ANNUAL REPORT

OF THE

STATE GEOLOGIST

OF NEW JERSEY,

FOR THE YEAR 1872.

TRENTON, N. J.:
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1872.

GEOLOGICAL SURVEY OF NEW JERSEY.

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STATE GEOLOGIST:

GEO. H. COOK, New Brunswick.

To his Excellency, JOEL PARKER, *Governor of the State of New Jersey, and ex-officio President of the Board of Managers of the State Geological Survey:*

SIR: I have the honor herewith to submit my report upon the operations of the Geological Survey for the year 1872.

GEO. H. COOK,
State Geologist.

RUTGERS COLLEGE, New Brunswick, N. J.,
December 10th, 1872.

REPORT.

The operations of the survey have been continued during the past year by the following persons:

Prof. John C. Smock has been engaged for a portion of the year. His work has been mostly in the iron ore region, and he has done much in the exploration of ground supposed to contain iron ore, and in the examination of new or extended openings.

Edwin H. Bogardus, chemist, has been engaged in the laboratory most of the year. His principal work has been analyzing iron ores, limestones, clays, soils, and fertilizers.

Prof. Edward A. Bowser has been in the service of the State only a small part of the year. He has surveyed and mapped several iron mines, and has lately been engaged in a partial examination into the condition of the monuments on the boundary line between New Jersey and New York.

My own time has been occupied in some degree in the field, but much more in office work, and in furnishing information to persons seeking it, in regard to various natural products of the State. Work connected with different drainage projects, now in contemplation, and which the Legislature has placed under the direction of the board of managers of the geological survey, has taken much valuable time.

PRESENT CONDITION OF THE WORK, AND PLAN PROPOSED FOR ITS COMPLETION.

The time contemplated in the act continuing the geological survey closes with the present year. Such a work can never be finished, and it would undoubtedly be for the best interests of the State if it were continued on, much further than it has yet been. The field work, however, is in such condition that it can be closed, and a report made upon it. The interruptions caused by work under the drainage law has not left time to write out in full the details of our iron mines and ores, or the generalizations upon our soils and our agriculture which the analyses and surveys have prepared the way for. The reports upon these two subjects are partly written out now, and will be completed by Prof. Smock and myself as fast as the studies connected with them can be carried forward. Elaborate mine maps have been prepared to accompany the "Report upon the Iron Ores and Iron Mines." It is proposed to issue these two reports separately, and in such way that they may be freely distributed among those most interested in the subject. There is a small balance of the appropriation still unexpended, which can be used to meet some unavoidable expenses, and we shall endeavor to complete the publication of our results as originally contemplated.

The law for completing the geological survey of the State, in which the board of managers and the State geologist were named, made provision for its surveying expenses for four years, and afterwards made provision for its further continuance four years longer. It also empowered the board of managers to pay the expenses of publication. The functions of the board are not limited in time, and the act to provide for the drainage of lands puts the work of making plans for drainage under the direction of the board of managers of the geological survey, and as such improvements are likely to continue for a long time yet, there is an obvious necessity for the board to continue its organization.

Should the board deem it best to have the northern boundary re-surveyed, and the condition and location of the monuments carefully examined and recorded, it will be necessary to ask for an appropriation to meet the expenses this would require.

PUBLICATIONS OF THE SURVEY.

The Geology of New Jersey with the accompanying portfolio of maps has been supplied to such institutions and libraries as have made application for it; and it is finding its way into the places where it can be used for its appropriate purpose as a book of reference. The annual reports for 1869, 1870, and 1871, have been extensively distributed already, and there is still a demand for them. The Geology has been sold at the cost of printing and paper; and the annual reports have been supplied gratuitously to all who apply for them. For present and general use, it appears that the small reports issued in pamphlet form are much more generally distributed and read than larger bound volumes.

THE ACT TO PROVIDE FOR THE DRAINAGE OF LANDS.

