REPORT

OF

PROFESSOR GEORGE H. COOK

UPON THE

Geological Survey of New Jersey,

AND

ITS PROGRESS DURING THE YEAR 1863.

TRENTON, N. J.:
PRINTED BY DAVID NAAR, "TRUE AMERICAN" OFFICE.
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READ BEFORE THE SENATE, AND ORDERED TO BE PRINTED.

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REPORT.

The Report which I have the honor to read before this body, is upon the Geological Survey of New Jersey, and its progress during the year 1863.

The account may be divided into two parts. 1st, A sketch of the surveys made previous to 1863. 2d, A report upon the progress of the work during the last year.

The geology and mineralogy of New Jersey, have attracted attention from its earliest settlement. Its ores of iron, copper and zinc have long been objects of laborious and expensive, if not systematic exploration. Iron was made in Morris County shortly after the year 1700, and in Monmouth before 1720. The copper mines of Belleville were discovered in 1719, and those at New Brunswick in 1748. The ores of zinc were discovered very early, but for a long time could not be successfully worked.

Appreciating the importance of an accurate knowledge of the natural resources of the State, the Legislature of 1835, authorized a Geological Survey to be made, and under this authority, Prof. Henry D. Rogers, then of the University of Pennsylvania, and now Professor of Geology in the University of Glasgow, Scotland, was appointed Geologist. He made a partial report upon his work, which was printed in 1836; and then a final report in 1837, which however was not published until 1840. This report was in an octavo volume of three hundred and one pages, and was accompanied by a geological map of the State, and several geological sections. This was a very able report; it sketched in a masterly manner the geological features and did justice in its descriptions to the rich and abundant agricultural and mineralogical resources of the State. For the time and and means expended, this was a most profitable work for New Jersey; and in the highest degree creditable to its distinguished author. At that date, it was undoubtedly the best of the series of reports which had been published upon the geology of the different States of our Union.

With the increasing development of the wealth of New Jersey, there arose a want of fuller and more detailed information in regard to its various soils, rocks, ores, limestones, building materials, fertilizers, and other useful natural products; and in 1854, the Legislature

authorized another and much more extended survey to be made. This survey was placed under the direction of Dr. William Kitchell, as superintendent, and the work of constructing a topographical map of each county in the State, upon a large scale, was immediately commenced. The collection of data for delineating upon the surface of the map the location of various kinds of rock, mines, marl-beds, &c., and for making a full report, was also commenced at the same time.

The progress of the survey in its several departments, during that year, was reported in a volume of one hundred pages, to the Legislature. In 1855, the work was urged forward under the same organization, and a report upon the work was made in a volume of two hundred and forty-eight pages, with many illustrations. The work was continued but with somewhat diminished force through 1856, and a third report upon the progress of the survey was made in a volume of seventy-nine pages, when, owing to a failure of means to carry out the work upon the scale on which it had been projected, it was suspended. The map of the County of Cape May had been engraved and printed. The map of Sussex was nearly all engraved, Monmouth was surveyed and the map drawn ready for the engraver, and several other counties were partly surveyed, when the work upon them was stopped. The geological survey of Cape May was completed and published; the materials for the reports upon Sussex and Monmouth were to a great extent collected, though not written out, and others were in an advanced state of forwardness at that time. Upwards of eighty iron mines were said by Dr. Kitchell, to have been enumerated and described. A large number of chemical analyses had been made, and geological specimens, minerals and fossils, had been accumulated in great quantities. Preparations had been made on an extended scale for a work which, when completed, should be a monument to the enterprise of the State, and a fitting exponent of her unequalled advantages in resources and location. To all concerned in this important State work, either as projectors or prosecutors of the survey, this suspension was a subject of mortification and deep regret. With only a mass of unfinished work, and unarranged materials to show for the great expense incurred, the labor of years seemed thrown away, and all who had been connected with the work were more or less discredited.

Dr. Kitchell, as superintendent, in particular felt that an injury was done to his scientific reputation in thus summarily closing the work in which his highest aspirations had been centered; and despairing of seeing it revived by the authority of the State, he, in 1860, came forward under the auspices of the State Agricultural Society, and offered to complete and publish at his own expense, a geological report and map of the State, and to find his compensation by the sale of the work; asking only the use of the apparatus and material belonging to the State survey. His offer was accepted, and he received the requisite authority. The completion of a State map was immediately undertaken, and by an arrangement with a publisher in

Philadelphia, it was issued the same year. The map is before you, it is an excellent one. Drawn to a scale of two and a half miles to one inch, it is large enough to show all the roads in the State, all the prominent physical features, as the mountains, rivers, &c., and in all except towns and villages, the locations of the dwellings are shown. It has only been offered for sale in a part of the counties, but wherever offered it has met a ready sale.

