Charles Darwin Esq.
Geol. Soc.
G84
with the respects of W. C. Redfield

STATE OF NEW-YORK.

No. 150.

IN ASSEMBLY,

February 17, 1841.

COMMUNICATION

From the Governor, transmitting several reports relative to the Geological Survey of the State.

EXECUTIVE CHAMBER,
Albany, February 16, 1841.

TO THE ASSEMBLY.

I transmit the annexed reports of the persons employed in the Geological Survey of the State.

WILLIAM H. SEWARD.

LETTER

From Dr. Lewis C. Beck, to the Governor, relative to the Geological Survey of the State.

New-Brunswick, New-Jersey, Jan. 29th, 1841.

To his Excellency, Gov. SEWARD.

DEAR SIR:

By this mail I have the honor to transmit to you the Annual Report from the Mineralogical and Chemical Departments of the Geological Survey. It contains merely an account of the field operations of the last year. I had intended to introduce into it a general view of our soils and mineral manures, but I found that this would extend the report to an unreasonable length, and I therefore determined to reserve it for the final work.

You will observe that I have made some suggestions in regard to the manufacture of salt. I have had no opportunity of conferring with Mr. Vanuxem since our return from Syracuse, and I had, therefore, no other course but to present my own views in regard to the points suggested by the superintendent. This is a matter of great importance to the State, and more especially so since the publication of the letters appended to the Comptroller's recent report. I would respectfully suggest, whether it would not be proper to have the whole subject referred to a committee of the Legislature, who should meet at Syracuse during the summer, and who should be authorized to direct such experiments to be made as they might deem necessary; the results to be reported to the next Legislature. I can think of no other way in which any thing can be accomplished. It is useless to perform experiments without a definite object in view, and without some sort of guarantee that the State will adopt those plans which such experiments shall prove to be the best. Although I have no desire to volunteer in the business, I will cheerfully devote as much time to any chemical investigations connect-

ed with it as you may deem proper. And should the subject take this turn, I will endeavor early in the spring to visit the salt works on the Kenhawa, in Virginia, for the purpose of examining minutely the details of the processes there pursued.

At page 11 of my report you will find a reference to another subject of extreme interest to the State, viz: that of the manufacture of hydraulic lime, to which I should be pleased to have your attention particularly directed.

With sentiments of much respect,
I have the honor to be,
Your obed't serv't,
LEWIS C. BECK.

REPORT

Of Dr. Lewis C. Beck, on the Mineralogical and Chemical Department of the Survey.

To His Excellency WILLIAM H. SEWARD,
Governor of the State of New-York.

SIR—

I beg leave to lay before you a report of the progress which has been made in the department of the Geological Survey of the State entrusted to me during the past year.

It may be proper here to state that, since the commencement of the survey, my object has been to obtain as complete an account as possible of the mineralogy of New-York. The final report from this department, the materials for which have been accumulating for several years, will embrace a general view of the present state of the science of mineralogy, both elementary and descriptive, and detailed notices of all those species and varieties which have heretofore been found within the limits of New-York. By the aid of maps and wood cuts, of which I doubt not the liberality of the Legislature will warrant the introduction, I hope to be able to prepare a work which will not only be useful as showing the applications of our mineralogy to agriculture and the arts, but which will also serve, either in its enlarged or abridged form, as a text book on the science of which it treats.

During the past year I have again had the able assistance of Dr. William Horton, who has accompanied me in all the tours which I have taken, and who has also separately devoted several weeks to the reëxamination of Orange County, which must still take rank of every other in the State for the variety and abundance of its mineral productions.

Lead or Zinc Mines of Sullivan and Ulster.—I commenced active operations in the spring by revisiting the mines of Sullivan and Ulster counties. During the year preceding large expenditures had been incurred at one of these mines, and smelting works had been erected, which were said to be in successful operation. It seemed to be a matter of importance, therefore, to ascertain their real condition, and more especially so, as the question still remained undecided whether New-York is to furnish any considerable proportion of the lead which is here annually consumed.

The mines of this region have been so minutely described in the preceding reports of the survey that it will not be necessary now to say much in regard to their location and geological relations. The mine belonging to the New-York and Shawangunk Mining and Coal Company has been more extensively wrought than any of the others, and consequently affords a better opportunity for studying the nature and extent of the deposit of metallic matter. It should, however, be premised in the outset that this may rather be called a *zinc* than a *lead*, mine; and the same remark will, I think, apply to all the mines at present known in the Shawangunk mountains. But the proportion of lead is ordinarily sufficient to warrant the expense of its separation and reduction, so long as lead bears a fair price. The deposit of ore is parallel with the stratification of the rock, and is from two to five feet in width, but the metallic minerals are largely intermixed with quartzose materials of different kinds. It has been worked by adits from below and by galleries leading from these at various points in the direction of the vein or bed. The workings are in every respect judicious; all the galleries being susceptible of complete drainage and ventilation. The amount of ore already obtained is large, and from all that appears it is quite probable that this may be increased to any extent and at a trifling cost.

The difficulties which attend the working of this mine have already been adverted to. The ore is a mixture of the sulphurets of zinc, lead, copper and iron, the sulphuret of zinc being in the largest proportion, while that of the others is in the order in which they are mentioned. Various attempts were made, and large sums expended, by the company in useless trials to effect the economical separation of these metals. At length, however, this object has been attained by an arrangement of apparatus equally ingenious and effective. The plans and processes for the separation and reduction of the ore which were in operation at the

time of our visit, and which are understood to have been principally devised by Mr. Hitz, were entirely successful, although I had no means of ascertaining what expense they involved. This last, viz. the expense at which these processes are conducted, is indeed now the only question which remains to be decided. And this has probably been already settled by the experience of the company.

I cannot omit this opportunity of expressing my thanks to Mr. Weed, the active and intelligent superintendent of the operations of this company at the mine just noticed, for the facilities which he afforded us in examining the mine and smelting works, and for other civilities extended to us.

Concerning the Red Bridge or Ulster Mine, as it is sometimes called, little need be said. The work has not recently been prosecuted to any extent. But I know of no peculiarity in the character of this mine, and there can be no reasonable doubt that a large amount of ore is here to be found. It may also be observed, that its metallic minerals are similar to those found in the Sullivan mine, and that they are associated with groups of quartz crystals, which are often of great beauty.

The Ellenville mine, which we also visited, is situated within ha. mile of the village of Ellenville, in the town of Wawarsing, Ulste county. This is the oldest mineral locality in this region, and probably one of the first places at which mining operations, with a view to obtaining lead ore, were carried on, in this State. There are here to be found inferior specimens of sulphuret of zinc, associated with quartz crystals, copper pyrites and the sulphuret of lead, the last, however, being in very small proportion. A few years since a good deal of money was expended to recover what was supposed to be a valuable vein of ore; but, judging from the direction of the level which was opened, there can be little doubt that its course was entirely mistaken.

It is probable that the deposit of these ores in this range of mountains is of great extent, as there are every where indications of the existence of similar metallic minerals, and it would not be surprizing if over an area of several miles a vein similar to that of the Sullivan mine should be found. This, however, can be of little consequence until the main question is decided, whether the separation and reduction of the lead can be advantageously accomplished.

The specimens obtained from these localities are interesting of their kind, although they want the beauty and variety which characterize the metallic and associated minerals found at the Rossie mines. A striking difference will, however, be found by the visiter in the facilities which are here presented for the examination of the mine and for the collection of specimens.

In order to arrive at correct conclusions with regard to the ultimate success of mining operations in the district now under review, several points require still to be settled. One of these relates rather to the company than to the mines. It is, whether any lead mine can reimburse them for the heavy outlay which they have incurred. Another circumstance of great importance is, the character which the lead there produced bears in market. It is also to be determined what amount of ore is lost or wasted during the various processes to which it is subjected.

The ore itself, aside from its associates, is as rich, as valuable, and as easily reduced, as that of any lead mine whatever. The location of the mine too, and the prospect of a supply of ore, are all as favorable as could be desired, while the average quantity of ore in a cubic yard of the vein is as great, if not greater than that of any lead mine now known in the northern part of the State.

The Sullivan and St. Lawrence mines may be thus briefly contrasted. In the latter, there are very small veins of good ore, with very good associates, very easily reduced; but the situation of the mines is bad. In the former, there are large veins, with bad associates, more difficult of separation and reduction; but the mines are admirably situated, whether we regard the removal of the ore, or the facility of transporting the produce of it. And perhaps, in one word, the Shawangunk lead mines (so called) have been somewhat underrated, while those of Rossie have been much overrated.

Valley of the Mohawk and Western New-York.—Our next excursion was through the valley of the Mohawk and westward. In Schenectady county a few minerals only were obtained, and these were almost entirely those forms of calcareous spar, occurring in seams of various widths in the limestone rock which abounds on both sides of the Mohawk, and which furnishes such an excellent building material. Ten miles west of Schenectady, in the town of Amsterdam, Montgo-

mery county, is a quarry of water limestone. The mineral is of a drab colour, and in external character it closely resembles that found at Manlius and the more western localities.

From thence we proceeded to Spraker's Basin, in the county of Montgomery. This is the centre of a mineral region, which, though limited, is of considerable interest. It has been at various times the scene of much speculation, in consequence of the supposed existence in the vicinity, of two very important minerals, viz: lead and coal. The anthracite, which is here found in small masses in the calciferous sandrock, occurs on the side hill north of Spraker's, near the rail-road, at an elevation of not less than two hundred feet above the level of the Mohawk. It is perhaps needless to say that the quantity is barely sufficient for cabinet specimens; it is usually associated with hornstone and with brown spar, which suffers decomposition and gives the rock a rusty appearance.

The, so called, lead mines of Montgomery county, are situated on Flat creek, in the town of Root, two miles southeast of Spraker's Basin. There are here several narrow veins of galena, iron pyrites and zinc blende, associated with calcareous and brown spar, which, however, are seldom crystallized. The geological situation of these veins has already been fully described by Messrs. Conrad and Vanuxem, in the Geological Reports of 1837 and 1838, and I shall therefore only add, that we succeeded in obtaining characteristic specimens of all the minerals of this region for the State collection.

At the North Nose, light coloured garnets occur in considerable abundance in the gneiss rock which here rises to the surface. After obtaining a supply of these, and of the crystallized quartz found in geodes and druses in the calciferous sandrock which overlies the gneiss, we proceeded to Little-Falls, in the county of Herkimer. Here we found several minerals of great interest to the mineralogist. Quartz crystals, or diamonds as they are sometimes called, occur at this place, as well as in various other parts of this county, in very beautiful and interesting crystalline forms. They often have particles of anthracite imbedded in them, while the cavities in which the crystals are found are not unfrequently filled with the same substance in the form of a black powder. There is, moreover, sometimes observable in the little cavities in these crystals, a fluid which is supposed to be naphtha.

The occurrence of these quartz crystals is almost coextensive with that of the calciferous sandrock, but they have no where been found in such perfection as at Middleville, in this county, where single crystals of various sizes and various tints of colour, and groups of crystals variously aggregated, have been obtained in great abundance. They cannot, however, at present be procured without great labor and without incurring considerable expense.

In the immediate vicinity of Little-Falls we found specimens of sulphate of barytes both in massive and crystallized forms, in veins and cavities in the rock which contains the quartz crystals and the pearl spar. The gneiss rock at that place furnished also a variety of feldspar, well worthy of a place in every mineralogical collection.

We next proceeded to Salisbury Centre, in this county, principally for the purpose of examining some deposits of iron ore recently discovered. Near this village were seen some excavations, made in the hope of finding lead ore, of which mineral, however, we could not observe the least trace. A deposit of magnetic iron ore is found about four miles northeast of the village just mentioned. The vein, into which several openings have been made, is on the land of Mr. Willit Congdon, but has been traced for three-quarters of a mile on the adjoining lots. The width of the vein could not be satisfactorily determined in consequence of the excavations being filled with water; indeed, it has not yet been sufficiently worked to enable us to form correct conclusions in regard to its extent or character. Several tons of ore have been raised of an excellent quality. And although no report had yet been received on this subject, there can be no doubt that, with ordinary management, good iron may be obtained from it.

The discovery of iron ore in this portion of the State is one of great importance. There are here all the facilities for its manufacture, and no iron is made near it. It is, moreover, interesting as being the nearest point to the Mohawk valley, where magnetic iron, in any abundance, has hitherto been found. It is to be hoped that the successful prosecution of the enterprise will not here be retarded, as has often been the case elsewhere, by extravagant notions in regard to the value of the mine and its products.

In Onondaga and Monroe counties a few suits of specimens were obtained, in addition to those previously collected. Among these may be

mentioned wad or earthy oxide of manganese from the town of De Witt, two and a half miles north of the village of Salina; and the calcareous serpentine, containing veins of the sulphates of barytes and strontian, which occurs at Syracuse and was first noticed by Mr. Vanuxem in his report of 1839.

At Lockport a large and important addition was made to our collection. The Herculean work which is now in progress at that place, has again exposed the singular and very showy minerals for which it was so celebrated on the first construction of the canal about twenty years since. Such are the nodules and geodes of crystallized calcareous spar, pearl spar and fluor, of anhydrite and selenite in several varieties, of sulphate of strontian, massive and crystallized, and of blende or sulphuret of zinc. Good specimens of these minerals are the more necessary in a public collection on account of their being so well known to travellers and so generally distributed throughout the country.

Specimens of the same kind, but less beautiful, were also found in the vicinity of Niagara Falls, where the limestone is similar to that of Lockport. Indeed, these minerals are undoubtedly coextensive with this rock and may be expected wherever excavations are made into it.

On the route, a brief notice of which has just been given, the mineral which is of the greatest interest to the State and perhaps to its citizens generally, is the hydraulic limestone or water lime, as it is sometimes called. In my Third Annual Report I noticed this subject at some length and endeavored to call the attention of the public to it as one which, in my opinion, is of vast importance. When it is recollected that the durability and strength of many of our public works depend upon the water cement employed, it must be a matter of deep interest to those who are entrusted with their superintendence. The water lime now used, being procured from various localities and manufactured in various ways, can not possess an uniform character. Furnished as it is at different points on the canal route by contract, it requires more than ordinary care and skill to ascertain the fitness of the several parcels for the works in which they are to be employed. After maturely considering this subject in all its bearings, it appears to me that the only way in which the objections to the present mode can be obviated, and an article of uniform purity obtained, is by having the quarrying of the water limestone and the process of its conversion into lime conducted under the direction of the agents of the State; when the

different parcels even thus produced should be constantly subjected to the severest trials before being used in any important structures. It is true that the expense of the article might thus be somewhat increased, but this would be trifling in comparison with the advantages which would be secured. For it should be distinctly observed that while a good water lime is invaluable in the construction of locks, a poor one is worse than useless. The State of New-York is at present, and must be for years to come, so deeply interested in this matter that, I can not hesitate to urge some modification of the present plan upon those who are charged with the direction of her public works.

For information general or local and for other assistance rendered on this excursion, my obligations are due to Mr. Joseph Spraker, of Montgomery, Hon. A. Loomis, of Little-Falls, George H. Boughton, Esq. Canal Commissioner, Mr. G. Hadley, Engineer, and Messrs. Foreman & McKinster of Lockport.

Westchester County.—After returning from the western part of the State, I next visited the county of Westchester. This county, although it may be termed a rocky one, is every where susceptible of cultivation. There is, therefore, a more complete exposure of its mineral productions than is usual in other parts of the State. The construction of public works, roads and field walls, as well as that valuable implement, the plough, has opened to view a large and interesting catalogue. In Eastchester, Mamaroneck, New-Rochelle and Rye, several minerals were procured, chiefly belonging to what are characterized as magnesian; viz. serpentine and its usual associates.

It was at one time supposed that the serpentine found here, from its beautifully variegated green colour and its resemblance to the Italian *verd antico*, might be employed as an ornamental marble. But a careful examination of the material, proved that it was traversed by seams and cracks which every where divide it into small masses. It is also penetrated by other minerals, which, however, they may add to its interest for cabinet specimens, render it unfit for the uses to which marble is applied. In a similar bed in the town of Rye, other and more rare magnesian minerals are found. Chromate of iron, the ore from which the chrome yellow of commerce is obtained, is here often disseminated through the serpentine, as it is also, although less abundantly, at New-Rochelle. It is doubtful, however, whether at either locality it exists in sufficient quantity to answer any useful purpose.

At New-Rochelle, West-Farms and Yonkers, we obtained suits of the minerals which characterize the rocks found so abundantly in this county; such as quartz, feldspar and mica, the two latter of which are found both massive and crystallized, and are sometimes of considerable beauty. Tourmaline and garnet also occur quite frequently in the gneiss rock along the line of the Croton Aqueduct. A solid mass of garnet, of the variety called almandine, nearly a foot in diameter and probably weighing fifty pounds, was found near Yonkers.

Of the minerals of Westchester, and the number is by no means inconsiderable, her marbles are by far the most important. Some of the quarries have been extensively wrought, and are still furnishing large supplies. All the varieties belong to what are called the primitive class, and most, if not all of them, contain a portion of magnesia, and are thus properly named dolomites. The Eastchester quarries are said at present to furnish the best material. The marble from these has a more compact structure, and is stronger and more durable than that from the other quarries. Blocks can be obtained of almost any size, and these are susceptible of a sufficient polish for ordinary building purposes. The objection to some of the other marbles from this county is, that in consequence of their friable character, they absorb water largely, and hence, during the winter, they crumble and are defaced. But there are undoubtedly many valuable beds of this mineral still unopened.

Warren, Washington and Essex Counties.—Having devoted as much time to the county of Westchester as was thought expedient, I proceeded to visit some localities in the northern part of the State. The region in the vicinity of Lake George being one possessed of great interest to the mineralogist, and not having been particularly explored during the progress of the survey was selected as the next field of research. This beautiful sheet of water is surrounded on all sides by rocks belonging either to the primary or transition classes, and which have imbedded in them a great variety of minerals. It is only, however, at particular points that the mountains can be advantageously explored. From the village of Caldwell, where we made our first halt, we traversed the mountains in the immediate vicinity. Here we found some of those minerals which in all other situations characterize the rocks of this class. Quartz, feldspar, mica and tourmaline may sometimes be obtained in forms which render them interesting as cabinet specimens. The sites and ruins of Fort George and Fort William Henry, at the head of the lake, besides the interest which they possess in connexion

with the early history of this country, are worthy the attention of the geologist and mineralogist. The limestone of which these works were constructed and upon which they were built is filled with seams of calcareous spar, which, although it does not exhibit the beautiful crystalline forms elsewhere observed, is still worthy of a place in a collection purporting to display the mineralogy of the State.

We have in the immediate vicinity of Caldwell another illustration of the evils which result from ignorance of mineralogy and the geological associations of minerals. Near the summit of one of these mountains which are all granitic, there occurs a mineral which, from its black colour, was mistaken for coal. Unfortunately, however, it was found that it would not burn, and it therefore wanted one of the important characters of that combustible. Notwithstanding this, the locality at which the supposed coal was found became an object of speculation and strife. The mineral in question was tourmaline, which here occurs in rather large masses associated with feldspar and quartz.

Small veins of magnetic iron ore are also found in these rocks. About three quarters of a mile east of Bloody Pond, and about two and a half miles south of Caldwell, excavations have been made in the mountain to some extent. But small quantities of ore only have been found, and the localities are almost inaccessible in consequence of the steep and difficult ascent to them. The ore is associated with feldspar which sometimes exhibits large and beautiful cleavages.

On descending Lake George the first object of interest is Diamond Island, about four and a half miles below Caldwell, and which has received its name from the abundance of quartz crystals which have been found on it. This is an old mineral locality, and a mere inspection of the fragments of rock and of the numerous excavations will afford sufficient evidence of the extent to which it has been worked. The rock in which these crystals occur is entirely similar to that which is the repository of them in the counties of Herkimer and Montgomery. No specimens, however, have recently been found, either at Diamond Island or Diamond Point, to be compared with those of Middleville or even of Little-Falls. But several interesting crystalline forms were obtained, which will be figured in the final report from this department of the survey. The similarity in the mineralogical character of the rock in this part of Warren county and that in Herkimer, is still further exhi-

bited by the crystals of pearl spar and the six-sided crystals of calcareous spar which are here, as well as there, associated with the quartz.

At Shelving Rock, about twelve or thirteen miles north of Caldwell, a belt of white limestone stretches through the granitic or mountain rocks. In this, nodules of serpentine were found with fine fibres of amianthus running through them in various directions. In another part of the same bed, the variety of this mineral called steatite occurs; as also tremolite, a common associate of the above, in small quantity. A similar belt of white and very crystalline limestone was observed about three and a half miles south of Shelving Rock on the farm of Mr. Samuel Phelps, in the town of Fort-Ann, Washington county. Here we also noticed dark coloured serpentine, pyroxene and common garnet, but the specimens were too imperfect for cabinet exhibition. It is not improbable that they will hereafter be found in a more perfect form.

The occurrence of beds of white limestone in this tract, otherwise so little favored, is one of considerable interest. It may be that it exists in sufficient abundance and may prove to be sufficiently compact for use as a marble; but it will certainly afford by burning, a good lime, an article which is almost everywhere valuable. The contiguity of these beds to the lake will render transport easy to all parts of it, and even to Lake Champlain, while fuel, necessary for carrying on the calcination, is here in exhaustless quantity.

The mountains on the northwest side of Lake George and near the line dividing the counties of Warren and Essex, are rich mineral localities. The principal ones at present known are near Rogers' Slide or Rock, which, tradition informs us, has received its name from an extraordinary incident of revolutionary times. Here are found in great abundance, the garnet-resinite of some authors, massive, granular and crystallized garnet of various shades of color, pyroxene both crystallized and granular, adularia and sphene, or the silico calcareous oxide of titanium, together with calcareous spar and graphite. Although rather remarkable for the great abundance and variety of a few minerals, than for the number of species, this spot is justly considered as one of the most interesting to the mineralogist which is at present known in the State. A short distance from Rogers' Rock, but in the same mountain range are found tourmaline, hornblende and feldspar, but not so well characterized as those from other localities.

On the mountain nearly opposite to Rogers' Rock, in the town of Putnam, Washington county, is another rich mineral locality. Here we obtained fine specimens of the so called hypersthene, in large cleavages and of different shades of color. A vein of this species seems to extend for some distance in the bed of a ravine or brook which passes down the side of the mountain. Accompanying this, were also found adularia, crystallized epidote, mica in plates of small size, and tourmaline. It cannot be doubted that this will hereafter furnish other interesting minerals, but at present, the unbroken character of the forest, added to the steep and rugged ascent of the mountain, render it by no means easy of exploration.

To the traveller who passes down this almost fairy sheet of water from its head at Caldwell to Ticonderoga, where it unites with Lake Champlain, its banks appear like a succession of mountains of nearly the same general character. Some of these have received distinct names, as French mountain, Tongue mountain, Black mountain, &c. the last of which is said to be the highest on the lake, being about 2200 feet above the level of the water. But although there is this apparent uniformity, the mineralogist and geologist notice some difference in their characters. Here almost horizontal layers of blue limestone appear, there the compound of limestone and sandstone or the calciferous sandrock, with its characteristic minerals. Again there rises up a bed of white primitive limestone with serpentine and other magnesian minerals similar to those which occur in the southern counties; and finally whole mountains show themselves near the termination of the lake, which, if they are not trappean, at least closely resemble those in many of their characters. Indeed, from one extreme to the other, Lake George is full of interest, and while its clear bright waters, and the picturesque scenery on its banks are the admiration of travellers, the naturalist will here find a rich and almost unexplored field of investigation, and will be amply repaid for all the toil and fatigue, the peril and privation, which he may be called upon to encounter.

From Ticonderoga, or Alexandria as it is sometimes called, we made excursions in various directions. One of these was the ascent to the summit of Mount Defiance. A short distance up the mountain we found a mineral vein, from which were obtained beautiful specimens of pyroxene (sahlite,) closely resembling those from the Forest of Dean, in Orange county; but here associated with feldspar and quartz. Before reaching the site of Burgoyne's Block-House, which commands a no-

ble view of the lake and its banks in all directions, we obtained specimens of a variety of specular iron ore usually called red hematite. This mineral occurs in a narrow vein in the mountain rock, is associated with quartz, and often passes into the variety known by the name of jaspery iron. It is used both as a paint and as an ore for furnishing metallic iron. About thirty tons of this mineral are said to have been here obtained, but the difficulty of access renders the locality almost valueless.

In the town of Crown-Point there is at least one important deposit of magnetic iron ore. This is the one which is usually known by the name of the Penfield ore bed. It is of great extent and it is advantageously worked. The ore, of which there are several varieties, is generally associated with quartz, from which it is freed before being used in the forge, by the magnetic separating machine.

On the way to Penfield's some excavations were observed, from the rubbish of which we obtained specimens of magnetic iron ore of good quality; it may hence be inferred that the deposits of this mineral are abundant, if not of sufficient extent to be advantageously wrought. The gneiss which is here the prevailing rock, occasionally furnishes good specimens of epidote, feldspar and mica.

Among the interesting minerals found in the vicinity of Ticonderoga, graphite or black lead deserves a prominent place, in consequence of the quantity and purity in which it here occurs. In the mountains from three to five miles northwest of the village, there are veins of it of different widths and with different associates. The best one at present known is on the land of Francis Arthur, Esq. who obligingly furnished some fine specimens for the State collection. At this locality the graphite is in large masses, both foliated and granular, and is of great purity, the calcareous spar which is immediately associated with it being e ily removed. Hitherto, however, comparatively small quantities have been obtained from this mine, which is perhaps rather to be ascribed to the limited demand for it, than to any deficiency in the supply. At Kirby's mine and others west of Arthur's, the graphite, although in considerable abundance, is intermixed in the form of small scales with quartz and feldspar. In the immediate vicinity there is a large deposit of pyroxene, both foliated and crystallized, with scapolite, minerals so closely resembling similar ones from the southern counties as when laid side by side to be scarcely distinguished from each other.

Indeed, I have more than once been struck not only with the general similarity of the rocks and minerals of the northern and southern extremes of the State noticed in my last report, but also with the exact resemblance of many of the varieties from these distant localities. And although it has of late become quite fashionable for geologists to discard the mineralogical characters of rock formations, in this State at least, they are too important to be overlooked or neglected.

For useful information in regard to the mineralogy of the district just noticed, we are indebted to Messrs. Roberts and Proser of Caldwell, and to Mr. Burnett of Ticonderoga. Mr. E. Stone, of the latter place, will be found a valuable guide to Rogers' Rock and the adjoining localities.

Orange County.—During the latter part of the season Dr. Horton was engaged in a reëxamination of some parts of Orange county, in which several suites of minerals, including iron ores, were obtained. When these come to be displayed in the proper apartments, it will be seen that this county is not excelled, if equalled, by any other in the extent, interest and value of its mineral productions.

Brine Springs of Onondaga and Cayuga.—After the season usually devoted to field operations had elapsed, Mr. Vanuxem and myself were requested by you to visit Syracuse for the purpose of conferring with the Superintendent of the Salt Works in regard to certain matters connected with the manufacture of salt. We accordingly proceeded to that place in the early part of December, and I now beg leave to present a summary of the information obtained from Mr. Spencer the Superintendent, and from subsequent examinations. I should state, however, that I am alone responsible for the views here presented, as we have not had an opportunity for consultation. Mr. Vanuxem will, I understand, also introduce this subject into his report.

According to the statements of Mr. Spencer it appears that during the past season two borings were made in the vicinity of the Syracuse pump-house, the one of which was 245 feet in depth, and the other 265 feet. The brine from both these wells was much stronger than is usual in this region. In that from the deepest, the salometer (graduated by marking pure water at 0° and brine saturated with salt at 100°,) stood at 78° to 79°; whereas in the other, the instrument stood at about 77°; showing a difference between these and most of the other waters on the Reservation, of from 10° to 20° on this scale. Both wells furnish

daily, brine for the manufacture of ten thousand bushels of salt. On examining the brine from these two wells, previously mixed by Mr. Spencer and put into bottles which were carefully sealed, I found the specific gravity to be 1.14344. 1000 grains of this brine when evaporated to complete dryness, left 182 grains of saline matter, or 18.20 in 100 parts.

This saline matter upon further analysis was found to contain 173.50 parts of common salt, and the rest to consist of the usual impurities (as they are called) of the brine, wherever it has hitherto been found in this vicinity; viz: sulphate and carbonate of lime, muriate of lime and of magnesia, and oxide of iron, the former being in much the largest proportion. The following will express with sufficient minuteness for all practical purposes, the composition of this brine, in 1000 parts, viz:

Common salt,.....	173.50
Various impurities, principally sulphate of lime,...	8.50
Water,.....	818.00
	1000.00

About thirty-five gallons of this brine, therefore, will yield a bushel of perfectly dry salt; and about thirty-three and a quarter gallons will furnish a bushel of salt in the ordinary state of dryness in which this article is sent to market. The superior strength of this brine will appear from the fact that the strongest brine previously obtained, required upwards of forty gallons for a bushel of salt in the ordinary state of dryness.

The difficulties to be overcome in the manufacture of pure salt from this brine are the same as in all the others, but perhaps somewhat increased by its very strength. I have in a former report (for 1838,) treated at so much length of the precautions which are to be used in the manufacture of salt in the district under consideration, that I shall not now notice them in much detail. In this, as in all similar cases, we shall arrive at correct conclusions by examining the processes of nature or those in which there is the least interference of art. In the solar evaporation works, there is a good opportunity for observations of this sort. The raw brine is here exposed in shallow vats to solar heat. After some time there is a deposition of the more insoluble impurities, as the oxide of iron, the carbonate and sulphate of lime. These are observed usually in a crystalline form in the upper tier of vats, and the

deposit continues until the *salting* process commences, which may be known by the shooting out of small cubic crystals on the surface of the remaining brine. This liquor is now drawn off into another tier of vats, where the crystallization of the salt is completed. There now remain some impurities less soluble than the common salt, viz: the muriates of lime and magnesia, which give to the fine salt the deliquiating character and bitter taste which are so injurious to it, but which in the coarse salt vats remain in the liquid form after the salt is removed.

Now the difficulty in the manufacture of fine salt by the operation of boiling, is, that these natural processes, which so easily and completely purify the salt, are interfered with. Instead of allowing time for the gradual subsidence of the insoluble impurities and the separation of the more soluble ones, the heat is so high that the precipitation of the sulphate and carbonate of lime and oxide of iron is more rapid, and these, not being effectually withdrawn by the pans which are used for this purpose, form a crust upon the kettles which requires to be repeatedly removed by mechanical force. The more soluble impurities also cannot be so well separated by the simple drainage to which this kind of salt is subjected.

To the question which is so frequently asked, how can the manufacture of the fine salt be improved? I can only answer in general terms, by imitating as closely as possible the processes observed in the coarse salt fields. This should be the standard, for here salt is obtained in the purest form, and yet by operations entirely simple and easily varied to suit particular cases. In applying these principles to the manufacture of fine salt, it cannot be too strongly urged that the first purification of the brine or the separation of the less soluble impurities which subsequently form the pan scale, should be effected in vessels (whether reservoirs or pans,) other than those in which the salting is to take place. A want of attention to this point, is, I am satisfied, the chief cause of the complaints which have been made in regard to this salt. Indeed, the condition of the kettles, containing as they often do a deposit of these impurities of three or four inches in thickness on which the salt is deposited and from which it is removed by simply *ladling* and drainage, forcibly exhibits the objections to which this mode of manufacture is ordinarily exposed.

Several plans have been proposed for effecting the separation of the impurities of the brine before the *salting* takes place. It might be

done, as it is in the coarse salt fields, by exposure to solar influence in separate reservoirs, and the purified brine then drawn into the kettles to complete the process. To this it is objected that the time required for the precipitation in this manner would be too long, and that for the supply of the manufacturer, vats of enormous size would be necessary. Hence the practice, almost universally adopted, of adding quicklime in small quantities to the raw brine, to hasten the precipitation of these impurities. I have on a former occasion, given my views in regard to the use of this substance. If added in small quantities to the brine, before it is introduced into the kettles where the *salting* takes place, I can see no objection to its employment, so far as the purity of the salt is concerned. But when it is thrown into the kettles, unless great care is taken to remove it, it undoubtedly injures the salt. In some foreign manufactories, blood is occasionally used for a similar purpose, and in some arts, not unlike that now under consideration, powdered charcoal is employed with the same object. A set of experiments is necessary to determine whether any other substance can be advantageously substituted in the place of quicklime. I am satisfied, by trial and observation, that the addition of lime causes a much more speedy precipitation of the impurities than is the result of a simple exposure without this addition. This, indeed, is confirmed by the experience of almost every manufacturer.

Another plan proposed, and one to which our attention was principally directed in the recent visit to Syracuse, is that of erecting works of sufficient extent to enable the State to carry through the process of purifying the brine under the direction of its officers, and to furnish the manufacturers with the purified brine. An attempt has already been made to secure this object by the construction of several large reservoirs in which the impurities are precipitated by the use of lime and by exposure for twenty hours. But the limited capacity of these reservoirs, as compared with the whole quantity of brine consumed, is such that they fail in securing that advantage which might otherwise be expected. The exposure is not continued long enough to effect the entire separation of the less soluble impurities above mentioned. And the question is then presented, whether these reservoirs shall be extended by the State to the capacity necessary for fulfilling this intention, or whether some other mode of purification shall be adopted?

