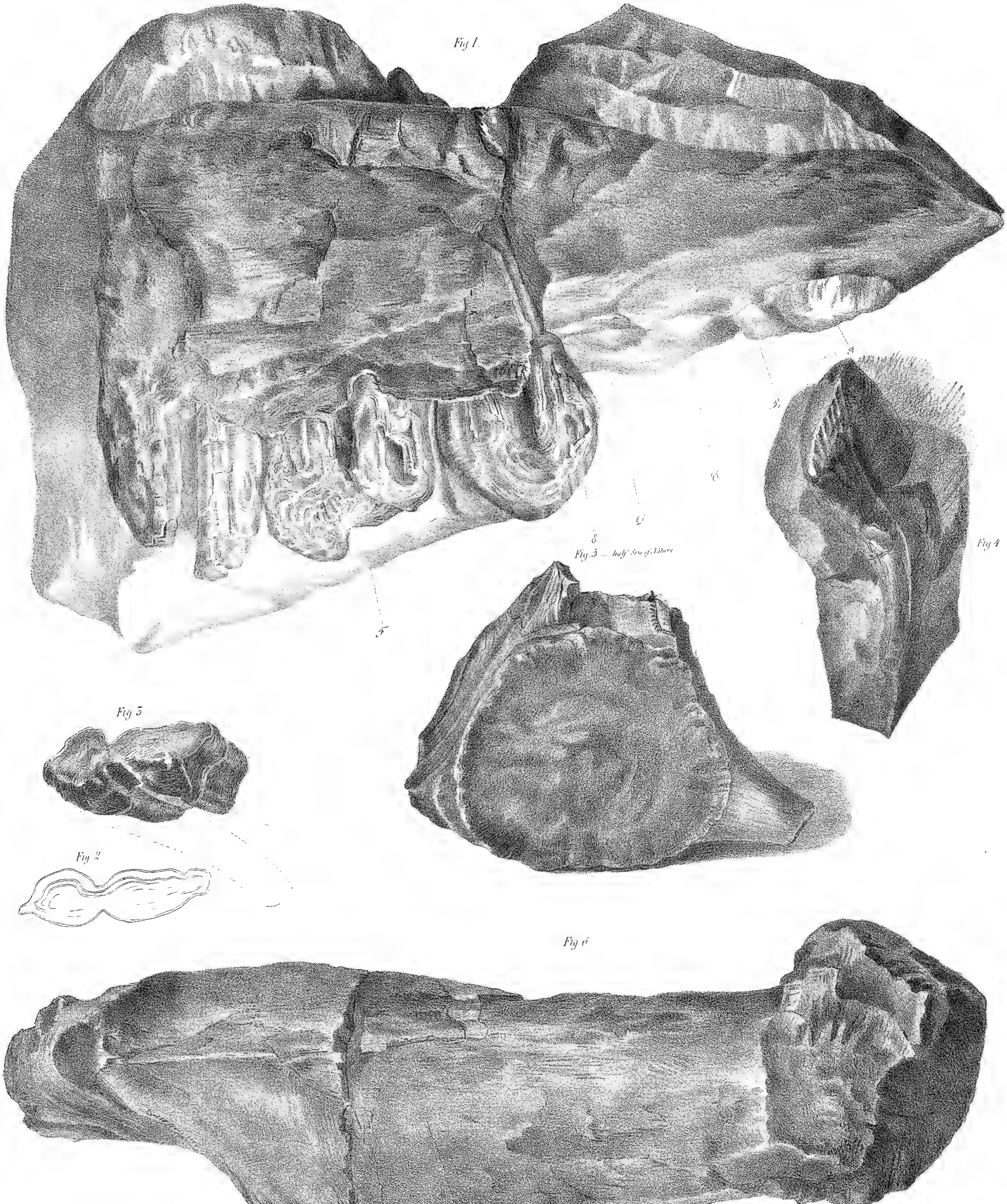
DESCRIPTION OF THE REMAINS OF THE "BASILOSAURUS," A LARGE FOSSIL MARINE ANIMAL, RECENTLY DISCOVERED IN THE HORIZONTAL LIMESTONE OF ALABAMA. By Richard Harlan, M.D., &c.

In the Transactions of the American Philosophical Society for 1834, will be found the description of an enormous fossil vertebra, presented to the Society by Judge Bree, from the "marly" banks of the Washita river, Arkansa territory. We ventured to refer this bone to the vertebra of a large extinct Saurien, of a nondescript genus, and proposed to name the animal provisionally "Basilosaurus."

Accompanying this vertebra, was a mass of the matrix which enveloped the fossil, and contained fossil shells, which Mr Conrad referred to the genus Corbula, and to a species found plentifully in the Alabama tertiary deposits. Regarding our opinion then expressed, as to the geological age of this marly deposit, our subsequent information furnishes no fact either to confirm or to disprove it.

In the course of last autumn Mr Conrad received specimens of fossil vertebræ, fragments of lower jaw, &c., from Alabama, about 30 miles north west of Clairborne, which resemble, in all essential particulars, that previously described in the American Philosophical Transactions, as above noticed. These fossils occur on the plantation of the Hon. John G. Creagh, Esq., in a limestone rock, of so solid a structure as to render blasting requisite in order to obtain the bones, which are consequently much broken—scarcely a single specimen having been obtained perfect.

Soon after the receipt of these bones, above noticed,



Drawn by R. C. Taylor

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Mr J. P. Wetherill joined me in the determination of investigating the new locality of this highly interesting fossil animal. We accordingly communicated our design to the Hon. Mr Creagh, requesting that he would use every exertion to procure us during the winter season a collection of these curious remains; noticing, at the same time, that the jaw, the teeth and long bones were more peculiarly desirable. Mr C. in the most liberal manner honoured our request in paying immediate attention to our demands, and this with the sole purpose of contributing to the advancement of science—the different parties being strangers to each other. We take this opportunity of offering that gentleman, in the name of all votaries of science, our warmest thanks.

The box received on this occasion contained the following named specimens: viz. A portion of the upper jaw of the right side, with several teeth, more or less perfect, all nearly buried in the matrix of limestone with which the bones are intimately incorporated (the rock is of a dull white colour, the bones of a brownish cast tinged with reddish); an os humeri, fractured transversely near the distal extremity, but in other respects nearly perfect (this bone is of a greyish-black colour); several immense vertebræ, with three or four of much smaller dimensions, and of different proportions; one isolated molar tooth, which was with difficulty separated from the mass; numerous pieces of ribs, both true and false; the inferior extremity of a tibia, and some fragments of solid bones, apparently portions of the shoulder and pelvis. From a similar rock in the vicinity of the bones were also obtained and forwarded, casts of a Nautilus, of a species peculiar to this formation (N. Alabamensis, Morton); a new species of Scutella (S. Rogersi, M.); and also the cast of a Modiolus, of a nondescript species, described and figured by Mr Conrad in the present volume of these Transactions;* together with some fossil teeth of the Shark.

Further north in the same state, from a place called Erie, in a limestone somewhat similar, but of a formation which Mr Conrad considers to underlie the above named rock, and of a less recent date, being equivalent to the green sands of New Jersey, I had previously received, through the politeness of Colonel Long, of the U. S. Engineers, a fine specimen of the caudal vertebra of the Mosasaurus or Maestricht Monitor, together with numerous Shark's teeth, similar to those found in the New Jersey green sand.

All the bones are alike totally destitute of animal matter, and are entirely destroyed and reduced to muriate of lime by the addition of weak muriatic acid; they differ from the rock only in colour; the pores occasionally contain casts of small marine shells.

We take it for granted that all the bones obtained from the same spot, and almost in contact with each other, constitute portions of one species. The great disparity in their proportions and size, presents a remarkable feature in the structure of this animal; so much so, indeed, that we were at first inclined to refer the large and small vertebræ to different species: and bearing in view the form and structure of the teeth only, we should have been inclined to rank the animal among the marine carnivorous quadrupeds; but a careful examination of other portions of the skeleton, and especially of the lower jaw, which is *hollow*, forbids this arrangement, and appears to force it to take its station among the Saurien order, as a lost genus.

We understand from Mr Conrad, that he was informed by Mr Creagh, that on his first settlement in that portion of the country, a train of vertebræ belonging to this animal, was observed on the surface of this rock, extend-

* Vide ante p. 340; plate 13, fig. 2.

ing in a line much over 100 feet in length. This statement agrees with that made by Judge Bree; 150 feet in length being attributed by the observers to the Arkansa skeleton. The comparative smallness of the bones of the extremities or fins, constrains us to look to the tail of the animal for the principal organ of locomotion of this huge mass.

Place in the geological series—most recent of the cretaceous groupe. Mr Conrad considers this horizontal limestone rock of Alabama as more recent than the true chalk of Europe, and even as occupying a place anterior to the Maestricht beds. For the accurate and beautiful drawings illustrative of these fossils, we are indebted to the skill and kindness of our friend Richard C. Taylor, Esq. who liberally offered his services "con amore" when his time was most precious to him. Such accurate illustrations obviate in a great measure the necessity of minuteness in written details.

Superior maxilla. Pl. 22, fig. 1.

This fragment constitutes the most important portion of the new fossil animal hitherto brought to view; it consists of a considerable portion of the upper jaw of the right side, containing four teeth more or less fractured, together with the sockets of two others: these, like most of the bones, are of a light brown colour slightly tinged with red; they are so extremely brittle, and so intimately consolidated and incorporated with the rock, as to render their separation almost impracticable. That portion of the palate bone remaining is nearly on a level with the alveoles; the side of the jaw presents a doubly concave surface, that is, concave from above downwards, and from before backwards; the superior border is convex posteriorly, and slightly concave before: this bone is unusually thin, and at the alveoles barely sufficient to accommodate the roots of the teeth. Pl. 24, fig. 2, displays these portions: A, the palate bone; B, the thickness of the side of the maxilla.

The teeth present a remarkable structure, and as far as my observations go are peculiar to the present species: of the four remaining teeth in this jaw no two resemble each other. The first in the existing series, or third from the anterior portion of the jaw, is conical in form, and was covered with a thin layer of enamel, presenting a crenulated surface, a small portion of which still adheres on the anterior portion of the crown; pl. 22, fig. 1, *e*. Fig. 4 is a view of an isolated molar. All the teeth appear to have been similarly enveloped in enamel: the roots are also remarkable both in length, form and curvature, descending $2\frac{1}{2}$ inches into the socket, and projecting 1 inch above the alveoles before they are united by the body of the tooth. Pl. 22, fig. 1, *f*. This is also a double tooth, yet totally dissimilar in form to the last; the outer surface is fractured, but the posterior part of the crown retains its natural form. Not the least appearance of enamel is observed passing into the body of the tooth: that it was covered with enamel is evident from the examination of a similar isolated tooth from the opposite jaw, in a better state of preservation, and the crown of which being weather-worn, enables us to present an outline of the enamel near the crown of the tooth; pl. 22, fig. 2. The whole tooth, is also represented at fig. 3. Posteriorly to this double tooth, in pl. 22, occur two single teeth with each one separate root; their original contour, especially towards their crowns, has been destroyed by fracture.

Anteriorly to the first or conical double tooth, the fossil jaw has been fractured traversely; it contains the socket for one double molar; pl. 22, *b* and *c*; and another anterior or canine tooth of considerable comparative size; pl. 22, *a*. Directly above this tooth, imbedded in the limestone which encloses the inner por-

Fig. 2.

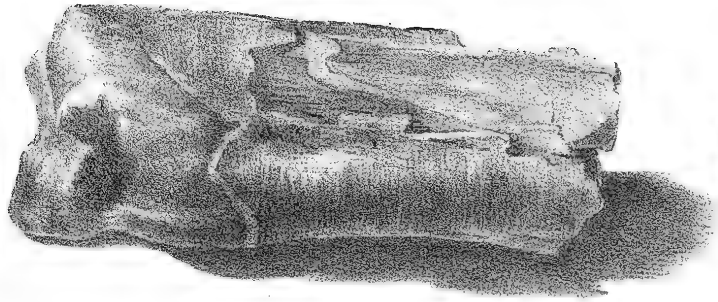


Fig. 3

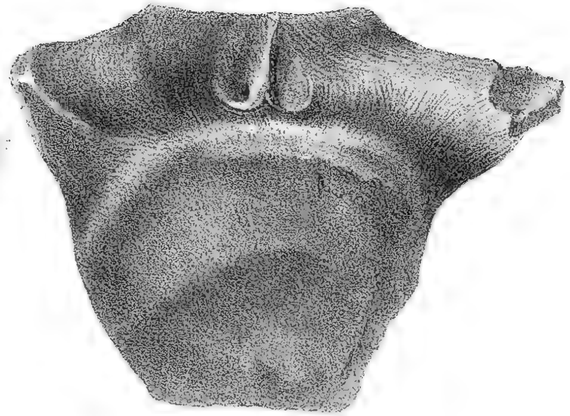
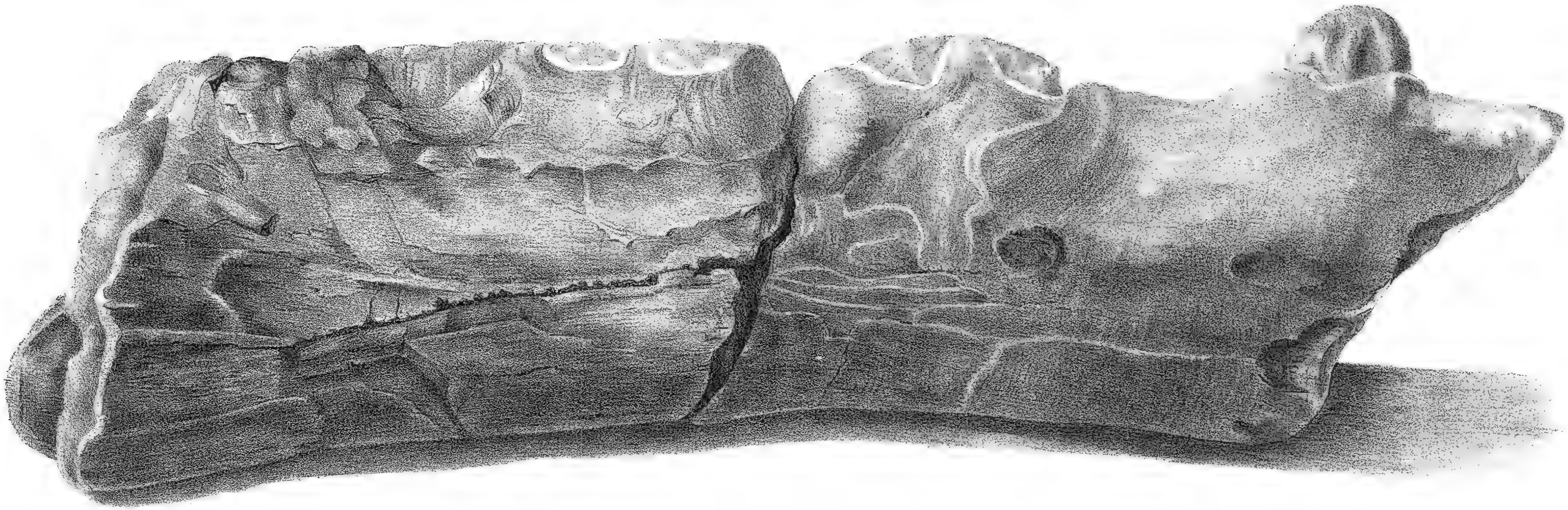


Fig. 4.