In the last report it was mentioned that an act, with the above title, had been passed, and that "the board of managers of the geological survey, on the application of at least five owners of separate lots of land included in any tract of land in this State, which is subject to overflow from freshets, or which is usually in a low, marshy, boggy, or wet condition, shall be and are hereby authorized and empowered to examine such tract, and if they deem it for the interest of the public, and of the landowners to be affected thereby, they are further authorized, from time to time, to make surveys of any such tract or tracts of land, and to decide upon and adopt a system of drainage for draining the same, and to cause maps of the same, together with the plans of drainage by them adopted, to be made; and, for this pur-

pose, they shall be authorized to call in the assistance of the state geologist and such other persons as they may deem expedient; and when they shall have completed their said surveys, maps and plans, they shall make a written or printed report of the same to the Supreme Court of this State; and thereupon it shall be the duty of the said court, at the same or next stated term thereof, or as soon as can conveniently be done, upon reasonable notice given to that effect, and published in a newspaper circulating in the county where such tract of lowlands is situate, to appoint three commissioners (not interested in the lands to be drained) to superintend and carry out the drainage of any particular tract or tracts aforesaid, whose duty it shall be to carry out and execute the system of drainage which may thus have been adopted and reported by the said board of managers in reference to said particular tract or tracts; *provided*, that if, at the time fixed for such appointment of commissioners, it shall appear to the court by the written remonstrance of the owners of a majority of the said low and wet lands, duly authenticated by affidavit, that they are opposed to the drainage thereof at the common expense, then the said court shall not appoint such commissioners as is directed in this section." Other sections prescribe the mode of proceeding to execute the work, to assess and collect money to pay the expense, to compensate for damages, and to perform all acts necessary to carry out the contemplated work of drainage. It was also reported that under this law proceedings had been instituted for the drainage of three tracts of wet land, viz:

1. The tract of land subject to overflow, bordering the Passaic river, between Chatham and Little Falls, in Morris, Essex, and Passaic counties.

2. The wet and overflowed lands on the Passaic river, between Millington and Chatham, in Morris, Union, and Somerset counties.

3. The wet and boggy land in the Great Meadows on the Pequest, in Warren county.

The application for the appointment of commissioners to execute the drainage works, in the first case, was strongly and ably contested by the owners of the water-power at Little Falls, and the arguments in the case were heard at the November term of the Supreme Court, in 1871. Objection was made to the constitutionality of the law upon various points, and also to the way in which the notices had been published. No decision of the court was announced at that term. But at the June term of this year, the opinion of the court was fully declared upon all the points which had been submitted to it. The constitutionality of the law was sustained in every respect. The simple publication in the newspapers of the intention to apply to the Supreme Court for the appointment of commissioners to execute the plan of drainage, was judged insufficient, and full and specific instructions were given as to the form of notice, its publication, posting in public places, and personal service upon those whose property might be damaged by the works to be executed. The case was continued, with opportunity to correct the deficiencies in notices. The notices have since been given in accordance with the directions of the court, and at the November term of this year the application was renewed; and the court has appointed Aaron Robertson, of Morris, Martin John Ryerson, of Passaic, and George W. Howell, of Morris, commissioners to carry out and complete the plan of drainage prepared by our board. It is but a few days since this appointment was made, and I am not informed whether any further steps have yet been taken in the matter.

In the second case, the application was met by a remonstrance from a considerable number of landowners who objected to the work being done at the common expense, and affidavit was made by one of the signers that he believed the persons signing the remonstrance were the owners of more than half the land to be drained. No further proceedings have yet been had in the case.

The third case has had no opposition, and, the notices being in proper form, when the application was made to the Supreme Court at its last term, it was immediately granted, and Amos Hoagland, James Boyd and Samuel S. Clark were appointed commissioners to carry out and execute the plan of drainage prepared by this board. There has not yet been time for further progress in the matter.

The projects for drainage have, so far, been slow and tedious, but opportunity has thus been given for a full discussion of the questions of law that were involved in the working of the act, and the way has thereby been smoothed for works of this kind to go forward without interruption or protracted delays.