In favor of the proposition that the business of purifying the brine be conducted by the State, it may be urged that in this way the purifi-

cation might be more advantageously and certainly accomplished. There would also be a great saving of brine, which would in that proportion diminish the expense now incurred in raising and distributing it. On this point I beg leave to refer to some calculations presented in my Second Annual Report, from which it appears that about one-fourth of the brine raised by the different pump works, is wasted, chiefly in consequence of the faulty construction and management of the reservoirs, by which the individual works are now supplied with brine. This waste might be in a great measure prevented, if the purification should be conducted under the direction of the State, as the numerous private reservoirs could then be dispensed with and the purified brine drawn directly into the kettles from the tubes used for its distribution.

Should the above question be hereafter settled affirmatively, a series of experiments will be necessary to determine the most advantageous mode in which the requisite purification can be accomplished. The exposure of the raw brine in reservoirs for a sufficient length of time will, as has been already stated, answer the purpose, but then an immense surface will be required and a great outlay incurred. The desired result might be attained by the plan adopted in France and other European countries, viz: that of allowing the raw brine to fall in small streams from a considerable height through fagots arranged across each other, or through a collection of ropes stretched perpendicularly. In this way, the strength of the brine might be so much increased as to cause the deposition of the less soluble matters.

An opinion seems to be entertained by some of the manufacturers at Salina that the addition of alum to the brine improves the salt. This practice is said to have been followed in Cheshire, in England, when the salt boilers wished to procure a hard, firm salt of large grain. By some, this has been considered a valuable addition, while others assert that the same object can be attained if the operation is conducted by a gentle heat. It is not easy to see the manner in which the good effects ascribed to alum are produced, for it appears that only three or four pounds of alum are added to a quantity of brine capable of yielding as many tons of common salt. It may, however, belong to that singular class of cases in which a very small portion of one saline substance exerts a great influence over the crystallization of another.

I may state, in conclusion, that great advantages would be gained, and perhaps, indeed, the whole object secured, if the manufacturers were to employ large, shallow pans, in which the brine could be sub-

jected to a gentle heat, for the separation of the less soluble impurities. From these, the partially purified brine should be drawn into other pans or kettles, for the formation of the salt. And lastly, the salt thus obtained, should be kiln dried for several hours to remove the earthy muriates, which render the salt bitter and cause it to become moist, and at length to form into hard masses. This is, in brief, the process which is generally adopted by the salt boilers in England, and there is no objection to its general employment here, except that a larger expenditure for works and fixtures is required. But this is of little consequence when compared with the great improvement in the manufacture, which would be the result, and without which, indeed, the Onondaga salt may fall into such disrepute as seriously to affect the interests of the manufacturers and of the State at large.

Montezuma brine.—I have examined a bottle of brine recently obtained at Montezuma, and which is stronger than any which has heretofore been procured at that place. I am unacquainted with the precise situation of the boring and of its depth. The specific gravity of this brine is 1.09767; and 1,000 parts of it contain 129.33 parts of dry solid matter, or 12.93, in 100 parts of brine. This is within one per cent of the strength of much of the brine now worked in Onondaga; a fact which would seem to warrant further expenditures and to strengthen the expectations which have been entertained in regard to the reëstablishment of the manufacture of salt at Montezuma..

I have collected many facts in regard to the soils and mineral manures of the State, a summary of which I had intended to lay before you in this report. But as this would greatly extend it beyond the limits which I had assigned, I shall reserve it for the final work.

I should not omit to remark, in conclusion, that in every part of the State visited during the past season, an increased interest in the survey has been exhibited. Every where, individuals who suppose themselves to have mines, minerals, or mineral manures, are anxious to have examinations made and to receive information in regard to them.

Upwards of two thousand specimens have been collected for the State, during the last year. These are now in boxes ready to be opened and arranged, as soon as a place shall have been provided for their exhibition. I have the honor to be,

Your obedient servant,

LEWIS C. BECK.

New-Brunswick, January 28, 1841.

FIFTH ANNUAL REPORT

On the Palæontology of the State of New-York, by T. A. Conrad.

In order to give a clear exposition of some of the geological phenomena connected with the Palæontology of the Silurian system, which embraces nearly all the rocks of the State of New-York, it is necessary to furnish a slight sketch of the various formations of more recent date which occur within the limits of the Union.

In this general and brief review of formations, I will commence with the earliest fossilliferous strata, or those which collectively constitute the Silurian system of Murchison, a very extensive series of rocks, formerly termed the Grauwacke group by De la Bêche, and by others classed with the Old Red Sandstone and carboniferous or mountain limestone, to which vast series the name of Transition was applied. Mr. Murchison has happily been able by means of Palæontology, or the study of organic remains, to give a more natural and definite classification of the various strata below the Old Red Sandstone or Devonian system, and accordingly we now follow his arrangement, separating the Silurian strata from the Old Red Sandstone and carboniferous limestone. Nature has probably enabled the geologist to apply this classification in a more clear and satisfactory manner to the rocks of this country than to those of Europe, since the series is certainly more complete and the organic remains more abundant in species. The horizontality and undisturbed condition of the strata have enabled us to trace their sequence or order of superposition with comparative ease, and greater accuracy than can always be obtained in regions where the formations have been much inclined or distorted. These divisions or series are usually composed of various layers, as compact limestone associated with friable shale, sandstone alternating with argillaceous shale, &c. and these modifications of their mineral constituents are generally accompanied by

some variation of the organic contents; new species have been introduced, or more ancient ones have disappeared. But it is only at the junction of two formations, that each *group* of organic remains is not perfectly distinct and characteristic, a mixture of species sometimes occurring which proves a gradual transition from one era to another, and gives rise to some uncertainty where the exact line of demarcation should be drawn. This fact opposes the idea sometimes indulged by speculative geologists, that sudden convulsions of the earth's surface have been the cause of exterminating forms of life, and the introduction of others to supply their place. The change seems rather due to alteration of temperature in the water, whatever new physical conditions of the earth resulted at the same time. Such phenomena, however, do not interfere with the general distinctive characters of the stratagraphical divisions adopted in this work. It is now, I believe, an undisputed point in geology, that certain groups of organic remains belong exclusively to certain formations, and that these strata, in a general way, may be known and compared by the same groups of genera, if not species, in every region of the earth. It is also established, that whilst some genera and many species are restricted to a single formation, others have originated at an early period and continued to exist throughout a large portion of the time occupied in the deposition of a system or series of formations. Although this may appear a stumbling block in the way of stratagraphical arrangement, I believe that a skilful palæontologist will find by patient investigation, that it is a difficulty more in imagination than reality, and will therefore be considered an objection only by those who are deficient in an industrious and minute observation and comparison of the various groups of organic exuviæ.

In the Silurian system, which is composed of the oldest fossilliferous rocks yet discovered in North America, we observe a variety of formations, consisting of siliceous and argillaceous limestones and shales, of various colors, as black, blue, gray and drab; sandstones, either red or olive, coarse or fine grained, though the latter variety predominates; conglomerates and breccia are comparatively very rare. Nearly all these strata appear to have been deposited in the bed of an ocean, undisturbed by violent currents or greatly agitated waters, because the general condition of the most fragile shells is so perfect as to preclude the idea of attrition. Even in the coarse grained sandstone at the falls of Oswego river, the fucoides exhibit no trace of a violent commotion in the waters of that period. One stratum only in the whole system

can be cited as an exception to this rule, where the shells are in a fragmentary condition. It is true that the valves of bivalves are generally found apart; but their most delicate characters, their angles and ornamental striæ, are beautifully preserved; and, indeed, shells with unseparated valves are common enough in almost every formation. Many of the testacea in the shales have lost their original form, by pressure from the superincumbent rocks, and are difficult in consequence to be determined with accuracy.

Shells, chiefly bivalve, for the univalves are comparatively rare, and multivalves are unknown, form the great bulk of the organic exuviæ, and by their immense accumulation have materially added to the thickness of many of the limestones and shales. Some strata, like the limestone at Lockport, are chiefly made up of the columns of crinoidea in a fragmentary condition. Some of these formations thin out and finally disappear when traced continuously, but reappear at a distance as if they had been deposited in extensive basins, and a change in the component materials of rocks is always accompanied by some variation, however slight, in the groups of fossil remains, although these sometimes vary where the difference of mineral character is not very obvious between two rocks in juxtaposition; hence the difficulty in many parts of Ohio and other western States, where the strata, though geologically distinct, are similar in color and composition, and thin and broken up, or detrital, at their *outcrops*, of procuring a section clearly illustrated by the succession of characteristic fossils; and thus several distinct formations have not unfrequently been comprehended under the same term.

The color, and even mineral character, of a formation, usually varies greatly over an extended region; but it may be recognized by its fossil contents; for example, the black slate of the Mohawk, characterized by a peculiar trilobite, Triarthrus, which has never been known to occur in any other geological position, is represented by a drab colored shale in the vicinity of Cincinnati, Ohio. There also the equivalent or continuation of the black limestone of Trenton-Falls, is of a gray or pale hue, and could be known as the same rock only by its organic reliquiæ. The Caradoc sandstone series of Wales is represented in New-York by limestone and slate in proportion equal to the arenaceous strata. The red sandstone and red marl with which the rock salt of Cardona is associated, are referred to the period of the chalk and green-sand of England, by Dufrénoy and Lyell. The green-sand of New-Jersey

passes into limestone in the Carolinas and in Alabama. It becomes therefore a point of great interest and importance to collect and compare the various groups of organic remains from all the different States of the Union, that a uniform system of classification may be finally constructed, applicable to the whole region; otherwise the usefulness of the science will be much restricted by a multiplicity of local appellations and want of connexion between rocks of the same geological date.

The stratagraphical distribution of the various genera and species of fossils is a subject replete with interest, but much time, labor and research are necessarily required clearly to decipher these ancient records of the earth's history, and guard against erroneous inferences. The following remarks, therefore, must be understood to apply to a subject not yet as fully investigated as we could desire, our opinions of which may be modified by subsequent discoveries.

The most distinguishing features in the palæontology of the system, are the trilobites in nearly all the strata, the vast proportion of brachiopodous bivalve shells in the lower and middle divisions, consisting chiefly of the genera Delthyris, Strophomena and Atrypa in the limestones; the large quadrangular fucoids in the sandstones; the linear Graptolites in the slates, and the abundance of bivalve shells of the genus Avicula in the upper division.

It is an interesting subject of inquiry what were the first created forms of animal life, and whether marine vegetation was introduced before, contemporary with, or after the earliest types of animal organization. Professor Phillips remarks that "the classes of mollusca are more ancient than those of zoophyta, if we trust our present knowledge, and both older than marine or land plants—a seeming paradox, since the preëxistence of vegetables seems capable of being sustained by strong arguments, drawn from the relations of animal and vegetable life." In this country, the oldest fossilliferous rock hitherto known to geologists is the calciferous sandstone first named, and described by Professor Eaton, which has yielded as yet no other fossil than two species of Lingula;* a small univalve, and something resembling fucoidal remains. Should future observation be disappointed in finding other remains, we must conclude that the first created genus of animal life was one of the very few of the Silurian system which was continued in

* One species occupies a lower position in this rock than the univalve alluded to.

nearly all the subsequent formations and yet exists in the ocean, a remarkable fact, since so many genera of plants, mollusca and zoophyta were subsequently created and exterminated anterior to the Tertiary eras. In the succeeding formation, a compact gray limestone with veins of spar, a well characterized fucoid is very abundant, (F. demissus) obscure traces of trilobites of the genus Isotelus, and a species of polyparia occur, but other fossil remains are unknown. In the rock next in order of sequence, the Mohawk limestone or breccia, a few of the fossil shells of the superincumbent Trenton limestone appear, and a new genus of Brachiopoda is introduced, (Strophomena.) The Trenton limestone succeeds, and now for the first time we find various species of trilobites, a profusion of shells and corals, and the genera Delthyris, Orthis, and Stenoscisma of the Brachiopodous bivalves. From our present knowledge, therefore, we must conclude the Testacea and marine plants to be the most ancient organized forms, and that the polyparia or corals were next in the order of creation.

It is acknowledged by geologists that organic remains imbedded in the earth are least analogous to existing species in proportion to their antiquity and therefore in the Silurian system we are not surprised to discover few even of the genera now in existence among the organic exuviæ. Such genera are restricted to the polyparia, radiaria, crustacea and testacea, for the Echinodermata, fishes and plants are all of extinct genera. Of the polyparia only three or four genera are known among recent corals. Of the radiaria, but two existing genera, (Asterias and Euryale.) Of testacea nine or ten recent genera are known, and among the crustacea not more than one, so that it is not probable that more than twenty genera of animals and plants of the Silurian rocks will be found by future observers referable to any of the thousands of types now existent upon the surface of the globe. The genera of shells which outlived the Silurian and carboniferous periods consists of Lingula and Orbicula among the Brachiopoda, Avicula of the division Mesomyona, and Corbula of the division Plagymyona. I have seen one species only of the latter genus. Among the univalves, all the genera of Cephalapoda are extinct; but a few of the Gasteropoda are apparently referable to existent genera; these are Trochus, Turritella and perhaps Natica, whilst in the higher strata of the system impressions resembling Solarium occur. Of the Annulosa we find a genus resembling Spirorbis. Of the crustacea, there are several species undistinguishable from the recent genera Cypris or Cytherina, to the latter of which I

have referred them as they are invariably associated with groups of marine shells, but all the other forms are very remote from living types, except the general resemblance in outline between Acidapsis of the middle division of the system and the living Limulus or king crab of the Atlantic coast.

The oldest rock in which fossils occur in profusion and considerable variety, the Trenton limestone, has hitherto yielded only four genera of recent shells, all very rare in comparison with the extinct Brachiopoda, which, although restricted to very few species, are so vastly abundant, that many of the limestone layers seem to be little more than an aggregate of bivalve shells.

In a division of the Silurian system into three large groups, for the sake of convenience, if not a strictly natural arrangement, I should propose to class all the formations below the Rochester shale in one group, designated by the term lower Silurian series, characterized by six genera of trilobites, which as yet are not known to occupy a higher stratagraphical position. Three genera of Cephalapoda are also limited to this division, and a new genus of Plagymyona.

The middle division of the system, if taking the Rochester shale and superincumbent rocks to the Onondaga limestone inclusive, will be characterized by seven genera of Crustacea, two of bivalve shells, one of plants and three of Crinoidea.

The third or highest division would embrace all the rocks above the Onondaga limestone and below the Old Red Sandstone, or that series on the borders of Pennsylvania and New-York, termed the Chemung group, together with a red sandstone which has been ascertained to hold the remains of the Holoptychus, a fish restricted to the Devonian system of Europe. This division will be characterized by two genera of trilobites.

The following table will show the limits of certain genera, as well as the relation of the strata to those described in Murchison's "Silurian System."

Formations.	Silurian formations in Wales.	Characteristic genera.
UPPER SILURIAN SERIES.		
26. Oneonta group.		*Crustacea.*
25. Cazenovia group.		Cryphæus.
24. Tully limestone	Aymestry limestone*	Dipleura.
23. Sherburne group.		
22. Shales near Apulia.		
21. Black slate.		
MIDDLE SILURIAN SERIES.		
20. Onondaga limestone.		*Crustacea.*
19. Corniferous limestone.		Odontocephalus.
18. Grit slate, (Eaton,)	Lower Ludlow rock.	Acidapsis.
17. Fucoidal sandstone.		Acantholoma.
16. Oriskany sandstone.		Platynotus.
15. Crinoideal sandstone,		Eurypterus,
14. Limestone and shale,		*Crinoidea.*
13. Pentamerus galeatus [limestone.	Wenlock limestone.	Astrocrinites.
		Lepocrinites.
12. Hydraulic limestone.		Caryocrinites.
11. Gypseous shales.		*Testacea.*
10. Rochester shale, ...	Wenlock shale.	Phragmoceras.
LOWER SILURIAN SERIES.		
9. Pentamerus oblongus [limestone,	Caradoc sandstone.	*Crustacea.*
8. Iron ore and green slate,		Triarthrus.
7. Red sandstone,		Isotelus.
6. Shales of Salmon river.		Ceraurus.
5. Trenton limestone,		Cryptolithus.
4. Breccia,		Illænus.
3. Sparry limestone,	Caradoc sandstone.	*Testacea.*
2. Calciferous sandstone,		Orthostoma.
1. Potsdam sandstone,		Cyrtolites.
		Phragmolites.
		Lyrodesma.

* It was conjectured that the Tully limestone might prove to be the equivalent of the Aymestry limestone, but a comparison of the fossil of both formations did not warrant this conclusion. Last summer, I was fortunate enough to find two species of shells which characterize the Aymestry limestone, and they occurred in the Tully limestone in Onondaga county. These are the Avicula reticulata and Atrypa didyma.

In the highest division, the whole assemblage of testaceous remains is so unlike those of either the inferior groups that the dissimilarity would be obvious to a superficial observer. The strata composing this division are many of them crowded with remains or impressions of bivalve shells, consisting chiefly of Delthyris, Strophomena and Avicula, and seem to be more completely developed than the Upper Ludlow rocks of Wales. Though a comparison of the fossils of this division with those of the Upper Ludlow has resulted in the identification of very few species, yet all the strata of which it is composed are clearly above the Lower Ludlow rocks and below the Old Red Sandstone, whilst the natural affinities of the organic remains bring them within the scope of the Silurian system.

Geographical distribution.—The general outlines of these three divisions, as they appear on the surface or in quarries, in ravines, beds, and walls of streams, and the scarps of hills, may be said to correspond with the northern, middle, and southern districts of the State of New-York; the first, or oldest, lying north of the Mohawk river and Erie canal, which, together, constitute a tolerably correct southern boundary. It reappears at Bedford Springs, and in the vicinity of Cincinnati, Ohio, judging from fossils that I have examined. The middle division occupies the central portion of the State, and beginning some distance east of the Hudson, is continued without interruption to Lake Erie. Rocks referable to this section, occur at the Muncey hills, and near Lewisburg, Northumberland county, Pennsylvania; at Richmond, Indiana; Garrard county, Kentucky, and near Florence, Alabama. To this section belong the interesting limestones and grits of the Helderberg mountain, and of the hills around Schoharie court-house; which latter localities have yielded to the untiring exertions of my friend John Gebhard, Jr. a rich harvest of the most curious and rare shells, crinoids and trilobites, highly characteristic of the strata of this division. The third or highest series, runs parallel to the latter, through the southern counties, bounded on the south by the Old Red Sandstone, and in many places extending in the adjoining counties of Pennsylvania.

Remains of Plants.—I have not met with impressions of land plants in the rocks of the system, but marine vegetation, on the contrary, was remarkably prevalent in all the periods, nearly all the arenaceous strata, exhibiting various forms of fucoids or plants allied to sea weed, and some of the sandstone and argillaceous shales, remarkable for the extreme abundance of very singular forms. One of the most prominent

characters of the larger species, is the quadrangular form of the fronds, and the terminations sometimes rudely resemble a human hand; whilst others are not unlike the foot-marks of birds, and led me into an error with respect to the impressions of feet in the New Red Sandstone. These fucoidal remains are most abundant and remarkable in the upper portion of the lower series of strata, or the Red Sandstone of Niagara and Genesee rivers. From the entire absence of land plants in the rocks of the lower and middle series, we may infer that little dry land, and that consisting of barren islands of primary rocks, interrupted the monotony of the shoreless expanse of ocean in those remote periods of the earth's history.

The characteristic forms are as follows:

MIDDLE SERIES.

Fucoides cauda-galli.

LOWER SERIES.

Fucoides Harlani, Dictuolites Beckii, Fucoides demissus,

which are imbedded in the order here given, the lowest being the first creation. No fucoids have yet been named as characteristic of the upper term of the system.

Remains of Polyparia.—Coralline remains are most abundant in the limestones of the middle series; they are less numerous in the shales, and the sandstones are comparatively almost destitute of them. They generally occur in detached masses, never of a large size compared with those of existing species, and they frequently lie in thin layers. Nothing resembling the coral reefs of the present ocean existed in this ancient era of the globe, for dwarfish indeed were the stony dwellings of the Silurian Polyparia, in comparison with the colossal structures of existing species in tropical seas. Nor do we find any very large masses of coral in the later formations of this country, except in the Medial Tertiary sands of Virginia. The genera which most abound in Silurian limestones, are Favosites and Cyathophyllum, and the former are the largest coralline remains of the system.

MIDDLE SERIES.

Species characteristic of the Series.

Favosites gothlandica.	Cyathophyllum turbinatum.
——— fibrosa.	——— lamellosum.
——— spongites.	——— vermiculare.
Aulopora serpens.	——— helianthoides.
Catenipora labyrinthica.	Syringipora vermiculare.

LOWER SERIES.

Columnaria, allied to C. sulcata. Favosites, 2 species.

Remains of Crinoidea.—Some of the limestones are composed almost wholly of the fragments of crinoidal columns and yet the globose or conical terminal portion is among the rarest of organic exuviæ in New-York, except in the shale at Lockport; whilst near Huntsville, Alabama, they are very numerous. This condition of the crinoidea is owing chiefly to the loss of gelatinous matter which connected the articulations, a very slight current being sufficient to scatter them in the bed of the sea. In the shales many of these columns may be traced unbroken the space of a foot or more, whilst in one very thin layer of shale at Schoharie the Astrocrinites occurs several feet in length, always lying in regular curves and occasionally with the terminal plates and fingers. Owing to the disjointed state of most of the columns, and the variety of forms appertaining to a single species, they are difficult to determine and are consequently much less known to geologists than the other classes of fossil remains. Most of the crinoidea were attached to such bodies in the sea as could give them a firm support; thus we behold their root-like bases upon the valves of the larger shells in the shales of Livingston county; and I have seen only one species which was apparently free, as the whole column has been frequently found and the base is always without any means or mark of attachment. The presence of Ambulacra in the plates of this genus, Lepocrinites (*nob.*) resembling those of the Echinida would seem to constitute this fossil a connecting link between the Crinoidea and the Echinodermata.

MIDDLE SERIES.

Species characteristic of the Series.

Lepocrinites Gebhardi. Caryocrinites loricatus.
Astrocrinites pachydactylus.

The species of the other series are undetermined.

Remains of Echinodermata.—When we consider the variety of delicate species of this fragile class of animal envelopes, which are preserved in various strata less suited to their perfect preservation than the Silurian limestones and shales, and at the same time remark their almost total absence from the latter, we are forced to conclude that they

did not exist in the periods of the lower and middle series of the system, where none have been discovered. One species only is known in the upper series, and the impression of this, although in sandstone, is very distinct.

Remains of Radiaria.—There is one species of Asterias in the Trenton limestone which I found in a quarry between Herkimer and Little-Falls, and is remarkably well preserved. No other species of Radiaria is known in the system, except an Euryale in the upper division.

Species characteristic of the Series.

UPPER SERIES,.... Euryale annulatum, (De Kay.)
MIDDLE SERIES,... None.
LOWER SERIES, ... Asterias primigenuis, (Con.)

Remains of Testacea.—Shells are the most important class of fossils in the estimation of geologists, because they are far more perfect and abundant, more generally distributed, and more satisfactorily determined and compared than remains of other classes of animals; and such is the similarity of groups in all the grand divisions of rocks throughout the earth, as the Silurian and Carboniferous systems, Old Red Sandstone, New Red Sandstone, Oolite, chalk, &c. that they alone furnish the clew to identity of time or periods of deposition between strata, the continuity of which cannot be traced in consequence of intervening seas or other obstructions. Testaceous remains of the Silurian system consist chiefly of bivalve shells of the division Brachiopoda, in the lower and middle divisions, and are almost entirely of extinct genera, the species of Lingula and Orbicula, recent genera, being comparatively extremely few, and are rarely abundant in specimens in their limited localities. All the various bivalves formerly referred to the genus Terebratula belong to the extinct genera, Atrypa and Stenoscisma. In the upper division, bivalves of the division Mesomyona are very abundant, chiefly of the genera Avicula and Inoceramus; but the generic relations of some others of the bivalves have not been accurately determined in consequence of the character of the hinge being concealed in the matrix or in casts of the external surfaces of the valves. Among the Cephalapoda, or univalves of the Nautilus kind, we find not one of the Ammonite genus, which in the Oolitic and Cretaceous periods flourished in vast abundance and variety of forms. Nor do we find the kindred genus Goniatites, so common in the Carboniferous limestone,

in any but the upper division of the Silurian system, and in that they are exceedingly rare. Among the multitude of shells, we are surprised to find but one species which is known to have outlived the Silurian period, and been continued in the Carboniferous; so that there is absolutely a greater amount of difference in this respect between the two systems than between the Secondary and Tertiary formations. The species marked with an asterisk are common to Europe and America.

UPPER SERIES.

Species characteristic of the Series.

BIVALVES.

* Avicula, (Pterinea) fasciculata.
——— subrecta.
——— bella.
Nuculites oblongata.
——— triqueter.
——— bellastriata.
——— cuneiformis.
——— rostellata.
Cypricardites elongata.
Cypricardites recta.
——— concentrica.
——— mytiloides.
——— alta.
——— oblonga.
——— carinata.
——— rugosa.
——— radiata.
——— subulata.

UNIVALVES.

* Bellerophon expansus.

MIDDLE SERIES.

Species characteristic of the Series.

BIVALVES.

* Strophomena rugosa.
——— costellata.
——— indenta.
* ——— euglypha.
* ——— lævigata.
——— corrugata.
Delthyris macropleura.
——— acuminata.
* ——— sulcata.
Delthyris arenosa.
* ——— lineata.
Atrypa elongata.
* ——— lacunosa.
——— unguiformis.
——— nasuta.
——— naviculoides.
* Pentamerus (Atrypa) galeatus.

UNIVALVES.

* Tentaculites ornatus.
Calceola indenta.
Euomphalus profundus.
Maclurites magna.
* Phragmoceras arcuatum.
* Lituites Biddulphii.
Cyrtoceras trivolvis.
Cyrtoceras Matheri.
* Conularia quadrisulcata.
Platyceras dumosum.
———— cirriformis.
———— Gebhardii.
Littorina pervetusta.
* Spirorbis tenuis.

LOWER SERIES.

BIVALVES.

Strophomena sericea.
———— alternata.
———— deltoidea.
———— compressa.
———— subtenta.
———— corrugata.
* Strophomena transversalis.
* Orthis testudinaria.
* ——— callactis.
* ——— flabellulum.
* ——— hemispherica.
* Pentamerus oblongus.

UNIVALVES.

* Bellerophron trilobatus.
* ———— bilobatus.
* Trochus lenticularis.
Phragmolites compressus.
Cyrtolites ornatus.

Remains of Crustacea.—The trilobites have excited more interest among naturalists than any other class of Silurian remains. They consist of the impressions, and not unfrequently of the shelly coverings of crustaceous animals of various genera and species, essentially different from existing types, and restricted to the Silurian and Carboniferous system. In the latter, few and imperfect specimens occur, never the same in species with those of the inferior system, which these curious remains peculiarly characterize by their abundance and variety of forms. Nearly all the species are quite limited in their stratagraphical positions, but Calymene bufo, the most common trilobite, is imbedded in a variety of formations, both in the middle and upper series of the system, but is not known to occur in the lower series or Caradoc sandstone equivalents. The trilobites are usually found in fragments, except in the shale at Lockport, where whole specimens of Asaphus limulurus,* are not uncommon. In some parts of the shale accompanying the Trenton limestone, I have found several entire Calymenes, of the species usually referred to C. Blumenbachii, by naturalists. One specimen of shale

* A. Wetherilli, (Green.) A. longicaudatus, (Murch.)

has as many as ten whole trilobites of this species upon it, and two or three imperfect individuals of the Ceraurus of Green. The Calymenes must have lived upon the spot where they were finally imbedded in a colony like many species of shells. I have ascertained that this species is not the same with C. Blumenbachii of Europe, nor does it correspond in geological position; whilst the Calymene platys of Green agrees with the Blumenbachii in every essential particular; it is associated with the same group of shells at Schoharie, which characterize the lower Ludlow rock of Murchison, and consequently its stratagraphical position is identical with that of the Blumenbachii. I propose, therefore, to name the Trenton species Calymene senaria; and I may remark that it has never been found in a rock above the shale at Rochester where it is not common, whilst the Blumenbachii has not been discovered so low in the series, nor indeed has a trace of it been observed in any of the equivalent strata of the Wenlock limestone, except a single fragment of a buckler, which Mr. Gebhard obtained from the Hydraulic limestone at Schoharie. Two entire specimens and several fragments have been met with in the grit slate of Eaton, at Schoharie, and a fine mould from which the model was taken, described by Dr. Green, occurred in the same rock on the Helderberg mountain. I have seen another specimen in the same geological position at Col. Clarke's, near Saugerties. These are all of larger size than the Trenton species ever attains, and in this respect are equal to the C. Blumenbachii major figured in Murchison's "Silurian system." Among the crustaceous remains, the most rare and curious is the Eurypterus, of which genus only two species are known, one peculiar to the Hydraulic limestone of New-York, and the other to a limestone at Burdie-House, in Scotland. When perfect, the E. remipes of Dekay has a long spiniform tail like Limulus, but more obtuse at the extremity, and finely serrated. It has been suggested that this genus was of fresh water origin, but the presence of fucoids in the same stratum where the Eurypterus occurs, and the absence of the slightest evidence of a fresh water deposit in any part of the Silurian system, leave no room to doubt that this singular crustacean inhabited the sea. The same remarks apply to the small fossils, resembling beans, usually referred to the genus Cypris; and as they were evidently tenants of the ocean, being associated with marine shells in abundance, they may with more propriety be placed in the recent genus Cytherina, which is restricted to the sea, but scarcely differs from the fresh water Cypris in the external character of the crust, the only part of the animal known among species imbedded in the earth.

The monograph of the trilobites, published by Dr. Green, has greatly facilitated our inquiries into their geological history,and if some errors occurred in his classification of the species, they were the unavoidable result of imperfect specimens, and no skill and care could reconstruct a species from the bucklers and tails and fragments so frequently associated in the same locality. Time and industry are gradually condensing them into a more tangible form, and while the discovery of whole specimens has reduced in some instances two nominal species into one, it has occasionally led us ro separate others, as in the case of the Calamene Blumenbachii and C. senaria.

Nothing is yet known of the internal organization, nor of the habits of trilobites, and it is not probable that any other guide than analogy will ever point out their relations to existing animals. They are generally divided, like the recent Serolis, into three distinct lobes, and have a body composed of articulations varying from seven to fourteen in number in the different genera; but there have lately been discovered some singular forms of crustaceans allied to, if not properly classed among trilobites, one of which is similar to Limulus, (Acidapsis;) another has a buckler like that of an eyeless genus, but with a short body destitute of lobes or dividing sulci, and with two long curved spines in place of the pygydium of other genera. The whole surface is without a single articulation.

UPPER SERIES.

Species characteristic of the Series.

Cryphæus calliteles.
——— Boothii.
Cryphæus Greenii.
Dipleura Dekayii.

MIDDLE SERIES.

Calymene Blumenbachii.
Asaphus laticostatus.
——— pleuroptyx.
——— micrurus.
——— nasutus.
——— limulurus.*
——— myrmecophorus.
Odontocephalus selenurus.†
Trimerus delphinocephalus.
Platynotus boltoni.
Acidapsis tuberculatus.
Acantholoma spinosa.
Bumastus Barriensis.
Dicranurus hamatus.
Aspidolites Gebhardii.

* A. longicaudatus, (Mucr.)
† Asaphus Selenurus, (Eaton.) Calymene odontocephalus, (Green.)

LOWER SERIES.

Isoletus gigas.
——— cyclops.
Ceraurus pleurexanthemus.
Triarthrus Beckii.
Cryptolithus tessellatus.
Illænus.
Agnostus latus.
Asaphus micropleurus.
Calymene senaria.

State of conservation of organic remains.—Of the plants of the Silurian system little more is preserved than the impressions, and among the fucoids, frequently the fronds in bold relief, but not distinguishable to the eye, in mineral structure, from the rocks on which we behold them. The corals are generally silicified, often forming layers of hornstone in the limestone strata. The crinoidea are universally converted into calcareous spar in every formation, either limestone or sandstone, in which they are enclosed; and in consequence of this law I have referred to the crinoidea some fossils with the same mineral character which are so remote from the usual forms, that otherwise mineralized they would hardly suggest the idea of affinity to crinoidal remains. Shells are either silicified, or converted into calcareous spar, and sometimes the only change they have undergone is the loss of their gelatinous matter, in which case they are chalky and friable. In this condition we find numerous specimens of Delthyris speciosa and other bivalves in the shales of the southern part of Onondaga county, where they have the appearance and perfection of recent shells. In some of the sandstones seldom more than the impression or casts remain; in others, as in the Oriskany sandstone, the mineralized shells of various species are abundant. Brongniart has remarked that different shells have different kinds of petrifaction, and that he has known instances where the shell was replaced by carbonate of lime and the ligament of silex. Small annular ridges are seen in many bivalves, which he thinks were occasioned by gelatinous silex taking the place of the shell, a process analogous to the formation of chalcedony. The rings are entirely siliceous, ordinarily opaque and not crystalline. Sometimes they are dispersed in the shell, at others, they are so numerous as to have entirely displaced the calcareous matter. It is remarkable, that whilst this is a frequent condition in bivalves, especially in the Green sand formation, univalves replaced by siliceous matter are hardly ever in a similar condition, but are composed of compact silex. I have, however, occasionally met with the annular structure in univalves.