Fig. 1.



Drawn by R. C. Taylor

On Stone by G. Lehman

Lehman & Duval Lith^rs Philad^a.

tions of this fragment, is observed a portion of bone, which most probably formed part of the intermaxillary bone. Letter *d* points to a vacancy occurring between the second and third teeth.

At pl. 24, fig. 3, there is an anterior view of this portion of jaw.

Dimensions of the various portions constituting this fragment:—

Total length of the fragment of upper jaw,	15 inches
Greatest width posteriorly, from the base to the alveoles, ...	5 "
Which gradually tapers anteriorly to .	2 "
Thickness of the side of the maxilla, .	2.5 "
Thickness of the palate bone, . .	0.7 "
Height of the largest double tooth, .	2.6 "
Greatest width of do. . .	3 "
Height of the root projecting above the socket,	1 "
Single teeth, height, ...	3 "
Breadth of do., ...	1 "
Length of the socket which contained the canine, ...	2.3 "
Breadth of do., ...	1.3 "
Height of conical double tooth, . .	2.3 "
Breadth of do., ...	2.7 "
Depth of root descending into socket, .	2.5 "

Inferior maxilla. Pl. 23, fig. 1.

General aspect of the lower jaw, compressed or subcylindrical, the shaft being hollow, and the cavity in the fossil filled with the matrix or limestone; the solid portions of the bone varying from a fourth to half an inch in thickness, with the exception of the alveolar portion, which is thicker. External or dermal aspect of the jaw slightly convex, in the direction of its axis, scabrous and weatherworn. The inner or mesial aspect displays the smooth and natural appearance of the bone, excepting a portion of the posterior extremity, which is scabrous and exfoliated; this surface is slightly concave in the direction of its axis, and marked with several foramina, for the transmission of vessels and nerves; basal surface, solid and rounded; dental aspect of the bone varying from one inch and a quarter, to one and six-eighths inches in thickness, marked with a longitudinal depression or groove, for the lodgment of vessels and nerves, exterior to the sockets; total length of this surface 17 inches, containing four sockets, and part of a fifth, all with remains of teeth more or less fractured and destroyed; the four posteriorly situated are the remains of double molars, similar to that displayed in pl. 22, fig. 1, *f*. Anterior to the first molar, a vacant and depressed curved space occurs, and then a pyramidal rising of the alveole, which contains a canine tooth, pl. 23, fig. 1, which has been fractured on its exterior and superior aspect, and from the internal surface of which the enamel has scaled; another vacant space follows this tooth to the anterior fractured extremity of the bone; the portion of tusk remaining is one inch in height, and one and a half inches in breadth at base. The fragments of the molars vary from two and a half inches to two and six-eighths inches in length, and from half an inch to six-eighths of an inch in breadth on the fractured surfaces.

The bone being fractured both anteriorly and posteriorly, leaves us at a loss to estimate the total length of the jaw, and consequently, the total number of teeth.

Dimensions—Total length of this fragment eighteen inches; height posteriorly, five inches—anteriorly, four inches; breadth posteriorly, two and a half inches—anteriorly, rather less than two inches.

Vertebræ.

These are from different parts of the column. Great discrepancy is observable in their relative proportions and size; and they are more or less imperfect; but all

Fig. 1

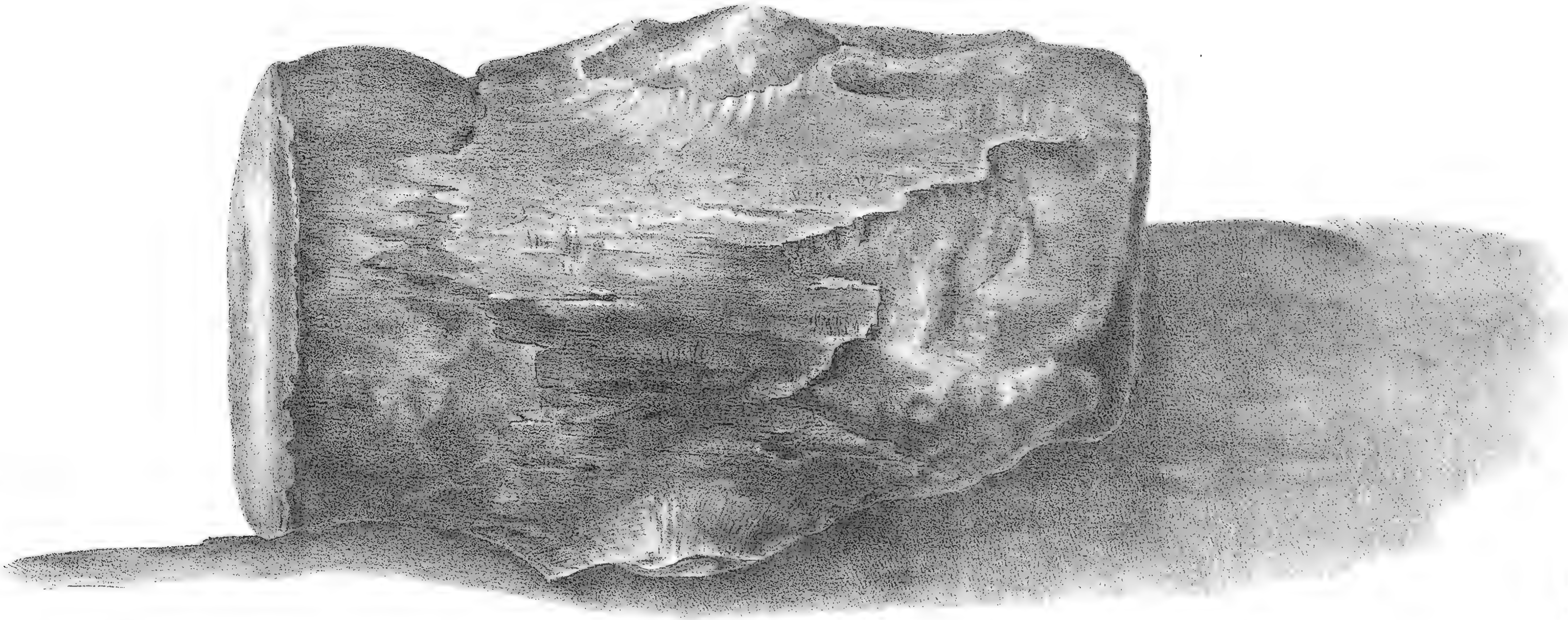
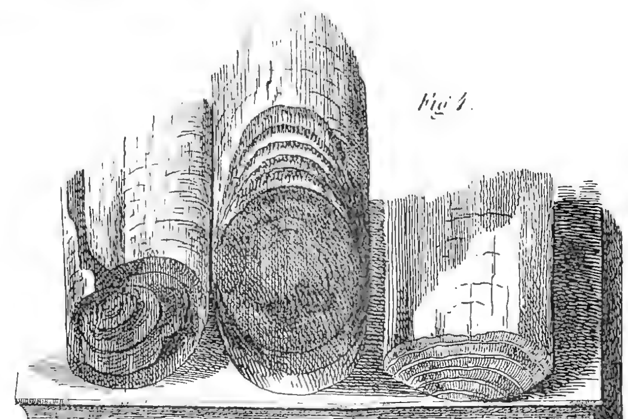


Fig. 2

Fig. 3

Fig. 4



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Lehman & Duval Lith.rs Philad.a

agree in having the transverse apophyses given off on a level (or nearly so) with the basal or inferior aspect of the body of the bone, and descending obliquely, so that the distal extremity of these processes is inferior to the base of the bone. All the vertebræ have the inferior aspect of the body marked with one or two blind foramina, according to the portions of the column to which they belonged—as in the vertebræ of the Plesiosaurus. Pl. 22, fig. 5, represents the transverse processes and a portion of the spinal canal, one half the size of nature. This specimen, like several others, has been fractured transversely in two places, so that one-third anteriorly, and one-third posteriorly, to the transverse process, have been lost. All the large vertebræ display a disposition to fracture at these parts, which arises, doubtless, from the existence of three several points of ossification, dividing the bone transversely, previous to ossification, into three separate portions. The present specimen is from the lumbar region, and measures eight inches by nine in diameter; width of the spinal canal, nearly three inches.

Pl. 24, fig. 1, represents another vertebra of the natural size, and as it presents no mark for the attachment of a rib, must also be referred to the lumbar region; it is nearly as long again as it is broad, being in total length twelve and a half inches, and not exceeding seven inches in diameter, and is nearly cylindrical, excepting in the vicinity of the processes. The blind foramen is almost obsolete. The spinous process has been elevated, contorted and fractured, by the pressure of the rock, when forced in whilst in a semi-fluid state, and which now occupies the place of the spinal marrow.

Ribs. Pl. 23, fig. 2.

The most numerous portion of our collection consists in fragments of ribs, not one of which even approaches to perfection; the spinal extremities, or articulating surfaces, exist in very few of them; these serve, however, to demonstrate an attachment both to the bodies and transverse apophyses of the vertebræ.

These bones are more or less cylindrical, although occasionally considerably compressed, and like the ribs of most marine animals, are destitute of cellular structure. In some instances they appear to the naked eye quite compact and solid; but the variously fractured surfaces of others display a peculiar structure, the whole cylinder being composed of eccentric laminæ: this appearance is accurately represented, pl. 24, fig. 4. The diameter of the largest specimens does not exceed three inches.

There are a few spinal extremities of the false ribs, sometimes with single, at others with double articulating facets. The shafts of these are considerably curved.

Humerus. Pl. 22, fig. 6.

One arm bone, which constituted a portion of this skeleton, possesses unique characters. The complexion of this bone is of a much darker tint than the other bones, owing probably to its accidental position in the rock. The head, neck and tubercles of this bone bear a striking analogy to those parts in the human skeleton. Its shaft is depressed, and particularly so as you depart from the proximate extremity, for two-thirds the length of the bone, where it is flattened, and produced outwards, to form a large depressed external condyle, when the bone becomes more cylindrical, and gradually attenuated laterally to the distal extremity, which terminates in a ginglymus articulation. The structure of this portion of bone leaves no doubt that the superior extremity of this animal assumed the form and functions of a fin or paddle; but a remarkable feature in this bone, is its extreme smallness in proportion to other portions of the skeleton, which renders it certain that the animal was incapable of progression on land, and refers to the tail as the chief means of locomotion.

Dimensions—Total length, sixteen inches; circumference, immediately below the neck, eleven and a half inches; depth at the same place, three inches; breadth, four inches; breadth taken at the external condyle, five and a half inches. The extreme accuracy with which this bone has been represented, renders further detail unnecessary.

Tibia. Pl. 23, *fig.* 1.

We have represented a portion of the long bones of the extremities, five inches in length, which can be referred to none other than the inferior extremity of the tibia: like the same bone in the human subject, it enlarges near its distal extremity, and is furnished with an internal and external malleolus. The tarsal articulating surface is small, and appears more adapted for the connexions of a foot than a paddle. This bone is of a solid structure, leaving but a small cavity in its centre for a medullary canal. Greatest circumference, seven and a half inches.

The collection in the cabinet of the A. N. S. includes a portion of the head of a femur, the circumference of which, in the antero-posterior direction, was, before fracture, twenty inches; transverse circumference, thirteen inches. A very small portion of the neck remains attached.*

* A letter has just been received from the Hon. Mr Creagh, dated May 29th, 1835, announcing the discovery and partial disinterment of another skeleton of the Basilosaurus; and assuring us of his determination to forward a large collection of these remains during the ensuing winter.

NOTICE OF NATIVE IRON FROM PEN YAN, YATES COUNTY, NEW YORK. By Thomas G. Clemson.

On the farm of Mr William Rouse of the above locality, there is found native iron, a specimen of which was sent me by this gentleman for examination.

"The rocks that are found upon this place are sandstones;" and according to Mr R. "the iron exists beneath and on the surface of the earth." The piece sent me was small, weighing in all 1.46 grammes; it was evidently a portion of a larger mass, for it bore evident marks of cutting instruments. It was of the colour and had the appearance of ordinary malleable iron. It was free from the oxides, and acted upon the needle.

The action of hydrochloric acid was marked by the evolution of the ordinary fetid odour usually given off from iron when treated with this acid; and the precipitation of a black pulverulent substance which entirely disappeared upon the addition of nitric acid. Carbon.

The solution of the hydrochlorite of iron was evaporated to dryness and re-dissolved in a few drops of acid and water; there remained no appreciable residuum.

To this acid solution was added an excess of ammonia: a voluminous precipitate of the oxide of iron was thrown down. Iron.

The filtered ammoniacal solution was evaporated to dryness and calcined in a platina capsule. The residuum was too small to be dosed. Previous to calcination, portions of the concentrated solution were tested and submitted to the blow pipe; we were not able to discover the presence of nickel or cobalt.

We have given the above examination, more to state the existence of native iron, than to give the result of this investigation as satisfactory, for we look upon the quantity examined as having been much too small to allow us to appreciate those substances that usually accompany native or meteoric iron, which most frequently are found in very small quantities. We hope to be able, at some future day, to give a more satisfactory history of this interesting substance.

ON THE SCIENCE AND PRACTICE OF MINING. By James Dickson, F. G. S. London; Hon. Mem. G. S. Penn., &c. &c.

CHAPTER I.

Whatever may have been the nature of that power which has occasioned those fissures in the strata of the globe which are termed lodes, it appears to have acted at various intervals of time; but to have exerted itself at the same epoch, with few exceptions, in a uniform direction.

The immediate effect of this power thus set in action, was a separation of the strata in a lineal direction, and a subsidence or displacement of one of the sides of the fissure.

As a proof of this partial subsidence of the strata, it may be observed, that whereas in simple fissures the two sides, whatever may be the variation in their distance, observe a parallelism and conformity; those of a lode, on the contrary, vary most capriciously in these respects, and are usually in opposition; concavity facing concavity, and convexity fronting convexity. It has also been remarked, that wherever the strata are not perfectly homogeneous, the corresponding beds are invariably found at different levels on the two opposite walls of the lode; and again the two segments of a lode which has been severed or intersected, are generally found more or less remote from each other, and the ends of the two segments are observed in numerous instances not to correspond with each other, at the same level, either in respect to breadth or the nature of their contents.

The original formation of lodes or veins is a subject which has excited much dispute among geologists; as yet

Fig 5. TREVAUNANCE.
Cross Section.