Dr. Kitchell's labors were suddenly terminated by his death, about the close of 1861. It is to be regretted that he did not survive to complete the work in which he had shown so deep and abiding an interest; and to fulfil the high expectations which a large and affectionate circle of friends had centered in him. The results of his efforts must be found in the published reports and map; and in such portions of his notes as may yet be used in preparing a final report.

During the progress of the survey in 1854, '55 and '56, I held the appointment of Assistant Geologist, and had charge of the geology of the southern portion of the State. After the death of the late Superintendent, I felt that it devolved upon me to see that a work of so much public importance was not entirely abandoned; and the State Agricultural Society, at my suggestion, requested and obtained from the last Legislature an act authorizing me to finish the survey on the same terms that were granted to Dr. Kitchell.

2. I have prosecuted the work during the past season as rapidly as the means and time at my disposal would permit. In all that has been done my object has been to survey and define, accurately, the great geological formations of the State and their relations to each other. To properly construct a frame-work, about which the facts and minutia of the survey may be systematically arranged as fast as they are collected. For this purpose a section has been surveyed across the State, from the mouth of Shark River Inlet, on the Atlantic shore, to the Delaware Water Gap. This section has the advantage of crossing all the principal geological formations of New Jersey, and by extending it on to Scranton, in Pennsylvania, it crosses nearly all the formations of the United States.

Beginning at the southeast extremity we have:

1. The drifting beach sands, piled up in hillocks on the immediate margin of the ocean. These are now in process of formation; and on this section occupy only a few hundred yards in width.

2. Sand, clay and gravel deposits, with a moderately undulating surface. They are represented as extending from the beach up to near Poplar, about two miles. This is probably of the Tertiary Age, though it is without fossils.

3. A bed of green sand or marl. This extends through Deal and Poplar, about three miles across, and is of the older Tertiary Age. Like the other beds of green sand, it is remarkable for its fertilizing qualities.

4. Beds of sand, clay and green sand or marl. These are of the

Cretaceous Age, and the belt they occupy is about twelve miles wide, extending from below Eatontown to near Middletown Point.

5. Beds of sand, and of spurious marl, containing some green sand and much iron pyrites and sulphate of iron in a dark, astringent clay. This, too, is of the Cretaceous Age. It is met with from Middletown Point to the head of Cheesequakes Creek, a distance of about five miles.

6. Deposits of potters' clay, fire clay and fire sand are next met with in regular beds. The Amboy and Woodbridge clays are of this deposit. On the section this extends from the head of Cheesequakes Creek to Lawrence's Brook, below New Brunswick, a distance of six miles. This is the lowest of our Cretaceous formations.

All the formations thus far are very regular and uniform in their position, all in regular and continuous layers, inclining towards the southeast, with a descent of about thirty feet to the mile.

7. The *Red Shale* and *Red Sandstone*, which constitute the rocks of the country on this section, from below New Brunswick to Lebanon, in Hunterdon county, which is twenty-five miles. This well known rock is remarkable for having all its layers descending gently towards the northwest. It belongs, probably, to the Triassic Age.

8. Gneiss Rocks. These rocks are stratified, but in layers which are almost vertical. The Schooley's Mountain range is of this kind. The section crosses this rock from Lebanon to Hampton—and also in the two ridges on either side of Oxford Furnace—a distance of thirteen miles. The *iron mine* near High Bridge, and those at Oxford Furnace, are in this rock and crossed by the section. Layers of white limestone are also found in this rock. One is crossed near Oxford. This rock is of the Azoic Age.

9. Sandstone. This is a thin layer of rock lying upon the gneiss. It is known in New York as the Potsdam Sandstone. It is only a few feet in thickness. It is of the Silurian Age.

10. Limestone. This rock is crossed in the valleys of the Musconetcong, the Pohatcong, the Pequest, and the Paulinskill, the extremes of which points are fifteen miles apart. It is everywhere the basis of a fruitful soil. It is of the Silurian Age, and is known as the Black River and Trenton Limestone.

11. Slate. This is the rock in which the slate quarries near the Water Gap are worked, and it is the basis of the soil in the rich dairy districts of Sussex and Warren. It is known in New York as the Hudson River Slate, and is Silurian in Age.

12. Conglomerate. This is the rock of the Blue Mountain and the Water Gap. It forms a prominent feature upon the surface of the State. It is frequently called the Shawanqunk Conglomerate, and it is of the Silurian Age.