Fresh Water Formations.—Throughout the Silurian system we never find any evidence of fresh water streams or lakes, doubtless owing to the very small proportion of dry land coeval with those remote periods of the watery surface of our planet. I formerly thought that such evidence was satisfactory in the Red sandstone at Medina, in Orleans county, where I found impressions of bivalve shells with the cardinal and lateral teeth of their hinges moulded into the exact form of the corresponding part of Unio on the fresh water mussel. The coexistence of numerous univalves, not to be distinguished from the fresh water genus Cyclostoma, completed the deception. Further research, however, has enabled me to detect among the marine bivalves of other strata, shells with a hinge so similar to that of the supposed Unio, but with characters essentially different from the fresh water genus, and which were probably concealed in the matrix of the Medina specimens, that I now believe the latter to be of marine origin. The univalve I believed to be a Planorbis is probably a Bellerophron, and if so, the shell resembling Cyclostoma can be considered only as an allied genus. They are also associated with two marine genera, Lingula and Orthocera. If this conclusion be correct, we are unacquainted with a single fossil of fresh water origin in any rock of earlier date than the Carboniferous limestone, in which Uniones occur in Pennsylvania; and it is remarkable that we do not find any which existed after this period, when there was so great an extent of dry land, especially in the Tertiary epochs, except those which Dr. Hildreth discovered in Ohio. These consist of ferruginous casts of Unio, approximating the existing species of that region in their general outlines, and have every appearance of appertaining to a Tertiary deposit.

Old Red Sandstone, or Devonian System.

This system, as I understand it, is largely developed in some of the contiguous counties of Pennsylvania and New-York. A part of the series may be recognized in the Chemung group of the annual reports, and another term in the red sandstone near Blossburg, Pennsylvania, which holds the remains of Holoptychus nobillissimus, a fish restricted to the old red sandstone, and by which I was enabled, in connexion with the geological position of the rock, to identify the formation with that member of the Devonian system, which this singular fish characterizes. Since I announced that important discovery, my attention has been directed to a group of shells quite distinct from those of the Upper Silurian division, and resting upon them. They are, however, more

analogous to Silurian than to Carboniferous types, and I was led to infer a correspondence between them and the Devonian species. It was therefore with deep interest that I referred to the figures of the latter, in the Geological Transactions, in which I found sufficient confirmation of my view. Not only does the group I allude to meet the conditions on which the Devonian system has been founded, that the fossils are of "a type intermediate between the types of the Carboniferous and Silurian systems;" but of the limited number of specimens in my cabinet, six appear to be identical with species figured in the Geological Transactions. These consist of Avicula pectinoides, Terebra nexiles, Strophomena (Leptæna) rugosa.* Atrypa decussata, A. desquamata, and A. squamosa. The Delthyris calcarata I have not seen in this group, but Mr. Hall found it in the Upper Silurian division, near Moscow, Livingston county. When my collection is more complete, I expect to be able to extend the list of corresponding species. It is remarkable that a Producta does not occur in this group of fossils, although it is the prevailing bivalve in the Carboniferous system. Two shells of the upper Silurian strata, which I formerly referred to this genus, prove to be Strophomenæ.†

The Devonian group consists chiefly of arenaceous strata, but there is a band of limestone associated with them which is replete with shells. The shale is remarkable for the abundance of a very large Delthyris, with a greatly extended hinge. (D. perlatus, *nob.*) The Chemung group of fossils belongs to the lower portion of the Devonian system, and the Holoptychus to the upper term. Great tracts of this system lie between Carbondale in Pennsylvania, and the Upper Silurian district of New-York, nearly all of which is quite destitute of distinct organic remains, except those of vegetables: It consists chiefly of a micaceous sandstone, either of a red or olive colour, and sometimes variegated, and is very remarkable for the universal occurrence of diagonal lines, apparently of deposition, in all those picturesque weathered masses which are so frequently met with in travelling along the roads of this wooded and hilly region.

---

* This is a new species, and not the S. rugosa of Rafinesque.

† This genus is generally confounded with Producta, although its character is very different, and I believe the fact is still unnoticed by geologists that Producta is unknown in deposits more ancient than the Carboniferous system.

Carboniferous System.

This system is not known to be represented within the limits of New-York, unless it be on the summit of the Catskill mountain. Besides the anthracite and bituminous coal of Pennsylvania, it embraces blue subcrystalline limestone, replete with Producta and Delthyris; also clay ironstone nodules, black or bituminous shale, full of shells, and cherty beds with the common and most characteristic bivalve, Delthyris trigonalis. All these rocks are characterized by the same group of fossils which occur in Europe in a similar geological position. Some members of the system may be seen near Blossburg, Tioga county, Pennsylvania, from whence I have received characteristic fossils in iron stone nodules. The black shale occurs overlying coal at one of the inclined planes of the Alleghany mountain. It also occurs near Pittsburg. The cherty beds compose Flint ridge in Ohio. Very fine fossil shells of this system were obtained at Engineer cantonment, on the Missouri river. The limestone occurs in Guernsey county, Ohio, and contains a Producta resembling P. punctata, and a Delthyris which I believe to be D. duplicostata, of Phillips. I have seen no remains of Trilobites from the Carboniferous strata. No fossil species of this system is known to occur in the Silurian rocks. The shells common to the European and American Carboniferous strata, are the following:

Delthyris trigonalis.
——— duplicostata.
——— cuspidatus.
Producta punctata.
——— scabricula.
——— scotica.
Producta hemisphærica.
——— sulcata.
Goniatites Henslowi.
——— minuta.
Amplexus coralloides.

New Red Sandstone or Saliferous System.

The system which succeeds the Devonian is the New Red Sandstone, which is known to occur in Massachusetts, Connecticut and New-Jersey, and was first described and classified by Professor Hitchcock, who has ably elucidated it, and accurately described the curious foot-marks which peculiarly characterize this system. No other distinct fossil impressions occur, except of fishes, which, as Professor Hitchcock remarks, having heterocercal tails, must be older than the Oolite, and as the rock which contains them is certainly above the coal, it holds exactly the same relative stratagraphical position as the New Red Sandstone of Great Britain. No brine springs or rock salt accompany this

sandstone, and hence the name of Saliferous would not be appropriate to the system as it occurs in North America.

Oolitic System.

No rock answering to the Lias of Europe has yet been discovered, but I now for the first time announce the occurrence of well chracterized and undoubted oolite, in the State of Ohio. At present I will merely observe that it contains two European species of Trigonia, T. costata, and another, both of which are restricted to the Oolitic system. Shells of this genus are unknown in more ancient rocks is this country, whilst they are abundant in the Oolitic and not very rare in the Cretaceous, but they are absolutely unknown in any tertiary deposit. In the Oolitic system we lose sight of the genera Producta, Strophmena, Atrypa, Pentamerus, and other bivalves, which are prevailing types of the Silurian, Devonian and Carboniferous systems. All the rocks of this country, hitherto described as Oolite, belong to very different systems, particularly the Silurian and Carboniferous. No geological oolite occurs in the State of New-York. The extinct genus Ammonites which contains such a vast assemblage of species, makes its first appearance in this system.

Cretaceous System.

This widely extended series, was first referred to the chalk of Europe by Vanuxem and Morton; and the latter author has amply illustrated the organic remains. He divides the system into three sections, upper, middle and lower. The latter consists chiefly of green sand in New-Jersey and Delaware, and in limited localities in Maryland, South-Carolina and Georgia, but it is generally an impure limestone in the southern States, with the same organic remains as those of the green sand. It is the substratum of all the prairie land of Alabama. Here we behold a new creation of genera of shells, saurians and fishes. The genera Baculites, Hamites, Crioceratites, Cirrolites, (nob.) Scaphites, all cephalapodous univalves, appear for the first time in the cretaceous series. Dr. Morton has referred this division to the Green-sand of Europe; and indicates one shell as identical with a British species, Pecten quinquecostatus, which occurs both in chalk and green sand. The following fossils I believe to be common to the European and American Lower Cretaceous strata:

Shells.

1. Pecten quinquecostatus—Chalk and Green sand.
2. Ostrea vesicularis—Chalk.
3. ——— falcata (O. larva, Nillson.)
4. Gryphœa vomer (Ostrea lateralis, Nillson)—Chalk,
5. Trigonia aliformis (T. thoracica, Morton)—Green sand.
6. Ammonites Conradi(A. sussexiensis, Mantell)—Chalk marl.
7. Nautilus expansus (N. Dekayi, Morton)—Chalk marl.

Fishes.

8. Galens pristodontus—Chalk.
9. Lamna acuminata—Ib.
10. ——— Mantelli—Ib.

Saurians.

11. Mosasaurus—Maestricht strata.

The middle division of this system was first discovered and described by Dr. Morton. It consists of gray marl, alternating with a limestone which appears to be of a kind of oolitic or granular texture, but when examined with a glass, this structure is found to be due to innumerable minute Nummites and small corallines. A band of this limestone runs through the Green-sand district of southern New-Jersey, from New-Egypt to Salem. It contains several of the fossils of the lower division, but others which are peculiar to it. It is remarkable that no trace of Ammonites has been discovered in this limestone, the Green-sand seeming to be the highest limit of the genus. I discovered this formation at Wilmington in North-Carolina.

The upper division of the Cretaceous system is composed of a chalky limestone which I was the first to trace in the southern States, and to collect the group of its organic remains which have been described by Dr. Morton. These, as a group, were ascertained to be unlike any observed in Europe, and to point to a passage or connecting link between secondary and tertiary deposits. The only extinct genus of shells found in it is Plagiostoma, but not one recent species occurs, and which are found in the overlying Lower Tertiary strata. This limestone contains those enormous vertebra of the Zeuglodon (Basilosaurus, Harlan,) which are not uncommon in Alabama, and characterize the formation. This division occupies a portion of South-Carolina, near the sea board, and of Georgia south of Augusta, but its great development is in the southern counties of Alabama and in Florida. There is a belt of prairie land

passes through central Alabama, based on the lower division or Green-sand, and where this terminates on the south, the upper cretaceous limestone commences, and is continued through Florida nearly to the Gulf of Mexico.

Tertiary Formations.

This class of strata I have investigated with sufficient care to enable me to separate them into three divisions, Upper, Medial and Lower, the last being certainly identical with the London clay or Eocene formation, to which I was not only the first to refer it, but to notice the formation at all. I was led to the comparison in the first place by finding the Cardita planicosta, a well known shell of the European Eocene period; and thus even a single fossil will sometimes truly inform us of the geological relations of a particular stratum. In some places the Green-sand derived from the Cretaceous strata enters largely into the composition of the Lower Tertiary marls. In Georgia, and more rarely in Alabama, a portion of the formation assumes the character of burr stone, and the shells which abound in it are beautifully silicified. Near Fort Washington, on the Potomac river, the Lower Tertiary is very similar in aspect to the Bognor rocks of Great Britain, and contains the Panopea (Mya) intermedia and Ostrea Bellovicina of that locality. In this formation we meet with the first creation of testacea which have a near resemblance to recent shells, but yet, in this country, all the species appear to be distinct from existing types. But two or three genera among the minute shells occur which are unknown in a recent state. A very interesting section of the Lower Tertiary is presented at Claiborne, Alabama; where I collected about two hundred species of shells and corallines, many of which are identical with Eocene species of Europe. Among these are Cardita planicosta, Corbis lamellosa, Cytherea erycinoides, Bulimus terebellatus, Pyrula tricarinata, Solarium patulum, &c.

Medial Tertiary.—An extensive formation of sand and clay, abounding in finely preserved shells, follows the preceding strata in the ascending order, and contains only one species which is not widely different from the fossils of the latter formation. There are about 170 species at present collected, and of these I have ascertained about 23 to be recent, nearly all of which inhabit the Atlantic coast and that of the Gulf of Mexico. Whatever the per centage of recent species may ultimately prove to be, I have no doubt the period of this formation was

contemporaneous with that of the Older Pliocene strata of Europe, a belief founded on the great similarity of their respective groups of shells and remote analogy of the American group to the Miocene of Europe, which I have long believed, has no representative in North America, at least among the known tertiary deposits. The Medial Tertiary formation occurs along the Atlantic border from New-Jersey, inclusive, to the Santee river in South Carolina.

Upper Tertiary.—This group of fossils is found in Maryland, Virginia and North-Carolina, in the same tract with the preceding, but is not so extensively distributed. Very few of the species of the Medial Tertiary occur, but the mass consists chiefly of recent shells, many of which inhabit the same parallels of latitude on the Atlantic coast of the Union, and the others chiefly the southern coast. There are, however, enough extinct species to bring the group within the limits of the Newer Pliocene.

Post Tertiary.—By this term Mr. Lyell designates a group of organic remains which not only embraces a less per centage of extinct species than the Newer Pliocene, but they are of a more *arctic* character than the recent group of the same parallels of latitude. In this series must be included the tertiary deposits on the borders of Lake Champlain, described by Professor Emmons, as they are identical with those of the St. Lawrence, described by Capt. Bayfield, and which Lyell refers to his Post Tertiary. The shells of the St. Lawrence are the same with those of the Champlain beds, and not only so, but Lyell has found them to be nearly all the same with the Post Tertiary species of Scotland, Denmark, Norway and Sweden, and there is less than one per cent of species unknown in a living state. This is the only described formation of the Tertiary character within the limits of the State of New-York, and the other systems also wanting are the following: Carboniferous, New Red Sandstone, Oolitic and Cretaceous. The Post Tertiary in New-York always reposes on strata of the Lower Silurian series.

Note. Since the above was written, I have read an article on the geology of New-York, in the New-York Review for Jan. 1841, in which I am opposed in the opinion that the Llandeilo flags are not represented in New-York; but more accurate observations have proved to my satisfaction that the Llandeilo trilobites do not occur in the Trenton limstone, but can be considered only as allied species. On the

other hand the respective groups of the Caradoc sandstone and Trenton limestone are so similar, that I could not resist the evidence and retain my first position. The reviewer censures me for regarding the Niagara sandstone as a Caradoc equivalent on the evidence of one shell, Bellerophon trilobatus; this I have not done, for the occurrence of the Pentamerus oblongus above the sandstone, a shell which marks the upper part of the Caradoc in Wales, led to the inference that the Niagara sandstone may be a portion of the great Caradoc group. With respect to the suggestion of the reviewer that the Caradoc series should terminate with the gray band of Eaton, I should have no other objection than its variation from Murchison's classification. The question is, should that be strictly adhered to or not?

Descriptions of New Genera and Species of Organic Remains.

CRUSTACEA.

GENUS DICRANURUS. No articulations; body short, without lobes; pygidium consisting of two long incurved spines. *Locality.*—Helderberg mountain, Albany county.

GENUS ASPIDOLITES. Buckler? trigonal, subrostrated, not lobed, but a depression along the margin; in place of eyes there are two rather deep impressions, above which the marginal sinus continues across the disk; surface tuberculated. *Localities.*—Schoharie, where Mr. Gebhard found it in the limestone which contains Asaphus micrurus; Helderberg, in shale, No. 14 of the table. It is doubtful whether the specimens described may not be entire; no trace of articulations has yet been found.

Asaphus? acantholeurus. Pygidium very wide at base; margin lunate, but projecting in the middle; a broad space between the ends of the ribs and the margin, on which are 9 thick, erect spines, the central one largest; surface of the lobes with coarse tubercles. *Locality.*—Near Schoharie, in limestone with Odontocephalus, (Onondaga limestone.) Found by John Gebhard, Jr.

A.? denticulatus. Pygidium with a lunate margin denticulated at the terminations of the ribs; ribs simple, with two rows of minute tubercles on each. *Locality.*—Schoharie, in grit, No. 18. Found by Mr. Gebhard.

A. nasutus. Buckler rostrated; ribs with a wide, shallow sulcus; a few of the ribs each with a large tubercle; two rows of tubercles on the middle lobe; obsolete on some of the ribs; tail consisting of a long, round, finely tuberculated spine. *Localities.*—Schoharie and Helderberg, in shale, No. 14, this trilobite attained a length of at least 6 inches.

A. aspectans. A small portion of the buckler and one eye only is visible, but the eye is of an extraordinary height; the margins parallel, and the lens arranged in parallel longitudinal lines; small and very numerous. *Locality.*—Near Schoharie. Found by Mr. Gebhard in Onondaga limestone.

Calymene senaria. This name is proposed for the trilobite of the Trenton limestone, usually confounded with C. Blumenbachii; it differs in having no tubercle between the eye and the middle tubercle of the central lobe; the front, anterior to the first tubercle, is much smaller and the margin more acutely rounded; there is also no tubercle on the margin of the middle lobe, between the second and third large tubercles; these latter are oblique, which is not the case in C. Blumenbachii; the granules of the surface are more minute and less unequal in size than those of the latter species. Its geological position is widely different. The specific name has allusion to the six tubercles of the buckler.

SHELLS.

Genus Nuculites. Equivalved; hinge with cardinal teeth as in Nucula, but apparently uninterrupted beneath the apex; an interior rib like that of Solecurtus, but narrower, extends from the apex, either direct or slightly oblique, towards the base, never passing much beyond the middle of the valve.

These shells have much the exterior aspect of Nucula, but the deep sinus in casts of some of the species, left by the interior rib, constitutes about the same amount of difference between the two genera, as between Solen and Solecurtus, especially, as I believe to be the case, that the series of cardinal teeth is uninterrupted by a fosset which in Nucula is a prominent character. This genus, so constituted, is restricted to the Silurian (and perhaps to the Carboniferous) system.

1. *N. lamellosa.* Ovate oblong; with regular concentric rather distant lamellar lines; umbonial slope not distinctly defined; posterior slope flattened; extremity obliquely truncated.

2. *N. emarginata.* Oblong, with concentric lamellar lines; umbonial slope profoundly angulated; posterior margin obliquely and profoundly emarginate. *Locality.*—With the preceding species, near Smyrna.

3. *N. triqueter.* Trigonal, umbo elevated; umbonial slope terminal and acutely angulated in consquence of the profound depression of the posterior margin; disk flattened; interior rib curved. *Locality.*—Cazenovia.

4 *N. oblongata.* Oblong, compressed; anterior margin acutely rounded; rib slightly oblique, nearly rectilinear. *Locality.*—Near Smyrna, Chenango co. tab. No. 23.

5. *N. rostellata.* Small, ovate-acute; posterior end rostrated and slightly recurved; disk with regular prominent concentric striæ. *Locality.*—Same with the preceding.

6. *N. bellastriata.* Subtrigonal; anterior and posterior margins rounded; disk with numerous fine, regular striæ; basal margin arched. *Locality.*—Same with the preceding.

7. *N. cuneiformis.* Cuneiform; umbo prominent; umbonial slope marginal, acutely angulated, rectilinear; posterior extremity narrow, obliquely truncated. *Locality.*—Near Oneonta, table No. 26.

8. *N. maxima.* Ovate-acute, compressed; posterior side cuneiform, extremity rounded; basal margin profoundly arched, except on the posterior side, where it is straight. *Locality.*—Oneonta, table No. 26.

9. *N. planulata.* Compressed; ovate-acute; posterior dorsal margin oblique, rectilinear, extremity acutely rounded; basal margin regularly arched; rib oblique. *Locality.*—Pulaski, Oswego county, table No. 6.

GENUS ORTHONOTA. Equivalved, profoundly elongated; hinge and basal margins straight and parallel; beaks near the anterior extremity; posterior extremity truncated.

The hinge of this singular group of shells is yet unknown, but as the external characters are remarkably prominent, I have ventured to pro-

pose a generic term to include the few shells of this peculiar form yet known to us. The genus appears to be restricted to the Silurian system. The first species appears in the Salmon river shale at Pulaski.

1. *Orthonota pholadis.* (Pterinea pholadis, *nob.*)
2. *O. undulata.* Posterior side with three oblique furrows, crossed by deep slightly waved sulci, which terminate at the furrow nearest the anterior side; anterior side with concentric angular sulci; an oblique furrow from beak to base, obsolete on the inferior half of the valve; posterior dorsal margin carinated. *Locality.*—Near Smyrna, Chenango county, tab. No. 23.
3. *O. carinata.* Destitute of undulations and with 4 prominent oblique carinæ on the posterior side; dorsal margin carinated *Locality.*—Near Apulia, at Labrador or Tinker's-Falls, tab. No. 23.

Genus Lyrodesma. Equivalved, inequilateral; hinge with about 8 diverging prominent cardinal teeth, transversely striated.

I was fortunate enough to obtain two fine casts of the hinge of this bivalve, with the teeth remarkably well represented. Occur in sandstone of Salmon river series near Rome, Oneida co.

L. Plana. Subrhomboidal, compressed; posterior margin widely and obtusely truncated; posterior basal margin rectilinear, extremity rounded.

Genus Cypricardites. Equivalved, profoundly inequilateral; hinge with 4 or 5 unequal cardinal teeth; anterior one largest and most prominent, oblique; lateral teeth short and very remote from the cardinal teeth.

This genus is allied to Pterinea of Goldfuss, but it is never properly alated, nor has it the very large muscular impressions of that genus; the cardinal and lateral teeth are also different; the anterior cicatrix is often deeply impressed; the posterior one not visible in casts of the interior. This genus abounds in the Silurian rocks, but I have not seen a species from any more recent formation.

1. *Cypricardites elongatus.* Subensiform, contracted from beak to base; concentric lines strong and irregular; anterior margin rounded, posterior margin obliquely truncated, slightly emarginate. *Locality.*—Smyrna.

2. *C. recta.* Oblong; dorsal and basal margins parallel; basal margin slightly and widely contracted; posterior margin very oblique and slightly arched, extremity acutely rounded; surface with distinct concentric lines; umbo prominent. *Locality.*—Same with the preceding.

3. *C. concentrica.* (Pterinea concentrica, *nob.*)

4. *C. bisulcata.* (Pterinea bisulcata, *nob.*)

5. *C. mytiloides.* Ovate, slightly ventricose; lines of growth prominent; umbo prominent; dorsal margin elevated; anterior basal margin very oblique and slightly contracted; posterior side profoundly dilated and the margins regularly rounded. *Locality.*—Near Ogden's ferry, tab. of form. No. 23.

6. *C. alta.* Subovate, rounded and inflated over the umbonial slope; concentric lines prominent, acute; disk slightly depressed from beak to base; posterior side dilated, margin obliquely truncated above; obtusely rounded inferiorly; basal margin oblique, slightly concave or contracted; hinge margin elevated, slightly arched. *Locality.*—Ogden's ferry, tab. No. 23.

7. *C. oblonga.* Proportionately longer than the preceding, much less dilated posteriorly and with coarser concentric sulci. *Locality.* Near Smyrna, tab. No. 23.

8. *C. modiolaris.* (Pterinea modiolaris, *nob.*) tab. No. 6.

9. *C. angustifrons.* Trapezoidal; dorsal and basal margins parallel; anterior side narrowed, somewhat produced; end margin angulated above, rounded inferiorly; posterior margin truncated, nearly direct; basal margin nearly straight, or slightly contracted; posterior extremity angulated. *Locality.*—Near Rome, Oneida co. tab. No. 6.

10. *C. nasuta.* Narrow subelliptical; anterior side rostrated, acute; posterior margin very obliquely truncated. *Locality.*—Same with the preceding.

11. *C. ovata.* Ovate, oblong; posterior side dilated; the posterior dorsal and posterior margin regularly rounded or arched, the curve more abrupt where it joins the base; basal margin slightly contracted anteriorly; hinge margin much elevated. *Locality.*—Pulaski, Oswego co. tab. No. 6.

12. *C. curta.* Suborbicular, compressed; hinge margin elevated; posterior margin obtusely rounded. *Localities.*—Near Rome, Oneida co. Richmond, Indiana, tab. No. 6.

13. *C. carinata.* Trapezoidal, compressed, contracted from beak to base; beaks distant from the anterior extremity; disk with distant prominent slightly waved concentric lines; umbonial slope profoundly carinated; posterior margin obliquely truncated; extremity angulated; basal margin sinuous. *Locality.*—Near Oneonta, tab. No. 26.

14. *C. rugosa.* Subrhomboidal; disk flattened, slightly contracted with numerous concentric prominent wrinkled striæ; umbonial slope elevated, carinated; posterior margin oblique and straight above, truncated and direct inferiorly; hinge margin elevated. *Locality.*—Near Smyrna, Chenango co. tab. No. 23.

15. *C. radiata.* Oblong, much compressed, with narrow radiating striæ, most crowded near the umbonial slope, rather distant towards the anterior and posterior extremities and crossed by fine wrinkles; basal margin nearly rectilinear; posterior margin obliquely truncated above, extremity rounded. *Locality.*—Same with the preceding.

16. *C. subalata.* Trapezoidal; hinge margin obliquely elevated or subalated; posterior margin widely and slightly arched; extremity rounded; disk contracted from beak to base. *Locality.*—Near Apulia, Onondaga county, tab. No. 22. Ithaca.

Posidonia? alveata. Subrhomboidal, with concentric furrows, forming angular ridges, becoming obsolete towards the umbonial slope which is angular; posterior margin long, oblique, rectilinear; extremity obtusely angulated; length $3\frac{1}{2}$ inches. *Locality.*—Near Hamilton, tab. No. 25.

P? arcuata. Differs from the preceding in having a rounded posterior margin, and the umbonial slope not angulated; length $1\frac{3}{4}$ inches. *Locality.*—Same with the preceding.

1. *Avicula subrecta.* Slightly oblique, with wrinkled radii; anterior margin projecting beyond the extremity of anterior wing; posterior wing dilated, not produced; posterior margin from extremity of hinge line to about one-third its length from base, nearly rectilinear and direct. *Locality.*—Cazenovia, Madison county, tab. No. 25.

2. *A. bella.* Slightly oblique, wider than high, ears large; inferior valve convex, and with about 20 acute ribs and an intermediate striæ, and in some of the interstices, two or three; concentric lines not numerous nor crowded, regular; anterior ear obliquely angulated; basal margin forming a nearly regular curve or arch. *Locality.*—Tinker's-Falls, tab. No. 23.

3. *A. Gebhardi.* Suborbicular, left valve convex, with about 15 slightly impressed radiating grooves, forming wide convex, obsolete ribs; ears equal, not produced; height 5 inches. *Locality.*—Schoharie, in Oriskany sandstone. The description is from a fine specimen found by the most industrious of naturalists, John Gebhard, Esq. of Schoharie.

4. *A. cruciformis.* Elevated, with both ears greatly elongated. *Locality.*—Near Oneonta: this species is remarkable for the great proportional height; very little oblique. Height 3½ inches.

1. *Delthyris perlatus.* Hinge margin profoundly elongated; valves with numerous not very prominent ribs; sides flattened; mesial elevation profound, expanded at base, rounded with 12 to 14 slender ribs or striæ. *Locality.*—Near Blossburg, Tioga county, Penn. in the Devonian group.

2. *D. mucronatus.* Trigonal, compressed, with numerous angular ribs, crossed by prominent lines; cardinal line extremely elongated and mucronate at the extremities; mesial elevation flattened and divided by a longitudinal sulcus. Width 3 inches; from beak to base ¾ inch. *Localities.*—Hamilton, in No. 25. Near Apulia in No. 23. Extremely abundant.

Strophumena gibbosa. Subtrigonal; inferior valve with back and umbo very prominent, and the sides compressed; surface with numerous equal slightly undulated striæ which bifurcate on the umbo; hinge extremities prominent and angulated. *Locality.*—Helderberg, in Onondaga limestone, No. 20.

S. undulosa. Surface with irregular, profound, concentric grooves, obsolete towards the base, and with crowded radiating striæ. *Locality.*—Schoharie, in tab. of form. No. 20. Differs from S. rugosa in its simple convexity, and more numerous undulations.

1. *Atrypa acutiplicata.* Short ovate-acute, compressed, with 6 to 8 acute profound plicæ; beak of larger valve acute, concave beneath the apex in front; 3 or 4 strongly marked concentric im-

pressed lines. *Locality.*—Near Waterville, in Onondaga lime stone, No. 20.

2. *A. arata.* Trigonal, with large unequal ribs; those on the lesser valve disposed to bifurcate, and becoming obsolete on the umbo; inferior valve capacious, widely depressed, or slightly concave on the back; some of the ribs bifurcating; beak very prominent. *Locality.*—Schoharie, tab. of form. No. 18.

3. *A. octocostata.* Subovate or suborbicular, with about 8 prominent irregular angulated ribs, some of which bifurcate; inferior valve ventricose, depressed along the middle; summit prominent; superior valve slightly elevated in the middle, and depressed at the sides. *Locality.*—Schoharie, tab. No. 18.

4. *A. flabellites.* Suborbicular, compressed; ribs about 13, rounded; the two middle ribs of the flat valve largest and rectilinear rather distant at base from the others, and separated by a deep interstice which produces a sinuous margin; middle of inferior valve depressed towards the base, the three middle ribs larger than the others. *Locality.*—Near Saugerties, Oriskany sandstone, abundant.

5. *A. pleiopleura.* Subtriangular, elevated in the middle of the lesser valve, and profoundly depressed towards the base of the larger; surface with about 50 rounded costæ; about 17 of which in mature specimens are on the elevated portion of the upper valve; sides dilated and rounded on their margins. *Localities.*—Near Saugerties and Schoharie, Oriskany sandstone.

6. *A. congregata.* Suborbicular, with about 15 rounded costæ crossed by wrinkled lines; lesser valve with the central part flat, slightly elevated, except towards the base where it is more prominent, wide at base and rapidly narrowed above, with 4 flattened ribs wide at base and rapidly narrowed above, inferior valve with a regularly concave depression in the middle. *Locality.*—Conklin's-Falls, near Apulia, Onondaga county. This shell is the most abundant fossil in a formation of shale, (tab. of form. No. 22.) The lower portion of which appears to be non-fossiliferous; but the upper part in many of the layers abounds with this bivalve, and few other species of shells appears among them. Cypricardites subalata, however, is not unfrequently met with.

7. *A. semiplicata.* Small, subtriangular, upper part of valves entire, the lower deeply plicated; lesser valve with a prominent middle divided by a sulcus. *Locality.*—Schoharie, a small but highly characteristic species of the Pentamerus limestone, No. 13.

A. unisulcata. Trigonal, superior valve with a broad, prominent middle, sulcated longitudinally, the sulcus being obsolete towards the base; sides concave; the depression giving the margins a carinated appearance; inferior valve deeply concave, subangulated in the middle; umbonial slope carinated, and the area between it and the margin much depressed. *Locality.*—Schoharie, in Onondaga limestone.

8. *A. peculiaris.* Subtriangular, with obsolete, fine, radiating lines; inferior valve flat, concave at base, with a linguiform projection; superior valve with a convex, mesial elevation at base, where the margins of the valves meet above the basal margin, and are notched or serrate; submargin of the sides of the flat valve serrated. *Locality.*—Schoharie, in Oriskany sandstone.

UNIVALVES.

1. *Platyceras sulcatus.* Subfalcate, rounded with well defined sulci or ribs crossed by waved lines; beak laterally curved; margin of aperture plicated. *Locality.*—Schoharie, tab. of form, No. 18.

2. *P. expansus.* Dilated, suborbicular, spire small, not prominent with 3 volutions; aperture profoundly dilated, labium angulated. *Locality.*—Schoharie, in Oriskany sandstone. 2¼ inches in length.

3. *P. nodosus.* Subfalcate with numerous thick, obtuse nodes. *Locality.*—Occurs with the preceding species. This is a cast in sandstone, and the shell was probably covered with spines. Length 2 inches.

4. *P. cirriformis.* Smooth, with 3 or 4 subangular gyrations.

5. *P. subundata.* Subfalcate, rounded; beak prominent, incurved and free; inclined towards the back of the shell; surface with obscure nodes or irregular undulations; margin of aperture slightly undulated; aperture rounded oval transversely. *Locality.*—With the preceding, on the Helderberg mountain, tab. of form. No.

1. *Conularia undulata.* Distinguished from C. quadrisulcata by having the striæ more crowded and undulated, and by the absence of lines crossing the furrows between the striæ. *Locality.*—Helderberg and near Middlebury, in Cazenovia shales.

2. *C. laqueata.* Slender, smooth, with 8 longitudinal grooves, well defined. *Locality.*—Albion, Wayne county, in Rochester shale.

LETTER

From W. W. Mather, to the Governor, relative to the Geological Survey of the State.

—

To His Excellency,
W. H. SEWARD.

SIR:—

I inclose herewith the Fifth Annual Report on the Geological Survey of the First District of New-York.

During the past season, I have been engaged in geological explorations for a portion of the time, in company with Prof. Vanuxem, along the common boundary of our respective districts, and for the remainder of the time, while in the field, I was engaged in making the examination of the geological phenomena and resources of the counties of Albany, Schenectady, Saratoga, Rensselaer and Washington.

Albany and Rensselaer counties had before been examined by Prof. Eaton, assisted by Professors T. R. and Lewis C. Beck, and M. H. Webster, Esq. and Dr. Eights, in 1821, under the sanction and at the expense of the late Hon. Stephen Van Rensselaer of Albany.

Some new developments have been made in a knowledge of their mineral resources, and in relation to important geological facts.

Schenectady county seems to be very barren of useful mineral substances, if we except the patches of the Helderberg and Trenton limestone series of rocks. The rocks present little variety, and are scarcely

useful for other purposes than a common wall stone. In some localities, however, good building stones may be obtained.

Saratoga county contains more varied mineral products, applicable to useful purposes, as iron ores, marl, limestone, granite, gneiss and various other materials, that will be mentioned in their proper places.

In Washington county the geological structure is more intricate, and its resources in useful minerals are greater than any other tract of equal extent in the First Geological District, unless it be that in the counties of Orange, Putnam and Rockland.

I have now examined the twenty-one counties that form the First Geological District, and have given to each about an equal share of attention; but while some have been examined with as much care as would be profitable in an economical point of view, there are others where the geological structure is more intricate, and where there is a great variety of useful and valuable mineral resources, and in which valuable deposits have been observed in some places; but their continuation, and, of course, many of the most favorable sites for exploration and transportation, are still undetermined.