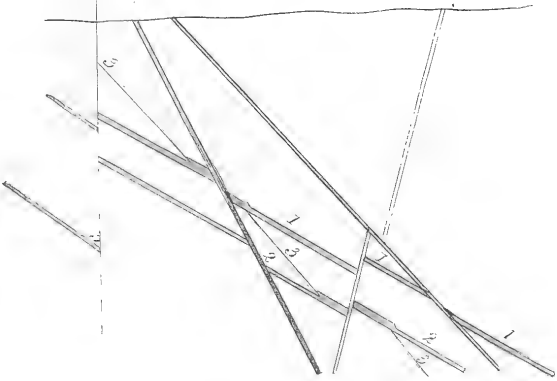
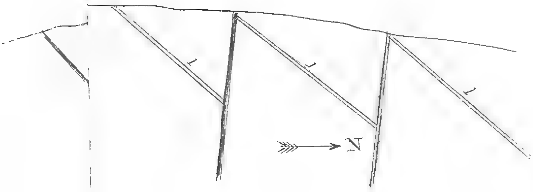


Fig. 6. HUEL DREATH
Cross Section



Elvan Courses

Oldest Tin Lodes

More recent Tin Lodes

East & West Copper Lodes

Contra Copper Lodes

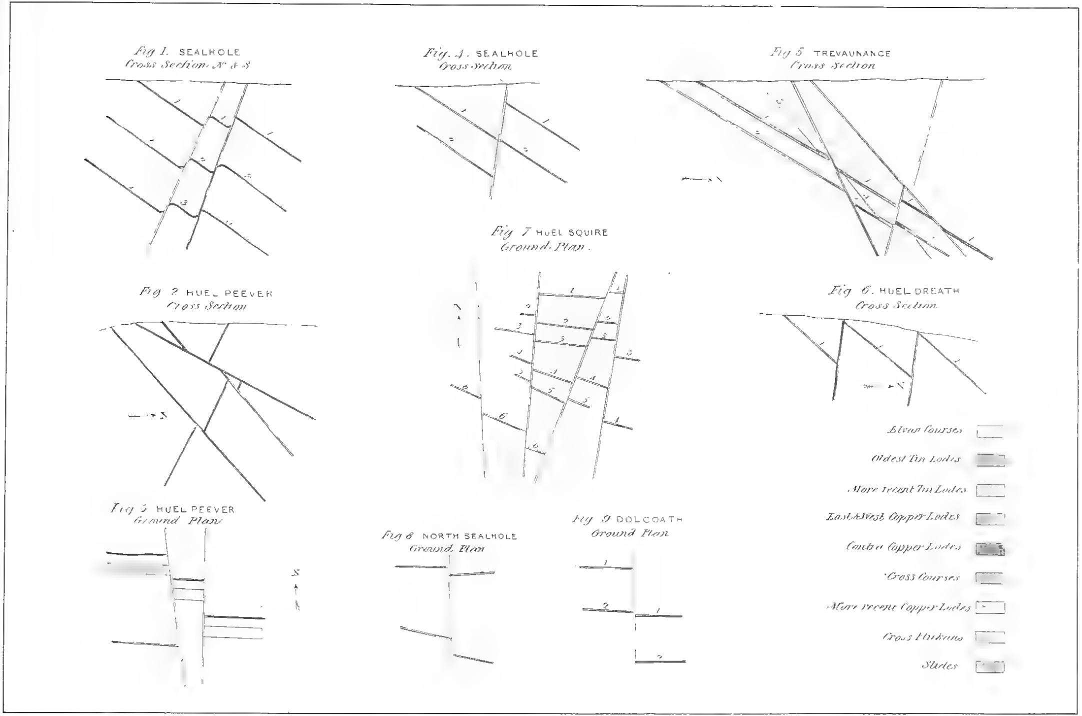
Cross Courses.

More recent Copper Lodes

Cross Flukans

Slides

Waterlow & Morland, Lith. 24 Birchin La. Cornhill.



Waterlow & Morland Lith 24 Birchin La Cornhill.

no theory has been advanced which would seem to reconcile even a large proportion of the facts and data before us. However great may be the diversity of sentiment as regards the mode of their formation, and however great may be the difference of opinion as to their positive age or to the period of their actual creation, it would appear, and justly so, that geologists (except those who hold that all veins are contemporaneous and were formed at the same times as the containing rocks) are agreed on one important principle, viz. *that a vein which is intersected, or traversed, by another vein, is older than the vein by which it is traversed.*

When two veins thus cross each other, it is evident that the one which is prolonged without interruption, is of a formation more recent than that which appears divided so as to allow the other to pass through it. We perceive, then, in such an instance, that subsequent to the formation of the first fissures, the same rocks or mountains have a second time been rent in a different direction along with the veins then existing, and that the new fissures have received substances different from those of the first. The result is that the new vein traverses the old.

There often occurs a third class of veins which cut through those of the two first epochs wherever they cross; and these in their turn are traversed by those of the fourth order whose formation is yet more recent.

It has been considered practicable to recognize veins as belonging to eight different epochs or periods of formation materially distinct, characterised by the metallic substances which the veins contain, the state in which they are found, the matrix which accompanies them, and the respective disposition of the different materials.

If we are to comprize in this grand scale of ages, the veins of quartz, heavy spar, clay and earthy matters, the number of these epochs would be still further multiplied.

It is not only the veins the age of which can be determined with respect to each other or with respect to the formation which contains them, there even exist some indications of the age of metals and of the substances which accompany them in the veins.

Veins have been divided into two general orders: viz. *contemporaneous veins*, or those which were formed at the same time as the rocks which environ them; and *true veins*, whose formation is considered to be subsequent to that of the rocks which contain them.

Contemporaneous veins have been usually distinguished from true veins by their shortness, crookedness and irregularity of size, as well as by the similarity of the constituent parts of the substances which they contain to those of the adjoining rocks, with which they are generally so closely connected as to appear a part of the same mass. Two other marks, more distinctive, must be added. When these veins meet each other in a cross direction, they do not exhibit the heaves or interruptions of true veins, but usually unite. In a multitude of contemporaneous veins, some may appear to be heaved; but the apparent heave seldom affects more than one vein, and it is in general easy to perceive that what appear to be separate parts of the same vein, are different veins, which terminate at or near the cross vein. When they meet with true veins, they are always traversed by them.

By a *true vein*, is understood, *the mineral contents of a vertical or inclined fissure, nearly straight, and of indefinite length and depth.* These contents are generally, but not always, different from the strata, or the rocks which the vein intersects. True veins have usually regular walls,* and sometimes a thin layer of clay between

* By this term is meant, that the rock of the country stands against the vein, on each side, as a wall, without being intermixed, or forming one body with it.

the wall and the vein: small branches are also frequently found to diverge from them on both sides.

With all these descriptive particulars, however, it is frequently very difficult to distinguish true from contemporaneous veins. There are few veins which can be brought to the test of all these marks; and there are probably exceptions to some of them. Some veins which are very short, are perhaps true veins, and others of considerable length and width, and tolerably straight, may possibly be contemporaneous; but with respect to the latter, if the dip of the strata of the rocks in which they are found be minutely examined, it will probably appear that, in most cases, the inclination of those veins is parallel to it, and that they are therefore contemporaneous rather as beds than veins. Other veins there are, of such a dubious nature, in many respects, as to render it necessary to place them in a different and separate order.

We shall briefly notice the various veins which would seem to come under the denomination of contemporaneous veins, presenting such details as will illustrate the peculiarities of each.

Granite veins, in a granite formation, occur in various parts of Cornwall, Great Britain. They are of three kinds. Some are of considerable size, and their granite is of the same kind and colour as that of the environing rocks, but rather decomposed; they have no regular walls; their direction is about north and south. The second class comprises those which differ only in colour from the granite which contains them; these are generally not more than one foot in width, and its large crystals of feldspar are of a beautiful red colour, while those of the adjoining granite are brownish-white. The veins of the third class are composed of compact and fine-grained granite, very different from the contiguous granite. They occur from six inches to a foot in width, running in all directions; when they meet each other they do not traverse, but unite.

Veins of feldspar are met with in the granite. They have no walls, and although one of them is nearly a foot in width, they are generally very small, short and tortuous. The feldspar is very compact, and the veins may be easily distinguished by their bright red colour.

Veins of mica are occasionally met with in granite. They are seldom more than half an inch in width; and although tolerably straight, are very short; they generally consist of two layers of mica, in plates which meet in the centre of the veins.

Veins of schorl are met with both in granite and clay slate; when occurring in granite, they do not appear to be much wider than one inch, and are tolerably straight and short. In the slate, they vary from an inch to one foot; of some the inclination is parallel to the dip of the slate, but of others it is different.

Veins of quartz have been found intersecting clay slate, green stone, grauwacke and granite, in all directions, and are met with more frequently in the clay slate and grauwacke. These veins do not seem generally to have distinct walls, and are irregular in size, direction and inclination. They are intersected by all true veins, and frequently, when in clay slate, by granite veins.

Veins of actynolite and thallite occur in clay slate and green stone. The asbestos actynolite, mixed with axinite, has been found in veins varying from four to twelve inches wide. The thallite are from two to eight inches wide.

Veins of axinite have been found in green stone, and abundantly in granite; and, in hornblende slate, veins of this mineral have occurred as wide as three feet; in some of them the axinite is of a beautiful violet colour.

Veins of garnet rock, almost a foot in width, have been met with in the green stone and clay slate.

Veins of prehnite have been met with in clay slate;

they appear to be irregular, both in size and direction, but generally not wider than six inches.

Veins of chlorite occur in clay slate and green stone.

Veins of iron stone or free stone, this name having been given to it in consequence of its great hardness, appear to consist principally of very compact hornblende, with chlorite and quartz. They are generally very large, sometimes having been ascertained to be more than one hundred feet wide. They have hitherto been found in the clay slate.

Veins of serpentine have been observed in the green stone formations, occasionally crossing without specific direction.

In serpentine formations it is usual to remark veins of one colour crossing a mass of a different colour. They are not generally very wide, and are short and tortuous.

Veins of green stone are met with in serpentine as also in the green stone itself, differing in this case by being either more compact or less so than the environing rock. They are, when occurring in the serpentine, very small.

Veins of asbestos are found in the serpentine formations; are also met with in green stone; their width being not great, and their position nearly horizontal. They are remarked of considerable extent in the gold districts of the United States in the talcose slate.

Veins of agate are met with in serpentine near its junction with clay slate. They are very minute and irregular; but little information has as yet been received of those occurring in Germany.

Veins of calcareous spar in limestone are so common in the transition limestone, that a particular description of them is unnecessary.

There are also other veins which appear under different circumstances, and which deserve a notice here. They may be styled veins within veins, as they are only found in the vein stones or matrix of other veins. They may be sometimes considered as contemporaneous with those parts of the other veins in which they are met with, although perhaps not always so with the rocks which contain those veins.

Veins of jasper occur in tin and copper lodes; are of various colours, green, yellow, red and black; they are of small size, under one inch, and appear to have no regularity of position or direction.

Opal has been also met with, in the quartz matrix of tin lodes; sometimes the fire opal has been found thus; the lodes containing opal and jasper are in granite.

Veins of fluor spar occur frequently as a vein stone of metalliferous veins, and is often found with purple veins of the same substance running through it in all directions.

These are, then, most of the veins of whose contemporaneous formation there is the greatest probability. It is not improbable, were the attention of miners more directed to this subject, that additional ones would be discovered, and more correct data than are now possessed, afford fresh light on this interesting subject.

There is another class which are of such a character as to render it difficult properly to designate them. We should, however, place them under the head of "doubtful veins." This order will comprize all those whose situation, appearance, and attendant circumstances, render it doubtful whether their formation was contemporaneous with, or posterior to that of the rocks which contain them.

Granite veins in the clay slate of Cornwall, have been the subject of much discussion; and it would appear that the more they are examined, the more difficult it will be found to form any consistent theory respecting them. So different are their appearance and attendant circumstances, in different parts, that a very plausible theory made with reference to the veins of one spot only, will be found quite inconsistent with those of another.

So far as they have yet been examined, it would appear that they occur under the following circumstances.

1. They are found only at or near the junction of the granite and clay slate.

2. They are not metalliferous.

3. They have no general direction or position; some are quite vertical, others nearly so, others at different angles and some quite horizontal.

4. Their direction is usually as straight, and their size as regular as those of true veins; but in some cases they become smaller as their distance from the granite mass increases.

5. Their greatest length has never been ascertained; some have been traced as far as 200 feet.

6. The granite of the veins generally appears different from that of the main body; it is of much smaller grain; it contains a much larger proportion of quartz and very little mica; sometimes, indeed, scarcely any perceptible mica.

7. The slate which is contiguous to the veins becomes almost imperceptibly changed from clay slate to mica slate, and sometimes has even the appearance of gneiss.

8. The slate which is close to the veins is frequently much harder than that which is more distant from them, and its texture, in general, not so slaty.

9. The veins have been traced to the granite mass, with which they appear to be in complete union, and to form one body, losing their character entirely as to veins. Whether the other veins unite with the granite mass or not, has not been ascertained, as the point of junction is seldom accessible or even visible.

10. One of the veins has been traced from the slate *into* the granitic mass.

11. Some veins are closely connected with the slate, and the two bodies appear intimately united and inseparable; in fact they appear contemporaneous. Others,

again, are so easily separable from the slate, and have walls so distinct, that, under any other circumstances, they would be taken without hesitation for true veins.

12. Fragments of slate are visible in several of the veins, though they have not been observed in the main body of the granite.

13. The clay slate is occasionally intersected by numerous small quartz veins, some of which are traversed by the granite veins; others, on the contrary, traverse and heave both the granite veins and the other quartz veins. An instance of such heaves has been noticed, where one of the granite veins is heaved three feet to the left by a quartz vein in which slate is mixed with the quartz: by another, two granite veins are heaved to the left, one nearly 3 feet, the other 6 inches.

14. At some sites, where the junction of the granite and slate takes place, they appear at some points so completely intermixed, as almost to exclude any other idea than that of contemporaneous formation, although at other points the junction is distinct and regular.

15. In most other places, where the junction occurs, the slate reposes on the granite, without any appearance of a dislocation or disturbance of the strata.

From the union of some of the veins with the granite mass, it has been concluded that the veins and the mass are contemporaneous; if so, was the whole formed before or after the slate? Some have considered that they were ridges protuberating from the mass of the granite, the spaces between which were afterwards filled with slate. The horizontal veins to be met with in their vicinity, would, however, seem to oppose this last conclusion.

Others again have considered, that both the veins and the mass are posterior to the slate, although they differ in their opinions as to the mode of their formation.

From the intimate union which subsists between some of the granite veins and the slate which contains them, it has been contended, by some geologists, that the veins and slate are contemporaneous; others have, however, come to a different conclusion. It has been argued, from the fact "of some of the granite veins traversing the contemporaneous quartz veins," and from the fragments of slate which are frequently found in them; that the granite veins are of a more recent formation than the slate which contains them. They also contend, from the granite of the veins being generally different in many respects from that of the mass, from the fragments of slate not being found in the mass as well as in the veins, and "from the slate being rarely overlaid by any part of the granite mass," that the main body of the granite may have preceded the slate, although the granite veins (as veins) may have followed it.

The apparent alternations of granite and slate, at different places, may be caused either by the occurrence of highly inclined granitic veins, or by the slate filling up the irregularities in the granite.