13. Red and Gray Sandstones. These are upon the northwest slope of the Blue Mountain, and their character is indicated by the name. The name Medina Sandstone is applied to it by the New York geologists. It also is Silurian.

In all these, from the Red Sandstone the rock is undulating or in folds, with a prevailing descent to the southwest. Here we pass out of the State and into Pennsylvania. But farther up the Delaware in New Jersey, other rocks are found as the Lower and Upper Helderberg Limestones; the Marcellus Shales; the Oriskany Sandstone, &c. If we pursue the direction of the section across into Pennsylvania, we cross these rocks in succession, and finally reach the coal at Scranton. The coal formation is geologically the rock next older than our red shales and sandstones.

In the collection of these details I have aimed to ascertain, describe, and sketch such localities as can easily be referred to by any one interested to verify them, or by any students of geology who may wish to visit localities where are exhibited, the truths which are recorded in our books. The accompanying section on a horizontal scale of one mile to an inch, and a vertical scale of two hundred feet to the inch, exhibits the principal results of the work upon it. Where more minute details seemed desirable, I have made sections of small parts of this upon an enlarged scale. Here are a number of such relating to the marl deposits, the red sandstone and trap rocks, and to the limestone and gneiss formations.

With a sufficient variety of these, I have endeavored to make plain and indeed to demonstrate a number of points which were not clearly settled in the first survey. Thus the commonly received opinion that the white limestone of Sussex is the same as the blue limestone only changed in color and structure by heat, is clearly shown to be erroneous by the sketch of a locality near Franklin Furnace, where the two rocks are seen to be totally distinct from each other, one of them being in layers which dip to the southeast, while the other lies upon the upturned edges of the former and dips to the northwest.

The Green Pond Mountain, that long, narrow and singularly unbroken ridge, formerly supposed to be of the age of the red shale and red sandstone, now proves to be of the silurian age, having the common Trenton limestone fossils upon one side, and a non-fossiliferous blue limestone upon the other.

The next step in the survey will be to trace out and describe the lines of meeting of the different formations by following them in a northeast and southwest direction entirely across the State, taking note of their peculiarities, and of everything that appears to be of moment.

Next will follow the collecting and describing of soils, rocks, minerals, building materials, fertilizers and other useful substances which may be met with. Something has already been done in this, but the labor required for it is so different from that needed in the work of exploration, that it is found easier to take the two parts separately.

The chemistry of geology is of vast importance, and is a subject of continual study. A large number of unpublished analyses of marls and limestones, iron ores and rocks are already finished.

The next and final business must be to arrange systematically the material which has been collected, and prepare it, with proper maps and illustrations for publication.

The importance of having this work so executed and published that all our citizens may understand the geology of the State can hardly be over estimated. To the practical man it is of the first importance to *know* that the materials of the globe are not jumbled together in a confused mass, where any particular substance can be found only by chance, but that there is an orderly arrangement of them, and each is to be found in its appropriate place. The soils upon each rock formation have their peculiar characteristics, and the farmer who wishes to devote himself to dairying, to the raising of stock, of grass, of grain, of fruits or of garden vegetables, will look for the rock formation and soil upon which his special product is most profitably raised. Our iron need only be looked for in one kind of rock, and that rock is confined to a particular district of country. The limestones are all in regular layers, traversing the country in a northeast and southwest direction, and never in any other. Our green-sand marls are only found in one favored portion of the State. The fire-clays are only in one belt of country which crosses the middle of the State from the northeast to the southwest. It would be worse than useless to look for magnetic iron in southern New Jersey, marl in the northern part of the State, or coal beds anywhere within our bounds.

It is only by surveys of this kind carefully carried out over the whole country, faithfully described and illustrated, and the results brought within the reach of all our citizens, that we can fully and profitably make this arrangement known and appreciated.

Our abundant but undeveloped resources require from the State this kind of survey and publication.

The United States Census Report, states that we have 5,324,800 acres of land within the bounds of the State of New Jersey. Of these, 2,984,531 acres are returned as constituting the improved and unimproved lands that are in farms; and the remaining 2,340,296 acres are not connected with any farm improvement whatever. Much of this wild land is no poorer than other land which is in a good state of cultivation. It is in the same geological formation, of the same general quality, spots of it which are cultivated produce crops, and it only needs to be put into the hands of enterprizing and skillful farmers to place it on a par with other productive land of the State.

The iron ores in the northern part of the State are capable of being greatly extended in their workings. Dr. Kitchell estimated that they were capable of yielding a million tons of ore a year, which is at least five times as much as they now yield.

Our clay-pits and our marl-beds are only beginning to yield the riches which they contain.