Having made such examinations in the district committed to my charge as the time allotted by the Legislature would permit, I purpose, after having made the present report on the economical geology of the counties examined the past year, to prepare the final report on the geology of the First Geological District of New-York, embracing, 1st, The economical geology with its statistics; and 2d, The various facts and phenomena connected with scientific geology, observed during the progress of the survey.

I have prepared maps of the different counties in the First Geological District, indicated on them by suitable colours the groups of rocks over the areas that they respectively occupy as surface rocks, have rectified many errors in the county maps, noted down the small streams that were before omitted, and villages that had no existence, or were omitted at the time the county maps were compiled.

About forty boxes of specimens have been collected during the past year, in the First Geological District, to illustrate the geology of the counties of Albany, Schenectady, Saratoga, Washington and Rensse-

laer. As the rooms and cases are not yet prepared in the State-House for the reception of these specimens, they can not be displayed at present.

Geological sections, diagrams, and maps to illustrate many of the various facts observed, are drawn, and most of them are ready for the engraver. About forty plates will be necessary.

I have the honor to be,
Very truly your ob'd't serv't,
W. W. MATHER,
State Geologist.

Jackson C. H. Jackson Co. Ohio,
Jan. 20th, 1841.

FIFTH ANNUAL REPORT

On the Geological Survey of the First Geological District of New-York, by W. W. Mather, Geologist.

Economical Geology of the Counties examined the past year.

TOPOGRAPHICAL AND AGRICULTURAL CHARACTERS.

The agricultural character of a district is dependent on the rocky masses under the soil, their stratification, the materials of which the soil is composed, and the topographical character of the country.

The two first of these points may be illustrated in the district under examination in this report, by calling the attention of the reader to those portions of Schenectady county, and to Rensselaer, Washington, and other counties, that have the Hudson slate rocks beneath their soils, and that lie higher in level than the ancient alluvion of clay and sand of the Hudson river valley. These rocks are alternations of slates, with slaty and fine grained sandstones, and hard grit rocks. The strata of slate, and many of those of the other rocks, are nearly or quite impervious to water. In Schenectady county, the strata of these rocks lie nearly horizontal, are impervious to water, and by decomposition form a highly argillaceous soil. The consequence is, that the hill lands are generally cold and wet soils. In portions of the other counties named, (and portions of Columbia, Dutchess, Orange, Ulster, Greene, Albany and Saratoga, might also be mentioned,) the rocks are the same, but the strata dip at a high angle, the rock more readily crumbles by the action of the weather on its edges, while the inclination of the strata enables the water to sink and be conducted off between the layers, and through the joints of the rock, to break out in springs at a lower level.

The hilly character of these counties also enables the water to drain in part from the surface more freely than if the lands were more level, and the consequence is a mellow, warm, and dry soil. The rocks here spoken of range through Orange county, between the Highland and Shawangunk mountains; thence through the east parts of Ulster, Greene, Albany, Schenectady and Saratoga, on the right bank of the Hudson; and through the west part of Dutchess, Columbia and Rensselaer counties, on the left bank of that stream. This range of rocks occupies a diagonal belt of country in the county of Washington.

A line of fracture and anticlinal axis extends from the line of New-Jersey through the Drowned Lands and Comfort Hills in Orange county, crosses the Shawangunk mountains with a very acute angle,* passes near Kingston, thence on by the falls of the Esopus creek (half a mile east of them,) by Saugerties, along the ridge between Catskill village and the Katerskill creek on the road to the Mountain House; near Madison three miles northwest of Catskill; four miles west of Athens; three miles west of Coxsackie, and about the same distance west of New-Baltimore and Coeymans. Its continuation in Albany county is seen only where the Norman's kill and Mohawk intersect it, in consequence of the sand and clay beds having covered all the rocks, and concealed them from view. It crosses the Mohawk a few miles below the aqueduct, and ranges thence by Saratoga lake to Baker's falls near Sandy-Hill. Beyond this, it is confounded with the axes of elevation connected with the mountains between Lakes Horicon and Champlain.

On the west side of this axis of fracture and elevation, the rocks dip to the westward at variable, but generally at small angles, while on the east side, they dip at a high angle to the eastward, and are frequently vertical in their stratification.†

Each kind of rock in the district under examination gives its peculiar soil, more or less modified by circumstances such as those just men-

* The Shawanguuk mountains, at the place of crossing, are broken into several subordinate anticlinal axes or wrinkles of the strata, with this main fracture crossing very obliquely, producing numerous faults and fractures of the strata.

† In many localities, where natural or artifical sections afford a view of the rocks along this axis of fracture and elevation, a great variety of curious contortions of the rocks may be observed; and even more remarkable contortions may be seen wherever the transverse axes of elevation cross the longitudinal ones. Various examples are figured in the plates prepared for the final report of the Geological Survey.

tioned, in the Hudson slate rocks in regard to stratification and topography.

The granitic and gneiss rocks of the northwest parts of Saratoga and Washington counties give a gravelly and rocky soil, while the country is very broken, with high steep mountains and narrow valleys, and is too broken and rocky for easy and profitable tillage.

The limestone lands are every where productive in these counties, to whichsoever of the geological periods they belong.

The talcose and talco argillaceous slates of the eastern parts of Dutchess, Columbia, Rensselaer and Washington counties, and which range through a part of Vermont east of Lake Champlain, are hilly and mountain swells of land, with a tolerably good soil. The strata dip at a high angle to the eastward, conformable to the gneiss, granular limestones, mica slate, and granular quartz rock of the Green Mountains.

The more recent rocks, as the Helderberg limestone series, Catskill mountain rocks, &c. approach more and more to a horizontal position, in proportion as they are more distant from the axis of elevation on the west.

The Helderberg limestone makes a good soil, and even where horizontally stratified, it is not often wet, in consequence of the numerous sink holes and fissures that serve to drain off all the superfluous moisture. This rock ranges from Carpenter's Point on the Delaware, to Kingston, Catskill, New-Baltimore, Knoxville, Schoharie, and thence on by Cherry-Valley, still farther to the west.

The soil of the Shawangunk grit is very thin, poor, and often almost barren. The red rocks of the Onondaga salt group are rich and productive, but they form so small a surface area in the First Geological District as to be scarcely worthy of notice.

The Catskill mountain rocks make soils that are very variable in character, dependent on the composition and destructibility of the rock, and porosity and permeability to water. The red slates and fine grits usually make warm and good soils. The gray and greenish grit soils are stony, and often cold and wet. Most of the soils of this series of rocks is well adapted for grazing, oats and potatoes, but not *permanently* productive of good crops of wheat and corn. The tract of coun-

derive their alluvial materials from the argillaceous and argillo-calcareous rocks of this part of the same county. The Batten kill alluvions of this part of its course, are mostly formed of sand, gravel and pebbles, derived from the granular quartz of the Green Mountains. This fact may be seen well illustrated about two miles from Salem, on the road to Cambridge, where the alluvia of Black creek and White creek mingle with that of the Batten kill, and it was observed that the alluvion of this last stream was much less productive than the others, although at a little distance, they appeared to be as good lands.

The alluvions of Wood creek are very productive, but have little extent above its delta in Lake Champlain. They are derived from slate, limestone, sandstone, granitic and gneissoid rocks, and the soils resulting might be inferred to be highly productive. The alluvion of the valley, at the junction of Pawlet river with Wood creek, has a width of a mile, and in several places on these streams it has a breadth of one-half mile.

Whitehall is usually called the head of Lake Champlain, but the lake for fifteen miles is rarely more than 100 to 150 yards wide. It is in fact a mere channel between mud flats of clayey alluvion, that form the delta of Wood creek, Pawlet river and Poultney river.* In several places the channel is divided into two or three, by alluvial ooze islands and shoals of recent origin. They are generally covered only by aquatic plants, as rushes, flags, lily pads, wild rice, coarse grass, bushes and small trees. One of the marshes is called "Twelve-Mile marsh," in consequence of its length, extending from South Bay twelve miles down the lake. This marsh has the same vegetable covering as the islands above described, except that bushes and trees are rarely seen.

The lake is skirted in many places between Whitehall and the north end of Twelve-Mile marsh, by a clay formation similar to that of the Hudson valley. This formation is elevated from thirty to sixty feet above the lake, and a small portion of the alluvion of this part of the lake is derived from the wash of the rivulets, and encroachment of the lake on this formation; but the effects produced by these causes are small indeed, when compared with the earthy materials brought down by Wood, Pawlet and Poultney creeks. From Whitehall to near the end of Twelve-Mile marsh, the channel of the lake is not generally more

* These rivers are not of such size as to justify the name. They are creeks, from one to four or five rods wide.

than 100 yards wide, and a sensible current flows through it. The channel is bounded on each side for a great portion of this distance by mud flats and marshes that are often overflowed, either in consequence of freshets in the creeks mentioned, or of strong or long continued north winds, which raise the water at the south end of the lake. The channel may be considered as an extension of Wood creek flowing through its delta.

Some of the alluvial flats and marshes of this part of Lake Champlain are already used for grazing cattle, and a coarse hay is cut on some others. It is believed that many of these lands will, before many years, be dyked* out to guard against their being overflowed, and then they will make most highly productive lands for tillage and hay.

It is well known that large portions of Holland are thus redeemed from the dominion of the sea. Small tracts of a few hundreds to a few thousand acres have also been dyked out on our own coast and on the Hudson, where they would otherwise be periodically inundated by the spring tides.

Lacustrine Alluvions.

These embrace the deposits of peat, marl, muck or imperfectly decomposed vegetable matter of our swamps, bog ore and wadd.

Peat in considerable quantities has been discovered in Washington county, and some in Rensselaer, Saratoga, Albany and Schenectady counties. The most extensive deposits of peat and marl are noted below. These materials are of great value to the farmer, to afford nutritive and stimulant manures for the soil. Peat is also a valuable fuel, and is extensively used in some parts of the world where it is abundant, and where wood and coal are dear. The collection of vast stores of these and other materials in such situations as will be most useful, and their accumulation in times past, when the surface of the earth was occupied by other animals than man, shows an adaptation of means to ends by the great Creator of the Universe for the supply of man whenever he may need them for use.

*A strong north wind or a more moderate one of some days continuance, raises the water a foot or more above its medium level, and one from the opposite point of the compass, would depress it as much below its medium level, so that dykes are necessary to protect the flats from occasional inundation.

by which these masses of drift have been propelled. It is only by the aid of a topographical map, that these facts can be fully illustrated.

The boulders and drift of the Hudson valley, (including in this valley the country within the extremities of its tributaries,) so far as regards the first district, lie below those deposits of sand, clay and gravel, that have heretofore been classed with the tertiary, where both formations occur, and the same fact has been observed by Prof. Vanuxem in other parts of the State, and by Prof. Hitchcock in the valley of the Connecticut in Massachusetts. I have remarked the same on Long-Island, in Suffolk, Queens and Kings counties, and on Staten-Island, where the boulder-beds underlie extensive tracts of clay and sand of more recent formation, in which no fossil remains have yet been found;* but they overlie also a formation composed of sands and clays containing lignite, and various species and genera of shells, which are supposed to belong to the pliocene strata. The only fossils found in the more recent formations above the boulder system or drift, so far as I know, are the plants discovered in one of the layers of the blue clay at Albany by Dr. Eights. These plants are the and are so recent, that the vegetable matter is not changed in any material degree. They are brownish, but the leaves are still flexible. This formation above the boulders and drift† which forms most of the level plains of Saratoga, Albany, Greene, Ulster, Orange, Rockland, Westchester, Putnam, Duthess, Columbia, Rensselaer, Schenectady, Schoharie and Washington counties, along the immediate valley of the Hudson, and of its main tributaries, and which furnishes such quantities of bricks for building, is, in my opinion, of more recent formation than any of the tertiary deposits, and yet, older than our alluvial formations. They are evidently the last strata deposited before the elevation of that portion of the continent on which we live, above the waters from which they were deposited; but it seems remarkable that a formation so extensive, so recent, and which was deposited from water in a comparatively quiet state, should contain so few traces of organic existence.‡ The clays

* The clay and sand beds above the drift in the valley of the Hudson, is believed to have been contemporaneous with that above the boulder-beds of Long-Island and Staten-Island. At Albany, plants have been found in the clay-beds by Dr. Eights.

† The only fossils found in the drift of the Hudson valley are masses of coralline animals, such as the Meandrina and Astrea. I have found them near West-Point, and have heard of their having been found in other places.

‡ The same formation (as I suppose it to be) on the coasts of Lake Champlain, has been examined by Prof. Emmons. He found it filled with fossil shells in some localities. Some of the shells seem to be identical with those now existing on our coasts.

of the Hudson valley are nearly uniform in appearance, and perhaps do not vary greatly in composition in its most distant parts. The lower clay bed is bluish, and the upper a buff-coloured clay in thin laminæ. In some places, thin laminæ of sand of the thickness of common writing paper alternate with the clay, in others the sand is absent, and again in others it forms such a proportion of the mass that no sand is required for mixture in the manufacture of bricks.*

Both kinds of the clay are more or less calcareous. They effervesce freely with acids, and have been used with advantage as a marl on sandy and light soils.

The clay beds at Albany are more than 100 feet thick, and between that town and Schenectady, they are overlaid by a bed of sand that is in some places more than 50 feet thick.

At Troy, the gravel and sand-beds overlie the clay to a depth of 30 to 50 feet. This may be seen at the south end of the city, at the locality where a land-slide occurred on the eve of the 1st of January, 1837, and by which several lives were lost, and several buildings destroyed.

The plains around Schenectady are almost entirely of sand, overlying the same clay beds as are those west, northwest, southwest and north of Albany, the northeast part of Saratoga county, and those west and southwest of Galesville in Washington county. These last seem to be in the original estuary of the Batten kill. At Sandy-Hill and Glen's-Falls, the same sandy plains are seen, and extend towards South-Bay of Lake George, and are a continuation of those of Saratoga county. The clay lands of the same formation occupy the valley of the Champlain canal to Fort-Edward and Fort-Miller on the Hudson, also a part of Argyle up the valley of the Moses' kill, and the west and southwest parts of Easton in Washington county. It also occupies the west part of Scaghticoke, Berwick, Greenbush and Schodack in Rensselaer county; a narrow belt along the Hudson and Mohawk rivers; along the Mohawk in Schenectady county; and in Albany county, belts more or less broad along the Mohawk and Hudson, and up the valleys of the Norman's kill, Vlamman's creek, and Coeyman's creek. Where the sand occurs, it is uniformly above the clay beds, and generally covers the plains that divide the waters of the creeks and smaller streams.

* Sand is used in brick-making to give such a porosity to the clay as shall prevent the raw bricks from cracking while drying.

York. The upper portion of this series, is the highest in geological position, of any of the indurated rocks of the State, (except some local consolidated gravel beds of drift;) but the highest of the Catskill Mountain rocks are below the coal formation of Pennsylvania, and reach only to its base.

The Montrose sandstone of Prof. Vanuxem is below the top of this series in the Catskill Mountains, and beneath this, nearly all the strata described by him in his last report are found, characterized by their peculiar fossils; but these rocks in the First Geological District are generally of a coarser texture, down to the Helderberg limestone series, than in the Third District, and the fossils are as rare comparatively in this, as they are abundant and beautifully preserved in the other.

In many of these strata, the fossils had entirely escaped observation, in consequence of their rarity, until, when in company with this gentleman, he recognized the particular strata he had described, and then, by careful examination, we found the characteristic fossils.

Marine testacea are the most numerous fossils in the lower, and marine and terrene plants in the upper part of this series.

This formation occupies but a limited area in the region that has been under examination the past year. It occupies the town of Rensselaerville, and most of those of Westerlo and Bern, in Albany county. This is the northeastern extremity of that formation, and each stratum at its outcrop to the north and east, occupies a terrace of greater or less breadth. In many localities, the greatest facilities are thus presented to the collector of fossils, to procure numerous fine specimens of these medals of a former epoch, and also to the quarryman to quarry extensively, with little or no expense in uncovering, the particular strata of rock that may be desired.

The flag-stone stratum was seen in many places in Albany and Greene counties, where it has not been worked. This stratum has been, and is still, extensively worked for flagging stone in Coeymans, in Albany county. This stone is not confined to the hills in which it is quarried, as is generally imagined by the people there, notwithstanding the numerous facts continually presented to eyes that do not see; but this, as well as each of the other particular strata, occupies a uniform and determined position, and by careful examination can be found, and opened in every hill along its range that is high enough to be intersected by its plane. The quantity of this rock is so great, that it cannot be ex-

hausted. It has been traced, exclusive of the sinuosities produced by valleys intersecting its plane, a distance of 140 miles in the First Geological District, and it undoubtedly underlies all the country that is occupied by that portion of the Catskill Mountain Series, that overlies this rock. The principal flag-stone quarries in Coeymans are those of Mr. William Briggs, and Mr. C. Brown.

Some of the grit rocks of the Catskill Mountain Series are adapted for grindstones and whetstones. Many of the strata will make good building-stone with little labor. They split out in regular layers from a few inches to two feet thick, and are intersected by vertical joints, that make faces as smooth as if sawed. There are two main systems of these joints nearly uniform in their directions, and in some places two other systems that are not so uniform in direction.

The two main systems of joints conform in direction to the main axes of elevation and fracture, which are from NNE. to SSW., and from ESE. to WNW. These joints are nearly vertical, and in slaty rocks very smooth. They traverse all the strata down to the primary rocks. They afford great facilities in quarrying, and save much labor by having their faces smooth dressed by nature.

The strata of the Catskill Mountain Series occur in the First Geological District, in the following groups, viz:

1. Conglomerates and grits.
2. { Red and gray grits with red shales mottled with green spots.
   { Montrose sandstone, of Prof. Vanuxem.
3. Chemung group of Prof. Vanuxem.
4. Ithaca " " "
5. Sherburne flags. " "
6. ———————
7. Hamilton group. " "
8. Marcellus shales. " "

Some of the groups of rocks described by Prof. Vanuxem, are wanting in the First District, or are so thin, or without showing their fossils, as not to have been recognized.

The following detailed section gives the rocks as they can be seen in the Catskill Mountain Series, from the top of the South mountain near the Mountain House, at the Pine Orchard, down to the Helderberg limestone series at Caterskill creek, by the stone bridge, between Cats-

Terrace 18.
60. Red shale, } These two strata are the same as the two preceding, and are crossed again, in rising, and descend again from the shanty in the ravine.
61. Green slate, }
62. Red shale.
63. Reddish gray slaty grit.
64. Red shale.

17.
65. Gray grit.
66. O ———— no rocks seen, soil, &c. cover them.
67. Red shale.
68. Greenish gray slate.
69. O ———— no rocks seen, soil, &c. cover them.
70. Red shale with green spots.

16.
71. Gray grit.
72. Red shale with green spots.
73. O ———— no rock visible.

15.
74. Greenish gray slaty grits.
75. Greenish gray shale.
76. Gray slaty grits.

14.
77. Gray slaty grit.
78. Red and brownish red shales.
79. Gray grit.
80. Red and green shales alternating.
81. Brown slaty grits.

13.
82. Red shale with green spots.
83. Greenish gray grit.
84. Red crumbling grits.

12.
85. Red and green shales.
86. Gray slaty grits and shales.
87. Brownish shale.
88 Red shale with green spots.
89. Gray shale.
90. Red shale. *To the toll gate.*

11.
91. Green shaly grits.
92. Greenish and brownish shales.

10. 93. Gray grit, laminæ of deposition distinct.

9. 94. Gray grit, do do do

8.
95. Gray shale.
96. Grayish green shale.
97. Red and green spotted shale.
98. Gray grit laminated.
99. Brownish red shale.
100. Gray grit.
101. Brown shale.
102. Red shale.
103. Brown sandstone.

7.
104. Red shale, green spots.
105. Gray slaty grit, to bottom of valley.

6. 106. Brown slaty grit.
   107. Gray slaty grit.
   108. Blue slaty grit.

5. 109. Red slaty grits with shales interlaminated
   110. Bluish gray slaty grit.

4. 111. Gray slaty grit.
   112. Brown crumbling grit.

3. 113. Gray crumbling shale.
   114. Red and green spotted shale.
   115. Brown crumbling shale.

2. 116. Gray slaty grit.

1. 117. Gray slaty grit, *to Kiskatamine creek, at the church in the valley.*

1′. 118. Gray slaty grit.
   119. Limestone, brecciated and conglomerate, two feet.
   120. Gray slaty grit.

2′. 121. Gray slaty grit, laminæ of deposition distinct.

3′. 122. Dark shales and shaly grits and flags, of several hundred feet in thickness, embracing from the Ithaca group to the Marcellus shales of Prof. Vanuxem.

4′. 123. Marcellus shales,
    124. Helderberg limestone, } At the stone bridge Caterskill creek.

The strata embraced in 122 have not been traced out in detail as those above have been. Subjoined is a local section of a small portion of the Catskill Series, at Post's Mills, in Durham, Greene county.

	Ft.	in.
1. Gray grit at the top of the ravine, surface rock.		
2. Red shale,	4	0
3. Greenish grit,	20	0
4. Red grit and red shale,	15	0
5. Hard band of red grit,	2	0
6. Red shale,	2	0
7. Hard band of red grit,	2	0
8. Slaty red grit,	2	0
9. Red gritty shale,	4	0
10. Greenish gritty shale,	3	0
11. Reddish slaty grit,	7	0
12. Green band of shale,	1	0
13. Red gritty shale,	5	0
14. Blue limestone, compact,	0	6
15. Red shale, and thin band of slaty grit,	8	0
16. Slaty sandstone, some spotted with green,	6	0
17. Green shale, and bands of red grit, unknown thickness.		
	81	6

the north, they are exposed in broad terraces, and offer facilities for examining minutely the fossil contents.

Above the Helderberg limestone series, south of Hyndsville, in Schoharie county, a shale or slaty crumbling grit was observed, which is a part of the Marcellus shales. This rock is traceable overlying the limestone and underlying the middle rocks of the Cattskill Mountain Series, throughout their range, along the belt of country between their respective lines of outcrop.

Above this, a series of rocks occurs, which are generally fissile sandstones, and contain many strata abounding in testacea of various species; also fucoids and terrene plants. This is the Hamilton group of Prof. Vanuxem.

Shells were seen in many places in the grits and gritty shales, between Summit and Jefferson Academy, especially on the high grounds and on the tops of the hills. They are particularly abundant about one mile north of Jefferson Academy. There are several strata abounding in marine testacea, between Summit and Richmondville, and the same strata are crossed on the road thence over the mountain to Hyndsville. Other strata abound in plants. The shell strata may also be seen on the road from Summit to Byrnville, in the town of Fulton.

Limestone containing carbonate of iron is common, and in its unchanged state it does not show its fossils distinctly, but by weathering, loses its carbonate of lime, and leaves a yellowish mass of spongy, impure limonite, filled with the impressions of shells. Loose blocks of this rock were seen in abundance one mile north of Jefferson Academy, Schoharie county. Fucoids, and the same terrene plants were observed here, as on the descent of the mountain north of Summit.

The gray grits by the falls at the tannery, at N. Blenheim, contain fossil shells. They were first observed by Prof. Vanuxem, who found the stratum about six inches thick. Several localities were observed where many species of fine shells may be obtained, in the bluish and brownish gritty shales on the road from North Blenheim to Gilboa.

At Gilboa, the red shales and grits of the Catskill mountain rocks are seen in the creek valley, from the water-level to 200 feet above, and thence they are found all along the valley to Hunter, and thence to the Mountain-House. Fucoids abound in some of these strata. This is the Montrose sandstone of Prof. Vanuxem.

Ripple Marks.—These were seen on a layer of brown sandstone on the road from Catskill to the Mountain-House, one mile above the toll-gate. If the direction of the current producing ripple marks be perpendicular to the general direction of the marks, the current forming these must have flowed from north 30° east, to south 30° west.

HELDERBERG LIMESTONE SERIES.

This series of rocks has been described to some extent in the preceding, or Fourth Annual Report. It is a mass of some 400 feet in thickness, composed of various strata of limestone, each characterized by its fossils and mineralogical characters, and interstratified with shales and grits; but limestone is the predominating rock. The rocks of this series occupy a great area in the central part of the State, and each stratum, in consequence of being nearly horizontal, forms almost the only rock over large tracts of country; but in the Helderberg mountains, and on the eastern and southeastern outcrop of the strata, the whole series can be examined within a very short distance, and the superposition of nearly all the rocks of this series may be seen by following up the ravines. In consequence of these rocks being so well developed on the Helderberg mountains, and their forming a natural group, strongly marked in their lithological and palæontological characters from the strata lying above and below them, I have used the term of Helderberg limestone series, as a convenient, and I believe a proper designation. Mr. Vanuxem has, very properly, in my view, divided this series into several groups, to which he has given particular names, indicative of localities where they can be examined easily, or where they are most largely developed, or best characterized by their lithological characters or organic contents.

Some of the rocks that are largely developed in masses of great thickness and extent in the central and western parts of the State, and the position of which is such in the order of succession as to place them within the limits of the series under consideration, diminish in thickness from west to east, so as to have wedged out and entirely disappeared, or to be very thin and not to be found except by careful investigation. Again, there are others well developed in the east part of the State, that gradually thin out and disappear as we trace them to the west. I am disposed to adopt the names that Prof. Vanuxem has proposed for the rocks embraced within the limits of this series in the First Geological District, *as subordinate members of a great natural group*, and which

Some of the strata will yield fine and beautiful marbles, black, gray, and veined like the "Egyptian," but with *white* and *gray* veins instead of *yellow*, and perhaps more difficult to work.

Some are also fitted for building purposes, as for public and private edifices, bridges, aqueducts, and canal locks. The layers, or individual strata, are frequently seen two, three, four, and five or six feet in thickness, and perfectly sound, in large blocks. All the strata of this series as well as those above and below, are intersected by two main systems of joints nearly perpendicular to each other, and these parallel joints are frequently within the distance of a few feet. In consequence of these natural divisions, the rock is easily quarried in large blocks from five to fifty tons weight, and these are easily wedged into blocks of the sizes required for buildings or other purposes.

There is an extensive quarry about three miles from Coxsackie Landing on the road to Greenville, owned by Mr. Melantho Bellows. Blocks have been quarried at this place for the weigh lock in Albany. The rock is one of the strata of the water lime, or the lowest of the pentamerus limestone, near the base of the Helderberg limestone series. The stone is hard and more expensive to dress than some others, but it is a material that will stand unchanged for any finite period of time. Blocks of almost any required size may be easily procured.

Another quarry that is extensively wrought for heavy blocks for the Erie canal enlargement, is on the farm of Abram Verplanck, Esq. in Coeymans, about four miles from the landing at Coeymans and New-Baltimore. As good and as large blocks can be procured at this quarry as at the one before mentioned; and while the stone seems to be as indestructible as that of the other quarry, it has the advantage of being much more easily dressed and quarried. It was said to me, that had the contractor for the lock stone known of this quarry, on commencing the fulfilment of his contract, he would have been enabled to clear $20,000 more on his contract than he would now be able to do.* This

* It is customary to pay no regard to the original bedding of the stone, when laying it up in buildings and other structures, but where it is to sustain a great pressure, this is a highly important consideration. I have often seen columns for buildings and store fronts, which, in their natural position in the earth, were in horizontal layers, and in the buildings the planes of stratification were vertical. The pressure was then in a direction perpendicular to that to which they had been subjected before. It is often the case that these masses begin to scale off the sides and crumble away, until the structure tumbles down, or the defective masses are replaced by better materials. This principle is almost universally neglected in

quarry is in one of the upper beds of the Helderberg limestone series, viz: the rock that in Schoharie county is burnt for lime, and that contains the several species of the Cyrtoceras. The strata dip about one foot in forty or fifty to the southwest.

ONONDAGA SALT GROUP.

This group of rocks, which is so largely developed in the central portion of the State, thins out in the First Geological District, so that in many places it is absent; and where it is found, it is but a few feet in thickness. It is perhaps more largely developed and better characterized at the High falls of the Rondout, than at any other exposed locality in the First District.

The grey and porous yellow limestone of this group was recognized by Prof. Vanuxem at Sharon Springs, overlying the Frankfort slates, and underlying the Helderberg series, opposite the mill, 200 or 300 yards north of the springs.

No salt water has been found in this group of rocks in the First District, unless the boring for the salt well on Fox creek, near Delhi, in Delaware county, penetrated into these rocks.

Gypsum occurs as an efflorescence on the pyritous limestone of this group, at High falls, on the Rondout, in Ulster county. The limestone is loaded with minute cubic crystals of pyrites. It was mentioned in the last annual report, that I had recommended to Mr. Robinson, the proprietor, to make a trial of some of the crushed or ground rock upon the soil, as a substitute for gypsum. The pyrites decomposing when exposed to the weather in contact with limestone, would form gypsum. Mr. Robinson has since ground some of the rock and made a trial of it as a substitute for gypsum, and has found that it answers the same purpose, promoting the growth of vegetation in a sensible degree. The rock may serve as a local supply of fertilizing material, if the cost of quarrying and grinding, or crushing, should not be too great. It should be borne in mind, however, that it will not answer for the *other* uses of gypsum.

The red and variegated shales of this group may also be useful as a stimulant manure, or rather as a marl for the immediate neighborhood,

the United States. I have seen some buildings constructed at great expense that are in a state of rapid decay from a neglect of this principle, which is recognized by every engineer that deserves the name, and *ought to be* by every architect.

forming a part of Petersburgh mountain in the former, and the high range of land west of Lebanon valley in the latter county. It is a greenish and bluish hard silicious grit, sometimes granular, sometimes brecciated, and at others a conglomerate or puddingstone. It contains no organic remains as far as is yet known, and it has been applied to no use except as a rough wall stone. The same rock, with some modifications, ranges through a part of Dutchess, Orange and Ulster counties.

The Frankfort slate rocks form most of the masses that have been called graywacke, slaty graywacke, and graywacke slate, of the preceding reports, and these rocks underlie large portions of Rensselaer, Washington, Albany, and Saratoga counties, and almost the whole of Schenectady county. It is a series of fine grained hard grit rocks, interstratified with shales and slates of a dark gray, bluish, or black color. The rock has been used in some places for building. Many of the strata are indestructible, and are easily quarried on account of the joints.

Mohawk slate, ("*Black slate.*")—The slate rocks lying below the Frankfort slates are more or less fissile, and interstratified with thin layers of sandstone and limestone. Some of them contain the impressions of various species of graptolites, or fucoids, others contain multilocular univalve shells and several species of trilobites. Some of the bands of limestone in this formation contain the Triarthrus Beckii. The calcareous layers are sometimes replaced by bands of iron ore (carbonate of iron.) Some of these slate rocks are traversed by seams in every direction, and the surfaces of the fragments are glazed with a black carbonaceous coating, and this has given rise to the name of "glazed slate," a name that is very appropriate for this part of the mass. This glazed slate has often been mistaken for anthracite, and many fruitless searches have been made for coal in this rock. The fact that the impressions of plants are usually found in the shale associated with coal, has, in some instances, strengthened the idea that coal in useful quantities existed where the excavations have been made. These impressions of plants which are supposed to be marine, are found in the greatest profusion at many localities, through a thickness of many feet of the slate rock. Baker's falls is a locality worth visiting by every geologist. Here a thickness of thirty feet or more of the slate rock, is so filled with these impressions, that the thinnest layer can scarcely be split off, without exposing a surface almost covered with them. Bands of iron ore and veins of crystalline carbonate of lime may be

seen in the same rock. At a little distance below the ferry, on the Saratoga shore, the junction of the Trenton limestone with the slate, and the graduation of one into the other, with their numerous and beautiful fossils, and which are intermingled near the junction, can easily be examined when the river is low. Ballston springs, Saratoga lake, the banks of the Norman's kill near Albany, the bank of the Hudson in the northwest corner of Columbia county, the bank of the Hudson at Hudson below the Pavilion, the old "coal mine" one mile and a half south of the Hudson, the slate under the grit in the Shawangunk mountain east of Ellenville, Blue Point in Ulster county, &c. are localities where similar graplolites, or fucoides, have been noticed in similar slate rocks, and it is believed also that these rocks are of the same geological age. The roof slate of Hoosick in Rensselaer county is also filled with vegetable impressions having a general resemblance, but evidently belonging to different species from any of those in the slates now described. Whether this slate belongs to the same geological period is not ascertained; but I think it not very improbable, from the fact, that the strata in the Hudson valley have been broken, by parallel lines of fracture in a nearly north and south direction, and the masses turned in echelon, so that in some places, each succeeding hill shows the same alternating strata, all dipping in the same direction, and some of these strata, so distinctly marked in their composition and external characters, that no mistake is to be apprehended. I have not, however, been able to trace this similarity to the roof slate beds. These rocks in the eastern parts of the counties of Washington, Rensselaer and Columbia, gradually change in their aspect, becoming more shining, more talcy, chloritic, and plumbaginous, more traversed by veins and nests of quartz, and assume more the aspect of metamorphic rocks. The rocks of the Hudson valley dip eastward with a few local exceptions at a high angle, and seem to dip under the rocks we have been accustomed to call primary, and those rocks on the eastern boundary of the valley, that from their *position*, would seem to be of more recent formation, approach in characters to those called primary, and finally become blended with them. I feel inclined to consider them *metamorphic with intrusive rocks interstratified.* Quartz veins we know are found everywhere in that region, and in many places the rock is permeated by it in every part like a sponge filled with water, and it is evidently an intrusive rock. Again, the limestones are in places a crystalline, white, or clouded marble, in others a compact limestone. Again, granite and quartz veins are very common in the mica slate, and talcy mica slate, of the Green

Centre; one mile west of Hebron; four miles southwest of Hebron; at Hartford lower village; between North-Granville and Middle-Granville in several places, as at the falls, one mile above, one-fourth of a mile northeast, and at Middle-Granville. The rock when long exposed is gray on the exterior, and the fucoidal marks imperfect. I examined many specimens before I was fully convinced that the markings were from organic bodies.* The fresh fracture of the rocks shows a slight mottled appearance, as if the carbonaceous matter of the fucoid had penetrated into the mass below and above the place where the impression remains. This rock is almost uniformly found near the calciferous sandstone, with a thickness of from 40 to 60 feet of slate intervening.