It would appear, from all that has been here observed, that two primitive rocks, at or near the point of their junction, sometimes alternate with each other, and render it probable that, although strictly speaking the main body of the one may be said to be anterior to that of the other, the formation of the former was scarcely finished when that of the latter began. It may be difficult else to account for the fact, that the granite and clay slate exhibit a change in some of their qualities, almost wherever a junction occurs.

Veins of steatite are abundant in the serpentine formations; they are from several inches to 3 feet wide, their colour from white to yellow, green and purple. They have distinct walls, and are as regular as true veins. Fragments of serpentine and calcareous spar are sometimes found in them. They bear a closer resemblance to true veins than any others; but they have been included in this order, as opinions have been entertained, that they bear the same relation to serpentine that kaolin bears to granite. Veins of white steatite have also been observed in clay slate.

Veins of calcareous spar have been found in other formations than the limestone, and in such cases come under the present order. They have been found in the serpentine, clay slate and grauwacke. In the serpentine and grauwacke they are generally small, short and tortuous, but have distinct walls. In the slate, although also small, they are for the most part tolerably straight, and have regular walls.

Elvan courses, more generally considered as porphyry dikes, are composed of a mixture of hornstone, quartz and feldspar, having the appearance of hornstone porphyry. Other substances are, however, termed elvan by miners. A stone composed of very compact hornblende and chlorite, is called blue elvan; a mixture of hard hornblende and quartz has received the same name; a compound of feldspar and hornblende is also called elvan; a combination of hornstone quartz, schorl and chlorite, has also been thus designated; and fine grained granite has been thus called. Hardness does not appear to be an essential quality of elvan.

The elvan courses vary in width from 1 to 60 fathoms. Their direction is generally a little north of east and south of west, and they almost always underlie toward the north, at an angle of 45°. The extent of their length has never been ascertained, although one has been traced as far as 5 miles. Elvan courses seldom, almost never, intersect true veins of copper or tin, although they frequently intersect and heave lead lodes.

Elvan courses have been considered as contemporaneous with their inclosing rocks, because they are traversed by metalliferous and other veins, in nearly the same manner as the granite and clay slate in which they occur: this, however, only proves their priority to those veins.

The third order comprises all that are generally acknowledged as true veins, especially all the lodes. These may be divided into several classes, the periods of whose formation appear to be different.

Before distinguishing these classes, it would be well to define the terms which are generally applied by the miners to the different kinds of lodes, as follows:

By a *lode*, is understood a metalliferous vein.

By *east and west lodes*, metalliferous veins, whose direction is not more than 30° from those points.

By *contra lodes*, metalliferous veins, whose direction is from 30 to 60° from east and west.

By *cross courses*, veins whose direction is not more than 30° from north and south.

By *flukan* veins, veins of whitish or greenish clay, generally argillaceous.

By *cross flukans*, veins of this clay, having the same direction as the cross courses.

By *slides*, veins of slimy clay, greatly inclined, having generally an east and west, and rarely a north and south direction.

Among the veins of Cornwall, where most data have perhaps been collected on the present subject, and relative to which the facts and conclusion about to be submitted are principally derived; the first class of these veins, in point of age, consist probably of the oldest tin lodes. Tin lodes are considered to be of two classes, because several instances have occurred in which, at the meeting of two tin lodes, one of them is traversed and heaved by the other. It may be stated, in general, that the tin lodes, which underlie northwards, are traversed by those which underlie towards the south. It is concluded, therefore, that the former, which form a very large majority of the whole, are oldest.

It may be observed that the term "*heaved,*" is used here as applicable only to a longitudinal shift of the vein, and "*thrown up*" or "*thrown down*" to those shifts which take place on the meeting of two veins underlying in different directions, in their downward course.

In describing the heaves as to the *right or left,* is meant, that when lodes are heaved by other veins, they may be found on the other side of the traversing veins, by turning either to the right or left hand. The *more recent* tin lodes comprize most of those which underlie southwards. A particular description of tin lodes will be found equally applicable to both these classes.

In order to prove, on the principles already laid down, that the tin lodes are the most ancient of the true veins, it must be shown that they are traversed by true veins of every other description.

They are traversed by east and west copper lodes. In one instance two tin lodes are traversed by one copper lode, and both are heaved about 12 feet. In another, two copper lodes traverse one tin lode, which is heaved by both of them. At the Huel Peever mine, a tin lode underlying south, has been met in its downward course by a copper lode underlying north, and has been thrown up 8 fathoms. It is also traversed by two slides, both underlying north; by one of which it is thrown down 14 fathoms, and by the other thrown up 9 feet (pl. 25, fig. 2); and at another point in the same, it has been heaved 70 fathoms to the right by two cross courses: pl. 25, fig. 3. A singular heave of tin lodes, by a copper lode, was observed in the Sealhole mine. A part of a very rich tin lode was heaved so exactly opposite to a part of an unproductive lode, as to occasion a dispute between two sets of workmen; pl. 25, fig 4. At the same mine the tin lodes are thrown up 2 fathoms by a copper lode, and 2 fathoms more by another tin lode; pl. 25, fig. 1.

In an old mine called Huel Dreath, the back or top of the tin lode appeared three times at the surface, by being thrown up twice on meeting with copper lodes, as exhibited in fig. 6, pl. 25.

In Huel Trevanaunce the tin lodes underlie 10 feet per fathom north, and the copper lodes 3 feet in the same direction; on their intersecting the tin lodes, the latter are thrown down nearly 5 feet. In this mine there is a junction of tin lodes all underlying north, as shown in fig. 5, pl. 25.

Tin lodes are traversed by cross courses. The shifts of lodes by cross courses and cross flukans, are of course always longitudinal or oblique. At Huel Vor, there are three cross courses which affect the lode in a different way. For several fathoms on each side of the western cross course, the lode is divided into small and almost worthless branches. The middle cross course heaves the lode 27 feet to the right. By the eastern cross course, the lode, at the depth of 20 fathoms, is heaved 42 feet to the right, but at the depth of 60 fathoms only 6 feet.

In the north Sealhole mine, the tin lode is heaved 6 feet to the right, whilst a neighbouring copper lode is heaved by the same cross course 16 feet; fig. 8, pl. 25.

The copper lode is intersected at a larger angle than the tin lode.

Tin lodes are intersected by cross flukans which are observable at various mines. At Huel Vor, there is a cross flukan about 15 feet from the middle cross course. The lode was much richer between the flukan and the cross course, than before it came in contact with either.

They are also intersected by slides as at Huel Peever; fig. 2, pl. 25.

A fine vein of tin lodes of both classes, and of their intersections, may be obtained at Carclase mine near St Austle, Cornwall, which is an immense excavation open from the surface.

The country is a decomposed granite of a greyish white colour; the lodes, which are composed of quartz and schorl, being of a blackish colour and seldom more than 6 inches wide: the contrast is very visible. The lodes of the oldest class are nearly perpendicular; some of them have a small inclination to the south; the more recent lodes underlie rapidly southwards, and traverse the others.

The third age comprizes the oldest east and west copper lodes, forming the great majority of all the copper lodes met with in Cornwall. The oldest east and west copper lodes are traversed in like manner by contra lodes, cross courses, cross flukans and slides, which, by parity of reasoning, are posterior to them; as more particular descriptions will be given of copper lodes in another portion of this work, the subject will be deferred for the present.

Contra copper lodes form the fourth relative epoch, as they have never been found traversed by the other older lodes. They are traversed, however, by cross courses, cross flukans and slides.

The fifth class includes cross courses; these veins are sometimes composed wholly of quartz, but they usually contain, besides quartz, a large portion of flukan, and in some cases the quartz appears on one side of the vein, and the flukan on the other: when this is the case, the flukan is most probably the oldest. The average width of cross courses is at least 6 feet; they have been met with as wide as 30 feet. Their direction is sometimes north and south, sometimes west of south and east of north, seldom exceeding 20° on either side.

These veins are sometimes the cause of incalculable trouble and expense to the miner by shifting the lodes from their usual course, by deranging their contents, and oftentimes by cutting out all their mineral riches. On the other hand they are sometimes advantageous, as that part of them which consists of flukan is impervious to water.

It has been shown that cross courses traverse all those true veins which have been already described; it remains to be shown that they are traversed by other veins.

There are several instances where these are crossed by the more recent copper lodes; also by cross flukans, as at Huel Damsel, in the valley north of it. This valley is intersected by a large cross course which is supposed to run from sea to sea; and this cross course is traversed most completely by a cross flukan. The country or formation in a part of this valley bears the marks of convulsion, being in great disorder and confusion. The cross course evidently partakes of this disorder, but the flukan appears to bear no marks of it. If, therefore, there had been no intersection, there would be no difficulty in ascertaining the comparative age of those two veins. Slides traversing cross courses have been found, as at Polgooth and other mines.

Cross courses are in general unproductive of copper or tin, but some rare instances have occurred to the contrary. Lead, arseniate of cobalt, sulphuret of antimony, native silver, with oxides and sulphurets of the same metal, occur most frequently.

The more recent copper lodes, forming the sixth class, comprize the east and west and also the contra lodes, which have been found to traverse not only other copper lodes, but cross courses also. They are not numerous, but may be seen in Huel Alfred, fig. 17, pl. 25, and the Weeth, fig. 12, pl. 25.

The veins of this class are traversed by cross flukans, as in Huel Alfred and the Weeth mines. They are also crossed by slides.

The cross flukans form the seventh class. They vary in width, from the smallest imaginable size to 9 feet: their average width may be stated at 1 foot. However small they may be, no water can percolate through them. Their general direction is nearly north and south, and underlying toward the east.

The eighth class is composed of the slides, probably the last of the true veins, being found to traverse veins of every other kind; they are composed wholly of clay, which is generally of a more slimy nature than is often found in other veins. They run in all directions; but their general direction is nearly parallel with that of the tin and copper lodes. Instead, therefore, of heaving them longitudinally, as the cross veins do, they appear either to throw them down or throw them up: the former, when they underlie in the same direction as the lodes; the latter, when in an opposite direction.

These veins are generally very small, seldom more than one foot wide; and they usually underlie very fast, which indeed is probably the reason of their being called *slides*; or perhaps because, when they underlie in the same direction as the lodes, the latter, on meeting them, appear to *slide* downwards.

Thus, then, have been described the various periods or ages of the different kinds of veins with which miners are acquainted. The details drawn from different data present many startling facts; and demonstrate clearly, in whatever manner they may have originated, that the power which was exerted, acted at lengthened intervals of time. It is a view pregnant with strong interest to geologists, and it is to be hoped that, in after times, such further light may be thrown on the subject as may tend to elucidate much that is now mysterious in the past operations of nature.

CHAPTER II.

The appearance of a fissure or rent in the rocky crust of the earth, approaching more or less to a vertical direction, and filled with metallic ores, will perhaps convey the clearest idea of the nature of a metalliferous vein; the object of mining being to break down and transport to the surface the contents of this supposed rent, or, in other words, to cut out from between the environing rocks this thin metallic plane. To effect this, galleries, called "*levels*," are driven horizontally on the vein, one above the other, and the ores, &c. produced by their excavation, are transported to the surface by large buckets called "*kibbles*," which are let down and raised up by machinery, through perpendicular pits or "*shafts*," cutting the former at right angles. The horizontal galleries are, in the first instance, about 2 feet wide and 6 feet high, but varying of course according to circumstances, and being frequently extended much beyond their original dimensions. They are driven one above the other, at intervals from 10 to 20 or 30 fathoms. When extended to a certain distance from the original shaft, it is necessary, for the sake of ventilation, as well as for other reasons, to form a second shaft, which traverses all the galleries, in the same manner as the first. The distance between shafts is very various, being from 20 to 100 fathoms. Frequently a communication is made between two galleries, by a partial shaft, (called a *wins*) in the interval between two shafts. When there are more than one lode worked in the same mine, as frequently happens, galleries or levels often run parallel to each other at the same depth. In this case they often communicate by intermediate galleries, driven through the rock, (or *country*, as miners term it) which are called "*cross-cuts.*" A mine thus consists of a series of horizontal galleries, generally one above the other, but sometimes running parallel, traversed at irregular intervals by vertical shafts, and all communicating together, either directly or indirectly.

In mines where many hundreds of men are employed under ground, more than three or four men are seldom to be met with in one gallery at a time; there they are seen pursuing the common operations of digging or boring the rock, in the inner extremity of the gallery, by the feeble glimmering of a small candle, with very little noise, or much latitude for bodily movement. Very seldom are they within the sound of each other's operations, except when occasionally they hear the dull report of the explosions. In the vicinity of the main shaft of the mine, indeed, the incessant action of the huge chain of pumps, produces a constant, but not very loud noise: while the occasional rattling of the metallic buckets (for conveying the ore) against the walls of the shaft, as they ascend and descend, relieves the monotony both of the silence and the sound. Still every thing is dreary, dull and cheerless; and one unacquainted with the details of mining, could be with difficulty persuaded, even when below in the richest and most populous mines, that he was in the centre of such extensive and important operations.

The extreme darkness of the galleries adds greatly to the impression of tameness. There is no light whatever, but that afforded by the candle of the workmen; while the universal presence of water, soaking through the crevices of the galleries, and intermixing with the dust and rubbish, keeps up a constant succession of dirty puddles, through which one must pass in inspecting a mine, besides being frequently obliged to crawl on all fours through passages too low to admit him in any other manner. The galleries are extended, by breaking down the looser parts by the pick-axe, and by rending the more solid by gunpowder.

Each miner has a candle, which is stuck close by him against the wall of his gallery, by means of a piece of clay; and besides those employed in extending the gallery, there are generally one or two boys occupied in wheeling the broken ore, &c. to the shaft. Each of these boys has also a candle affixed to his wheelbarrow, by the universal subterranean candlestick, a piece of clay. A certain band of men undertake the work of a particular gallery.* These subdivide themselves into smaller bodies, which by relieving each other at the end of every six or eight hours, keep up the work uninterruptedly, except on Sunday. By means of this subdivision of the pairs, there is in general not more than one-third of the underground labourers below at any one time.

Notwithstanding this incessant labour, the progress of the miner in excavating his gallery is, in general, very small; one, two or three feet in a week, or a few inches daily is often the whole amount of the united operations of 20 or 30 men.

In loose lodes, and in clay slate country, they often cut more than this, but often they do not cut so much. It is to be recollected that the lode is very rarely so wide as the gallery, so that it becomes necessary, to continue this of the proper size, to hew through the solid rock on each side, which is often very hard even when the lode is soft. It is not customary for a miner to sleep or eat below ground, but he returns to *grass* (the technical name for the *surface*), at whatever depth he may be, when relieved. The mode of ascent and descent, in mines, is by means of vertical ladders fixed in the shafts.

Whoever calls to mind the manner, object and results of the common process of sinking wells, will be prepared

* It should be observed that only one pair can work in the extremity of a gallery, but there are several pairs in general stoping, or working horizontally, both overhead and under foot in each gallery.

to expect the presence of water in mines. The quantity of this varies very much in different mines at the same time, and in the same mines at different times. Some of the circumstances which occasion this difference are very obvious; for instance, the topographical relations of the surface, the nature of the rock and lode, the number and size of the lodes, cross course, &c. Many galleries, both on the lode and through the *country*, are quite dry; but in general, the reverse is true. Commonly, the water oozes almost imperceptibly from the lode and walls of the galleries, and gradually accumulates, as formerly mentioned, so as to form puddles and pools of considerable size under the feet of the miners, and it is very common to find the bottom of long galleries covered, for some hundred feet, with dirty water of this kind to the depth of several inches, and sometimes of a foot or more; sometimes, but rarely, brisk streamlets or springs are met with gushing from the lode. In most mines we meet with currents of water flowing towards the pumps from the upper galleries, or from parts of the mine that have been abandoned.