This is the condition of our resources now, and yet if we look back ten years, and see the progress which has been made, and then com-

pare it with the progress in neighboring States, we shall find reason for congratulation.

1. A comparison of the cash values of farms per acre, in 1850 and in 1860.

	1850.	1860.	Gain per acre.
New Jersey,	$43.67	$60.40	$16.73
New York,	29.00	38.00	9.00
Pennsylvania,	27.33	39.00	11.67
Delaware,	19.75	31.00	11.25
Connecticut,	30.50	36.00	5.50
Rhode Island,	30.82	37.00	6.18
Massachusetts,	32.50	34.00	1.50

The returns show 230,000 acres of land in farms in 1860, above the number in 1850. This is not materially different from rate of increase in the other States.

2. In mining iron ore, it was thought in 1855, that there might be mined in all New Jersey, 100,000 tons of ore a year. This year the Morris Canal has carried 176,531 tons of ore, and a large quantity in addition has been carried over the Central and Warren Railroads, enough in the aggregate to amount to 200,000 tons. A large quantity in addition has been consumed in forges and furnaces not reached by canal or railroad.

3. The business of transporting marl to comparatively distant points, had hardly commenced at that time. This year the Freehold and Jamesburg Railroad has transported 12,130 tons of Squankum marl and distributed it over a country from seven to twenty miles away from the pits. The Burlington County Railroad, has, within the last eight months taken from Pemberton, 15,000 tons of marl, which have been distributed along the line of that road, the Camden and Amboy Railroad, the Delaware and Raritan Canal, and in Pennsylvania; and the annual demand upon these lines will fall but little if any short of 50,000 tons a year.

The West Jersey Railroad has commenced the transportation of marl to the country along the line of that road, and of the Millville and Cape May roads, and the demand is such as to warrant them in preparing for an annual sale of 100,000 tons. In a very short time they will be prepared to supply that amount.

The Raritan and Delaware Bay Railroad has carried 6,037 tons of marl for use upon the farms along its line, and the want of transportation has hindered it from doing much more.

The Camden and Atlantic Railroad is also engaged in transporting marl, though I am not furnished with statistics of the extent of the trade.

These only show the extension of the use of marl in districts where it would not be profitable to transport it by teams. The great con-

sumption still is in the vicinity where it is dug. 10,000 tons have been taken from a single pit by teams in a year.

The work of collecting fertilizing materials from the waters of the Atlantic and of Delaware Bay is carried on to some extent. From 300 to 500 tons of a concentrated manure prepared from king-crabs, and worth about half as much as Peruvian guano, are annually prepared on the Bay shore of Cape May. And a commencement has been made in preparing a manure from the fish which abound in our bays and sounds. I have no account of the extent of this useful work, but am confident that it is only the beginning of what will prove an important branch of industry, and furnish a full substitute for all the guano that is needed in the State.

But the field for the development of our natural resources is still very large, and it becomes us, both by publishing and giving direction to capital and energies at home, to aid in carrying it forward.

The publication, either by other parties or by those controlled by a narrow interest, is always incomplete. The United States Census Report credits us with 57,800 tons of iron ore, instead of our present 200,000 tons. And our zinc ores, amounting to from 10,000 to 15,000 tons a year, are not even mentioned. And some other branches of industry are in the same condition.

Again, our iron ores are mostly carried out of the State to be worked—carried westward into Pennsylvania—and when worked the iron is brought east to New York, passing directly by the mouths of the mines from which it was first taken. The coal used in manufacturing iron could as cheaply be brought to the ore as to carry the ore to the coal; a long double transportation would be saved, and our farmers and mechanics benefitted by the home market thus created. Should not every effort be made to restore these manufactures to their proper locations?

And in general, with lands as productive as the virgin soils of the West, and the best markets on the continent at our very doors; with mines of iron and other useful metals, rich and abundant, and with every facility and stimulus for increasing our material wealth, we have still vast stores of undeveloped riches; riches awaiting the hand of the diligent, and only needing to be known to be appreciated.

With the value of our farm lands increased $40,000,000 in ten years, and a like rapid improvement in the value of farm implements, of live stock, of farm and garden products, we may well feel satisfied with the progress of New Jersey in the accumulation of physical comforts. And when we consider that the addition is nearly twice as great as in the neighboring States, difference in size being allowed for, we very naturally inquire for its causes. Has the geological survey had any agency in it? Ten years ago it was commenced; imperfectly as it was carried out, and incompletely as its results were published, I know individual cases of rise in value from its investigations which are more than equal to its whole cost. And taking all

its results into account, I cannot but think the money expended in it has been one of the best investments ever made by the State.