Red slate.—There is a red slate in the Hudson slate series that seems to be coextensive with this series of rocks. I have traced it almost continuously from Vermont on Poultney river, through Hampton, Granville, Hebron, Salem, Jackson, and White-Creek in Washington county to the Hoosick river, thence from the northwest part of the town of Hoosick through Pittstown, Grafton, Sandlake and Nassau, in Rensselaer county to the line of Columbia county, whence its range has been traced in preceding reports to the Hudson at Fishkill, and thence across the base of the Highlands through Warwick in Orange county, to the New-Jersey line. There are numerous detached patches of this rock, and their disconnection from the main mass seems due to the breaking up of the strata which has been alluded to, and will be more fully illustrated under the head of Mohawk limestone.

CHLORITIC AND TALCOSE SLATES.

These form the eastern boundary of the slaty rocks of the Hudson valley, within the boundary of New-York north of Dutchess county, but I think them metamorphic rocks. They have many peculiarities of the slates I have described, except their lustre and unctuosity of feeling. They are traversed by quartz veins in every direction, which are filled with chlorite, and often with pyrites, carbonite of iron, and brown spar. The slate rock is frequently so permeated by quartz, that a sponge filled with water, may be considered a good comparison. The

* The Rev. Mr. Newton of Cambridge, who is an ardent admirer of geology as a science, and who is an active and useful laborer in geological instruction and observation, first called my attention to the fucoidal impressions in this calcareous slate near Cambridge, and I have to express my thanks for his kind co-operation in aiding my investigations in the south part of Washington county.

quartz is doubtless an intrusive rock, and by its heat when injected, has changed the aspect, and modified the mineralogical aggregates and composition of the rock.

TRENTON AND MOHAWK LIMESTONES.

These are important rocks in the First Geological District, on account of their extent, the quality of the soils over and near them, and their applications for building stones, marbles, and lime.

The Trenton limestone is generally a dark coloured compact or subcrystalline limestone, sometimes slaty, in others in strata two to four feet thick, separated by thin layers of black shale. Some of the strata are replete with fossil remains, others are nearly destitute of them. Some of the thick strata are easily sawed and polished and make a beautiful black marble; others contain hornstone and chert in small nodules and irregular masses, that render it useless for such purposes.

This rock occupies a small portion of Schenectady county near Amsterdam, on both banks of the Mohawk; thence it ranges northwards into Saratoga county; thence eastward around the points of the mountains and along the eastern slope, and enters Warren county at Glen's-Falls. The Trenton limestone is extensively quarried in Schenectady county, near the Erie canal, a few miles from Amsterdam, for building, flagging and curb stones, for the New-York, Albany, Troy, and other river markets. It is also quarried for stones for locks and aqueducts. It is a durable and valuable stone for such purposes.

At Glen's-Falls, on the Saratoga side of the Hudson, it is quarried for a black marble. It is easily obtained in large blocks within a few rods of the marble mills, where it is sawed into slabs and other suitable forms for fire-places, tables, window and door caps, and sills, &c. Mr. Rice, the proprietor, was sawing at the time of my visit 1,000 feet per week, and thought the amount sawed in 1840 would be 50,000 feet. This marble is mostly shipped to the New-York market. The supply is inexhaustible; but in proportion as they quarry farther from the banks of the river, the amount of earth and rock necessarily removed to uncover the marble beds will be greater, and the expense increased. Some of the beds of this rock are burnt for lime. One of the strata of this rock at Glen's-Falls shows marks on the upper surface of the layers, like those produced in soft mud by drops of rain falling on its surface. Similar facts have come under my observation in other places.

Emmons. These rocks, however, were not observed at Bald mountain, or on the continuation south of Galesville.

A similar range of limestone was seen on the east bank of Pawlet river, near the northwest corner of Granville. Another in Salem, three miles south of the court house. Another on the west side of that branch of the Owl kill that flows from the lakes in Jackson. This ranges north and south by Cambridge, two or three miles in length. Another about one and a half or two miles east of Wait's Corners in White-Creek, and here the calciferous sandrock is also present. These two rocks are associated near Cambridge Centre, and four miles northwest of Cambridge, in Jackson, in several localities; also at Battenville, and thence range north by North Greenwich and Summit lake to two miles northeast of Argyle Corners. They occur also at Centre falls. These are isolated upturned masses, the connexions of which have not been traced out.

Another range extends from near the northwest corner of Hoosick in Rensselaer county, up the valley of the Hoosick by Hoosick falls and Hoosick Corners, thence up the valley of the Little Hoosick, through Petersburgh and Berlin* to the Lebanon valley, whence its range SSW. has been already described under the name of Barnegat limestone.

Local patches of this rock occur in various other places where the rocks have been very much broken up, as on Little White creek, near its mouth; on the Wallensack, near its junction with the Hoosick river,† one mile, and two miles southeast of Hoosick Corners.

The rocks in the region of country in which these various patches and detached ranges of limestone have been seen, have been broken up and upturned, so as to present an appearance similar to that produced by ice fields, crushing against each other, and then freezing, so that the fragments stand edgewise at a greater or less angle of inclination. The dip and strike of these masses are variable, but in the aggregate conform to the adjoining rocks of the country, viz. to the ESE. NNE. and SSW.

* In 1820, Prof. Eaton of the Rensselaer Institute, made a geological and agricultural survey of Rensselaer and Albany counties, and he has described the range, and general characters of our rocks, more accurately than could have been expected under the many disadvantages of the time. Although I cannot agree with him in the superposition and names of *some* of the rocks, I have appreciated his labors more, since I have had occasion to examine them critically.

† The dip is here to the southwest and the strike to the northwest.

Another mass of the Mohawk limestone follows the range of the Trenton limestone as far as I have described it in Schenectady and Saratoga counties, and in Washington county it ranges along the base of the mountains in the valley of the west branch of Wood creek to Fort-Ann, where it joins the mass that ranges from Lake Champlain to Bald mountain.

"*Calciferous Sandstone.*"—This rock ranges through Washington county, underlying the Mohawk limestone in most places where the limestone occurs. This rock, like the limestone, laps around the points of the mountains and up the valleys, very much deranged in its stratification near the primary rocks. It may be seen in numerous places between Fort-Ann and Patten's mills, in the valley of the west branch of Wood creek. From one mile east of Fort-Ann, it may be traced by Comstock's landing to Whitehall, where it may be seen in the mountain east of the village. It may also be seen in most of the ridges for three miles to the east of Whitehall, and in some places it has been quarried for building stone and lock stones.

Several ranges of this rock, caused by the rocks having been upheaved into parallel ridges, extend with the limestone described as occurring at the lead mine in White creek; also near Cambridge-Centre; 3 miles from Cambridge, on the road to Union village; four miles NNW. of Cambridge; at Battenville; Centre falls, and thence north on to southeast part of Summit lake; near Union village, and several localities in a line nearly north to the northwest part of Summit lake; sotuhwest of Hebron, two and four miles; several places between South Granville, and Fairvale; and several in the west part of Hartford, and east part of Fort-Ann.

The same rock has also been observed in numerous places in Rensselaer and Columbia counties, but the limestone is there thin, and in some places absent, as at the quarries near Lansingburgh. This stratum thins out as well as the limestone near the Hudson, until it disappears before reaching Dutchess county.

Quartz crystals were observed in some abundance in a rock intermediate between this and the limestone, in Galway, Saratoga county; but they were not as numerous as they are in a similar rock in the valley of the Mohawk, still farther west.

Potsdam Sandstone.—This rock underlies the calciferous sandrock, and this latter is intermediate in composition, as well as in age, to the

The rocks of this region of country are mostly gneiss and granite. The gneissoid rock has all the characters of gneiss, except that the mica is very generally absent, and the same remark generally applies to the granitic aggregate. Garnets, hornblende or magnetic oxide of iron, frequently seem to form constituent parts of the rocks. The gneiss and granite are gray and reddish, according to the colour of the feldspar. Hornblende is so abundant in some of the rocks laminated, as to make the name of hornblendic gneiss appropriate.

In some places, particularly the upper portions of the mass, in some localities along Lake Champlain, the gneiss seems to be a metamorphic rock, that was once the Potsdam sandstone. In Galway, the same rock (it is believed) is a quartz rock, sometimes resembling granular quartz rock. These metamorphic rocks are every where in the vicinity of undoubted intrusive rocks.

Granite is a very abundant rock in the region of country described. On the eastern shore of Lake Horicon or George, it is one of the most common rocks, and may be seen on almost any part of its coast. It is gray and red, the colour depending on that of the feldspar, and it is generally rather fine grained. On the canal, half to one mile south of Comstock's Landing, a mass of granite rock with red feldspar, may be seen. It is here coarse grained.

Limestone is also a very common rock in this primary rock region. It is generally a coarse, white, crystalline limestone, containing various embedded crystalline and amorphous minerals, the most common of which are plumbago, augite, and hornblende. Hornblende, coccolite and plumbago are the almost constant associates. Scapolite is not uncommon. It is very similar to the beds of white granular limestone in Warwick and Monroe in Orange county, and I suppose to those of St. Lawrence county, but it does not contain the various beautifully crystallized minerals, (so far as I have seen,) that exist in those rocks. In some places, the limestone is so much intermixed with other materials, found in the gneissoid and granitic rocks, that without close examination, it would not be suspected as a limestone. Quartz is frequently found in it, transparent or translucent, with irregular, rounded forms, as if it had been partially melted. Many localities that I have visited show that it is undoubtedly an injected rock.

The descriptions and diagrams of the limestone in St. Lawrence county, by Prof. Emmons, leave no doubt that it is an injected rock in

that part of the country, and I have seen examples as striking and as demonstrative of this fact in the primary mountain region of Washington county.

There is a locality to be seen on the road between Mount-Hope furnace and the iron mines south, that will leave little doubt of the rock having been injected in a fluid state.

In another locality about one or one and a half miles from Fort-Ann, to Whitehall, a cliff of the white limestone is exposed on the road-side, and a mass of stratified hornblendic gneiss is distinctly seen imbedded in it. This last example is adduced, not so much for evidence on the point of former fluidity, as on account of ready access on a public road, by which the stages pass daily. Here are also rounded grains of quartz, and scales of plumbago* are seen with augite and other minerals. Numerous localities might be referred to. They are indicated on the geological map of the county. There are many in Putnam and Fort-Ann. Some of the limestone beds have been mentioned as evidently injected, or at least have been fluid, or partially so.

There are other beds of this limestone that I have scarce a doubt are metamorphic rocks, once beds of the Mohawk limestone, now altered rocks, partaking of the character of primary rocks, and interstratified at high angles of inclination with gneissoid and granitic rocks.

MAGNETIC IRON ORE.

This mineral is very common in the district under examination, and has, in most places, the general appearance of a stratified rock, but from the localities examined, I am satisfied that is frequently, if not always, an injected mass, or rather an intrusive rock. Frequently it spreads between the strata of gneiss, and communicates with larger masses, like the trapean rocks.

At some of the ore beds, dark brown or blackish garnet, colophonite and coccolite are very abundant, and even form by far the largest portion of the mass of the ore bed, and frequently they resemble the ore so closely, that ordinary observers do not distinguish the true ore from those materials intermingled with it.

* A small vein of plumbago was pointed out to me by the proprietor, of Fort-Ann, near this mass of limestone, but it is too thin to be of any use.

taken place in a north and south direction farther to the eastward, that have broken up and upheaved the more ancient as well as the more recent rocks in parallel ridges and l reaks of the strata. There have also been transverse axes of elevation, that have broken and contorted the strata, changing their dip, and it is believed also the directions of streams. The evidences belong more properly to the final report, and will there be adduced.

MINERAL SPRINGS.

There have been few new discoveries of important mineral springs in the First District this year.

The sulphur spring in the south part of Greenbush, in Rensselaer county, on the farm of Mrs. Genet, has been known for many years, and has been described by Prof. Eaton, in the report of the agricultural and geological survey of that county. It emerges from the clay beds of the Hudson valley overlying the black slate, which, in that vicinity, is loaded with pyrites. This may be seen in the head of the deep ravine near the spring, and limestone is also associated. The rocks here are very much deranged. The decomposition of pyrites in the slate, is probably the origin of the sulphuretted hydrogen in the water. The water is strongly hepatic, and sufficiently abundant to make it useful to a great number of such persons as require this kind of mineral water. It is also favorably located, near the Hudson, and within an hours' ride of Albany, with a pleasant country and fine views around.

The mineral spring in Greenbush, opposite Albany, has been described by Prof. Eaton and others, as well as the nitrogen gas springs of Wm. Bratt in Hoosick. The water flowing from some of these latter springs is now applied to manufacturing purposes. One of them turns an oil mill, and the water power might easily be more extensively economized. The flow is copious, and the gas rises in abundance. No rock is seen in the immediate neighborhood, but the roof slate stratum ranges west of them within a mile, and this rock is throughout skirted at a distance of one to two miles on the east with limestone, so that it is probable, that the rock at some distance below the soil may be limestone of the character of that at Lebanon Springs. It is a well known fact, that nearly all the copious, and especially the gaseous springs, issue from limestone, or from very near limestone.

In Sandlake, a chalybeate spring was observed by the road-side, on the land of Mr. Ricord. This spring had not before been noticed, so

far as I know. It is by the road-side and issues from a gravel bank. It is a sufficiently strong and copious chalybeate spring for use. It is a mile or perhaps less from the village in the west part of Sandlake, on the road from Albany to Sandlake.

Reed's mineral spring in South Argyle, near the Moses' kill, is an acidulous carbonated water, something like the Saratoga waters, but contains less gas than some of those. Some bubbles of carbonic acid rise in the spring, and the taste of the water is distinctly acidulous from the carbonic acid in it, but it does not sparkle. It is resorted to some by the people around, and many ride there from Saratoga to drink the water for a change. It is an excellent, and well tasted carbonated water. It is used by the people in the vicinity for raising their dough preparatory to baking it. No yeast is required. The gas extricated slowly from the water used in wetting the flour, is amply sufficient to effect this purpose. The spring issues from the Mohawk limestone.

The water of the Ballston springs rises from a bed of quicksand, beneath the bed of clay filled with pebbles, boulders, and gravel, and which is commonly called "hard pan." This sand bed is supposed to rest on the fucoidal or graptolitic slate before described, (and this slate is seen in place at a very short distance) The water is acidulous, and more or less sparkling. The proprietors of these springs have difficulties that have thus far proved insurmountable. The mineral water rising through a bed of quicksand, carries much of this sand along with it, and this packs so tight in the tubes as to obstruct the free flow, and frequently causes it to break out elsewhere. The springs are thus lost. Springs of fresh water also frequently break into the wells and dilute the mineral qualities of the water. This last may be obviated by tubing down the springs to some little depth below the issue of the fresh water, as they do in salt wells, but the tube would probably become so tightly packed with sand as to obstruct the flow. It is probable that the mineral qualities of the water originate at the contact of the fucoidal slate with the underlying Trenton limestone which is probably not more than fifty feet below the level of the valley at the springs. If this be true, (and it is thought highly probable,) mineral water may probably be obtained in a permanent fountain, and free from the difficulties the proprietors now labor under, *by boring into the slate rock* (at some suitable point, at as low a level as practicable,) *until they strike the limestone below.* Water impregnated with

other furnaces. A small quantity of this ore, mixed with the magnetic and other ores, makes them work more easy in the furnace.

Lead ore (galena) has been found in the impure limestone or calciferous sandstone in White-Creek. It lies in small strings and bunches in the rock, and the indications on the surface are such as to justify the belief that it will be explored at some future time; but whether it would be a profitable investment of capital, can only be known by experiment. I would not advise any one to embark in such an enterprise, unless he could lose all embarked without inconvenience. The expenses of exploration are certain, while the result is very uncertain. It is favorably located for drainage. It has the same geological position and relations as the mine four miles south of Lebanon Springs on the east side of the road to Green river, in Columbia county, the Livingston lead mine in Ancram in the same county, and the mines on Judge Bockee's and other adjoining farms, four or five miles southeast of Pine-Plains in Dutchess county. The ore from the White-Creek lead mine, like that from the other mines just mentioned, is said to contain silver. It is highly probable, but I have not assayed it.

Specimens of this ore are in the State collections, but as there are no cases provided for the numerous specimens, they have not been unpacked from the boxes containing them.

It is hoped that during the ensuing season, the rooms intended to receive the State Cabinet will be prepared to receive them, in order that each person engaged on the survey, may open and arrange the various specimens of the natural productions of our territory.

W. W. MATHER,
State Geologist.

Jackson Court House,
Jackson County, Ohio,
January 20th, 1840.

FIFTH ANNUAL REPORT

Of Ebenezer Emmons, M. D. of the Survey of the Second Geological District.

To his Excellency WILLIAM H. SEWARD,
Governor of the State of New-York.

In the prosecution of the duties of the last year, it has been my object to obtain those facts which were essential to the perfection of the final report: those, therefore, of a general character and which relate to the connexion of the subordinate members of the groups of rocks, have principally engrossed my attention.

Arrangements for the Field.

In making the arrangements for the field it was my wish to make such a disposition of time and labor, as would facilitate the objects in view. My assistants, E. Emmons, Jr. and Mr. Edward Hall, were directed to take the field on the first of May and explore in detail those parts of Warren and Essex counties which are adjacent to the junction of the transition and primary rocks. In those duties they continued until the last of June or first of July. At this time, Mr. Hall was obliged to be absent one month, and did not resume his duties until about the sixth of August. He was then directed to examine several towns in St. Lawrence county which had not been sufficiently explored, in which labors he continued till about the last of October.

Farther prosecution of the Survey in the interior of Hamilton, Essex and Franklin counties.

It being necessary that farther examinations should be made in the unsettled portion of my district, I made arrangements with Dr. DeKay of the Zoological Department, to perform this duty in June. We proposed to commence the tour at Lake Pleasant and proceed

to Racket lake by way of Lewis and Indian lakes, thence to Cedar river, and then to the upper waters of the Racket, and by following them down reach this lake; after which we proposed to proceed to Long lake to its outlet which forms the Racket river, and thence down this river to its junction with the Stony creek, and thence to the Saranac waters, which were to be followed till we reached the settlement at Miller's in the town of Franklin. In the execution of this project we procured guides, packmen and provisions in part at Lake Pleasant, and proceeded on the tour about the 6th of June, and reached Lewis lake the same day. A part of the route is on the old State road, which, though it has been built a long time, is still substantial in its foundation. It has probably been protected by the growth of bushes and small trees which sprang up very soon after it was made. This road being judiciously located, one of the most useful and important works would be, to cut it out and open once more a thoroughfare into the heart of this interesting region.

For the value of the land, for its character, scenery, &c. I must refer to the report of 1839. The whole route to Lewis lake is over gneiss, in which there is a large admixture of hornblende and occasionally coarse and imperfectly formed garnets. Lake Pleasant is situated between two ranges of mountains, one upon the east and the other upon the west. These ranges pursue nearly parallel courses, and the route to Lewis lake is between them. But the western range is approached, till finally, at the distance of 20 or 25 miles to the north, it is passed through, in a depression, without obliging the traveller to surmount much of a rise. It is this range, which, taken in connexion with Round lake and the neighboring hills, forms the beautiful scenery of Lake Pleasant, a view of which has been furnished by Mr. Hill, a distinguished artist, who accompanied us on the expedition. It is this range which gives origin to Jessup's and Cedar rivers, which flow in a northeasterly direction and fall into the Hudson. They pursue a parallel direction and are distant from each other from four to six miles, the former passing through Indian lake; while the latter, so far as I could learn, is unconnected in this manner in any part of its course. Lewis lake is small, and is from 50 to 75 feet deep. It abounds in lake trout which weigh from four to twelve pounds.

Soil—Rocks.—Indian Guide.

The soil of the adjacent ridges and meadows, or rather woodlands, is rich, warm and deep, supporting a heavy growth of maple and beech. The rock is gniess and without imbedded minerals. We remained at Lewis lake only one night, and then proceeded to Indian lake, a distance of nine miles. From this place our guide was a native of the forest, who with his birch canoe gave us a safe transport through the wilderness for at least one hundred miles, together with our camp equipage, as tents, pork, bread, fish, meat, guns, nets, traps, hammers, and the various objects caught by the way, making, in the whole, a tolerable load for so frail a bark, considering that it must necessarily pass over stones and sandbars and against rocks and logs, and overcome the various obstructions incident to a wild and unfrequented country.

Mountains, Scenery, &c. of Indian Lake.

The neighborhood of Indian lake is mountainous ; the lake itself lies under the eastern face of the same range which bounds the view in the west at Lake-Pleasant. The peaks attain an elevation from fifteen hundred to two thousand feet. The scenery is fine, and such as characterizes a northern region, as forests of deep green pines and spruce, intermixed with the lighter hues of the white birch and poplar ; these when contrasted with the purple skies and reflected from the bosom of some lake, create a scene of unrivalled beauty.

The waters of Lewis lake empty into Jessup's river by a short passage of four miles ; the first mile is rapid, while the remainder of the route to Indian lake is boatable. The rock formation does not change, and it may be remarked, that it is barren of valuable minerals ; this is the case with the same variety of gneiss throughout New-England. Indian lake, though it is quite noted for its fish, is small, being only about three miles in length and half a mile in width. It is of an irregular oblong shape with projecting headlands on the west. It has only one small island from which there is a fine view, and which was sketched on the place, by Mr. Hill for the survey. Its average depth is forty-five feet, though in some places it is seventy-five. The country around this lake is not so favorable for tillage as that in the vicinity of Lewis lake, being more mountainous and broken.

Departure for Cedar River, and discovery of Limestone.

Having made such examinations here as seemed necessary, we left for Cedar river. The first part of our route was down Jessup's river,

by its exit from the lake, which forms a series of rapids for three-fourths of a mile, during which the whole fall amounts to seventy-five feet. We followed the river only two miles, where we reached an Indian trail which leads to Cedar river. Abundance of limestone was observed on the banks as we passed down the stream, which is sufficiently pure for all purposes, though in some places it is charged with augite, hornblende and small crystals of phosphate of lime. After passing the rapids, the stream becomes smooth and quiet, and the adjacent banks resemble artificial meadows; they present, too, a pleasing appearance in consequence of the clusters of the soft maples which have sprung up at different points since a sufficiency of soil has been deposited from the annual flooding of the river. Our course on leaving the river was about northwest, and as was hinted above, followed the Indian trail. It has become obscure in consequence of the desertion of the former occupants of these wilds. Our guide however, though he had passed over it only once in his life, and that eighteen years before, not only found no difficulty in following it, but even, with his canoe on his head, he kept us quite busy to preserve our hailing distance. We soon reached Cedar river, which we found to be about one-fourth less than Jessup's. Where we struck it, it is distant about four miles from Indian river, and this distance it preserves most of its course to the Hudson. The country between the two rivers is low and rather marshy. The rock is gneiss and destitute of interesting minerals. We found on the banks of Cedar river abundance of limestone similar to that on Jessup's river already spoken of. All that is necessary to remark of the geology of the route we had passed over is, that it is the same as at Lake-Pleasant, gneiss, with veins of limestone and hornblende occurring occasionally with a few imbedded garnets.

Leave Cedar River.

After having examined the shores of Cedar river, both above and below our encampment, our guide sought out the trail which leads to a small lake lying in our most direct route, and which was supposed to be distant about six miles. Notwithstanding this comparatively short interval, it required a march of five or six hours to reach it. The trail led us through a tangled thicket and into a low pass in another range of mountains, or rather high hills. The ascent, however, is scarcely perceptible. The soil of course is wet; this is especially the case two-thirds of the way; the remainder is, over a tract of excellent land, covered with heavy timber of beech, maple and yellow birch.

On reaching the lake it was evident from its position, and relation, that it was unknown except to hunters, and without designation or place upon the maps. We therefore called it Lake Maria. It is a beautiful sheet of water with a single island which we named Pine island, and on which we encamped for a few days, while we explored its neighborhood. Northwest from this lake and at the distance of five or six miles is, Mount Emmons. This name I find necessary to adopt in consequence of its having become current, and in use by those who have occasion to pass through the wilderness. The inlet and outlet of this lake is to the west or southwest of Pine island, and in close proximity. The former comes from the direction of the waters of the Racket, the latter by a circuitous route joins Cedar river. On the east and southeast are the mountains we had just passed, and which range towards the outlet of Long lake. The geology of this neighborhood I found similar in all respects to Indian and Lewis lakes and the intervening places.

Break up our Encampment and leave for the Racket waters.

About the middle of June, we left Pine island and proceeded up the inlet. It was called by our guide the *Connetquet*. We were able to ascend it two miles only, where there is a portage of three miles most of the way over low marshy ground. On this portage, however, we came quite unexpectedly on to a fine gravelly ridge, about twenty feet high and fifty base, a ridge which was evidently produced by an ancient lake. Those who are disposed to doubt such a conclusion, may be convinced by observing the effects of waves on sand beaches at the present time. Ridges of this kind are a part of a series of changes to which the superficial parts of the earth have always been subject, and by which its physical features have been more or less altered. Previous to our reaching this gravelly ridge, our Indian Guide became evidently quite thoughtful and sober, and occasionally a guttural ejaculation was heard to escape him, accompanied with an upward look, but he was otherwise quite mute; this led however to some inquiry which resulted in the acknowledgment that the way was not quite clear, and the the truth was, that eighteen years had made so many changes in the tangled thickets and brush of the Canonquet, that even the child of the forest might be confused by them. Still, the native pride was very clearly manifest by his observation, "that it would do for white man to be lost, but never do for Indian." Our affairs of course led to a halt, and our guide very characteristically left us without explaining his designs. After an absence of four hours he returned. It appeared

from his account that he struck immediately for Mount Emmons, which was upon our right at the distance of four or five miles, and which he ascended; from its summit he had seen Racket and Long lakes, and the whole of the valley through which we were to pass; in fine, it all resulted in the discovery that we were *right*, a discovery as important as any other under those circumstances.

On leaving this ridge, on which we had encamped, we again took the Canonquet, which was still of sufficient depth for the canoe and baggage. This we ascended for about two miles farther, when we came to its source in the same marsh in which we had travelled nearly twelve hours. The remainder of the route to the next lake was over firmer ground, but still a very small rise only intervened between the head waters of the Hudson and the Racket in this direction.

Reach the Upper Waters of the Racket.

We soon reached a lake which we supposed was the Ragged lake of one of the hunters, who occasionally came here for the purpose of trapping for martin, but inasmuch as it had not been described or noticed on the maps of this region, we named Lake Janet. The waters of this lake are very clear and its borders indented; its general form is quadrangular. It has eighteen islands. Its eastern shore is the most rocky and broken, while on the southwestern extremity there is some very good land. In consequence of its position and the little disturbance from man, it is a place of resort for the large white and gray gulls during the season of breeding. Its length and breadth is about two miles. Its outlet is at the southern extremity. From this point Mount Emmons bears N. 70° E. and aobut five miles distant. It is joined to another lake by a communication of only two or three rods, in the course of which there is a fall of four or five feet. This lake is only about half the extent of the preceding, and being also undescribed, we conferred the name of Eliza upon it. This communicates with another still, by a short passage, which is five miles in length, and which we called Eckford lake, in honor of the late Henry Eckford, whose enterprise and public spirit are well known to the commercial world, and whose fame as a ship builder is not confined to this side of the Atlantic. These three lakes constitute the Eckford chain of lakes, and are truly the upper waters of the Racket. They lie in a narrow valley which opens to the south. Their shores are mostly bold, being surrounded by gneiss, passing into granite, but without in-

dications of important minerals. Magnetic iron sand, it is true, occurs occasionally upon the shore, but in this instance as in many others, does not prove the existence of beds or veins of iron in the vicinity, inasmuch as it is a common occurrence for particles of iron to be disseminated through the primary rocks, and to be transported along with other disintegrated matter. At the distance of five miles, in a southeasterly direction, is a range of mountains with a northeast and southwest direction. At the base of this chain, are two or three small lakes which we were unable to visit.

Marion River—Peat—Tamarack.

Pursuing our route from Lake Eckford by its outlet, we soon found it so obstructed with logs and rocks that we were obliged to make a portage of half a mile; this brought us to a still and unobstructed passage down a large and navigable river, but quite tortuous. This river connects the Eckford lakes with Racket lake. We estimated its length at about seven miles. We named it Marion river. It passes through a deep marsh which in many places is a quaking bog of an unknown width, and containing an inexhaustible quantity of peat. The most valuable production, however, of this and the adjacent bogs is, the larch or tamarack. It grows here to a large size, perfectly straight. The smaller trees are suitable for spars, while the larger, together with the principal roots are adapted in all respects to form the substantial parts of vessels or boats. This tree, according to an experienced ship builder, Mr. Young of Westport, ranks among the most valuable for this purpose, a fact which the owners of this timber are not fully aware.

After much toil and labor in rowing, in consequence of a strong head wind, we reached the lake at its eastern extremity. This accomplished, our next business was to find the establishment of Beach and Wood situated on some point on the opposite shore. By a fortunate conjecture, our guide struck upon the right course and soon landed on Indian point at the residence of the above named gentlemen. Here we determined to remain till we had thoroughly explored the region. We first took a glance at the neighborhood. We found that Indian Point was situated about midway in the lake between its southern and northern extremities and projecting far into it towards the northeast. It contains four or five hundred acres of excellent land, a warm, rich soil, as it appeared from the fine state of the vegetables which were growing in the garden, and which were in an equal state of forwardness with

the same vegetables growing on Lake Champlain. The view of the lake from this point is also fine, and it is no exaggeration to represent it as equal to any in the northern highlands of New-York. The waters are clear but generally ruffled with the breeze. It is well supplied with lake trout which often weigh twenty pounds. The neighboring forests abound also in deer and other game. Hence it is finely fitted for the temporary residence of those who are troubled with *ennui*, or who wish to escape for a time during the months of July and August from the cares of business or the heat and bustle of the city. To enable the traveller or invalid to make the most of the situation, a supply of light boats are always on hand for fishing and hunting, or for exploring the inlets and neighboring lakes which are connected with the Racket.

Survey of Racket Lake.

The following observations were made at the time of our visit; they may appear tedious and too minute, still, they were recorded and may not be uninteresting to some of the readers of the report.

The lake is in township No. 40, and is State property. It extends almost over the entire township. It is quite irregular in its form, and may properly be divided into two parts, the southern and northern. The former receives the principal tributaries, and in consequence, is much more shallow than the latter. The outlet is from the northern portion. Its depth varies from 20 to 75 feet. Its greatest length from southeast to northwest is full fourteen miles, and it varies from half a mile to six miles in width. The rise of its waters by spring freshets is about thirty inches. In exploring its coasts and islands, headlands and bays, we were taken by our guide, Mr. Wood, to a point opposite Indian Point, upon the east shore, a point called *Sandy Bay Point;* it bears east, distant half mile from the former. Following Sandy Bay Point, we passed a shallow bay, with a long silicious sand beach, and an outlet to a small oval lake, a mile long, with a stream coming into it from the northeast. It is three-fourths of a mile wide. Proceeding along the coast in a southerly direction, we came to Osprey Point, which bears from Indian Point north 30° east. It is so called from its being the breeding place of the Osprey.

Leaving this place, we passed into a deep bay, which sets up in a northeast direction. In this bay the Marion river from the Eckford chain of lakes empties its waters, a river, which, it will be remembered, flows for nearly seven miles through a tamarack swamp, in which there

is an inexhaustible supply of peat, and upon which there is a great amount of valuable tamarack timber. From the centre of this bay, which is three-fourths of a mile wide, Mount-Emmons bears east, distant 23 miles.

The next point or cape is on the south side of this bay, and is called Paddle Point. This is a double headed cape. Its northern head is noted as being the one on which the Aborigines always landed, and on which they placed a paddle to indicate to their comrades the direction in which they had gone. The coast then runs SSE. for three-fourths of a mile, and is only slightly indented. We then came to East Point; from this a bay sets up in an irregularly angled manner easterly, and then northerly, to within a few rods of a spot called Desolation rock, where the Marion river widens into a bay; when the waters are high, it is possible to go with a canoe across into Marion river. Following the course of the coast, which now takes a westerly direction, we passed a white sand beach half a mile long; we then came to the south inlet, a river which comes from the southwest; it is about six rods wide, and from thirty to thirty-five feet deep, for three miles in a direct line. We then meet with falls. Half a mile above the falls it divides into two branches, one coming from the west and the other from the east, and on both branches there is a lake between which the State road passes. The lake on the east side is one mile above the fork. The one on the west side is two wiles above the fork. The land about the last is very good, but on East lake is quite poor. A mile and a half from South Inlet we came to Rush Point, bearing west from the last point.