To prevent the works from being inundated, each mine is furnished with a chain of pumps, extending from the bottom to the surface, or *adit level*, if there is one, worked by a single pump rod; each pump receiving the water brought up by the one immediately below it. All the water of the deepest level of the mine finds its way into the bottom of the mine or *sump*, whence it is finally elevated to the adit, through which it flows, by a gentle descent, to the surface of the valley where the *tail* of the adit empties itself.*

The quantity of water discharged by the pumps from many of the Cornish mines is very considerable. Huel

* The water from the upper levels is received into cisterns placed in different parts of the shaft, at the termination of each tier of pumps, from whence it is drawn to the adit.

Abraham discharges, from the depth of 1440 feet, about 2,092,320 gallons every twenty-four hours. Dolcoath mine, from nearly the same depth, about 535,173 gallons in the same time; and Hurl Vor from the depth of 950 feet 1,692,660 gallons.

In no mining district of the world has the drainage of water from mines, and the machinery and power appertaining to it, received greater attention and undergone such important improvements as in Cornwall. Ever since the efforts of Messrs Bolton and Watt, and their high talents and abilities were exerted to bring into practice their improvements on the steam engine, this mode of power has added greatly to the development of the mineral resources of that district of England. Much has since been effected by the practical skill and repeated experiments of the Cornish engineers; and even within the last year an extraordinary increase of power has been attained in consequence of the improvements introduced by Messrs West and Petherick, two young engineers of great rising eminence; and whose engine, erected at the Lanescot mine, I had much satisfaction, lately, in inspecting. The increase of power, thus obtained, will be seen in the annexed tables of the duty of the various steam engines of the different mines of Cornwall.

The term "horse power," commonly used to express the power of steam engines, is never used in Cornwall, but the word "duty" substituted in its place. As these engines are principally employed in drawing water from the mines, it is the practice to express the duty of an engine by the number of pounds it raises in a given time to the height of one foot. This is ascertained by multiplying the weight lifted in a stated period, by the height in feet it is lifted. Thus, if 1000 pounds of water are lifted 20 feet high per stroke, it would be equivalent to 20,000 lifted one foot high. The *power* of an engine, therefore, is expressed by the number of pounds it can lift one foot high in a given time; and its *expenditure* of fuel and consequent efficiency, by the number of pounds it lifts to the height of one foot with one bushel of coals. The comparative merits of different engines, therefore, (whatever be their power, or depth of the mines, are easily ascertained by this simple process. Therefore, if an engine lift 100 millions of pounds one foot high per hour, we ascertain its power; and if it lifts 100 millions one foot high whilst it consumes two bushels of coal, the work done with one bushel of coal is ascertained: and by comparing that performance with another engine with the consumption of the same quantity of fuel, we thus ascertain the comparative efficiency of the two engines.

The term "horse power," however vague at first, has, from long use, become as expressive as any other, and conveys to those who understand it, as definite an idea of the power of an engine, as the more intelligible mode adopted by the Cornish mining engineers. It is only necessary to know that the power of a horse is estimated at 150 pounds lifted 220 feet per minute, or 33,000 pounds lifted one foot high per minute, and we can instantly compare the power of an engine estimated by horse power, with the power of one estimated by the Cornish method.

It would appear, from authentic experiments, that the best engines, by Bolton and Watt, are estimated as capable of raising 19,800,000 pounds per bushel of coals, while that of Messrs West and Petherick raises 97,856,382 pounds per bushel of coals, being 80 inch cylinder, single.

The improvements generally, in the Cornish steam engines, without including the additional ones introduced by Messrs W. and P., would appear to be, in the opinion of competent judges, as follows:—

1. *Cylindric boilers* of considerable length. A large tube passing concentrically through them. Fire applied in the tube, and the heated air made afterwards to circulate first under, and then along the sides of the boiler. The area of the side flues are generally as large as the area of the tube, and the passage is contracted by a damper being placed in the tunnel, from the boiler to the stack, or chimney.

2. *In the management of the fire itself.* The fire is large and thick; the fire-bars open nearly to the full breadth of the tube; the coals are spread or dusted over the surface of the fire; the fire is never *stirred or slaked*, except at the time of cleansing. The fireman, in cleansing, first shuts down his damper to prevent the rush of cold air, which would otherwise lower the steam in the boiler, and turns the good fuel on one side, and raking off the clinkers, (the only refuse) turns the fuel back on the clean bars, and performs the same operation with the other side. The fire, before cleansing, is about 6½ inches deep; and after cleansing, about 3 to 3½. By closing the dampers, no decrease of steam is observable during or after the operation of cleansing. The coal which is preferred, is a mixture of various Welsh coals, which clinker most in a brisker fire.

3. In using steam of 20 to 50 pounds to the inch, and in expanding the steam, by cutting off the communication between the boiler and cylinder, at one-fourth or one-fifth of the stroke.

4. In covering or clothing the boiler, steam pipes, steam chests and cylinder, with a non-conducting substance, such as saw-dust or straw, where the heat of steam only can be in contact; and "cob," that is, clay and straw, over the brick work of the fire.

5. In suspending the action of the piston, at the completion of its stroke, allowing time for the perfect

condensation of the steam in the cylinder, before making the returning stroke.

The quantity of water evaporated with one bushel of coal was, according to Mr Watt, rather more than 8 cubic feet, converting it into steam of 220°. It would appear, from experiments in Cornwall, with engines on the above principles, that there was an increase, at the rate of 13.824 to .8, by each bushel of coal.

The expansion of the steam in the cylinder, as alluded to in No. 3, seems to have been the main cause of the enormous advantages obtained by the extension and *safe* application of this principle. By this, use is made of a certain power that was before lost; for as, in the steam engine, a certain quantity of fuel is required to raise steam to a certain elasticity, so then if the steam be allowed (after having moved the piston) to escape into the atmosphere, without having acted expansively, the fuel, which was consumed to raise it up to that elasticity, will have been principally lost. Therefore it is saving, and not gain, that thus results.

The value of the advantages of clothing or covering the boiler, &c., so variously estimated, is so effective, as scarcely to permit the radiation from the boiler to be perceptible, nor does the heat in the engine room materially affect the boiler. It is considered that this improvement *has alone increased the duty of a bushel of coals, on the average,* 40 *per cent.*

Suspending the action of the piston, as described No. 5, produces a considerable increase of effects, as the superior efficiency of engines for drawing water is dependent upon their power being greatest at the commencement of the lifting stroke, where more power is necessary to overcome the vis inertiæ of the matter raised, than to continue its motion. It is considered that this tends to increase the duty at least one-sixth.

It has been deemed proper here to adjoin a copy of one of the monthly statements of work performed in Cornwall, by the various steam engines at the numerous mines, the details of which cannot fail to prove interesting; and the more so, as it is not presumed that a similar table has yet been published in the United States :—

WORK PERFORMED BY THE FOLLOWING

MINES.	ENGINE, and the diameter of the cylinder.	Load in horse power, on the piston.	Load per square inch, on the piston.	Length of the stroke, in the cylin-der.	No. of lifts.	Depth.	Diam-eter of the pump.	Time.	Con-sump-tion of coal in bush-els.
			lbs.	feet		fms ft	ins.		
Wh. Unity Wood	Williams's engine, 80 inches, single.	229,8	6,86	10	1 1 3 1 1 1	31 5 35 1 32 3 10 0 11 5 7 0	12 18 14 9 9 6	Sep 1 to Sep 30	
Poldice	Sims's engine, 90 inches, single.	322,3	7,6	10	1 5	4 3 111 0	13 $17\frac{1}{4}$		
Wh. Damsel	Stephens's engine, 50 inches, single.	155,7	11,9	9 33	8 1 1 2 1 1	157 0 11 0 5 0 37 2 10 4 6 0	9 6 7 6 5 $3\frac{1}{2}$	Sep 2 to Sep 30	812
Wh. Jewell	39 inches, single,	78,4	9,85	8,5	1 1 1 1 1	32 5 32 3 20 0 8 0 15 3	10 9 8 $7\frac{1}{2}$ 6	ditto	272
Cardrew-downs	66 inches, single.	228	10	8,75	2 1 2 2	50 0 4 0 18 3 50 0	$7\frac{1}{2}$ 10 $16\frac{1}{2}$ 16	Sep 1 to Oct 1	1134
Wh. Tolgus	Davey's engine, 70 inches, single.	202,1	7,88	10	1 1 2 1 1 1	4 0 29 1 57 3 11 4 11 3 11 4	$8\frac{1}{4}$ 10 $14\frac{1}{4}$ $14\frac{3}{8}$ 12 $8\frac{1}{2}$	ditto	962
Ditto	Horton's engine, 70 inches, single.	243,7	9,5	10	2 2 1 1 1	33 3 65 4 22 5 10 1 10 0	8 $14\frac{1}{4}$ $16\frac{1}{2}$ 11 10	ditto	1638

STEAM ENGINES, IN SEPTEMBER 1834.

Number of strokes.	Lgth of the stroke in the pump.	Load, in pounds.	Pounds lifted one foot high, by consuming a bushel of coal.	Number of strokes per minute	REMARKS, AND ENGINEERS' NAMES.
	feet				
146970	7,5 5,75 6,25	32681 14686 2476		3,5	Drawing the load in three shafts 65 fms. perpendicularly, and the remainder diagonally. Main beam over the cylinder, two bobs and 40 fms. of horizontal rods at the surface, and two V-bobs and 40 fms. of horizontal rods underground. SIMS AND SON.
	7	69114			Drawing perpendicularly, with main beam over the cylinder; one balance bob at the surface, and one ditto under ground. SIMS AND SON.
153520	7,25 6,25	27322 3445	41,521,440	3,8	Drawing the load in two shafts perpendicularly 17 fathoms, and the remainder diagonally. Main beam over the cylinder; two bobs and 164 fathoms horizontal rods at the surface, 47 fathoms under ground, and 4 shieves and 110 fathoms dry rods in the shafts. SIMS AND SON.
65670	6	16780	24,307,557	1,63	Drawing the load in two shafts perpendicularly, with main beam over the cylinder, and two bobs and 112 fathoms horizontal rods at the surface. SIMS AND SON.
177380	7	42953	47,030,883	4,1	Drawing perpendicularly. Main beam over the cylinder, and one balance bob at the surface. SIMS AND SON.
129360	7,5	40447	40,791,766	2,96	Drawing perpendicularly. Main beam over the cylinder, and one balance bob at the surface. F. MICHELL.
234960	7,5	48886	52,592,740	5,43	Drawing perpendicularly 80 fathoms, and the remainder diagonally. Main beam over the cylinder; one balance bob at the surface, and an angle bob in the shaft. F. MICHELL.

WORK PERFORMED BY THE FOLLOWING

MINES.	ENGINE, and the diameter of the cylinder.	Load in horse power, on the piston.	Load per square inch, on the piston.	Length of the stroke, in the cylinder.	No. of lifts.	Depth.	Diameter of the pump.	Time.	Consumption of coal in bushels.
			lbs.	feet		fms ft	ins.		
Ditto	Pryce's engine, $25\frac{1}{2}$ inches, single.	76,8	22,6	6	1 1 1	21 3 10 2 8 4	$11\frac{1}{2}$ 13 11	ditto	696
Dolcoath	76 inches, single.	368,9	12,2	9	1 4 4 1 1 1	3 0 70 2 75 4 26 5 15 3 7 0	10 $13\frac{5}{8}$ $12\frac{1}{2}$ 12 $13\frac{1}{8}$ 13	Aug 29 to Sep 26	1818
Stray-park	60 inches, single.	173,4	9,2	8	1 3 2 1 1 1	6 0 72 0 43 0 28 0 10 0 10 0	$11\frac{3}{8}$ $11\frac{1}{4}$ 11 $9\frac{1}{2}$ 7 6	ditto	972
East Wheal Crofty	80 inches, single.	192,	5,73	10,33	1 2 1 1 1	20 1 47 1 19 3 8 1 24 5	$13\frac{1}{8}$ 15 9 9 10	ditto	736
North Roskear	New engine, 70 inches, single.	161,6	6,3	10	1 1 1	30 0 3 3 40 0	16 11 13	ditto	558
South Roskear	W. Chance engine, 60 inches, single.	122,5	6,5	9	2 3 1	38 3 71 3 16 0	9 10 9	ditto	954
Binner Downs	Wh. Treasury engine, 50 inches, single,	188,4	14,4	9,66	1 1 1 1 1 1	24 1 41 3 15 0 15 0 8 3 8 1	8 15 14 $11\frac{1}{4}$ 9 7	Aug 26 to Sep 25	819

STEAM ENGINES, IN SEPTEMBER 1834.

Number of strokes.	Lgth of the stroke in the pump.	Load, in pounds.	Pounds lifted one foot high, by consuming a bushel of coal.	Number of strokes per minute.	REMARKS, AND ENGINEERS' NAMES.
	feet				
390530	6	11533	38,827,435	9,04	Drawing diagonally. Main beam over the cylinder, one balance bob at the surface, and 100 fathoms dry rods, and an angle bob under ground. F. MICHELL.
149830	7,5	66494	41,100,643	3,7	Drawing perpendicularly 179 fathoms, and the remainder diagonally. Main beam over the cylinder; four balance bobs under ground, and one at the surface. JEFFREE.
115860	5,5	37846	24,811,323	2,87	Drawing perpendicularly 110 fathoms, and diagonally 24 fathoms. Main beam over the cylinder; five bobs and 70 fathoms of horizontal rods under ground, and one balance bob at the surface. JEFFREE.
92710	7,75	38400	37,487,086	2,3	Drawing in two shafts perpendicularly 63 fathoms, and the remainder diagonally. Main beam over the cylinder, and two bobs at the surface, connected to 180 fathoms of horizontal rods. JAMES SIMS.
123640	8	30402	53,891,086	3,06	Drawing perpendicularly. Main beam over the cylinder, and one balance bob at the surface. JOHN WEST.
218430	7	23654	37,911,113	5,4	Drawing perpendicularly 110 fathoms, and the remainder diagonally. Main beam over the cylinder, and one balance bob at the surface, and an angle bob under ground. JOHN WEST.
143730	8	34386	48,276,432	3,33	Drawing perpendicularly, with main beam over the cylinder. GREGOR AND THOMAS.