To draw from the survey the fullest practical results, a few facts and suggestions are here offered in the hope of calling out inquiry and awakening interest throughout the State. A very large and important part of the survey must be to collect from intelligent and observing men the facts which have come within their knowledge, and as completely as possible arrange and combine these in a general system from which other and important conclusions and inferences may be drawn; and correspondence and inquiries relating to them and to similar subjects are invited from persons interested in them.

LEAD ORES.—A lead mine of extraordinary richness has been discovered within the last two years, upon the northwestern slope of the Blue Mountain, a few miles beyond our northern boundary. It is upon the range, and in the same rock with the lead mines at Wurtzboro' and Ellenville. The first indications of it were found in masses of lead ore lying loose upon the surface where the mine is now opened. As the same rock is found in New Jersey from near Port Jervis down to the Water Gap, it is possible that other veins of the ore may be found in our State, and the surface should be carefully examined for that end.

ZINC ORES.—In Sussex County at Franklin Furnace, and at Sterling Hill, there are immense beds of zinc ore. The ore is of a kind found no where else in any quantity. From ten to fifteen thousand tons of the ore from these mines are consumed every year in the manufacture of white paint. Recently the manufacture of the metal itself from these ores has been successfully commenced. The only other zinc mines at present worked to any extent in our country are near Bethlehem, in Pennsylvania. An inspection of the map shows that the same geological formation extends from one mine to the other. The ore found at Bethlehem is a hydrous silicate, and ore of the same kind is found in small quantity at Sterling Hill. Other mines are looked for in the range between the two places. As the supply of this metal is not at all equal to the demand, it becomes an object of public importance to increase the manufacture. The ore has not a metallic appearance, but resembles a drab colored limestone. It is easily recognized by the white smoke which it gives off when pulverized and thrown upon a very hot coal fire.

IRON ORES.—The iron ores of New Jersey are an unfailing source of wealth to the State. They occur in beds which stand nearly vertical, and interposed between the layers of gneiss rock. They descend between these layers towards the northeast, and when followed in that direction beneath the surface they hold their full size and thickness as far down as they have been worked. The general structure as well as the peculiarities of this system of beds of magnetic iron ore,

must be the subject of patient and laborious examination. It is specially desired to collect further facts in relation to the folding or doubling of the beds, the thinning out of beds and the commencement of others parallel to them, their peculiar effects upon the magnetic needle, &c.

WHITE LIMESTONE.—In addition to the white limestone which is found all along the northwest border of the gneiss rocks, from the northern line of the State down to the Delaware, detached beds of a white limestone containing serpentine have been found in the valleys between the ridges of gneiss, at Winoke above Pompton, at Montville, at Mr. Sander's farm, four miles west of Morristown, at Lamington Falls, near the head of Lake Hopatkong, and it is said to be found on the Pequanock, a few miles above Bloomingdale. These beds are of much value to the country in their vicinities, and some of them will be of still more importance from their nearness to canal or railroad transportation.

BLUE LIMESTONES.—On the eastern side of the rock of the Green Pond Mountain, good limestone is found, at West Milford, at Mockapin, and then at the middle forge, above Rockaway. The same bed must exist throughout the whole distance, and quarries of limestone may be looked for anywhere on the range between the two places.

In regard to the limestones of the State, it becomes an interesting inquiry as to the relative values of those which are nearly pure compared with those which are partly composed of magnesia. The limestones of the Paulinskill, Pequest, Pohatcong and Musconetcong valleys, and those of Clinton and Peapack, are magnesian; and so is much of the lime brought into the State from Pennsylvania. Lime from northwest of the Blue Mountain, that from the yellow limestone of the marl region, that from oyster shells and that from stone quarried at Rondout, is comparatively pure lime. Which is the best for agricultural purposes, or for building, or for use in blast furnaces?

FIRE CLAY.—This clay, which is largely dug at Woodbridge, South Amboy and at Trenton, is of much importance to the industrial interests of the State. It is used in making fire-brick, and already it has driven foreign bricks from the market, and has supplied their place at about half their cost. New localities of this substance may be looked for at other localities in the central part of the State.

CALCAREOUS MARL.—Calcareous or shell marl, similar to that found in the southern States, occurs in many places along the shore of the Atlantic and Delaware Bay at heights of from one to ten feet above high water mark. It is a valuable fertilizer, and all accessible localities should be known.

COPPER ORE.—Copper mining has not heretofore been found profitable in our State, but the large sums of money which have been spent in the business make it of general importance. A full collection of facts relating to all the localities where copper has been noticed, or mining enterprises undertaken, might, when compared with each other do something to either discourage or else to give intelligent direction to this branch of industry.