Double Head Point is the next, and is known by three or four large rocks; it is half a mile from Rush Point; near the northerly part there comes in a small stream from *Twelve Acre Pond.* Crossing Rush bay, which is about a quarter of a mile deep, we reached *Rush Bay Point*, which bears SSE. from the west end of *Wood's Island.* Passing this point, we traversed over to *West Bay*, which is one and a half miles wide, to the opposite point, called *Sand Point.* In the centre of this bay is the *West Inlet.* It is a crooked stream, and boats can ascend four miles by following its course. Like Marion river, it passes through a peat marsh. In a direct line, the distance traversed is not more than two miles. Where the navigation ceases is a portage of a mile and a quarter to the eighth lake, of which we shall soon have occasion to speak.

The west inlet arises from two lakes in a chain, each about a mile square but not more than sixty rods apart. The first of these lakes has a remarkable island in its centre, which is nearly one hundred feet high. Leaving *West Inlet*, we came to a point called *Rock Point*, and a short distance beyond is a low sand spit called *Sand Point*, bearing nearly W. from *Osprey Island*; then succeeds a deep bay, called *North West Bay*, into which there flows a small stream, about three miles long and heading in a swamp. From this inlet the coast takes a northwesterly direction to Indian Point, our place of departure.

Islands in the Southern part of Racket Lake.

Osprey Island, is distant from Osprey Point half a mile; it contains twelve acres, and is of an oval form.

Wood's Island, named after Mr. Wood the hunter, who by exposure to cold several years ago lost both of his legs, still pursues the business of hunting, attends himself to the sable lines, and makes journeys of hundreds of miles without an attendant. It is a mile long east and west, and lies between Paddle Point and West Inlet.

Strawberry Island, of only a few rods in extent, lies west of the preceding.

Pine Island is opposite to the mouth of West Inlet, containing an acre and a half; it is covered with tall pines.

Rock Island is quite small and lies between the last and the mouth of West Inlet.

High Island bears ENE. from Pine Island, is rather elevated and contains about an acre and a half; it is one of the most picturesque islands in the lake. It is underlaid by gneiss, which dips to the north at an angle of 70°. The northern part of the Racket was not explored so minutely as the southern. In fact, in consequence of high wind, we were obliged to lie by the day we intended for this business. It is more regular in its form and deeper than the southern portion, and from which it is separated by a narrow strait. It is the fishing ground during the summer, while the southern is resorted to for this purpose during the winter.

The outlet is at the north, and takes the name of Racket River. A considerable fall exists soon after it takes its exit from the lake. It is six or eight miles above Long Lake. The difference in level between

the two is one hundred and fifty-five feet. Forked lake intervenes between them, and is about twenty-seven feet below the Racket.

I might here go into a detailed account of the features of this section of country, now a wilderness, and speak of its natural resources in connexion with the number and extent of its lakes and rivers, and the almost unparalleled extent of natural batteaux navigation, but as many of those details may be found in the preceding reports, I forbear to state them now. It will be perceived by them that I have accomplished much in making known the true condition and value of this hitherto neglected region, and that much has been accomplished in furtherance of the designs of the friends and projectors of the survey.

Journey to Brown's Settlement.

Having explored the shores of Racket lake, it was next proposed to visit Brown's settlement on the Black river, which, according to the reckoning of Beach and Wood, is distant about 20 or 25 miles. The whole distance the travelling is by water with the exception of a few short carrying places. The journey is accomplished in one day by a diligent plying of oars. The first part of the route is through the western inlet which is a crooked but deep channel; so crooked, that in rowing four miles we gain only two. After ascending the inlet two miles we came to the first portage, which is only a mile and a quarter long, and terminates at the Eighth lake. It is proper to remark here that the route to Brown's settlement from Racket lake, lies through an east and west valley. In this valley is a chain of lakes, eight in number, and all connected together by a short intermediate stream. They are reckoned from west to east. It will be perceived that they constitute the head waters of the Black river. The last or most easterly is within a short distance of the Racket, and may be easily united with it, as the difference of level between the two is not greater, it is supposed, than about six feet.

The eighth lake is about two miles long; on its north shore the traces of a tornado are still manifest which passed over this section of country fifteen years ago. It extended thirty miles east and west, and varied from one-half to two miles wide. The channel between the Seventh and Eighth lake being blocked up by logs, we were obliged to make another portage of one mile.

The seventh lake is two and a half miles long and one mile broad. It has extensive sand beaches composed of comminuted gneiss. The

rocks are gneiss which dip 25° to the northwest. At one place upon the north shore I found rose quartz and tremolite.

The passage between the sixth and seventh lakes is rather narrow and in some places rocky; it is however only about three-fourths of a mile long. The fifth and sixth lakes are quite small. It is between these that we find the only fall of any consequence between the Racket and Brown's settlement. Those falls I estimated at about seventy-five feet. They may be considered as the first step in the descent from the table land on which the waters of the Racket are situated.

The fourth lake is upon State land, in township No. 6. It is six or seven miles long, and upon an average two miles broad. The shores are all sandy and pleasant, though I found in the vicinity much peat, a substance which has become so common and abundant that it has almost ceased to excite interest.

The third and fourth lakes open almost directly into each other; and in fact the dam at Brown's settlement, it is said, raised the water in the fourth lake nearly four feet. There is therefore only one obstruction really existing between the Racket and this settlement.

The third and second lakes are about two miles long. The first is separated from the second by a long sand bar, portions of which must be flooded in the time of high water.

The first lake is small, from which we pass into the middle branch of Moose river. On the south of the first lake at three-fourths of a mile only, is Moose lake. It is four miles long and two and a half miles broad; it lies east and west, and empties its waters into the south branch. The rock at Brown's settlement, and in fact as it appears throughout this region, is gneiss with a northwesterly dip varying in amount from 23° to 70°. Its colour is generally gray, but sometimes reddish. The strike of the bed, about northeast.

The county line between Herkimer and Hamilton passes through the fourth lake. Near this line, and a few miles to the north is an iron ore bed, which, so far as can be judged of from hand specimens, is of a good quality. The idea, however, which commonly prevails, that this region is remarkably rich in iron and other minerals, is not true; and the erection of a forge at this settlement is an instance of folly which it is quite difficult to account for.

The mountains adjacent to the chain of lakes, appear as we pass through them, to have an easterly and westerly direction; this, however, is only apparent. Their true direction I found after an inspection from various points is northeast and southwest, and this apparent direction is produced in part, by a remarkable continuous break, or interruption on this particular line, the line of this east and west valley.

It is an important feature in the country and one which permits a direct and easy passage from the Black river to the waters of the Racket, the centre and heart of this northern wilderness. No one who has passed through this valley doubts the fact that this must be the channel through which to penetrate this important section. Whether the communication is to be by canal, is a matter quite doubtful, notwithstanding, nature has done much to facilitate the plan, and it is undoubtedly feasible. But what is most wanted at present is a substantial road. This may be constructed through a section of fine arable land, which extends from the head of Racket lake, through to Brown's settlement, on the south side of the chain of lakes. The section here referred to, is well timbered with maple and beech.

In relation to the extension of the Black river canal in this direction and which has been contemplated by individuals it will be seen, that there will be required quite an amount of lockage, Racket lake according to the barometrical measurements of last year is 1731 above tide. There is however this consideration, the summit level once surmounted, and there is no section of the State so accessible as the heart of this wilderness. It is penetrated in almost all directions by small rivers and lakes. Hence a ready means of rafting timber into the Racket, and thence through the chain of lakes and down the Black river, or down the Racket to Long lake to an intersection with the contemplated southern line of rail-road from the Champlain to Ogdensburgh. In fact when the table land of the Racket is once gained, a large and important territory is as it were acquired and annexed to the State.

How to gain the table land of the Racket.

To gain the table land of the Racket it will be perceived that there are four routes which intersect each other nearly at right angles in Racket lake. Thus there is the old route of the State road which strikes the south end of the lake and which connects with Lake Pleasant, and then the eastern route which has been rather minutely described, and which was followed by Dr. Dekay and myself. This route

might be extended to the Hudson river, and intersect it near the junction of Cedar or Jessup's river with the Hudson. The rise is entirely gradual on this route.

Again another main route is through Long lake and down the Racket through the Stony creek ponds to its intersection with the contemplated rail-road, or it may go down the Racket river, or else it may pass to the east, and be connected with the Pendleton road. The last route is by the chain of lakes already spoken of, and which is by no means the least important.

It is proper, however, to mention the route up the Oswegatchie, which I explored the second season of the survey. In going up to Cranberry lake we passed within twenty-five or thirty rods of a small lake whose waters flow north into the Racket, but I was unable to obtain any information of its distance.

The resources of this country when thus opened, would consist of lumber of various kinds. I would by no means represent it as rich in minerals; though representations to this effect are not unfrequent, yet the peculiar appearance of the rock does not indicate their existence.

Return to Racket Lake.

From this digression I return to the narrative of our tour through the lakes; and here I would remark, that two of our party, who were volunteers, left us at the settlement, in consequence of fatigue and exposure, and the excessive annoyance from musquitoes and flies. Dr. De Kay and myself returned to the Racket by the chain of lakes, and having completed our designs, left for Long lake, by way of the outlet. The first settlement on Long lake is Mr. Sargeant's, where we remained two or three days. During our stay we visited again Lake Janet, which is distant only five or six miles. The route is southeast, and passes through Lake Elizabeth, a fine sheet of water.

Discovery of Primary Limestone.

On this tour, we discovered abundance of *primary limestone*, on the north and west shores of Lake Janet, a discovery of great importance to the settlements on Long lake, and one which had not been made before in this region. All the chimneys and walls of every description had to be laid in clay. The rock formation at Long lake is gneiss; no change was perceived in this respect until we had passed the falls on Racket river, eight or nine miles below the lake. We then observed

masses of hypersthene rock, containing sahlite, coccolite and hornblende.

During the whole distance down Long lake, Mt. Seward is the most conspicuous object in view. It is not, however, an insulated peak, but a cluster of mountains which, as a whole, presents a very imposing appearance. In one of the lower peaks it is, that there appears a remarkable white spot, which is always distinctly seen when the mountains are not enveloped in fog.

Reference to Preceding Reports.

For a more detailed account of this lake, of the adjacent mountains, and the amount of navigable waters, the reader is referred to the preceding reports, particularly that of 1840. We left the waters of the Racket at the mouth of Stony creek, and proceeded up as far as possible, passing through, in our course, three small lakes at its head, after which there is a fine portage to the Upper Saranac. There is so little difference of level between the Saranac and the Racket river, that no obstacle prevents their junction by a short canal. We then necessarily passed through a portion of the Upper Saranac lake and Round lake, and then into the Lower Saranac, and thence by the way of the river, to Miller's in the town of Franklin, Franklin county.

It will be observed that I have just stated a change in the character of the rocks, a change favorable to the existence of beds or veins of magnetic iron. Accordingly, we find that there exists in this neighborhood a very fine vein, which is upon the land of Mr. Miller, and about three-fourths of a mile west from his house. Another exists still farther in the interior, viz: on Tupper's lake, at the northwest end, on a ridge near its outlet. Having determined to travel on foot to Keene, by way of the Elba iron works, our Indian guide left us.

Aboriginal Names.

Some of the Aboriginal names of the rivers and lakes were obtained from our guide, which are here subjoined:

Racket Lake, *Fobullangamuck*—full of crooks and turns.
Crotched Lake, *Pahmechinbaguck*—water right across us.
Tupper's Lake, *Paskungameh*—a lake going out from the river.
Long Lake, *Weechobadcho-nee-pus*—lake abounding in bass wood.
Racket River, *Maslegui.*
Stony Creek, *Wahpolichan-igan.*
Saranac, *Senhaneenapay.*

The name of our guide is Elijah Benedict, of the Saint Francois, or Paleseegantuck tribe. He resides on Indian lake and is a safe intelligent man, and may be employed by those who have occasion to pass through the wilderness, either for pleasure or business.

Resumption of tracing the lines of demarkation, &c.

Having completed our tour through the wilderness in its greatest length, I resumed the business of tracing out the lines of demarkation between the primary and transition series in the counties of Essex, Clinton, ond Franklin. In addition to this, I deemed it very desirable, if not necessary, that the relation of the New-York rocks should be ascertained in the adjacent parts of Vermont. In these duties I was assisted by my son, who has been in the survey most of the time it has been in progress.

Without stating in particular all the steps of my progress, together with the reasons therefor, I deem it sufficient to say, that I have accomplished in the main, the objects in view, and that I have obtained many important facts relating to the geology of the sections under consideration.

Visit to the Troy Iron Mine.

Sometime during the month of August, I visited the celebrated iron mines in Troy, Vermont. Much had been said by those whom I occasionally met, both of the quantity and quality of this ore. I deemed it therefore of sufficient importance to visit the place, and I take this opportunity to state briefly, the result of my observations.

The ore is the magnetic oxide of the same mineralogical species as that of northern New-York. It is in a vein which traverses serpentine, that variety which is known to our mineralogists as mostly peculiar to the green mountain range, having a lustre more dull and a structure rather coarser than that of St. Lawrence county. Its color is yellowish green and destitute of translucency. The vein of ore is about ten feet wide at the top, or where it appears at the surface of the rock. Its width, however, varies when traced along the top of the ledge on which it runs, so that it nearly, if not entirely, threads out in the course of fifteen or twenty rods to the south. It is also remarkably shifted to the right and left, or rather, to the east and west. It also thins out in its downward direction so as to lose nearly one-third of its thickness in fifteen feet.

If we compare this account with what I have said of metallic veins in serpentine in the report of last year, it will be perceived, that we have here a principle of some importance, if not a principle, at least an interesting fact. It may be premature to generalize and it may not be right to say that all mines in serpentine will soon run out, and their materials be soon exhausted and unproductive; I say no such thing, but the facts that have fallen under my observation thus far, favor such a generalization. I wish to stick to facts, until by their concurrent testimony safe and correct principles shall flow from them spontaneously. These few facts are thrown out to those who are on the point of investing capital in iron mines. It will be evident to all, that the business of mining will be rather retarded than benefited by pursuing and working unproductive mines; hence the necessity of submitting all deposites of ore to the inspection of a competent geologist before expense is incurred. Mining is based on scientific principles, and it is not every one who can dig a ditch who is competent to give an opinion in this matter.

As it regards the propriety of pursuing geological investigations out of the limits of the State of New-York, it is probably sufficient to state, that the projectors of the survey took enlarged views of the subject, and in directing those who were to labor directly in the work, they said, "labor where you can do the most for science, do as much as you can for the establishment of doctrines, and make such applications of them to our own State, as your judgments shall dictate;" such too is the spirit and policy of the present government, if we may judge from their acts and the different kinds of encouragement we constantly receive from their hands.

Stay in Clinton County.

As this report is intended to present the progress of operations in the survey and not a full statement of the geological relations of the rocks, I have very little remaining which I wish to communicate. I spent about three weeks in Clinton county; a period less than I should have been glad, but longer than I at first intended.

Discovery of Gray Encrinal Marble.

The series of rocks occurring in the northern part of this county, are of an interesting character, although they are not extensive. Among them, besides the black marble in the Mohawk limestone, the series embraces a rather beautiful gray marble with reddish spots, similar to that of

Lockport. It cuts and polishes readily, and presents a modest, chaste appearance. Besides this reddish gray marble, this same series embraces the *water limestones*, which it appears to me may become an important rock. Experiments and trials are however wanting to prove the real value of both of these masses.

Flagging Stones.

In the upper portion of the same series of rocks, but in the vicinity of Essex, a very good flagging stone also occurs. It is in fact the Hudson river slate, and forms the shores of the lake for a considerable distance. It is unnecessary to speak of the Potsdam and Keeseville sandstone, except to remark that its general boundaries have been defined in the preceding reports; a more minute examination of this rock enables me to state that its extent is somewhat greater on its southern border than I at first supposed.

For example, I found it upon the Saranac, two miles west or southwest of the glass works in Redford. It also extends up the Salmon river, six miles at least south of Malone. Omitting to notice some irregularities, we may consider it as extending from Keeseville to Hopkinton, and embracing and extending around the primary in a somewhat circular manner. Commencing at Plattsburgh and passing through Ellenburgh, upon the military road, the traveller will scarcely see any other rock on the route to Malone; only a short interruption occurs, and that twelve miles west of Plattsburgh, and another four miles west of Malone. Both of these are produced by spurs from the primary ridges, but which extend but a little distance north of the military road.

To give the reader a general notion of the relations of the Primary and Transition of northern New-York, he may consider the whole from Little-Falls north to the Provincial line, and from Champlain on the east to the St. Lawrence on the west, in the shape of an egg. The central position of this mass is Primary, and the borders on all sides is Transition, surrounding the whole of this central portion. One extreme of the Transition forms the northern slope, embracing in it the towns along the Provincial line, while the towns along the valley of the Mohawk form the southern slope; the Transition along the Champlain forms the eastern, and the Transition of the St. Lawrence the western slope. This view is correct in the general; many minor exceptions of course are found of a limited extent. The dip of the rocks on all these sides corresponds to the slope of the country, leaving out of view again all minor irregularities.

Embraced in this idea is that which considers the whole as an uplift subsequent to the deposition of the transition, and by which their obliquity was given, both as to amount and direction. By this view I do not intend to be understood as asserting the fact, that the central mass of this great Primary portion was thrust through the Transition, for it is by no means proved that the latter ever extended entirely over the former. Yet there can be but little doubt, that their superficial area has been much diminished, as they every where bear marks of attrition, and on their portions adjacent to the Primary, they are much broken and deranged, as well as worn. Again, far to the south their fragments appear every where, forming not only heavy gravel beds above the general level of the country, but they are also found two hundred and forty-seven feet beneath the surface, as at the salt wells at Salina and Syracuse.

Absence of useful Minerals.

Of the useful imbedded minerals in the Transition series of the northern counties, it appears well established that none exist, at least not in sufficient quantities to be objects of value. It is true that some lead and zinc exist in the Trenton limestone, and I have observed the latter the last season in Warren county, yet it does not amount to any thing. The lowest of the Transition, the Potsdam and Keeseville sandstone, is particularly barren. It is, however, to be understood, that in some places, as in St. Lawrence county, the *peroxide of iron*, the specular ore occurs in some of its inferior layers, while the greater portion of the mass is in the Primary beneath. Some of the inferior layers are deeply stained with iron, in Clinton county. In the latter county the matter staining the rock seems to be derived from the broken down Primary, which contained originally the protoxide. One of the geological positions of the peroxide is evidently between the Potsdam sandstone and the Primary, so that it becomes necessary to search for it along the junction of the two systems of rocks.

If these views are correct, beds of ore, similar to the Parrish and Kearney beds, may yet be found in Clinton and Franklin counties. Those who live in the vicinity of those red masses in Chazy, might search successfully, perhaps, in them for the specular oxide; at least, those are the most probable places. In the body, however, of this sandstone, and when it has much thickness, there is not the least probability of finding ore of any description. It is, in fact, one of the most barren rocks in the State.

Enough has probably been said in the preceding reports of this sandstone as a building material, and of the other purposes to which it is adapted. Quarries exist along all the large streams, and in consequence of fractures, seem to be already opened. In fact, it is quite remarkable, that all the rivers in the northern counties run through deep and narrow gorges in this rock, where the edges of the strata are finely exposed. I have already stated the occurrence of a reddish gray marble, and which I discovered this last season; also, the existence of water lime in two geological positions, one in the Calciferous, the other in the Birdseye. These beds of water lime may be readily distinguished from the other layers by their drab color. The softest layers ought always to be selected for burning, for there is more danger of their containing too much silex than too much lime.

Agricultural Remarks.

To speak of the soil of the northern counties may seem unnecessary, inasmuch as it has become rather a common theme of remark, since the agitation of the subjects relating to internal improvements. Though much correct information is spreading in community, still there is yet some necessity of calling the public mind to the valuable farming districts of the north. If we look at soils and climate in the light of adaptations, we shall regard the north as equal, and in some respects superior, to many other portions of the State. What towns produce better than Chateaugay, Malone, Moira, Constable, Bombay, Fort-Covington and Hogansburgh; although they are on the north and northwestern slope, and have a northern exposure? Some portions of those towns are, it is true, quite sandy, and in others the soil has rather too much clay; yet, upon the whole, the mixture of the two is excellent, and forms a remarkably productive soil for grass, wheat, oats, &c.

Water.

Another important consideration is the purity of the water in the northern primary district. Pure water is not a mere negative comfort, it is a positive good. Health, pleasure, elasticity both of mind and body, flow from its use. All the streams, large and small, originate in springs, in silicious soils. It is true that they are sometimes charged with lime. A remarkable instance of this kind, and which furnishes a large deposit of calcareous *tufa*, exists two miles from Chateaugay Four-Corners. Similar formations often exist, yet they are so local as not to affect general considerations.

Mineral Springs.

The most important mineral spring is in Massena. I directed my assistant to visit it, and procure some of the water for examination. This spring is highly charged with gas, principally sulphuretted hydrogen. It contains no iron, if I may judge from the colour and appearance of the saline matter in the waters. It is, however, much resorted to, and according to the testimony of Roswell Bates, M. D. of Fort-Covington, who is authority in such matters, in consequence of having much experience in the use of the waters of the Massena spring, it is very useful in many diseases. It is also pleasantly located, and has convenient accommodations for invalids. Constitutional derangements, arising from disordered functions of the digestive apparatus, diseases of the skin, &c. are among the most common complaints which these waters are known to benefit. The saline matter of this spring was furnished me by Dr. Bates. It is evidently a chloride either of lime or magnesia, or a mixture of both. It is very deliquescent, and is of a pure white, when obtained with care.

ORES OF CLINTON AND FRANKLIN.

The Skinner ore bed is about seven miles from Cadyville, and about three miles north of the Saranac. It requires no farther testimony in its favor than has been given already to the public. It is a very valuable ore. It makes a tough iron, hammers smooth. It is a harder iron than the Arnold, and is more like the iron made from the Cooke vein, near Clintonville. It is in a vein traversing a reddish granite, the general structure of which is coarse; the ore has mixed with it, a greenish mineral resembling phosphate of lime and hornblende. A portion of the ore is black and pure. Other portions are impure and lean, resembling in the mass the gray ore of the Arnold vein. One-third of the lean portion of the vein is earthy matter. It is also mixed with granular hornblende.

Sailly and Averil's. This ore breaks into angular fragments or masses. It is fine grained, intermixed with greenish matter which appears to be pyroxene. It contains pyrites, and the ore is too bright and shining to please the bloomer. It contains at least one-third of its amount of earthy matter. Its matrix is a red granite, composed of large masses of reddish feldspar. In this respect it resembles the matrix of the Skinner ore, and may be considered as a continuation of the same vein.

Conger Ore. Is rather coarse, and black. The recent fracture of the ore is too bright. Some portions are fine and intermixed with decomposed feldspar. It contains also white flint, and some that is of a rusty brown.

DUANE ORES.

Deer River Ore. Is of a resinous lustre, and its masses are intermixed with hornblende. The natural joints are traversed by a thin coating of green earth, or chloritic matter, which is not uncommon in ores of this description. The seams too are often incrusted with a yellowish oxide of iron. Intermixed with the ore is also hypersthene. The vein is also traversed longitudinally with seams of light colored feldspar, especially by that portion containing hornblende. The faces of the crystals of hornblende have a glassy lustre. Its gangue is hornblende and coarsely crystalline, intermixed with large imperfect garnets and some black mica. Hypersthene is mostly wanting.

Duane Bed. It is a mixture partly fine and partly coarse, rather more of the coarse than fine. It is a rich ore. It is mixed with particles of granular greenish white feldspar.

Steel Ore. Like the preceding, is a mixture of fine and coarse ore, more however of the latter. It is characterized by containing more hypersthene, by which it exhibits the lustre of bronze; it is also somewhat irridescent. Some small particles of sulphuret of iron appear in it, but not enough to injure it. Small masses of granular feldspar and minute reddish garnets appear in it. Outside becomes yellowish brown on exposure, probably by the decomposition of the pyrites. The recent fracture presents rather a high lustre combined with that of bronze, some portions fine granular mixed with feldspar, but still exhibits a tendency to crystallization in the mass.

The castings from the "steel ore," as it is termed, have of late acquired considerable celebrity, in consequence of their having been employed for edge tools, and I have considered the subject and the statements of sufficient importance to require from me experiments which should set at rest the questions in regard to them.

If a single edge tool, of any kind, can be made in the mode specified by Mr. Duane, the fact itself is not only interesting but important. It is not, however, necessary for me, in this place, to go into a detailed statement of the results of my experiments, inasmuch as several of

the leading ones have already been communicated to the honorable Assembly in a separate report. I shall only say that they have confirmed the statements of Mr. Duane, and I cannot now perceive any reason why, for many kinds of edge tools, the material is not likely to come into extensive use; we are not to suppose, however, that every article will be equally good; this is not the case with those manufactured from the best of steel; still, no instance of failure has come to my knowledge, when the tool had been properly tempered. It will be understood that I have no occasion to speak of the propriety of terming the ore from which the tools are made, a "natural steel ore," or whether the tools themselves are really steel or pot-metal. I only say that they perform well. I merely state this fact; those who dispute the fact may satisfy themselves by trying the tools.

My views, as they regard the change which the cast metal undergoes to fit it for use, are given in part in the communication just referred to. I shall probably be able to communicate some additional facts hereafter, which will serve to extend the use of this material.

CORRECTIONS.

In the report for 1838 I described a substance under the name of Chiltonite, which I then supposed to be new. Since then, specimens more distinctly crystallized have fallen under my notice, and I am disposed to regard this substance as Prehnite, at least I shall so consider it until it has received a more satisfactory examination. Minerals belonging to the natural family of Kouphone spar are so nearly related and are so much alike, both in external characters and chemical constitution, that they require the most careful examination in order to be clearly distinguished.

While upon this subject, I take this opportunity for stating my dissent from the opinion of Dr. Beck in relation to Eupyrchroite and Rensselaerite, as given in his report for 1840. I consider that the principles of mineralogy require the separation of the two respectively from the species named in his report, viz: the former from phosphate of lime, and the latter from stealite or augite. This, however, is not the proper place for discussion, and I therefore leave the subject without further remark.

In conclusion, I beg leave to remark, that during the last winter, myself and assistant have been engaged in the separation of the speci-

mens collected for the State and colleges, and preparing the latter for distribution whenever they shall be called for. The time of my assistant was, however, taken up about a month after the close of the ordinary duties of the season, by a visit to Franklin county. The particular duties which called him there were but partially fulfilled in consequence of the lateness of the season.

In order to bring my field labors to a close in a manner satisfactory to myself, it will be necessary for me and my assistant to be engaged in the field most of the coming season; at its close, I hope to be able to prepare my final report.

I have the honor to be
Your obedient servant,
E. EMMONS.

Albany, Feb. 1st, 1841.

FIFTH ANNUAL REPORT

Of the Geological Survey of the Third District, by Lardner Vanuxem.

To his Excellency WILLIAM H. SEWARD,

Governor of the State of New-York.

DEAR SIR:

In accordance with the act of the Legislature, requiring generally, the progress annually made in the Geological Survey of the State, the undersigned respectfully presents the Fifth Report of the Third District.

The first part of the season was occupied in examining, conjointly with Mr. Mather, the boundary between the First and the Third Districts. The same rocks being common to the two districts, it was of importance that we should understand each other fully, as to their characters, superposition or order of arrangement, the names given to them, and their location along the common boundary line.

From the close of the first year of the survey to the present time, the want of permanent and suitable rooms for unpacking and arranging the specimens collected, has been no small obstacle to the progress of the survey. Had such existed, each one would have a more detailed, and a more connected knowlege, not only of his own labors, but which is of equal importance, those of his co-associates likewise. In a well arranged cabinet, such as that of the State should, and no doubt will be, a knowledge of its rocks, and their mineral and fossil associates, can as readily be acquired in Albany, as in the fields; but until the cabinet exists, the knowledge which it could give must be sought whence its materials were derived.

A considerable portion of the time was taken up with new explorations, with those also which had been commenced, but not finished; likewise with reviewing past labors, so that the work might be made as

accurate as is practicable for the time given, and to increase the number of specimens, and their goodness or quality, in order that the collection should be characteristic of the rocks of the Third District; and being so, to serve conjointly with the collections made in the other districts, as the type or standard of the immense series of rocks which in New-York, west of the Hudson river, intervene between the primary and the coal; knowing, so far as information has been obtained, that there is no series elsewhere known more complete, not only as respects the number and the variety of its rocks, but its fossil or organic contents likewise.

In our last report, we adverted to the importance of knowing the whole chain of organic matter; for as the world, or system to which we belong, is essentially one of cause and effect, its great Author pronouncing himself affirmatively to be the same yesterday, to-day and for ever; a Being in whom there is no manner of change, it becomes us, living in a world where all things must be significant, dependent one upon another, and to which each day's experience teaches us that knowledge is power, to omit no source whence knowledge and its concomitant, power, can be obtained. The pursuit of science, using this word in its most enlarged sense, eminently distinguishes the modern from all former periods. Its principles are to advance mankind beyond conception, because they are immutable, admitting of universal application, and can have but one origin, namely, the cause of all things.

We are well aware that many good men of all times, entertain the opposite opinion, and look with dread upon the advance of science from misapplication, as the sure road to infidelity and pantheism. This arises in such, from a bias of mind toward what is called our spiritual or metaphysical nature; and hence physics, or the nature of body or of bodies, has but little influence, comparatively, with them. Whilst on the contrary, those generally who pursue science in its restricted sense, seem to believe that should they let go their hold on tangible things, they would have no guide, having little confidence in what are called the imaginative faculties, as a source of knowledge.

Those who fear the progress of science, seem to overlook that they are in opposition to the highest authority to which they can appeal. "For the invisible things of Him, from the creation of the world are clearly seen, being understood by the things that are made;" and according to this canon of metaphysics they are in duty bound to study

the visible things, in order to acquire knowledge of the invisible ones, if not for themselves, to instruct those who can not otherwise acquire or understand them.

Great is the evil which results to mankind by keeping these opposite propensities or classes of mind separate, which ought to be united; and should the survey tend in the least towards that desirable result, the gain to the State and to the world will be infinite, for the ultimate result of their union must be to give unlimited knowledge, power, security and rest.

All this we have written might be deemed a digression, were the plan of the survey not directed as much to scientific investigations as to economical objects; and were the Third District not eminently calculated to lead the mind from effects to causes, and consequently to make known and to develop scientific principles.

By a resolution of the Legislature of the last session, the survey was to be extended to the first day of January, 1842, provided the funds in the hands of the Governor admitted of it; and the final report of each district was then to be presented. This resolve would seem to require either no report like those of the four which have been published should be made, or that the one of this year should be such, as would merely show existence and progress; and in accordance with this latter view, we have made a brief report.

After the completion of the labors of the field for the season, your letter of the 24th November unexpectedly called me to Albany, the object stated being "for the purpose of making an examination of the water recently discovered at the salt springs in Onondaga." Whilst in Albany, further information being received from Mr. Spencer, the superintendent of the salines, it appeared necessary to accompany Dr. Beck to Syracuse, not only for the more effectual examination of the subject matter of your letter, but for other objects of like interest to the State, and which seemed to require to be considered at that time.

The following were the principal objects for which Dr. Beck and myself were required to visit Syracuse.

First. To devise some remedy for the inconvenience attendant upon the recently discovered salt water, when used by those who boil for salt.

Secondly. The necessity of experimenting upon a large scale with a view to the discovering of a method which would insure salt of an uniform good quality from those who manufacture by boiling, which no mode of manufacture or inspection hitherto used, has been able to effect.

Thirdly. The propriety of recommending to the Legislature the carrying out in full the plan suggested by Dr. Beck, and in part commenced by Dr. Wright, in the event of their being no better method, namely: the erecting of large reservoirs for the purpose of furnishing prepared brine to the salt boilers, so as to insure an uniform result.

The first object, that of the water, mentioned in your letter, was from a boring of about 265 feet deep at Syracuse, which had been made the last season by Mr. Spencer, being the deepest hitherto there made by about 100 feet. The strength of the water is the greatest of any yet discovered there, marking 78°; water saturated with brine being 100; the water of the old well being 56°.

Some inconvenience, but trifling in comparison with the advantage, has been experienced in the use of this new water, by those who manufacture with artificial heat or fire, from the salt beginning to form before all the impurities have subsided, owing to the degree of heat being too great to allow sufficient time for the impurities to collect together, and to subside or fall down. There is no remedy for this evil, so long as the present arrangement of kettles exists; the system of blocks, as they are called, requiring that the brine should be freed from its impurities before it is delivered to the manufacturer, or if purified by him, before being let into the kettles to be boiled for salt.

In the manufacture of salt by solar evaporation, the advantages of the new brine in all respects, as might be supposed, are exceedingly great. In the returns of the two establishments at Syracuse for the last season, there is a difference between them of more than 20,000 bushels of salt. Now, both being of like capacity, it was asserted that where the gain was so great, the strong brine was used, whilst the weaker brine was used at the other establishment.

Before the survey, no attempt was made by the State to prepare the brine for the salt-boiler; each manufacturer managed that business for himself. The result not being satisfactory, led Dr. Beck to suggest that the State should undertake the preparation of the brine. His sugges-

tion was at once followed by legislative action, and the purification, upon a moderate scale, was commenced by Dr. Wright, the late superintendent.

The plan was to form reservoirs, sufficient in number and capacity to supply the demand. In these reservoirs the brine was to be collected and agitated with a given quantity of caustic lime, and then a sufficient time allowed for repose before being used, so that the impurities might subside to the bottom. This, in all respects, is the same plan used by the salt-boilers, the advantage gained by the State preparing the brine, being that the quantity of lime would be uniform, and the time of settling likewise, both of which circumstances were but little attended to by the manufacturer.