WORK PERFORMED BY THE FOLLOWING

MINES.	ENGINE, and the diameter of the cylinder.	Load in horse power, on the piston.	Load per square inch, on the piston.	Length of the stroke, in the cylinder.	No. of lifts.	Depth.	Diameter of the pump.	Time.	Consumption of coal in bushels.
			lbs.	feet		fms ft	ins.		
Binner Downs	Gregor's engine, 42 inches, single.	160,7	17,4	9	1 1 1 1 1 2 2	22 3 3 0 43 3 27 2 32 0 17 3 41 3	6 7½ 11¼ 11 7⅝ 6¼ 7	ditto	1457
Ditto	Wh. Penny engine, 24 inches, single.	54,2	18	5,25	2	39 5	10	ditto	597
Wheal Darlington	80 inches, single.	376,9	11,25	10	3 3	65 5 75 0	19 12	Aug 23 to Sep 23	2210
Marazion Mines	Powlet's engine, 60 inches, single.	238,6	12,66	9	1 1 1 1 1	30 0 29 0 40 4 40 4 20 4	8 12⅛ 13 7 15	ditto	1172
St Ives Consols	36 inches, single.	113	16,67	7	4 2 1	74 6 40 0 18 0	8¼ 8 6	Aug 25 to Sep 23	498
Wh. Reeth	36 inches, single.	105,1	15,5	7,5	3 1 1 5	89 0 10 3 30 0 110 0	8 6 5 4	ditto	681
Consolidated Mines	Taylor's engine, 85 inches, single.	436,5	11,36	10,33	1 6 2 1	10 2 193 0 25 5 11 3	15 13 17 5	Sep 2 to Oct 1	2703

STEAM ENGINES, IN SEPTEMBER 1834.

Number of strokes.	Lgth of the stroke in the pump.	Load, in pounds.	Pounds lifted one foot high, by consuming a bushel of coal.	Number of strokes per minute	REMARKS, AND ENGINEERS' NAMES.
	feet				
265360	7,5 7	25090 4160	39,575,429	6,14	Drawing the load in two shafts perpendicularly. Main beam over the cylinder; 215 fathoms of horizontal rods, connected by two bobs at the surface, and 70 fathoms of dry rods in the shaft. GREGOR AND THOMAS.
507570	5,25	8147	36,364,584	11,4	Drawing perpendicularly. Main beam over the cylinder, and one balance bob at the surface. GREGOR AND THOMAS.
306130	8	70701	78,348,224	6,84	Drawing perpendicularly. Main beam over the cylinder, and one balance bob at the surface. EUSTIS.
235640	8	40292	64,808,238	5,28	Drawing perpendicularly. Main beam over the cylinder, and one bob at the surface. GROSE.
	7	16956			Drawing the load perpendicularly 18 fathoms, and diagonally 101 fathoms. Main beam over the cylinder; one balance bob at the surface. EUSTIS AND SON.
154710	7,5 4	13958 3600	27,053,803	3,7	Drawing perpendicularly 28 fathoms, and the remainder diagonally. Main beam over the cylinder; three bobs and 130 fathoms of horizontal rods at the surface, and 180 fathoms of dry rods in the shaft. EUSTIS AND SON.
272150	7,75	87329	68,143,193	6,5	Drawing all the load perpendicularly. Main beam over the cylinder; two balance bobs at the surface, two ditto under ground, and a balance lift in the shaft. HOCKING AND LOAM.

WORK PERFORMED BY THE FOLLOWING

MINES.	ENGINE, and the diameter of the cylinder.	Load in horse power, on the piston.	Load per square inch, on the piston.	Length of the stroke, in the cylinder.	No. of lifts.	Depth.	Diameter of the pump.	Time.	Consumption of coal in bushels.
			lbs.	feet		fms ft	ins.		
CONSOLIDATED MINES	Davey's engine, 80 inches, single.	356,2	10,63	11,33	1 9 1	4 4 225 4 4 4	14 12 10½	ditto	2329
DITTO	Pearce's engine, 65 inches, single.	351,7	15,9	9	1 1 8 2 1	9 0 1 2 199 2 37 4 7 1	12 11 11⅛ 11 7	ditto	1086
DITTO	Woolf's engine, 90 inches, single.	474,1	11,18	10	8 1 1	233 2 9 5 7 0	14 8 5	ditto	3321
DITTO	Bawden's engine, 90 inches, single.	351,1	8,28	10	1 6 1 1 1	15 3 159 1 23 0 11 2 10 1	12 13 13 12 10	ditto	3325
DITTO	Shears's engine, 65 inches, single.	282,2	12,76	9	5 1 1	136 0 12 0 11 3	13 11 6	ditto	1088
UNITED MINES	Cardozo's engine, 90 inches, single.	468,2	11,04	9	2 3 3	26 3 74 5 74 5	10 16 15	ditto	2330
DITTO	Little engine, 30 inches, single.	84,6	17,96	9	1 1	5 1 34 1	12 14	ditto	634

STEAM ENGINES, IN SEPTEMBER 1834.

Number of strokes.	Lgth of the stroke in the pump.	Load, in pounds.	Pounds lifted one foot high, by consuming a bushel of coal.	Number of strokes per minute	REMARKS, AND ENGINEERS' NAMES.
	feet				
279090	8,75	69194	72,552,315	6,67	Drawing perpendicularly. Main beam over the cylinder; two balance bobs at the surface, two ditto under ground, and a balance lift 31 fathoms of 17 inches in the shaft. HOCKING AND LOAM.
126290	7,5	63482	55,367,001	3,02	Drawing the load perpendicularly. Main beam over the cylinder; one balance bob at the surface, two ditto under ground, and a balance lift in the shaft. HOCKING AND LOAM.
259030	7,5	94839	55,479,101	6,18	Drawing perpendicularly. Main beam over the cylinder; two balance bobs at the surface, and two balance lifts in the shaft. HOCKING AND LOAM.
288380	7,5 6	59584 13368	45,714,778	6,9	Drawing perpendicularly. Main beam over the cylinder; one balance bob at the surface, one under ground, and 50 fathoms of diagonal rods in the shaft. HOCKING AND LOAM.
161710	7,5	50828	56,659,438	3,87	Drawing all the load perpendicularly. Main beam over the cylinder; two balance bobs at the surface, and one balance lift in the shaft. HOCKING AND LOAM.
183520	8	79044	49,806,540	4,39	Drawing the load perpendicularly. Main beam over the cylinder, and one balance bob at the surface. HOCKING AND LOAM.
353840	7,5	15219	63,703,757	8,47	Drawing all the load perpendicularly. Main beam over the cylinder, and one balance bob at the surface. HOCKING AND LOAM.

WORK PERFORMED BY THE FOLLOWING

MINES.	ENGINE, and the diameter of the cylinder.	Load in horse power, on the piston.	Load per square inch, on the piston.	Length of the stroke, in the cylinder.	No. of lifts.	Depth.	Diameter of the pump.	Time.	Consumption of coal in bushels.
			lbs.	feet		fms ft	ins.		
Wheal Beauchamp	Western engine, 36 inches, single.	109,5	16,14	7,75	1 1 1 1 1 2 1 1	32 3 21 1 21 1 21 1 10 3 23 0 12 3 9 0	8 11 10 9¼ 8½ 6 5½ 4½	Sep 1 to Sep 30	602
Ditto	Powning's engine, 36 inches, single.	58,3	8,6	8	1 2 1	21 3 31 4 3 5	10¼ 10 8½	ditto	406
Polgooth	66 inches, single,	202,9	8,9	9,8	1 1 1	30 3 18 3 18 3	20 18 9⅛	Sep 5 to Oct 4	1078
Pembroke (Old Mine)	New engine, 50 inches, single.	93,5	7,15	9	1 1	32 1 11 0	15 12	Sep 5 to Oct 3	545
Ditto	Edgcumbe's engine, 40 inches, single.	116,4	13,9	9	2 1 2 1	52 0 30 0 44 0 11 4	8 12 9 7¼	ditto	686
East Crinnis	Hudson's engine, 76 inches, single.	347,7	11,5	10,33	1 3 1	6 0 101 4 12 2	13 18 14	ditto	1808
Ditto	Rundle's engine, 41 inches, single.	164,4	18,69	9,3	2 2	57 1 42 4	14 10	ditto	562
Fowey Consols	Austen's engine, 80 inches, single.	283,1	8,45	10,3	3 1	97 2 12 3	15 10	Sep 4 to Oct 3	598

STEAM ENGINES, IN SEPTEMBER 1834.

Number of strokes.	Lgth of the stroke in the pump.	Load, in pounds.	Pounds lifted one foot high, by consuming a bushel of coal.	Number of strokes per minute	REMARKS, AND ENGINEERS' NAMES.
	feet				
153650	6 4,5	19078 2840	32,477,832	3,68	Drawing the load in two shafts perpendicularly, with main beam under the cylinder. 328 fathoms of horizontal rods, connected to three bobs at the surface, and 103 fathoms of dry rods in the shafts. HOCKING AND LOAM.
245100	6	11664	42,248,961	5,88	Drawing perpendicularly, with main beam over the cylinder. HOCKING AND LOAM.
250430	7,4	40365	69,391,179	6,0	Drawing perpendicularly. Main beam over the cylinder, and one balance bob at the surface. SIMS AND SON.
209870	7	18043	48,636,313	5,2	Drawing perpendicularly. Main beam over the cylinder ; one balance bob at the surface. SIMS AND SON.
244520	6,5	24187	56,038,387	6,06	Drawing the load perpendicularly, with main beam over the cylinder, and one balance bob at the surface. SIMS AND SON.
179840	7,25	74400	53,653,592	4,46	Drawing all the load perpendicularly. Main beam over the cylinder; one balance bob at the surface, and two balance lifts (40 fathoms of 17 inches) in the shaft. SIMS AND SON.
118140	7,25	31645	48,228,500	2,93	Drawing perpendicularly. Main beam over the cylinder. SIMS AND SON.
133700	9,25	47317	97,856,382	3,2	Drawing perpendicularly. Main beam over the cylinder one balance bob at the surface. W. PETHERICK AND W. WEST.

WORK PERFORMED BY THE FOLLOWING

MINES.	ENGINE, and the diameter of the cylinder.	Load in horse power, on the piston.	Load per square inch, on the piston.	Length of the stroke, in the cylinder.	No. of lifts.	Depth.	Diameter of the pump.	Time.	Consumption of coal in bushels.
			lbs.	feet		fms ft	ins.		
LANESCOT	Sawle's engine, 24 inches, single.	39,6	13,14	8,5	1 2 1	4 3 53 2 11 1	7 8 $8\frac{3}{4}$	Sep 4 to Oct 3	248
ROCHE ROCK MINE	36 inches, single.	71,2	10,5	8,5	1 1 2	26 3 10 0 20 0	$12\frac{1}{8}$ $11\frac{5}{8}$ $8\frac{1}{8}$	ditto	551
WHEAL LEISURE	Truran's engine, 70 inches, single.	283,4	11,05	10	2 1 1 1	73 5 22 1 12 0 12 1	16 $14\frac{1}{4}$ $11\frac{1}{4}$ $10\frac{1}{4}$	Sep 3 to Oct 2	
DITTO	South engine, 66 inches, single.	206,3	9,05	9,83	2 1 1	62 0 10 5 10 5	16 $14\frac{1}{4}$ $10\frac{1}{4}$	ditto	476
WHEAL VOR	Borlase's engine, 80 inches, single.	418,2	12,48	10	6 1	188 2 13 3	14 $10\frac{1}{4}$	Aug 30 to Sep 27	1966
DITTO	Trelawny's engine, 80 inches, single.	524,4	15,65	10	6 2 3 1 1	150 5 45 1 33 0 18 3 12 0	14 15 $16\frac{1}{4}$ $9\frac{1}{2}$ $9\frac{1}{2}$	ditto	3438
DITTO	Woolf's engine, 53 inches, single.	235,2	16	9	1 5 1	3 0 134 0 10 0	10 12 $10\frac{3}{4}$	ditto	
DITTO	Carleen engine, 45 inches, single.	180,2	17	6,8	1 1 5 1 1 1	28 2 29 3 90 1 11 3 10 2 13 1	$9\frac{1}{2}$ 8 10 $10\frac{1}{2}$ 8 8	ditto	762

STEAM ENGINES, IN SEPTEMBER 1834.

Number of strokes.	Lgth of the stroke in the pump.	Load, in pounds.	Pounds lifted one foot high, by consuming a bushel of coal.	Number of strokes per minute	REMARKS, AND ENGINEERS' NAMES.
	feet				
201370	5,5	9182	41,005,590	4,8	Drawing perpendicularly, with main beam over the cylinder. W. PETHERICK AND W. WEST.
291320	6,8	13433	48,294,828	6,97	Drawing in two shafts perpendicularly, with main beam over the cylinder; and two bobs and 100 fathoms horizontal rods at the surface. S. TRETHEWY.
262700	8	53173		6,28	Drawing the load perpendicularly. Main beam over the cylinder. S. TRURAN.
68720	7,75	39292	43,962,465	1,64	Drawing the load perpendicularly. Main beam over the cylinder, and one balance bob at the surface. S. TRURAN.
259720	8	78404	82,860,984	6,44	Drawing perpendicularly 160 fathoms, and the remainder diagonally. Main beam over the cylinder; one balance bob at the surface, and four ditto and a V bob underground. RICHARDS.
258120	7,5	104909	59,073,104	6,4	Drawing perpendicularly 135 fathoms, and the remainder diagonally. Main beam over the cylinder; three balance bobs under ground, and one at the surface. RICHARDS.
	7,5	42446			Drawing perpendicularly 131 fathoms, and diagonally 20 fathoms. Main beam over the cylinder; two bobs under ground, and one at the surface. RICHARDS.
223290	5,6 4,8	31480 1724	54,082,830	5,5	Drawing the load in two shafts perpendicularly. Main beam under the cylinder; two bobs and 117 fathoms of horizontal rods at the surface. RICHARDS.

WORK PERFORMED BY THE FOLLOWING

MINES.	ENGINE, and the diameter of the cylinder.	Load in horse power, on the piston.	Load per square inch, on the piston.	Length of the stroke, in the cylinder.	No. of lifts.	Depth.	Diameter of the pump.	Time.	Consumption of coal in bushels.
			lbs.	feet		fms ft	ins.		
GREAT WORK	Wheel Breage engine, 60 inches, single.	223,7	11,87	9	2 1 4 1	23 0 32 3 105 0 11 0	15 12 10 8¼	Aug 30 to Sep 27	1296
DITTO	Leeds's engine, 60 inches, single.	219,7	11,66	8	1 5 1	35 1 126 5 10 3	12 10 8	ditto	702
GREAT ST GEORGE	North engine, 60 inches, single.	195,2	10,36	10	1 2 1	6 0 62 3 11 0	10 17 17½	Sep 3 to Oct 2	1548
DITTO	South engine, 40 inches, single.	131,7	15,74	9	2 1	68 5 10 0	12 13	ditto	415
DITTO	Devonshire's engine, 70 inches, single.	246,2	9,6	10	1 1 3	1 1 43 1 69 2	13 9½ 17	ditto	1530
WHEAL PRUDENCE	33 inches, single.	84,3	14,8	8,75	1 2 1	45 0 56 1 12 5	6 9½ 10¼	ditto	790
WHEEL RETALLACK	North engine, 36 inches, single.	81,4	12	7,84	1 2	7 0 54 3	6 12	Aug 26 to Sep 25	510

STEAM ENGINES, IN SEPTEMBER 1834.

Number of strokes.	Lgth of the stroke in the pump.	Load, in pounds.	Pounds lifted one foot high, by consuming a bushel of coal.	Number of strokes per minute	REMARKS, AND ENGINEERS' NAMES.
	feet				
182480	7	43165	42,544,170	4,5	Drawing 90 fathoms perpendicularly, and 87 fathoms diagonally. Main beam over the cylinder; one balance bob at the surface, and one under ground. RICHARDS.
173980	7	37675	65,360,221	4,3	Drawing perpendicularly 108 fathoms, and the remainder diagonally. Main beam over the cylinder; one balance bob at the surface, and one balance lift (30 fathoms of 14 inches) in the shaft. RICHARDS.
164510	6,5	45063	31,128,257	3,9	Drawing perpendicularly. Main beam over the cylinder, and one bob at the surface. S. GROSE AND J. WEST.
109810	7,5	23730	47,092,313	2,6	Drawing perpendicularly. Main beam over the cylinder, and one balance bob at the surface. S. GROSE AND J. WEST.
141940	7,5	49356	34,341,130	3,4	Drawing perpendicularly. Main beam over the cylinder, and one balance bob at the surface. S. GROSE AND J. WEST.
257930	6,75	16439	36,228,798	6,17	Drawing perpendicularly. Main beam over the cylinder, and one balance bob at the surface. J. WEST.
123110	5,75	16668	23,135,265	2,85	Drawing the load 47 fathoms perpendicularly, and the remainder diagonally. Main beam over the cylinder, and one balance bob at the surface. EUSTIS AND SON.

WORK PERFORMED BY THE FOLLOWING

MINES.	ENGINE, and the diameter of the cylinder.	Load in horse power, on the piston.	Load per square inch, on the piston.	Length of the stroke, in the cylinder.	No. of lifts.	Depth.	Diameter of the pump.	Time.	Consumption of coal in bushels.
			lbs.	feet		fms ft	ins.		
Halla-maning	Hawkin's engine, 36 inches, single.	98,9	14,6	8,66	1 1 1 1 1	14 4 31 4 18 1 10 3 11 0	9 12 12 10 8	Aug 26 to Sep 25	1058
Wheel Relistian	60 inches, single.	190,9	10,13	9	1 2 1 1 1 1 1	28 1 70 4 11 4 15 3 10 4 10 1 10 1	9 12 11 10½ 8 6 4½	ditto	1170
Wheel Virgin	30 inches, single.	40,9	8,7	9	1 2	13 4 33 5	6 10	ditto	380
Ballas-widden	24 inches, single.	28,6	9,49	7	2 1 1 1 1	23 1 17 3 22 0 11 0 14 4	4 7 5 3½ 6	Aug 27 to Sep 24	140
Levant	26 inches, single.	52,3	14,8	4	1 6 1	27 0 153 4 11 0	5 4½ 4	ditto	220
Ding-dong	30 inches, single.	35,8	7,6	6	2 2 2 1	37 3 29 3 25 0 15 3	4 6 5¼ 4¼	ditto	144

STEAM ENGINES, IN SEPTEMBER 1834.

Number of strokes.	Lgth of the stroke in the pump.	Load, in pounds.	Pounds lifted one foot high, by consuming a bushel of coal.	Number of strokes per minute	REMARKS, AND ENGINEERS' NAMES.
	feet				
319610	6,25	20585	39,865,618	7,4	Drawing perpendicularly. Main beam over the cylinder, and one balance bob at the surface. EUSTIS AND SON.
183730	7,5 6,5	31863 2894	49,480,822	4,25	Drawing perpendicularly 98 fathoms, and the remainder diagonally. Main beam over the cylinder; one balance bob at the surface; and fathoms of flat rods under ground.
229630	7	7914	33,476,428	5,3	Drawing perpendicularly. Main beam over the cylinder. GROSE.
193120	6	4993	41,324,921	4,78	Drawing the load in three shafts perpendicularly, with main beam over the cylinder and three bobs and 280 fathoms horizontal rods at the surface. J. ROWE.
283000	4	7862	40,453,563	7	Drawing perpendicularly 75 fathoms, and diagonally 70 fathoms. Main beam over the cylinder; one balance bob at the surface, and one under ground; and three angle bobs in the shaft. F. MICHELL.
148140	6	5372	33,158,670	3,67	Drawing diagonally, with main beam over the cylinder, and one bob at the surface. T. BOLITHO.

WORK PERFORMED BY THE FOLLOWING STEAM							
MINES.	ENGINE, and the diameter of the cylinder.	Length of the crank	Length of the stroke, in the cylinder.	Diameter of the fly wheel.	Number of heads.	Time.	Consumption of coal, in bushels.
		feet	feet	feet			
WHEAL VOR	Old Stamps, 24 inches, double.	3	6,5	12	34	Aug 30 to Sep 27	875
DITTO	South Stamps, 27 inches, double.	2,5	5	15	48	ditto	1126
DITTO	Bratt's Stamps, 16½ inches, double.	2,5	5	14,5	24	ditto	1193
BALLASWIDDEN	24 inches, double.	2,5	5	13	32	Aug 27 to Sep 24	768

*** The North engine at Great St George has had leaky boilers; and the exposed; and also Truran's

Average quantity of Water per minute, drawn from the Mines, in September 1834.

MINES.	Imperial Gallons.	MINES.	Imperial Gallons.
Wheal Unity Wood	289,94	Fowey Consols, Austen's	227
Wheal Damsel	76,06	Lanescot, Sawle's engine	57,6
Wheal Jewell	33,34	Roche Rock Mine	237,46
Cardrew	250,46	Wheal Leisure	549,26
Dolcoath	175,6	Great Saint George	596,68
Stray-Park	68,1	Wheal Vor and Carleen	769,92
East Wheal Crofty	136,9	Great Work	257,24
Wheal Tolgus	485,82	Wheal Prudence	128,1
Binner Downs	606,88	Retallack and Hallamaning	307,47
Marazion Mines	313,89	Relistian	156,47
Saint Ives Consols		Wheal Darlington	948,84
Wheal Reeth	60,5	Ballaswidden	56
Consols	1458,98	Levant	19,32
United Mines	575,86	Ding-dong	27
Wheal Beauchamp	217,42	North Roskear	141
Polgooth	605,43	South Roskear	155,86
Pembroke	472,49	Wheal Virgin	126,45
East Crinnis	499,05		

ENGINES, STAMPING ORES, IN SEPTEMBER 1834.

Average height which every head lifts, in inches.	Number of times which every head lifts, at a stroke.	Number of strokes.	Weight of heads, and lifters, in pounds.	Pounds lifted one foot high, by consuming a bushel of coal.	Number of strokes per minute.	ENGINEERS' NAMES.
10½	2¼	689630	12640	19,613,077	17,1	Richards.
10½	2¼	743070	18760	24,374,406	18,4	Richards.
10½	2	867820	9460	12,043,378	20,8	Richards.
10½	2½	682650	12900	25,082,720	16,9	J. Rowe.

South engine and Devonshire's engine have been working with the cylinder engine at Wheal Leisure.

In reference to the quantity of water drawn by the Steam Engines from the Mines, it should be observed, that some of the Engines deliver the water to the Adit level, through double columns of Pumps; others by Shammal Engines, that is, they deliver the water at a level beneath the Adit, and from thence it is drawn by another Engine to the Adit level. There are other Steam Engines assisted by Hydrostratic Engines, in which case the quantity of water cannot be correctly ascertained, and consequently the account is omitted.

CHAPTER III.

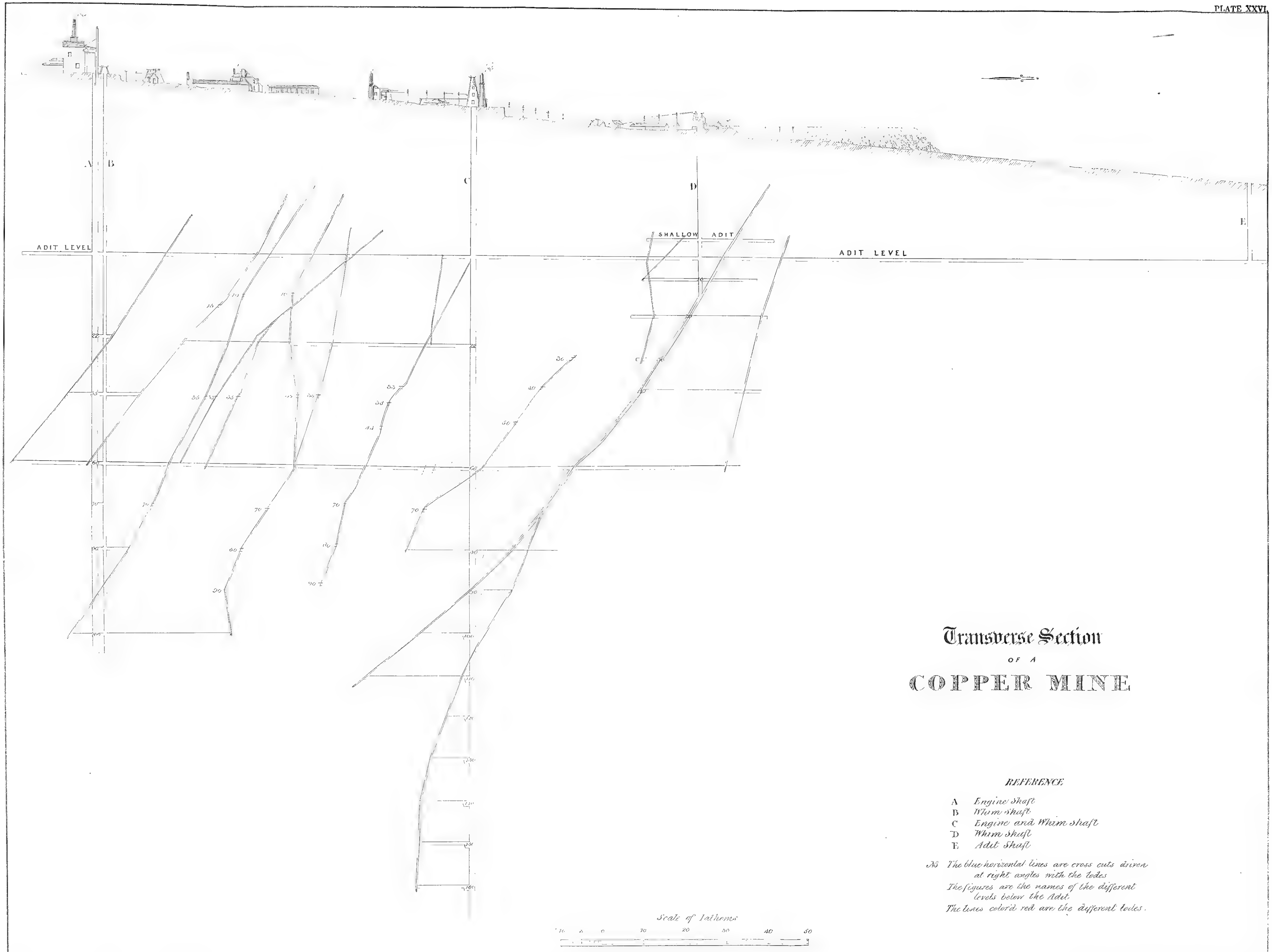
The *ventilation* of mines being the next subject which comes under consideration, and as there are startling facts connected with it, which have of late engaged attention, I will take occasion to place them in that light which their importance merits.

Under this view, it becomes necessary to allude to the temperature and degree of heat which exist at various depths in mines. It would appear, from data entitled to every credit, that a considerable increase takes place, in a certain ratio, as we proceed in depth; that it exceeds 80° in the deepest mines; that it amounts to 70° at a less depth than 1000 feet, and that it is 5 or 6° above the mean temperature of the climate, at no greater depth than from 200 to 400 feet.

The existence of this temperature, at the bottom of mines, will, of itself, necessarily occasion a constant circulation of air upwards, through the shafts; and as what ascends must be replaced by the air above, there will, of course, be a constant current downwards, through the same or other shafts. The extent of ventilation in mines will depend on many circumstances, more especially on their depth, the number of shafts, the degree of communication between the different galleries, and also on the state of the wind at the surface.

Variations in the wind at the surface would appear to affect considerably the currents of air underneath in the levels as well as in the shafts, and that where at one shaft the current has been upwards, and in another downwards, a change in the wind has placed it vice versa—thus making the current run in opposite directions at different times. The strength also of the current underground would seem to depend upon the wind at the surface blowing hard or softly.

In a mine extensively worked, where a communica-



Transverse Section of a COPPER MINE

REFERENCE

A Engine Shaft
B Whim Shaft
C Engine and Whim Shaft
D Whim Shaft
E Adit Shaft

N.B. The blue horizontal lines are cross cuts driven at right angles with the lodes. The figures are the names of the different levels below the Adit. The lines colour'd red are the different lodes.

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tion is made from one level to another, by means of a shaft or "winze," or from one shaft to another by a level, even in the deepest parts, there is no want of air under ground. The current of air is frequently so strong, even towards the bottom of the mine, as sometimes to blow out a candle; in fact, no deficiency of air is found under such circumstances, except when a level is extended a considerable way from the shaft without having a communication with any other part; or in a shaft sunk far below a level; in which case recourse is had to some artificial means to procure air in such a position. In galleries of great length and where there is not very frequent communication with other levels or with more than shaft and a level, the current of air is often scarcely perceptible, although the air may be good.

In sinking deep shafts or driving long galleries, where the air becomes vitiated by respiration and combustion and the gases generated by the explosion of powder, artificial currents are produced by air pipes, &c. In galleries which have been long abandoned and whose communication has been partially stopped, bad air often accumulates; except in coal mines, no explosion from contact with fire occurs, owing to the absence of hydrogen gas.

It was stated in the preceding page that there is a progressive increase in the temperature of mines as we descend in depth. It is not to be pretended that this can be accounted for by animal heat of the miner, combustion of candles, explosion of gunpowder, friction and percussion. These, no doubt, have some influence, but are decidedly unable to account for those startling facts that are about to be stated.

The most conclusive proof of the increase of temperature, as we recede from the surface of the earth, is afforded by the relative temperature of the pump water of the same mines at different times. In one instance in

Cornwall, well authenticated, the temperature of the pump water, when the mine was 510 feet deep, was 62°; when the mine was 670 feet deep, it was 67°.

Observations of a similar character have been made in Germany, at one of the mines of Freyburg, which was worked to the depth of 1200 feet and then abandoned in a great measure; and the water consequently had greatly accumulated: when the external air was 39° the temperature of the water was 61°, which is about 10° above the mean temperature of Freyberg.

I recollect well, in 1828, making some experiments on this subject at the mine of Valenciana, Mexico, at the period that they had drained the water to the depth of 1500 feet; and the water which was delivered at the mouth of the shaft from that depth, was very much above the temperature of the atmosphere. The precise number of degrees, said to be 96 by Professor Millington, I regret being unable to state, having unfortunately lost all my papers when attacked by banditti, in the autumn of that year, on the route from Mexico to Vera Cruz. As near as I can remember, it fully corroborated the experiments tried in England and Germany.