To this plan there are two objections, one of which is merely relative to the monctary state of our country, and were that settled, would not be a valid one. According to Mr. Spencer, it would require an expenditure which would absorb the whole revenue of one year which the State derives from the salines, to carry the plan fully into effect, so that the supply of prepared brine should be equal to the demand.

The second objection is the use of lime, being in theory opposed to chemical experience, which admits of nothing foreign in its operations that can be dispensed with. Though lime appears to answer the purpose, being in general use with the boilers of salt at Onondaga, yet as it is wholly dispensed with in the operation by solar evaporation, and by which the purest salt is obtained, its use is not necessary, only and merely so far as experience extends where raw brine is used, and evaporation is carried on as rapidly as heat can dissipate the water, which holds the salt in solution. According to the effects observed by solar evaporation, it would appear, that were a gentle heat to be applied in the first instance, the impurities would fall before the salt would form, and such should be the mode of conducting the operation.

There is another plan, and which has not yet been tried in the United States: this is the graduating house. It is used at many of the salines of the continent of Europe, and with good success, and is probably superior to any method yet devised, being simple, expeditious, and for the object required at the salines of the State, must be efficacious, and merits that at least a trial should be made, or that it should be well considered before the other plan be finally adopted.

The graduating house consists, in few words, of a reservoir of ample capacity, whose length is greater than its breadth. This reservoir forms the base of the building. Upon the top of the reservoir, are two rows or piles of fagots arranged parallel to each other, and in the direction of the length of the reservoir, and rising to the height of about thirty feet, more or less. On the top of each pile of fagots, and extending their whole length, is a trough full of small holes, into which the brine is pumped. The whole is covered with a roof to protect it from the weather, but the sides are left open, so as to be fully exposed to the air.

The brine in falling upon the fagots through the holes in the trough, gradually finds its way into the reservoir beneath, not only in a more concentrated state, but having parted with its oxide of iron, its carbonate of lime and its gypsum, should circumstances be favorable, these materials depositing themselves upon the fagots, which in time become encrusted with them.

Substances that are held in solution, separate in the order of their insolubility, using this term as it is applied in a relative sense. Thus, when oxide of iron, carbonate of lime, gypsum and common salt are in solution, the order here enumerated will be the order of their separation. Iron first, salt last. To effect a separation, there is no power so efficient as crystallization, and by no known process could so many of the conditions of this agent or power be obtained, or so cheaply, as by the graduating house. An extended surface is given to the water which is made to cover the whole body of the fagots, and falling from one to another, presents a division the most favorable for evaporation, which is very rapid when a dry breeze prevails. Secondly, exposure to air and light, are likewise conditions of crystallization, and a rough surface for its particles to adhere to, is an important element; the whole combined invariably quickening the process.

In Europe, the graduating house is used more for the purpose of cencentrating the brine on account of the scarcity of fuel, than for getting rid of the impurities for which lime is resorted to here, though it answers the two-fold purpose, and in both respects would be useful at the salines.

It must be obvious, that as our report is not intended to show how a graduating house should be constructed, no mention is therefore made

of the use of two rows of fagots, nor what other conditions are necessary, in order to obtain all the advantages which the system presents; our object simply is, to give an idea of it, hoping that a trial of it may be made.

Should some cheap and effectual mode be adopted for ridding the brine of its impurities before it is delivered to the salt boilers, it must materially diminish the expense of its manufacture, because the kettles will be less liable to injury, there will not be that loss of time which now takes place in cleaning the kettles, which must be done every six or ten days; and from having clean kettles there will be less loss of heat.

The salines are of no small importance to the State. The average number of bushels made for the last two years being about 2,700,000. And from the short period which the boiling establishments generally were in operation this last season, it is certain that more than double that number of bushels, with the fixtures now in use, might annually be made. In proportion to the quantity of salt made, so would be its cheapness; in proportion to its cheapness, would be the increased number of uses to which it would be applied; and from supplying the wants of what now may be called a limited section of country, it could be made to supply the wants of an extensive one, and if desired, to compete in the Atlantic waters with the foreign article.

It does not seem right or proper to dismiss the subject of the salines, without venturing a few observations, which we hope may lead to favorable results, and which we must regard as being within our province, since it is obvious, that if those who are engaged in the Geological Survey are in duty bound to give their time and attention to the interest which the State has in the salines, the limit of their duty is not defined, and whatever departure they make from it, must be attributed to that circumstance.

In the organization of the superintendency, we should infer from the call made upon those engaged in the survey and from other circumstances, that the duty of the State extended no farther than to furnish brine; to collect the duty or revenue; and to inspect the salt made; but in no wise was its attention to be directly given to the insuring of an abundant supply of good and of cheap salt, though the consumers within the State, were the owners of the property. It would seem that it was

taken for granted, that if the State furnished the water, that individual competition would insure by means of inspection merely, salt of the desirable quality, and at the lowest price for which it could be manufactured. Should such have been the expectation of those to whom the trust was confided, experience has fully proved that they have not been realized; and that to gain these objects, some alteration is required to be made in the organization of that department. Whatever may have been the original intention of the State, it appears certain, that the purification of the brine is now to form a part of the duty of the State; and that which we would have recommended, if called upon in the beginning, we now recommend.

In order that improvements may be made in the manufacture of salt, it is requisite that either the superintendent or a coadjutor should be well acquainted with chemistry, both in its theory and practice. The former enabling him to take advantage of all hints or lights which the operations going on at the salines admit, as well as to avail himself of the experience and communications of others elsewhere; and having a knowledge of the practice, he would be enabled to experiment, and to apply whatever information he might acquire, to the improvement of the department entrusted to him. Where the required chemical knowledge exists, combined with readiness of observation and an aptness to apply, there would be no difficulty in perfecting that part of the business.

The other part, that of furnishing salt at the lowest price for which it can be produced or should be sold, we should pass over entirely, had we not been directly required to attend to the interests of the State; and if facts obtained there and elsewhere, had not in an especial manner called our attention to it, and convinced us that sooner or later the subject must receive a thorough investigation by the people, both in their individual and sovereign capacity.

Where power comes directly from the many, as in the United States, government in its theory is but the action of the people collectively, doing those things which the people cannot do for themselves as individuals. Government must do those things for the people which the people, advantageously, cannot do; but it must not do those things which the people advantageously can do. These principles, no doubt, are founded upon the circumstance that man is a progressive being, as to improvement, the limit of his progression, perfection, for short of

that there is no stopping place, and the means of attaining that state are individual and collective, the latter to diminish constantly in influence as the individual improves in his condition.

From the fact that there is always a tendency in the few, where the gain is great, to combine against the many, it is the duty of the many, in a two-fold point of view, to anticipate such combinations if possible, or to do them away when formed, if practicable. We are induced to make these remarks from the condition in which the salines in the United States are now placed, being few in number east of the Mississippi, and too far in the interior to be affected by foreign competition, they with scarcely if any exception, are now a monopoly; and, if report speaks truly, they neither make salt of the best quality, nor do they sell it at a reasonable price. Thus, for example, we are informed that were a moderate reduction of duty and toll on the Erie canal to be made upon the New-York salt, even with the recent restriction upon it, that notwithstanding the distance which the article has to be transported, it could compete, at this time on the Ohio, with the Kiskiminitas and Kenahwa salt, from Cincinnati downwards. The maxim of political economy, that where a business is left free to individual competition, the best results as to quality and cheapness are obtained, does not apply to the salines of the United States. It is in the same category with *laissez nous faire*, or let us alone, as commonly translated, being of application only where legislative interference takes place, the nature of the business being such that no combinations could exist, excepting those of the many against the few, and these are difficult to form, and were they to exist, would be of little evil, since the greater good of the greater number is sound doctrine, equivalent to our political maxim, that the majority should govern; the obvious providence being, that an enlightened, elevated and benevolent many, and such might possibly be, for it can be, could readily and permanently elevate the few, but the few never have, or ever can, permanently elevate the many.

Great will be the gain when that time arrives that the people can manage all these undertakings with advantage which benefit the many, for as the smaller the capital or credit the greater must be the per centage profit, the dearer must be the article or thing produced. And the greater the capital or credit, the less the per centage profit, the cheaper must be the article, and hence it is obvious, that the few cannot contend with the many, and what the people will do, when enlightened and united, will be done at the lowest possible rate.

The subject of procuring salt at the cheapest price at which it should be sold, would not have been attempted but from the circumstance of the people being the owners of the salines; from the State furnishing, first the brine in a crude or raw state; secondly, commencing to purify the brine before delivery to the manufacturer, requiring but one step more, that of manufacturing the salt, in order to complete the whole business.

The question may well be asked, can this step be wrong? either as to principle or expediency, should the others be right, since it is but the next in order being in fact but their consequence. Or can they all be wrong? since were the whole to be abandoned to what is called individual enterprise, the result would be a combination of the few against the interests of the many, sacrificing the greater good of the greater number.

For this evil, and for many others now pressing upon the people, there seems to be no remedy, so long as the basis of our political systems is restricted to liberty and equality of rights in the eye of the law. These, like all other principles, are limited, capable merely of advancing us to a certain point with harmony and unity, but beyond that point have no power. To that point we seem to have attained, but from the state of progression in which the world now is, before many years new elements must be engrafted upon our political systems, and these, like all future changes, must be under the guidance of science in its enlarged sense.

Before closing our report, we would again call attention to the recently discovered strong brine at Syracuse, an object of no small importance to the State—to the salt-boiler from the saving of fuel, and to the manufacturer by solar evaporation from the saving of time; the gain in strength being 22° over that of the other wells. This boring is 100 feet deeper than any hitherto made at Syracuse, and is still in the alluvial, giving now a known depth of 265 feet for the ancient Onondaga valley. What the real depth of that excavation is, cannot well be conjectured, though it must fall short of the bottom of Lake Ontario, for that lake must have received the waters which gave origin to it, being, without doubt, a valley of excavation. It is of no small importance to ascertain its real depth, from the circumstance that the deeper its materials are penetrated the stronger is the water, and the ancient floor or bottom of the valley must yield the strongest yet obtained, from the loose or permeable nature of the materials with which it is filled—from the heavi-

est brine sinking to the bottom, and from the diminishing influence of surface waters.

The materials which fill this excavation from all the borings and wells which have been made in it, show that they consist of sand, gravel and other rolled stones, being chiefly round fragments of the dark colored limestone, which crops out about nine miles north of Syracuse and which passes under the red shale, in which, at all the salines, the excavation was made; also, of the red sandstone which borders Lake Ontario—the gray sandstone which underlies the red, the same which forms the High falls of Salmon river, in Oswego county, and likewise fragments of primary rock, either of Canada or the northeastern part of New-York.

From the red shale being more than 500 feet thick at Salina, which the deep boring of 1839 made known, and from the depth of Lake Ontario, the depth of the ancient valley of Onondaga is not so extraordinary.

LARDNER VANUXEM,
State Geologist.
EZRA S. CARR, *Assistant.*

FIFTH ANNUAL REPORT

Of the Fourth Geological District, by James Hall.

To His Excellency WILLIAM H. SEWARD,
Governor of the State of New-York.

SIR—

In accordance with the act of the Legislature of May 8, 1840, extending the time for the completion of the Geological Survey, to January 1st, 1842, I herewith submit the Fifth Annual Report of the Fourth Geological District.

The survey has been prosecuted in this district, without interruption, from the early part of May to November. A portion of this time has been given to revisiting several localities of importance, in order to settle some points which are not so clear in other places; but the principal part of the season has been devoted to Erie and Chautauque counties. This length of time seemed required here for several reasons. The situation of these counties on Lake Erie shore, and particularly that portion about Buffalo, renders every thing of mineral or agricultural wealth available more readily than in some of the others counties in the same range east. The shore of the lake, also, affords better opportunities of examining strata than any place west of Genesee river, thus rendering it desirable to make the most minute examination.

I have before said that all the rocks of the Fourth District bear evidence of thinning out in a westerly direction, but from the limited exposures it was impossible to say, with any degree of accuracy at what rate this diminution proceeded.

From recent examinations I have ascertained the thickness of the most important masses, and these when compared with the thickness farther east will show that the conclusion was correct. There is probably not one rock which maintains a uniform thickness over a space

of twenty miles, and when we undertake to rate the mineral wealth of a region from the examination of one or two localities, it becomes evident that we shall fall into error.

From the mouth of the Niagara river along its course, and thence along the shore of Lake Erie to the Pennsylvania line, we have a grand natural section exhibiting nearly all the rocks yet enumerated in the Fourth District. This section exhibits the superposition of the different masses in perpendicular cliffs from ten and twenty to three hundred feet high. It is evident that this section projected on a uniform scale and accurately drawn will be far more satisfactory, regarding order and extent of rocks, than all the ideal ones which can be presented. With this view I have spent much time and labor to render it as accurate as possible. This, however, with all the other illustrations, is reserved for the final report.

ERIE COUNTY.

My examinations commenced in the northern part of this county, with the lowest mass, which is the Onondaga saliferous group, succeeded by the hydraulic limestone, the Onondaga limestone, the limestone with hornstone, and the middle portions of the county are occupied by the shales of the Marcellus, Ludlowville and Moscow groups. The southern portions present the upper shales and sandstones as high as the Portage mass; all those above the Moscow shale are nearly destitute of fossils except some fucoides.

These rocks have been described in previous reports, and therefore it is unnecessary to dwell upon them here, further than to point out their limits, and other matters of more immediate interest.

The Onondaga saliferous group occupies all that low ground on the north of the limestone terrace, which is generally designated Tonawanda swamp. The greater part of this portion of country is, however, very far from being a swamp, and at present the term may be applied only to that portion bordering the creek. Even here too, its necessary condition is not a swamp, but requires only proper drainage to convert it into excellent agricultural land.

From the ancient condition of this part of the county, and the deep deposit of alluvial matter, the rocks appear but in a few places, and these only for a small extent. The principal place is in the bed of a stream on the farm of Mr. Martin, in the north part of Clarence.

The rock seen here is that portion containing fine cavities of the size of flax seeds, often running together, forming linear ones; and in a few cases, the hopper shaped cavities were observed, though the rock is usually quite solid and firm. Where the rock is not exposed, these cavities are filled with plaster. The portion of the mass here exposed is concretionary, or presents a structure as if force had been applied to it before hardening, and thus curvatures, contortions, &c. are produced. No plaster, or even any evidence of it, appears at this place; the mass in question, however, is apparently that which has before been found, separating the upper from the next successive course of gypsum beds. It is marked upon the exposed surface, as if hacked with an axe.

The shaly and marly portions of the group are met with in digging wells, generally from 10 to 20 feet below the surface; in some places they are not found at all, and it becomes quite difficult to obtain water at the ordinary depth of wells.

Approaching the foot of the terrace, springs are numerous and water easily obtained. From this fact we perceive, that a search for plaster, however successful as to the discovery, would be of little benefit, owing to the great depth below the surface, which would not allow of its being raised at the present prices. That the plaster exists there can be no reasonable doubt, for there is nothing in the character of the rocks or of the plaster in the western part of Genesee county, which indicates that it disappears farther west. Plaster is also obtained on the Grand river in Upper Canada, 40 miles west of the Niagara. A great portion at least of the intermediate space between the two rivers, is in a similar condition to the country along the Tonawanda creek.

Thus far no excavations have been made in search of plaster; and in digging wells I am not aware that it has been seen. Neither is it probable that such would be the case; for I am informed that soon after coming to the rock water is found, and the object of search thus obtained, nothing else is thought of. Should the value of plaster increase with the exhaustion of the beds farther east, we may then expect that search will be made for it in this region; and when the price is such as to repay its being raised from 15 to 30 feet below the surface, we shall in all probability find a sufficient supply in this county for a long period.

I would not be understood to favor the idea that as great a quantity will be found in this region as in places where the alluvial agency has

been less powerful, and where the rocks are less removed; for in most cases where these masses have been undisturbed, we find the successive series of beds occupying a portion near the surface. Now if the alluvial agency has been so great as to remove these beds, we shall find them continuous at a greater depth and further south, passing under the superior limestone much sooner than in other cases, and thus rendering it more difficult and expensive of extraction. From the present condition of the plaster beds further east, and the facilities of transportation, it does not seem probable that excavations will be made in search for it in Erie county, for many years to come. It is possible however, that there are points, where the rocks with plaster approach nearer the surface, and may be sufficiently near to allow of extracting the plaster at present prices. I offer this suggestion, that every one may be prepared to observe; for I have already established the fact, that the portion of level country north of the limestone terrace is occupied by the formation containing gypsum or plaster. The indications of plaster, those elevations or hillocks raised above the general surface, which occur further east, are mostly concealed by alluvium along this valley. These appearances occur where the superficial soil is thin; and though their presence may always indicate plaster beneath, their non-occurrence does not prove the plaster to be absent, for the soil may be so deep as to prevent any of those apparent elevations and depressions.

This subject leads directly to an answer to the inquiries which are frequently made regarding the formation of plaster; whether it be now forming beneath the surface, or if it be deposited from water, particularly sulphur springs. To the latter we may say, that although plaster results in minute quantities from the decomposition of pyrites and the union of the sulphuric acid with lime in the higher rocks; still, in no known localities is it formed in large quantities from this source, neither is it deposited from sulphur springs; these waters resulting from the decomposition of pyrites without relation to sulphate of lime or plaster. Sulphur springs too occur throughout the rocks of N. Y.; yet all the workable plaster is confined to one rock; and although the great sulphur springs of the district occur just above the plaster, still they are the result in part of the arrangement of matter which produced the plaster, but not in any way giving rise to it. The other consideration regards the appearance of the surface, and it is asserted that the inequalities indicating the presence of plaster take place or come into existence long after the settlement and clearing of the country; and

that numerous instances are known where buildings, erected in such places have been deranged or partly thrown down by the rising of the plaster, forcing up the rock, and thus elevating one side of the structure. I have before given these assertions without comment. It appears to me however that the cause of the disturbance of structures erected over these masses of gypsum is not that some parts are elevated, but that others are depressed. This may be explained in the following manner. The plaster occurs in spherical masses, and when the rocks are hard above, it presents them broken up and inclining on every side. These masses occur in irregular succession; the strata above the plaster sloping down to the depressions between. The original deposit of alluvium might have left the whole covered evenly, and while the country was wooded the inequalities may not have been made apparent; but after clearing, the drainage would take place along these lowest depressions, the water being thrown there from the sloping strata. Now the consequence of this has been to remove more soil along these depressions of the strata, which has been carried into the fissures beneath and otherwise disposed of, and the true contour of the strata distinctly seen. That the formation of plaster, which required solution should be going on in the rocks at present, is an absurd supposition. Its formation took place at the time of the deposition of the other rocks, and its tendency to crystallization caused it to assume the spheroidal form. In cases where the rocks around it had not become hard, no resistance was offered to the aggregation of the plaster; where on the other hand the rocks above had hardened, the crystallization of the plaster forced up the mass, exhibiting the appearance, so common in the plaster region. In many localities however, as at Seneca-Falls, there is scarcely any sensible uplifting of the strata above; though the masses of plaster are very large.

The surface of the country north of the terrace is level, or greatly undulating, the inequalities are caused by the accumulation of gravel or sandy loam, the latter often covering gravel. The soil for the most part is loamy, of a yellowish or brownish colour, a few inches of the surface is usually blackened by vegetable matter; sometimes the loam becomes stiff, from admixture of clay, and at other times it is mixed with fine gravel. In the lowest grounds the soil is clayey, often a stiff white or bluish-white clay, frequently stained with iron, at the depth of six or eight inches. On this kind of soil we find evergreens. The clay or soil in such cases, seems to have been deprived of its colouring

matter, which iron, by the percolation of water through the carbonaceous matter above. This solution and removal of the iron by the carbonated water, gives rise to the small beds of bog ore, so frequent in this valley. Where the rock is near the surface, or the soil contains much lime, this also is dissolved, and we have a deposit of tufa, charged with iron ore. Several of these beds have been met with, and one of them, north of Clarence Hollow, was formerly supposed to be valuable. There is not, however, sufficient iron to be of any importance, and the tufa is of no other use than for burning into lime.

From the generally even surface of this tract, we find numerous swamps, of small extent; in these are valuable deposits of muck, which will always be available as a fertilizer of the soil, more particularly the clayey portions, which require vegetable matter to render them lighter and easily worked, as well as more productive.

Hydraulic Limestone.

This rock follows the course of the terrace, lying at its base, or outcropping along the northern slope. It is characterized here, as elsewhere, by numerous and copious sulphur springs. These are generally to be found near the base of the terrace, or within a mile to the north. Near the eastern edge of the county, this limestone is developed in its entire thickness, at the falls on Murder creek.

The upper portions are extensively quarried and burned for cement. It possesses all the essential characters of that from Onondaga and Williamsville. The quarries are worked by Delano & Barney, who burn about 200 to 300 barrels per week, from two kilns, during the time which they continue the work. The burning of the rock was commenced at this place only last year. The works on the Genesee Valley canal, at Portage, are supplied from this place. The outcrop of the mass may be traced from hence westward, along the slope of the terrace. At Clarence Hollow it has been quarried and used in building.

At Williamsville it is extensively quarried by J. S. King & Co. and burned into water cement. There is made at this place annually from 40,000 to 50,000 bushels, or 10,000 to 12,000 barrels; the ground water lime sells for $1.88 to $2 per barrel. At this place the rock slopes off to the north more gradually than any place farther east, consequently a large space is left for quarrying, without removing any of

the superincumbent mass. About three feet of the upper part are un fit for burning, being too calcareous; below this there are four feet of good quality, and then a shaly mass of two or three feet thickness below which the rock is fit for cement.

The facilities for quarrying and grinding the cement are here very great, the Ellicott creek descending from the summit of the terrace at this place. Care is required in selecting the rock as it is quarried, thin seams of shaly matter intervening between the thicker masses, which only are fit for cement.

I observed at this place as well as at some others, fine and beautiful implantations of black oxide of manganese on the surface of the layers of this rock, proving the presence at least of this mineral, whether it may or not have any influence upon the quality of the cement. The stream falls over the edge of the hydraulic limestone and exposes the strata to the depth of 30 feet or more.

The next place west of Williamsville where this rock is exposed to any great degree, is in the Conjocety creek, about four miles from Buffalo. Here there are about twenty feet of the rock visible, extending for half a mile north of the road. The upper portions abound with cavities, many of them containing sulphate of strontian, but principally empty, and showing the remains of a small coral (cyathophyllum) which has been partially removed. Below this the mass is quarried for rough building stone, in blocks from four to eight inches thick; thin layers are often quarried for flag-stones or door steps. The rock has all the external characters of the water limestone of Williamsville and Falkirk, and is probably as good for cement.

Between the place just mentioned and Black-Rock, the hydraulic limestone appears in several places; the most prominent however is on the land of Mr. Arms, a mile and a half east of Black-Rock, where large quantities can easily be obtained. The burning of the rock at this place has been heretofore attempted but unsuccessfully. There is no reason however why it may not produce as good cement as any of the localities mentioned; the failure has been owing no doubt, to the manner of burning.

At Black-Rock and the vicinity, the water lime appears in several places. At the quarries near the ferry the rock is visible to a depth of eight feet, underlying the blue limestone. Here, as at other places,

the upper portion of the mass is too calcareous, and it is only the ash colored and striped layers beneath that are fit for use as a cement. The situation at this place is very favorable, but where covered by the other rocks it cannot be profitably brought into use. By pursuing examinations to the northeast of the village the same mass may be found, covered only by the soil, and consequently much more easily obtained.

We might enumerate many other localities where this rock can be seen, but as its course is easily traced it is not necessary to go more into detail. The quality does not differ essentially in the different localities, but the quality of the manufactured article often differs greatly from too much or too little burning.

Two other limestones of different character, every where succeed the hydraulic limestone ; these are, the mass known as the Onondaga limestone, and that containing hornstone. In many places, and for the greater part of the breadth of this county, the Onondaga limestone forms a very thin mass, or the limestone above rests immediately on the Hydraulic limestone. It is owing to the resisting nature of these two limestones, and to the soft nature of the rock on the north, that the terrace is formed, leaving the valley of the Tonewanda excavated from the rocks below. The undulating outline of the terrace is also caused by the greater or less thickness of the limestone. Sometimes we find it jutting out to the north a mile beyond the general line, and again falling below or south of the general direction nearly as far; the latter appearance usually occurs where the terrace is cut through by streams running to the north.

This terrace is not confined to Erie county, and may be traced almost without interruption, at a greater or less height, through the District from Cayuga lake to the Niagara river. It forms the southern boundary of all the plaster beds yet discovered, and there is no possibility of the existance of this mineral, except in very minute quantities to the southward of it. With the southern limit of this terrace terminate all the important limestone beds west of Canandaigua lake.

Should the demand for plaster increase, as has been the case for many years past, hundreds of quarries might be opened along the line of the terrace, from Black-Rock eastward. The absence of water power along this line operates as one objection, but within a few miles of the river it may be transported before grinding. In some places on the

Hudson river steam mills have been erected, and they may be employed to equal advantage and at a cheaper rate in Erie county, the fuel being less expensive.

At Black-Rock there is only from six to fourteen inches of the Onondaga limestone; it is of a grayish color, crystalline, and containing few fossils. This mass has been quarried, producing excellent stone for fine building or underpinning; some of it has been sawn and polished, being sufficiently compact to form a good marble; the colours however are dull. These characters will distinguish it from the mass above, which is from 25 to 30 feet thick, containing abundance of hornstone. It is dark coloured, fine grained, and far less crystalline than the thin mass below. It breaks into irregular masses of all shapes, often with curved surfaces, which present thin layers of black carbonaceous shale, containing Gorgonia and other corals; also, sometimes shells and trilobites. The fossils are almost wholly confined to these thin layers of shale.

It is extensively quarried at Black-Rock for the public piers, breakwaters, &c, and serves a very good purpose where rough stones are required. From its position, and its vicinity to the public works and canal, it becomes invaluable to the State. In its fresh fracture, and particularly when wet it presents an almost black appearance, which has given name to the place.

The usual appearance of this rock where exposed to the weather, as in many places along the terrace, is not observed at Black-Rock. The limestone, dissolved by the rains, leaves the hornstone in projecting irregular angles and nodules, usually encrusted with a yellow or greyish crust, giving this general colour to the whole mass. When freshly broken, however, both the limestone and hornstone present a black colour. The expressive name of "*chawed rock*," is applied to this mass when it lies on the surface, presenting its rough and jagged outline, resembling in some degree a much travelled muddy street, suddenly hardened by frost.

East from Black-Rock, the direction of the turnpike nearly coincides with the line of the limestone terrace; the rock is scarcely seen till we come to the Conjocety creek, where it is found with its usual ragged surface in the bed of the stream. A short distance to the north of the road, the Onondaga mass appears, underlying the "cornitiferous,"

attaining however only a thickness of one or two feet. It is deposited irregularly, in some places being a few inches only in thickness, appearing much as if after deposition, a depression had been scooped out of it by running water previous to the deposition of the "cornitiferous" mass above. From this place as far as Williamsville, the outcropping edge of the limestone is almost constantly in view. The "cornitiferous" portion is largely quarried for use on the McAdam road, and is an excellent material for this purpose, the hornstone, from cracks and fissures, readily falling to pieces by the action of frost, produces a bed of angular fragments little affected by the changes of weather.

Approaching Williamsville, the Onondaga mass thickens, and here we find the first lime kilns. (The "cornitiferous" mass is entirely unfit for burning, owing to the large portion of silicious matter.) It contains its usual accompanying fossils, and also a greenish shaly matter, seen in seams, causing the rock to split in thin courses, and rendering it unfit for fine building stone. A mile east of Williamsville, the mass attains its maximum thickness, which is not more than 25 feet; thence easterly we find it of variable depth, extending beyond Clarence Hollow. East of this place it gradually thins out, and is scarcely visible at the extreme eastern limit of the county.

The "cornitiferous" limestone retains its thickness more permanently, varying but little through the county. Its presence is easily determined by the large, rough masses lying upon the surface, in the immediate vicinity of the outcrop of the strata.

In the western part of the county, there appears above the "cornitiferous" another mass, containing a little hornstone, but compact and fine grained, readily quarrying into thick blocks. It is seen in the bed of the Cayuga creek, at Hitchcock's mills, and also above and below this place; it is quarried on the Batavia road, four and five miles east of Buffalo. Its general appearance resembles the compact portions of the Onondaga, but is less crystalline, and contains different fossils; these, with other characters, distinguish it also from the Seneca limestone. It furnishes a good building stone, of a durable nature, and is also a good material for burning into lime. The same rock approaches the terrace near Williamsville, where it is burned for lime on the land of Mr. Herr.

Fossils.

In the cornitiferous mass at Black-Rock, we find Gorgonia, Calymene, and occasionally an Orthis or Delthyris; farther east it abounds in a species of Cyathophyllum, and other corals, particularly on the farm of Mr. Youngs, near Williamsville. At the latter place, also, the Onondaga mass abounds with fossils, (though at Black-Rock it contains none, except encrinal joints,) Cyathophyllites, Favosites, and other corals, large stems and joints of encrinites, Orthis, Delthyris, &c. The Favosites gothlandica occurs in very large masses, and of a fine white colour; other portions of this coral appear never to have been solidified, and are of an open, porous structure, nearly white, and very friable; these have been excavated by some individuals, in the belief that they were plaster. In some places the quantity obtained from a single mass, is nearly a ton weight. On the same farm large numbers of the Cystophyllum, and other corals, are found. A mile east of Clarence Hollow, the Onondaga mass is filled with fossils, particularly crinoidal stems, which have given to this portion a highly crystalline structure.

Oriskany Sandstone.

Easterly from Clarence Hollow we find fewer fossils. In the town of Newstead a mass of partially decomposed clay and sand, lies between the water lime and Onondaga rock; it is about six inches or a foot thick, highly stained with iron, and exhibiting a partially conglomerated appearance. In this are several peculiar coralline fossils. It occupies the place of the Oriskany sandstone, and is its only representative. The mass above the "cornitiferous," contains a peculiar Strophomena, with several species of Orthis, and Delthyris in abundance.

Lime.

Lime being an important source of income to the inhabitants of Erie county, I have endeavored to present a statistical account of the quantity burned, as far as could be satisfactorily ascertained. I must however remark, that I have found frequently a great aversion among the people, to giving this information;* there are, however, many exceptions, and among these I found every disposition to give the desired information, as well as to facilitate, in other ways, the objects of the survey.

---

* The objection arose from the supposition that they were to be taxed according to the amount of this produce, and for this reason they declined to give the information.

The table below exhibits the quantity of lime burned annually in Erie county, and the situation of the kilns, which indicates the presence of limestone free from hornstone or flint. Buffalo is the principal market for all the lime burned.

Names.	*Relative situation of kilns.*	No. of kilns.	*Average No. of barrels burned annually.*
Smith & Baley,	3 m. E. Buffalo, ...	2	800 to 1000.
Mr. Reid, ...	3 m. W. Williamsville,..	1	1000.
B. & J. Hershey	Williamsville.....	1	None burned recently.
Jno. Hoyle,....	2 m. W. Williamsville,..	1	1000.
A. Younghime,.	1 m. W. Williamsville,..	1	500 to 700.
David Long,...	1 ¾ m. W. Williamsville,..	1	2000.
Mr. Herr, ...	2 m. W. Williamsville,..	2	1000 to 1500.
L. McNeil, ...	3 m. NE. Williamsville,.	3	3000, previous to 1838, since that time 1000 annually.
C. Hershey, ...	¼ m. E. Williamsville, ..	1	500, and previous to 1838, 1000.
I. Hershey,....	½ m. E. Williamsville, ..	1	800.
J. Hutchison,..	¾ m. E. Williamsville,...	1	600.
Geo. Snierly, ..	2 ½ m. NE. Williamsville,	1	200 to 500.
I. S. Youngs, ..	1 m. NE. Williamsville, .	4	5000. This lime maintains a better demand in Buffalo than any other.
Mr. Peck,.....	3 ¾ m. NE. Williamsville,	3	2500 annually, previous to the 3 past years.
Mr. Mets,.....	3 m. NE. Williamsville,.	2	1000.
Mr. Baker, ...	5 m. SE. Williamsville, .	1	750.
Mr. Bomire,...	2 m. SE. Williamsville, .	1	600 to 800.
Mr. Leseur, ...	2 m. SE. Williamsville, .	1	800.
Mr. Bowman,..	3 m. SE. Williamsville, .	1	800 to 1000.
Mr. Erb, ...	3 ½ m. SE. Williamsville,	2	1000.
Mr. Hill,.....	5 m. W. Clarence Hollow	1	800.
Mr. G. Bagley,.	4 ½ m. SW. C. Hollow,.	1	500.
Mr. Parsons, ..	4 m. W. C. Hollow, ...	1	500.
Mr. Wilsie,....	4 m. W. C. Hollow, ...	1	700.
Mr. Bomire, ...	2 ½ m. W. C. Hollow, ..	1	250, for agricul'l purp's
Mr. Wynor, ...	3 ½ m. W. C. Hollow,...	2	850.
Mr. Slason,....	3 m. W. C. Hollow,....	1	250.
Mr. Vincent,...	1 m. W. C. Hollow, ...	1	300.
Mr. Hershey,..	1 m. W. C. Hollow, ...	...	300, none burn'd rec'ly
Mr. Creist, ...	1 m. SW. C. Hollow,...	...	Burns only for Agricultural purposes.

The estimate here given doubtless falls short of the truth, particularly in times of commercial prosperity, as it will be seen that within three years some have diminished the amount one-half and others have ceased burning entirely.