The fact of this increase is so well sustained by the experiments of Daubisson in the mines of Saxony and France, by Patrin in Siberia, by Humboldt in South America and by late investigators in England, that it will be only necessary to give place to the following table drawn up with much care by Cornish geologists.

Mean Results of the Temperature of Six Mines.

Depth in feet.	Huel Neptune.		Botel Lack.		Little Bounds.		Ding-dong.		Huel Vor.		Dolcoath.		Mean.	
	Air	Wat	Air	Wat	Air	Wat	Air	Wat	Air	Wat	Air	Wat	Air	Wat
120 to 150	57		59	57			55						57	57
150 " 200	56		60	58	54	54							57	56
200 " 250	56		61		57	55			60	57			58	56
250 " 300	56	55	61	59	57	59					60		58	58
300 " 350	58	54			55	55							57	55
350 " 400		57	66	62			55						60	59
400 " 450	60		66				56	54					61	54
450 " 500							60	59					60	59
500 " 550	67	67	67	68					61	60	64		65	65
550 " 600							63	63					63	63
600 " 650							62	63	61	63			62	63
650 " 700							64	64	65	64			65	64
700 " 750									67	65			67	65
750 " 800									68	68			68	68
800 " 850									66	66			66	66
850 " 900										68			*	68
900 " 950										71	62		62	71
950 " 1150											70	66	70	66
1150 " 1260											71	71	71	71
1260 " 1350											76	74	76	74
1350 " 1400											83	79	83	79

* Here there was a strong current of air.

In giving the preceding statement relative to the rate of increase of temperature in mines according to their depths, it has been assumed that the increase commences immediately below the surface. This, however, cannot be considered as the case; and although it is difficult to define the precise point, it was placed with some degree of reason at about 200 feet.

From all that has been advanced, it would be conclud-ed, that there exists a high temperature in the interior of the earth. If this is admitted, what is to be said to the fact, and one which has been considered not readily reconcilable with the doctrine of internal heat, that the mines of Saxony, situated 1500 feet above the level of the sea, are of equal warmth with those of Cornwall, which are below the sea level. How also can be accounted for, the high temperature of the South American mines, as recorded by Humboldt, situated at the height of 7000 feet above the level of the sea? And will this accord with the well known fact of the very low temperature of the water of the ocean, and of lakes at very great depths?

It is obvious, that however high the temperature at which the earth might have been formed, it must have been, within a certain time, cooled down to the mean heat of the atmosphere in which it was placed. If then it be true that at certain moderate depths under the surface, the earth continues to be of a temperature very considerably above the mean of the atmosphere at its surface, the conclusion inevitably is, that there must even *now* exist some means of constantly renewing the supply of caloric in the interior of the earth. If we acknowledge the existence of a permament source of heat in the interior of the earth, it might be conceived that the caloric process was restricted to a nucleus of a greater or less radius; that the source from whence it emanates may be far beneath an investing stratum of a determinate depth under the surface, and that in consequence of the more conducting nature of earth and rocks, the heat is slowly evolved at the remote distance of the surface of the earth; and then might be accounted for the high temperature in mines, by considering that the metallic lodes being the best conductors, and evidently placed in fissures of later origin than the rocks which contain them, they may prove to be most direct channels to that interior source; and to descend more into minutiæ, as copper lodes are of later origin than tin, may this not be the cause of the opinion, which is well received, of copper mines being warmer than tin.

(*To be continued.*)

MISCELLANEOUS INTELLIGENCE.

Extract from the Report of the Committee of Inspection. February 25, 1835.

"The Committee appointed under the fifteenth by-law of the Geological Society of Pennsylvania, for the purpose of "inspecting the papers, collections, library and other property of the Society, and of auditing the treasurer's accounts," respectfully submit the following statements as the result of their investigation. Anxious to present to the members of the Society, on the present occasion, such a statement as would afford a correct and satisfactory view of the existing condition and future prospects of the institution, your committee, in addition to their personal examination of its property and effects, requested and received from the curators and other officers, written reports of their respective proceedings. From these documents, and from the recorded minutes of the society's transactions, the following details have been chiefly derived. Since the date of the last annual report, it will be seen, on referring to the minutes, that much has been accomplished towards promoting the objects of the society, by diffusing useful knowledge and in its endeavours to effect a complete geological survey of the state of Pennsylvania. For this purpose a committee was appointed with instructions to urge upon the legislature of the state, the importance of such a measure, with a view of obtaining pecuniary assistance in aid of this great work. The committee, anxious to second the views of the society. prepared at considerable expense such documents as were deemed necessary to explain fully the intentions of the society: these were transmitted to Harrisburg by a sub-committee, consisting of two members of the society, every way qualified for the performance of the duty assigned them. Thus, it will be seen, that an enterprise, so important in every point of view, has been zealously brought before the public, in the confident belief that the legislature would speedily provide the means of effecting so desirable an object. In addition to these efforts on the part of the society, lectures on geology, mineralogy and other branches of science have been delivered at its weekly meetings. Many interesting verbal and written communications have been made from time to time. The cabinet and library have received numerous accessions; the former being materially enriched by valuable donations and deposits. Minerals and other substances have been analyzed by members of the society at the instance of individuals in various parts of this and other states. Examinations, by special committees, have been instituted and reported upon, relative to the Gold region of Pennsylvania and Virginia. Five hundred copies of the first half volume of the Transactions of the Society, consisting of one hundred and eighty pages of letter press work, and six plates of fossil remains and other appropriate illustrations; five hundred copies of the charter, constitution and by-laws of the society, together with several reports of committees and other minor papers, have been printed, and extensively disseminated. These proceedings, in connexion with the more local concerns of the society as recorded in the minutes, form, in the opinion of your committee, satisfactory evidence of the zealous endeavours of its members to augment the usefulness of their growing institution, and manifest a desire on the part of the society, generally, to diffuse, as far as possible, a correct knowledge of geology and other important branches of physics.

"Although the society can date its existence no farther back than the month of April 1832 (less than three years), when it consisted of seven members only, it now numbers more than two hundred resident or corresponding members and four in the honorary class. The list includes some of the most distinguished individuals in Europe. The efforts of the society are seconded also by several local institutions, which have been established in some of the counties of the state, for the promotion of a general state survey."

By reference to the above report, it will be perceived that the committee on the geological state survey have not relaxed in their efforts to accomplish this all-important measure; but this society has again to regret its further postponement, by the state legislature. During the recent session, discussions relative to the political state of our country, generally, appear, in too many instances, to have occupied the attention of the members, to the exclusion of measures of permanent utility.

In the mean time, the legislatures of our sister states have shown increased interest in obtaining a correct knowledge of the mineral wealth of their respective states. In addition to those portions of our country whose legislatures have already availed themselves of the scientific labours of native geologists, as mentioned in the first part of these Transactions; we are now enabled to add the states of Virginia, New Jersey, New York, Connecticut and Maine, where active measures are at present in operation to secure complete geological surveys.

Geological and Topographical Survey of the State of Maryland.

Messrs J. T. Ducatel and J. H. Alexander, who were appointed by the Maryland legislature for the survey of that state, have published their first report for the year 1834, by which it appears that their principal attention was directed to the commercial and agricultural interest of the state.

The extent of their very useful exertions, during the past year, will be seen by reference to the objects embraced in the following sections.

1st. Southern limits of the shell-marl deposits on the eastern shore of Maryland, available for agricultural purposes.

2d. Principal location of the shell-marl deposits between the Choptank and Chester rivers.

3d. Nature of the materials contained in the shell-marl deposits of the eastern shore of Maryland.

4th. Mode of extracting the marl, its uses and its application.

5th. Of the different kinds of soil belonging to Caroline, Queen Ann and Talbot counties, their natural susceptibilities to improvements, and the mode of amending them.

6th. Miscellaneous resources of the eastern shore of Maryland for agricultural and other purposes.

7th. Geology of Prince George and Charles counties on the Potomac, and characters of their soils.

8th. Principal localities of the shell-marl deposits on the Potomac, their constitution, relative value and uses.

9th. Mineral resources of the portions of Prince George and Charles counties on the Potomac.

Messrs Ducatel and Alexander will continue the prosecution of their labours until the state be completely surveyed; a report, more particularly devoted to geology proper, is anticipated at the close of the present year.

Mr Featherstonhaugh's Geological Report.

REPORT OF AN EXAMINATION, MADE IN 1834, OF THE ELEVATED COUNTRY BETWEEN THE MISSOURI AND RED RIVERS. Published by order of both houses of Congress. Washington, 1835.

This is a neat, concise, yet elaborate report, forming an octavo volume of 97 pages, in which the learned author has shown himself fully adequate to the duties of his very arduous and highly important appointment. The report is enriched by a geological section, upon a large scale, of an extensive portion of this continent, commencing at the Atlantic ocean and passing, in an irregular line, across the Ohio, Wabash, Mississippi, Arkansas and Red rivers to the province of Texas.

We are pleased to learn that Mr F. has already arrived on the field designated for his second tour of observations, viz. "the investigation of an undescribed chain of high lands, lying between the head waters of the Mississippi and the Missouri rivers, called *Coteau des Prairies.*"

Hall of the Geological Society of Pennsylvania.

Since the publication of the first part of Volume I. of their Transactions, the Society has found it necessary to remove to more convenient quarters, and has accordingly engaged commodious apartments in the new Exchange buildings. Numerous accessions have been made to their list of resident members; and an evident increased interest in the objects which principally engage the attention of the society, has been excited in our citizens generally. By reference to the volume now completed, very flattering evidence will be perceived of the activity and zeal, as well as the increased numbers of our scientific collaborators; in addition to which it is no more than justice to specify the very liberal aid in scientific contributions and donations for which the society have been indebted, during the last year, to the enlarged views of their fellow associate, James Dickson, Esq., to whose public spirit is, in no small degree, due the present flattering condition, as well as the cheering prospect of the future success and permanency of this institution.

August 1835.

Fossil Corn? (*Zea Maize.*)

We insert the following letter which has just been received from Dr Johnston of Louisville, Kentucky, without further comment at present, than merely observing that we place entire confidence in the author's statements, whose observations were made on the spot. Specimens of the substance in question, have been placed in the cabinet of the Geological Society of Pennsylvania, and in the private collections of Messrs Taylor, Harlan and Wetherill. It is the intention of Mr W. to analyze these grains, which appear in some instances to display, when fractured, a shining surface. Exposed to the blow pipe, they are reduced to a fine white ash, and yield neither smoke nor flame. The grains represent the true Indian variety of corn.

Louisville, July 6*th*, 1835.

My Dear Sir,

I now send you, by Mr Frazer, the *fossilized corn* of which I spoke when I last saw you. It is found in the alluvial bank of the Ohio river, about 25 miles below Wheeling, both above and below the mouth of Fish creek, and extending up the creek some distance, and four or five miles on the Ohio; it may extend farther, but it shows itself only that distance by the washing of the river against the bank. The stratum is generally from 8 to 10 inches thick, and from 5 to 6 feet below the surface, and contains nothing but the *corn grains* closely impacted together with the black dust, which you perceive among the corn, filling up the interstices. No *cob* or *stock* of the corn has ever been found with the grains. The same stratum has been met with in places distant from this in digging below the surface. This is all that I could learn relative to this interesting and unaccountable deposition. Why or how did the corn get from the cob? It certainly must have been charred, or it would not have been thus preserved. It could not have been reduced to this black cinder, like the loaves of bread and grains of different kinds found at Pompeii; or rather it could not have resulted from a like cause. I do believe, that if all the corn raised on the Ohio and all its tributaries above this point was collected in one mass, it would not amount to one-tenth of this deposition.

Most truly yours,

J. C. Johnston.

R. Harlan, M.D.

Mr Lyell's Geology.

THE PRINCIPLES OF GEOLOGY: BEING AN INQUIRY HOW FAR THE FORMER CHANGES OF THE EARTH'S SURFACE ARE REFERABLE TO CAUSES NOW IN OPERATION. By CHARLES LYELL, Esquire, Fellow of the Royal Society, and Foreign Secretary to the Geological Society of London.

It is with much pleasure that we announce to the general as well as scientific reader, that Messrs. Kay & Brother, Publishers, for the Geological Society of Pennsylvania, of this volume of their Transactions, have in press the volumes, the title of which stands at the head this notice.

It can scarcely be necessary to say any thing in praise of this work. Its appearance will always form an epoch in the history of geology. Up to that time the doctrine which assumed the causes of changes, whether of a destroying or productive character, actually in progress on the surface of the globe, to be utterly inadequate to explain, scarcely even to illustrate, the earlier changes of which that surface exhibits such striking traces, held almost undisputed sway in the geological circles. Mr Lyell, applying himself to the elucidation of the existing causes of change, and their probable influence on the older geological formations, with an industry and research which are joined to the happiest powers of description and command of language, has produced a work not only of the highest interest to the scientific world, but of the most popular and fascinating nature to the general reader.

Messrs Kay & Brother, with an honourable zeal for the advancement of Geological science, propose to issue the reprint of this important and interesting work as speedily as possible. The distinction with which it has been received in England and on the continent of Europe, and the bestowment of one of the royal medals on its gifted author, have stamped its value, and rendered superfluous from us any further testimony to its unrivalled excellence.

We understand that it will be printed in this country in a style in all respects equal to that of the third and last edition of the London copy. The engravings will be from 150 to 200 in number; and the whole will be comprised in 2 volumes royal 8vo.

Subscription price $5.

We have just had an opportunity of examining a fine Diamond, weighing one carat and a half, recently found in the washings of a stream in Carolina. It is in the possession of Mr T. G. Clemson, whose intention it is to favour the Society with a more particular account of this discovery.

September 10*th*, 1835.

INDEX.

END OF VOL. I.

ERRATA IN PART I.

Page 7, line 12 from bottom, for "their" read *them*.
9, line 6 from bottom, for "ascertained" read *ascertain*.
11, line 3 from top, for "weaves" read *waves*.
19, line 14 from top, for "Gorgo" read *Gongo*.
line 7 from bottom, for "Ionora" read *Sonora*.
32, line 4 from bottom, for "ci-devant of the Spanish" read *ci-devant Spanish*.
39, lines 6 and 16 from bottom, for "Prestroich" read *Prestwich*.
42, line 1, for "Chœlopus" read *Cholœpus*.
43, line 3 from top, ditto.
51, line 9 from top, for "American" read *Animaux*.
69, line 5 from bottom, for "M." read *Megatherium*.
112, last line from bottom, for "measurers" read *measures*.
149, 8th line from bottom, for "South Brooks" read *South Brook*.
151, 9th line from top, for "common slate" read *talcose* slate.
155, 10th line from top, for "earthy water" read earthy *matter*.
15th line from top, for "amalgamation" read *amalgam*.
12th line from bottom, for "amalgams" read *amalgam*.
8th line from bottom, for "parity" read *purity*.
3d line from bottom, for "and we doubt" read and *no* doubt.
158, 7th line from bottom, for "principal veins" read principal *vein*.

In Fig. I. the letters C. and F. are omitted at the upper end of the straight lines commencing at D. and E.