It will be seen that the kilns are nearly all situated between Clarence Hollow on the east and three miles west of Williamsville. It is along this distance that there is a thick mass of limestone free from hornstone, consisting principally of a gray crystalline rock, composed mostly of crinoidal joints, and other coralline remains.

The rocks forming the rapids in the Niagara river, at the outlet of the lake, and the remains of a small island, known as Bird island, are of the limestone which has here been worn down to this depression, producing the channel. It rises again on the Canada shore, pursuing its course westward and forming the northern boundary of the lake for many miles. This place is probably the lowest point in the terrace; at all events the point where the limestone is thinnest, and is the only one where the river could so readily have found a channel. From the occurrence of this limestone along the north side of the lake, and its dip southward, it seems probable that the bed of this lake has never been excavated below it; and that it now forms the floor beneath the deposit of alluvium.

Shales above the Limestone.

The great accumulations of alluvial upon the southern slope of the terrace prevents for the most part the examination of the shales above the limestone. It is only in a few places along the Eleven-Mile creek and the Cayuga creek that they can be seen; and these exposures are very partial, and would lead to little information concerning the rocks did we not know their character at places farther east.

Half a mile east of the village, in Alden, we find the Ludlowville shale exposed for twenty feet thickness, containing however at this place few fossils, but abounding in nodules and concretions. Sometimes these nodules have aggregated about them all the fossils, and the surfaces are covered, while the shale around contains none. North of the creek at this place, the shale approaches the surface and produces a clayey soil; on the south side it is more deeply covered. Half a mile south of the village the encrinal limestone occurs, separating the shale last named from the Moscow, and contains in profusion the charac-

teristic fossils; still further east it occurs in the stream, forming a fall of a few feet, and above it we find the Moscow shale, little developed however.

Following this stream below Alden we trace its course in a deep alluvium, till near the line between Alden and Lancaster, where it covers the limestone which is exposed by the creek and otherwise for a considerable extent. These shales are slightly seen in several places on the Cayuga creek, but the banks almost continuously are of alluvium, from ten to twenty feet depth. The junction of the Little Buffalo with the Cayuga creek exhibits the calcareous mass, which separates the upper Marcellus from the shale above. The lower Marcellus shale is seen at only one place on the Cayuga creek, and here only in the bed of the stream.

On the Seneca creek, and the Cazenovia creek, on the Indian reservation, these shales occur, and here we find them much better developed than elsewhere in the county, except on the lake shore. The lake shore for eight miles above Buffalo exhibits no rocks; the whole country is low and nearly level, constituting what was formerly designated "the swamp." Near the Indian council house on the Cazenovia creek, appears the limestone separating the upper and lower Marcellus shales. It abounds in a Trochus-shaped fossil and in fragments of Orthocera. This is the only place so far as I know where this mass is visible in Erie county.

At Comstock's tavern, eight miles from Buffalo, the shale appears for the first time on the lake shore. It is here entirely destitute of fossils except some imperfect fucoides. It appears to be the upper part of the Marcellus shale, though this is not easily decided, from the want of connexion with the rocks below. From this place the rocks dip generally to the south, with occasional undulations and often slight uplifts which have broken the continuity of the strata for a short distance. There are few fossils in the shale before coming to Davis' tavern, eleven miles from Buffalo; here a thin stratum occurs in the shale, more compact and highly charged with fossils. Fragments of Orthocera are abundant, Bellerophon, three species of spiral univalves, a spinous Atrypa, and several other shells.

Above, the shale becomes more fossiliferous, containing Delthyris, Atrypa, Strophomena, Calymene, &c. These increase in numbers as we ascend, and finally in many places the rock is completely loaded with

them. Between Davis' tavern and Eighteen-Mile creek, the Ludlowville shale is the principal mass. It abounds in fossils, particularly at the mouth of Eighteen-Mile creek. Calymene bufo, Atrypa affinis, and concentrica, with two species of Delthyris, are very abundant. It is here succeeded by the Encrinal limestone, well characterized, and separating this mass from the Moscow shale above. The limestone is here about eighteen inches thick, and in general very compact; it forms a very visible line in the high bank fifty feet above the lake, and gradually declining towards it, disappears one and a quarter miles southwest of Eighteen-Mile creek. It lies strewed upon the beach in large masses, almost covering the sand in many places, having been undermined by the destruction of the shale beneath. The rock is crystalline, composed in great proportion of fragments of fossil bodies, principally encrinites, stems of which are frequently seen of large size. It contains also a large Avicula in great numbers, but from the highly crystalline nature of the shell it is not often obtained, and casts are the only representatives. A peculiar Delthyris and one or two species of Orthis are also found. Scarcely a fossil belonging to the shale above or below occurs in this mass. Its under and frequently its upper surfaces are covered with a thick coating of iron pyrites, which decomposing stains the rock an iron rust color, though being confined to the surface it does not injure its durability. It has been used as building-stone and for lime, and is a good material for both.

The iron pyrites has been wrought, in the belief that it was silver ore, and a company formed for the purpose of carrying on mining operations. The work was commenced by a designing individual, who is said to have produced silver from reducing the pyrites in a crucible. After having sold several shares in the silver mine, he disappeared, and I was told had been subsequently engaged in similar mining operations elsewhere.

Moscow Shale.

This shale is seen in one or two places in the eastern part of the county, but very imperfectly in any place till we come to the lake shore. Its first appearance on the lake is in a high bank, about twelve miles from Buffalo, it also is seen at Eighteen-Mile creek, the space between being too low to admit of its appearance. In both these places it succeeds the encrinal limestone which separates it from the shale below. In its general character it resembles the shale below; it decomposes

like it, into a tenaceous clayey mass, and produces when near the surface a clayey soil; this is peculiarly well marked along the road from Comstock's, eight miles from Buffalo, to Eighteen-Mile creek. It is seen in the banks of Eighteen-Mile creek as well as upon the lake shore for one and a half miles above.

This shale is well characterized by its fossils, which are Delthyris distans, D. granulosa, D. undulata, Atrypa prisca, Cryphæus.

The lower part of this shale resting on the encrinal limestone, is completely loaded with a small orthis or Stenoscisma, with one valve very convex and the other flat. This species so abounds, that in some places there is scarcely enough shaly matter to cause the mass to cohere. Atrypa concentrica is rare and cannot be considered as a characteristic fossil.

Calymene bufo and Cryphæus calliteles are occasionally met with. A peculiar species of cystophyllum also occurs in the Moscow, which I have not seen below.

Tully Limestone.

The only representative of the Tully limestone is a layer of argillaceous, often concretionary limestone, about three inches thick, succeeding the Moscow shale.

Upper Black Shale.

This shale succeeds the Moscow, and is found near the limit of the county on the Eleven-Mile creek; it appears also on Cayuga creek, lot 30, town of Wales; again, at Hatch's mill on the Seneca creek, Indian reservation; and also on Cazenovia creek, near Aurora, and is barely visible in many other places in the small streams. It every where presents its usual character of black, slaty shale, and is every where characterized by the presence of Posidonia lirata. Its first appearance on the lake shore is in a high bank, twelve miles from Buffalo, forming about six or eight feet of the upper part of the rock; beyond this it is not seen till after passing Eighteen-Mile creek, where its whole thickness is visible, lying between the Moscow and Cashaqua shale. It disappears beneath the lake, nearly two miles southwest of Eighteen-Mile creek.

Cashaqua Shale.

This name is retained for convenience of reference, and applies to a mass which is persistent throughout the district; though in its eastern extreme it consists of argillaceous sandstones interstratified with shale. In Erie county it is seen in the Cayuga, Little Buffalo, Seneca and Cazenovia creeks; also, in the banks of Eighteen-Mile creek, extending for two miles or more from the lake. Southwest of the mouth of Eighteen-Mile creek it appears in the high bank, exhibiting its whole thickness. It is of a greenish color, embracing numerous courses of irregular, flattened concretions, consisting of clay and sand with some carbonate of lime. These masses are the only representatives of the continuous layers of calcareous and argillaceous sandstone, which occur further east. The only fossil, except fucoides, found in this mass, on Lake Erie, is a small Atrypa or Orthis. This shale forms a very tenacious, clayey soil, as is well seen after ascending the hill beyond Eighteen-Mile creek, where the soil is almost entirely formed from this rock. It disappears near Lay's tavern, three miles southwest of Eighteen-Mile creek. Immediately succeeding this mass, or more properly perhaps, interstratified with it, occur about twenty-five feet thickness of black shale, abounding in large septaria, and above it, eight feet of green shale with flattened concretions, having altogether the appearance of the green mass below the black, and doubtless part of the same, essentially as to time and composition.

Gardeau Group.

Above the Cashaqua, we find black and dark colored shales, and to these succeed alternations of dark, green and black shales, the green portions often predominating for miles, and the whole extending beyond the county line. These are all destitute of fossils except occasional traces of fucoides. The characteristic fucoides of the Gardeau are not found on the lake shore in Erie county, but on the higher grounds which exhibit the upper part of the group these fossils are abundant. The greater portion of this group may be seen in following up the Little Buffalo, Seneca, and Cazenovia creeks and their tributaries. The layers of sandstone are thin and afford good flagging stones, they are also used for other purposes. This group occupies all the lower portions of the hills and moderately elevated grounds in the southern part of the county. It can be seen to advantage at Griffin's mills three miles south of Aurora. Several of the thin layers of sandstone alternating with shale are seen in a small stream on the farm of Deacon Enos, a mile east of Aurora.

Several quarries are opened near Boston Centre, where the flagging stones of this group are quarried. The stone occurs from one to six inches thick, and in slabs, separated by joints, of eight feet by six broad, some are fifteen or twenty feet in length.

The following section will give a general idea of the strata where these thin flag-stones occur.

	Thickness. Feet.	
1	20	A sloping bank of loamy soil.
2	2½	Shale.
3	1	Sandstone.
4	6	Shale.
5	8 inches,	Sandstone.
6	4	Shale.
7	6 inches,	Sandstone.
8	1	Shale.
9		Shale with septaria.

Portage Group.

The rocks of this group occupy the highest grounds of the southern part of Erie county, frequently outcropping on the small streams and ravines. The sandstone of this group is thin compared with the same farther east, and there are but few quarries opened.

About two miles south of Aurora the rocks of this group are quarried by Mr. Treat and Mr. Jones; they are here characterized by a fucoid vertical to the strata. Half a mile east of Griffin's mill the same mass is quarried by the road side.

On lot 22, six miles west of Springville, on Mr. Packs' farm, two quarries have been opened in this rock. There are also two other quarries about one mile north of Springville. The stones from all these are usually thin, though affording good material for ordinary building purposes.

Rocks of this group and the Gardeau occur in the banks of the Cattaraugus creek, and no where in Erie county do we find rocks of any higher series.

The commencement of this group is at the commencement of the ascent south of the Indian reservation. The thicker sandy portions occupy the brow of the hills or most elevated situations, while the whole slopes off to the north in proportion as the hard layers diminish.

Thin flag stones and building stones are obtained from the upper part of this group everywhere in the county south of the Indian reservation.

Soil.

The soil between the top of the limestone terrace and the Indian reservation on the south, is for the most part a gravelly loam, though in many places it possesses different characters; towards the Niagara river, in the lower grounds around Buffalo, the soil is clayey. For some distance east of Buffalo, and particularly near the creek, it is a clayey loam, being adhesive when wet but readily crumbling when dry.

Along the Cayuga creek, in many places, there are deep accumulations of gravel. Whenever the shale approaches the surface it produces a clayey soil; but this is a small proportion of the whole, which is mainly of materials from farther north—limestone, sandstone and argillaceous matter from the saliferous group north of the terrace.

On the north side of the creek, in the towns of Alden and Lancaster, a deep gravel deposit extends for several miles. In its eastern termination it is more loamy, and the soil south of the creek possesses the same character, or becomes clayey.

For the most part, the soil along the outcrop of the black shale, and for a little distance north, is clayey, but this is often concealed by the gravel accumulations. Along the Cayuga creek, and some other streams, we notice this character of soil.

The present stream runs in a narrow channel with a gravelly bottom; from four to ten feet above, a level bottom land spreads out on both sides for a quarter to one mile. This bottom is composed of fine loam, and evidently has resulted from quiet waters, both from its nature and its evenness. The sides of these flats are terminated by banks from fifteen to thirty feet high, sometimes rising gently, at other times abruptly, sloping back more or less gradually. These banks, which appear to be the limit of a former stream, or estuary through which a stream flowed, are of mixed materials, coarse and fine gravel, sand and loam. The general character of the soil of these high banks is gravelly, and its extent on either side of the creek is variable. Sometimes, beyond this there is a second ascent or terrace, particularly

where we come into the region of the rocks above the black shale, and the sides of this are also covered with gravel to a certain height.

Round gravel, however, occurs but sparingly at an elevation much more than two hundred or three hundred feet above Lake Erie. The soil above this level is of a different character, being what is often and very expressively termed, "*flat gravel.*" By this is meant, that fragments of rock contained in the soil, are flat and angular, having never been subjected to rounding.

This kind of soil covers a large portion of the southern half of the county, more exclusively the higher grounds; rounded and worn materials occupy only the valleys of the larger streams, diminishing as we ascend from them. The "flat gravel" consists of the materials of the rocks, in place near, and appears never to have been transported to any great distance. These rocks consist of soft shale, argillaceous and calcareous sandstones, consequently the soil is of the same nature; varying in proportion as the rocks beneath vary, sometimes more sandy and at others more clayey. It may be characterized as a clayey loam, becoming tenaceous when wet but not cohering when dry. The coarse materials consist mostly of argillaceous sandstones in thin angular fragments, and in some places still undecomposed shale. The transported materials in this part of the county are confined to those valleys which are connected with others farther south, and through which the north and south current found an outlet. In this soil there is a much larger proportion of lime, and we find it more productive in certain crops than the higher grounds. In some of the valleys this kind of soil prevails more than in others. The valley of the eastern branch of Cazenovia creek, and the northern branch of Eighteen-Mile creek, have a much greater surface covered with this kind of soil than the others, and we find that these communicate more directly with the Cattaraugus creek at the south.

Along the Cazenovia and Seneca creeks above their junction, there is much gravelly soil, forming an almost level surface for considerable extent. This extends below the junction of these streams on the south side, and is seen in isolated patches, mounds and low ridges, extending to the lake four miles west of Buffalo.

The same soil is found along the Cattaraugus creek, and at about the same elevation above the lake; it also occurs in less extent in several other places, and is characterized by a growth of oak. It is evi-

dently a deposit from coarse materials brought into the lake by streams, and by the action of its waters, spread evenly over the bottom. The same features to a small extent are now to be seen on the shores of the present lake, where a large stream flows into it.

CHAUTAUQUE COUNTY.

The general face of the country in this county resembles that of all the southern counties in the district. It differs in some degree however in its soil, which is of a loamy character in a greater proportion than many others. The hills, although of the same nature, are less elevated, either from the general elevation having originally been less, or that the abrading action has been more effective. The latter may perhaps be the cause, as the proportion of hard materials is less than farther east, and there is also evidence that the rocks all grow thinner on going westward, and in Ohio the highest rocks of Chautauque county are little above Lake Erie.

It has been ascertained from surveys, that the highest parts of this county do not attain so great an elevation, by two hundred feet, as some parts of Cattaraugus and Allegany.

The valley of the Conewango on the east side, bounds the county by a depression of five hundred to eight hundred feet lower than the high hills; while on the north, the deep gorge of the Cattaraugus creek is even lower than that of Conewango.

On the northwest side we descend, in the distance of five to eight miles, from an elevation of about two thousand feet above tide water, to Lake Erie, (which is five hundred and sixty feet above the sea,) nearly all the descent being in the first three or four miles. This is a remarkable feature in Chautauque county, and one which can only be accounted for by the abrasion and removal of the materials once filling these spaces. In fact we shall perceive readily that it was commenced when the water was elevated to nearly the height of this portion of country, and that as it gradually subsided it wore away and scooped out its present bed.

Another remarkable feature in Chautauque county is the existence of the lake of the same name, the northern extremity of which is only eight miles distant from Lake Erie and yet empties its waters by the Conewango, Allegany, Ohio and Mississippi into the Atlantic. This lake is sixteen miles long and 1291 feet above tide water, and 726 feet

above Lake Erie. It is a beautiful sheet of water, bounded on its eastern side by gravelly sloping banks, and on the west by more level and in some places marshy shores. The valleys of the streams flowing into the Allegany, are all more than 1200 feet above tide, the valleys and hills range at all points between this height and 2000 feet.

To superficial observation there are few rocks to be seen in Chautauque county, but examinations made along the deep ravines prove the existence of all the great masses further east, and from the destruction of which the soil of the country is produced.

Along the lake shore, from near Cattaraugus creek to the State line, we find the banks are perpendicular bluffs from ten to one hundred feet in height. The green shale alternates with the thicker courses of black, and beyond this the black shale increases in proportion as far as Portland harbor.

Both the green and black shale scontains eptaria, and more rarely, thin sandy layers, which are so numerous in this group constituting the flagstones further east. From Portland harbor to the State line we have similar slaty and crumbling shales, alternating with thick and thin courses of sandstone, all possessing a similar general character. Arriving at the State line we are able to trace the same group in the deep ravines for two or three hundred feet higher before there is any marked change. Throughout the whole extent there are scarcely any fossils except fucoides, and these abound wherever the thin sandy layers occur. At one place only, six miles above Van Buren harbor, do we find shells, and here only a few species.

The whole of this mass occupies a very great thickness, and constitutes what on the Genesee river is divided into the Gardeau and Portage groups, each well characterized and distinct. On Lake Erie shore, however, from the great increase of argillaceous matter and the diminution of sand, the two groups intermingle. The vast extent of shaly matter in the lower part prevents the appearance of the fucoid peculiar to the Gardeau rocks on the Genesee river, which only occur in the sandy layers. The thicker masses of sandstone of Portage have diminished to a few insignificant layers fit for flagstones.

In the ravines at a distance from the lake shore, there are in some places the peculiar characters of the upper part of the Portage group. The sandstone is from one to three feet thick, bearing the vertical fucoides as at places further east.

The shaly portions are best exhibited on Lake Erie shore, from the Cattaraugus creek to Portland harbor; here the sandy layers begin, and by following up the Chautauque creek from this place ,we have a full view of the upper part, and its connexion with the fossiliferous rocks composing the Chemung group.

The same rocks which we find in Chautauque creek, appear in part on the lake shore, above Portland harbor, but we do not find the higher portions before coming to the State line.

All the northern part of the county below the elevation of 1400 feet above tide water, or about 840 above Lake Erie, is underlaid by the shale and thin sandstone of the groups above mentioned. These rocks are distinguished from those above by the absence of all fossils except fucoides, as well as the greater predominance of shale.

In the southern part of the county the rocks of this group are not seen, having passed below the level of the lowest valleys.

All the southern part, as well as the higher portions of the northern part, are occupied by the Chemung group, readily known by the great number of shells of the genera, Leptæna, Orthis, Delthyris, Avicula, &c. which characterize it every where. In this group the proportion of sand increases over that below, and in its upper part the larger proportion is sandstone.

The rocks of this group can be seen to great advantage in the Chautauque creek six miles above Westfield, and in the outlet of Chautauque lake below Jamestown. They can also be examined to some extent above Rice's mill on the Twenty-Mile creek, and in many of the ravines along the Conewango and Cassadaga valleys. The strata are no where seen except in ravines or the banks of streams.

The extreme southern part of the county is comparatively low, rising to less elavation than the middle portions.

Conglomerate.

Many of the hills are capped with conglomerate, which is the highest rock in the county. This has been described in a previous report. It is composed of sand and quartz pebbles; it succeeds the red sandstone where that rock is present, but in its absence rests upon the Chemung group.

The Old Red sandstone (unless this may be considered as a part of the same,) is not found west of the Genesee river, leaving the succeeding grey sandstone and conglomerate as the terminating mass. In many places, in Chautauque, this rock consists of a few loose fragments scattered upon the tops of hills or along the higher depressions having no rock in place. In others it appears in place for a few rods in extent, while all around, the surface is strewn with fragments as if it had extended farther, and being undermined, from the softer nature of the rock below, was left in isolated masses. Indeed there can be little doubt but it was once the surface rock of nearly all the county of Chautauque, but from the excavation of the valleys, the greater portion has been removed. The softer shales beneath are readily acted on by water and the rock above is thus preserved only in a few places.

From the portions remaining, the rock appears to have been originally of variable thickness; in some places not more than five or six feet, and in others fifty or sixty.

Where the rock is free from pebbles, it is known by being more friable than any of the sandstones below; and also by the lines of deposition being at varying angles, as if acted upon by currents from different directions. In such cases it forms a good building or underpinning stone, easily dressed, and readily obtained in blocks of large dimensions. It is in fact almost the only stone in the southern part of the county which can be obtained more than a few inches in thickness.

The principal places where it is quarried are upon the top of a hill about two miles from Ashville. Another quarry four miles north of Panama, and again one mile northwest of this. From these places considerable quantities of the rock have been taken. It is associated with a few inches of the coarse conglomerate.

On the north side of Chautauque lake it occurs on the land of Mr. Young, also on the land of Mr. Barnard and Mr. Preston, passing from Ellington Centre to Cassadaga creek; and again further north, on the land of Mr. Strong, three miles north of Ellery Centre.

In all these places it is found only in loose blocks scattered thickly over the surface for a small extent, and evidently the remains of a continuous stratum.

At Panama the conglomerate occurs upon both sides of the stream between the upper and lower village, and follows the eastern slope of

a hill for more than half a mile. Where I measured it upon the stream it was about sixty feet thick. It lies in huge masses sixty or seventy feet long, by twenty or forty wide and thick, with deep fissures between; sometimes the masses are so arranged that these fissures form caverns, and one place I was shown, is so excluded from sunlight that snow and ice remain during the summer.

These masses diminish in size and frequency towards the south, and soon disappear. The whole appears as a continuous mass, with the exception of the deep fissures separating it into blocks, and has evidently occupied a higher level, having fallen down to its present position from the wearing away of the soft shale which has been removed over considerable surface. The conglomerate in the ravine now rests upon a greenish shale, and by rising to the top of the hill and going a little to the west of where the conglomerate appears on the surface, a similar shale is found on digging a few feet. The mass therefore evidently rests on the sloping face of a hill of green shale of the Chemung group; the higher surfaces of each occupying about the same level.

Four miles northwest of Panama, on the land of Mr. Field, the conglomerate and sandstone are found covering the ground to considerable depth. The whole is composed of fragments, most of them small, which are piled irregularly one above the other, as if rolled down from a higher eminence. The situation is at the foot of a hill upon the western side.

Several miles west of this place, in Clymer, there is a locality of this sandstone, which has formerly been quarried for grindstones, and also for other purposes.

About three miles southeast of Panama on the east side of the valley of the Little Broken Straw, the conglomerate is found on the land of Mr. Lloyd. Still further east, on lot 13, land of Mr. Vosburgh, the sandstone occupies the surface of two or three acres, outcropping on the northern and eastern sides of the hill. In digging a well near the summit of the hill, the same rock was found. It was covered with a layer of "fine beach sand;" the rock beneath was fractured, and the surface worn and smooth.

It is nearly impossible to indicate every point where this rock may be found; those mentioned have been personally examined; other

places probably occur, but as the hills are frequently covered with forests and without road, it becomes a tedious operation to examine every one, particularly as we can not reasonably expect any substance of importance associated with this rock.

The only remaining places to be noticed, are two hills in the southeast corner of the county, on either side of Case Run, which I visited on my way south to Warren. The mass here consists mainly of sandstone, with little conglomerate. It lies scattered over the sides of the hills and upon the tops, in huge blocks, the thickest noticed being about thirty feet. This place is on a range of elevated ground which extends southward between the Allegany river and Conewango creek; the conglomerate and gray sandstone accompanying it, with some interruptions, nearly the whole distance to the point where these two streams meet. Six miles south of the State line, there is a thin bed of coal, apparently resting upon the conglomerate.

Numberless examinations have proved satisfactorily that coal is not to be found beneath the conglomerate as has been supposed by many, and from some of whom urgent solicitations have been made for boring to ascertain the fact. So long as there is confidence to be reposed in the deductions of any science, we may rely upon this one, particularly where the whole succession of rocks is so plainly developed as we find it in New-York.

SOIL.

The soil of Chautauque is principally of two characters. That resulting from the decomposition of the rocks in place, is a clay loam mixed with angular and unworn fragments of the harder portions of the rocks, and known as the "flat gravel." This occupies all the hills and a large portion of the higher ground.

The materials of this soil are coarser as we descend beneath the surface, and below are frequently composed of large angular masses and often boulders of foreign rocks, closely impacted together and forming a mass of variable thickness, lying upon the surface of the rock beneath. Where in such cases the surface of the rock below is level it is scratched and worn smooth, evidently from the materials moved along its surface.

In one place near Portland harbor in opening a quarry a considerable quantity of this kind of material was removed; the larger masses

fit for rough walls were reserved, and the finer thrown into the lake; the quantity thus reserved was sufficient to have covered the whole surface, when packed closely, to the depth of four feet, though the original depth of the whole was only five or six feet.

Numerous similar instances appear in the bluffs of gravel along the lake; the moving force seems to have torn up the surface layers and to have pressed them onward, accumulating in power and quantity, lifting the strata for great distances, bending and breaking the uplifted edges, and leaving them in all manner of contortions, with rounded gravel above and below. In some instances the gravel is forced under the uplifted edge of a stratum to the distance of many feet, and if the gravel were only hardened would appear like a contemporaneous deposition.

The valleys are covered with a soil consisting of fine loam and gravel of rounded materials which has been derived from more northern rocks. Many of the lower valleys have evidently been overflowed with quiet water from which the fine loamy deposits have been made.

Lakes and Valleys.

The small lakes, Bear lake, Cassadaga lake and Mud lake, have once been much more extensive, filling the valleys to greater elevations with water; by successive drainage, they have left marks of their subsidence along the sloping hills around them.

The valleys of the Cassadaga and Conewango creeks have evidently been extensive lakes, as would appear both from the nature of the materials in the bottom of these valleys and from the evidences along the elevated grounds bordering them, as also from the narrow outlets worn through rocky strata.

In the valley of the Chautauque lake we find satisfactory evidence of its former greater elevation in ridges or terraces of gravel and sand; these are particularly well defined upon the north side. On examinations about the outlet, the cause of this greater elevation is found to have been the obstruction of its former outlet which was nearly in an easterly direction to the Cassadaga, whereas now, by the accumulation of large deposits of gravel it is turned in a southerly direction; and only joins the Cassadaga valley by a channel excavated through the solid rock. This direction is seen very clearly by examining its course on

a map, and the effects of the wearing action upon the rocks are still visible at Dexterville below Jamestown.

At the time the original outlet was obstructed, the waters of the lake must have been raised to more than thirty feet above the present level, overflowing for a great distance the low valleys on its western side and its northern extremity, and which exhibit clearly the evidence of such condition from the almost level deposits of fine alluvium which cover them.

MARL AND LIME.

Deposits of marl are less numerous in Chautauque county than in the counties farther east. The largest deposit of this kind is in Cassadaga lake and the marshes which nearly divide it into two portions. This marl has been used for several years for burning into lime, of which 2,000 bushels are annually made. The marl is burned by Mr. Beebe, and is owned by Mr. Wilcox.

In many places recourse is had to large boulders and transported fragments of limestone for burning into lime. One of these masses found near Forrestville yielded one hundred and fifty barrels of lime. A few miles to the southeast of Fredonia a large mass of the water limestone was found, which burned into quick lime of a dark colour. This gave rise to the belief of the existence of the same rock in place in the neighborhood, but it will not be found south of the limestone terrace in Erie county.

GRINDSTONES.

In the southwest corner of the town of Clymer, and within a few rods of the Pennsylvania line, Mr. Beardsley has opened a quarry which affords good grindstones. The rock is of great extent and can be easily quarried for all the supply required. It is of the same mass as that quarried in Freedom in Cattaraugus county, and in Rushford in Allegany county. The same is also to be seen in the western bank of the Little Broken Straw below Panama. It is here characterized by a species of fucoid found also at Freedom and Rushford. This mass is probably extensive in the county, but from the points where rocks are seen, few localities can be named.

FLAGSTONES AND BUILDING STONES.

The rocks occupying the high grounds of the southern part of Erie and the northern part of Chautauque afford excellent flagging stones

some of them of large dimensions. Those about Boston, in Erie county, are commonly eight to ten feet long and ten to twelve broad, and sometimes are obtained of twice these dimensions. Near Westfield, in Chautauque county, these flagging stones are obtained of very large dimensions, often fifteen or twenty feet in length, with a width of ten or twelve. The surfaces of these are rippled in large waves. The same courses of rock are very extensive, and every where furnish this material.

Few of the layers are thick enough to afford good building stone, though there are some quarries of this kind in the Portage group. The principal which I have seen in Chautauque county, are near Forrestville, and about four miles from Fredonia, on the line of the rail-road.

The rocks from the two quarries near the rail-road, have been used in constructing the arches over the streams for the passage of the road, and in the public works at the harbor of Dunkirk.

Quarries have been opened at Shumla on the Canadawa creek, and at Laona on the same stream. The mass at Laona has been noticed by Dr. Beck, and in his report called Laona sandstone. It is somewhat peculiar in character, being much thicker here than the same layer in other parts of the county. The whole is about five feet thick; the upper three feet often forming but a single course, thus affording blocks of large dimensions. It is highly bituminous, and petroleum is seen on the water which rises from the earth in the vicinity of the rock. Going southward this mass becomes much thinner, and at Westfield there is no appearance of it, except in a layer of about one foot thickness, and considerably changed in character.

The Laona sandstone appears to have been deposited in a depression of the strata below, which causes it to grow thinner on either side

About three miles south of Fredonia, there is a quarry of shale and sandstone from which some blocks have been obtained of about a foot in thickness; these are succeeded by shale and thin layers of sandstone. The thickest layer furnished the stone for the pillars of the Johnson House at Fredonia.

The localities enumerated under the head of Conglomerate, afford excellent building stone of any required dimensions. From some of

these places large blocks of stone for pillars, &c. have been taken to Mayville, Dunkirk, and Buffalo.

CARBURETTED HYDROGEN GAS.

Carburetted hydrogen gas is every where common in the higher rocks of New-York, and in Chautauque county is unusually abundant. In many places the escape of this gas is accompanied with petroleum, which forms a pellicle upon the surface of the water, which latter indicates the escape of the gas; in other places the gas rises alone, and in many places there may be seen considerable quantities of petroleum where no gas escapes.

At Laona, petroleum and gas both escape from the surface, and from the rocks and earth beneath the stream; and there are several other localities where the same phenomena may be seen along the outcrop of the sandstone, which is quarried on the line of the rail-road. Near Forrestville there is a copious discharge of this gas, which it is contemplated to convey to the village for the purpose of lighting it.

The village of Fredonia is lighted with this gas, which issues from the shale forming the bed of the stream passing through the place. The quantity collected in a reservoir during the day is sufficient to supply all light required during the night.

It has been frequently remarked that "this gas is supposed to issue from beds of bituminous coal." Now there is no necessary connexion between it and coal, although this gas frequently issues from coal beds and the strata embracing coal; still it is found in many other countries as well as this, issuing from rocks where there is no coal. Its origin is doubtless from vegetable matter, which will be more fully explained at another time; but the quantity is so small as to preclude the possibility of any important deposits of mineral coal. Suggestions or suppositions like the above, come from what source they may, cannot fail to do harm by keeping alive the belief of the existence of coal, and consequently lead individuals to the expenditure of money upon what is worse than useless. These arguments have often been advanced, but still this mistaken notion prevails to some extent.

At Portland harbor the lighthouse is illuminated with gas supplied from a place on the margin of a small stream, near the lake shore, half a mile northeast of the place. The quantity issuing from this

place is so great, that no reservoir is required, and it is suffered to escape during the day, and only a part of the whole is used during the time it is burned. Large quantities of this gas issue from the waters of the lake near the shore for three miles northeast of Portland harbor, and in numerous other places further north and east. At Buffington's well there is a large quantity of this gas constantly issuing from the lake near the shore; apparently sufficient in the space of a few rods to illuminate a city. This product will hereafter be considered of importance as the country becomes more populated, and villages formed in the vicinity of those places where there is at present so large a supply. The same gas is doubtless issuing from the earth in equal quantities where we have no means of detecting it.

It is not necessary at this time to enter into more minute detail regarding the geological character and resources of these counties. Of the different rocks named, and their contained fossils, there have been forty boxes collected from the two counties, and ten boxes from other localities, besides a large number of specimens from Lockport.

The tabular arrangement of strata given at the conclusion of last year's report, is fully borne out by the examinations of the past season, with the exception of the Ithaca group, which cannot in most parts of the district be identified as distinct from the Chemung.

I would beg leave to acknowledge my obligations to Mr. Foster, government agent at Dunkirk harbor, to Mr. Haskin, and Dr. Hayes of Buffalo, to Dr. Lewis of Black-Rock, and Hon. Edmond Hull of Clarence Hollow.

I will also take this opportunity of acknowledging my obligations to —— Brooks, Esq. of Wyoming, Genesee county, to whom I am indebted for many facilities afforded during my examinations in that vicinity.

My obligations are due to the following gentlemen of Lockport, both for aid and information, as well as for additions to the State collection: Mr. G. H. Boughton, Canal Commissioner, Mr. Barrett, engineer, Mr. G. Hadley, Dr. Smith, Dr. Fassett, Mr. Shuler, Mr. Douglass, Mr. McKenster, Mr. Foreman, and also several gentlemen in the engineer department, who have generously furnished specimens of the fossils and minerals of the place.

JAMES HALL,
State Geologist.