There are a number of tracts in the State where the agency of this law could be used for both public and private benefit. And as the great improvement which drainage effects is more generally seen and known, so works for its accomplishment must be extended.

In the cases already brought before the board, the plans for drainage were prepared after a careful survey and examination of the tracts and the channels for carrying off the water, and great confidence was felt that nothing was proposed but what was absolutely essential to the success of the improvement demanded. In order, however, to give the fullest assurance as to the correctness of the plans proposed, it was thought desirable to get the opinion of some engineer outside the officers of the survey. Application was accordingly made to Ashbel Welch, at present chief engineer of the railroad works at Harsimus Cove, and who for forty years past has occupied responsible and prominent positions in the construction of public works in this State. He generously, and with considerable trouble to himself, went carefully over the three tracts to be drained, examining into the condition of the lands, and the plans proposed for their drainage.

The questions submitted to him were :

1. Is the drainage of the lands in question necessary to their proper improvement, and of public importance?

2. Is the work proposed in these plans essential to the beginning of any system of permanent drainage?

3. Will the works effect the objects for which they are planned?

4. Can they be carried out without being burdensome to the landowners?

The answers to these questions were received in the following letter:

TRENTON, September 17th, 1872.

To Prof. Geo. H. Cook, State Geologist of New Jersey:

MY DEAR SIR: I have your favor of the 6th instant, asking my opinion of your plans for draining the wet lands which I visited with you along the Passaic river and its branches, and along the Pequest. In answer to your questions I reply:

1. The drainage of the lands in question is necessary to their improvement, and is of public importance.

2. On the Passaic, the work proposed is essential; on the Pequest it is important, but some of the lands on the latter stream can be partially reclaimed without it.

3. The proposed works will effect the objects intended, that is, afford an outlet for the local drainage to be subsequently effected on the lands themselves.

4. If I were one of the landholders, I should be glad to contribute to the expense rather than miss the improvement.

Very respectfully yours.

ASHBEL WELSH,
Civil Engineer.

This endorsement of our plans by our eminent and justly valued citizen and engineer is gratifying to this board, as well as assuring to those interested in the success of the improvement.

THE BOUNDARY OR PARTITION LINE BETWEEN NEW JERREY AND NEW YORK.

The division line between New Jersey and New York is not defined by any natural objects, such as fix the limits of the State on all its other sides. The northern boundary was long in dispute, but was at last defined by agreement as a straight line, having its eastern end on the west bank of Hudson's river, at 41° north latitude, and its western end at the junction of the Machockemack or Neversink river with the Delaware. Our Legislature, by an act passed September 26th, 1772, appointed commissioners to establish this line, who, with other commissioners appointed by the Legislature of New York, did trace out, define by stone monuments set at the end of each mile, and marked by blazed trees along the line, the boundary in question. No record of this work has been found among our documents, but a copy is in Albany, among the Clinton papers in the office of the Secretary of State of New York. The New Jersey commissioners were James Parker, John Stevens, and Walter Rutherfurd; and those from New York were William Wickham and Samuel Gale. The surveyors were James Clinton, of Ulster county, New York, and Anthony Dennis, of Monmouth county, New Jersey. The commissioners' report is dated November 30th, 1774; a complete copy of that and the surveyors' report is to be found in the Geology of New Jersey, 1868, pp. 1 and 2. They state that the line was run N. 54° 40′ W., as the magnetic needle then pointed, and that the distance was 48 miles and 38 chains. Almost the whole of the line was run through woods, over a very rough country, and in some parts the compass needle was so much affected by local attraction that they were obliged to correct the error "by staking." In the long time which has elapsed since that line was run, several of the monuments have been broken down. The 15th, which is not far from Sufferns station on the Erie railway, is broken off, and lies beside the adjacent fence. The 26th, which was on the west bank of

Greenwood lake, is broken down and now lies in a pile of stone near its original location; and the 44th, which is four-and-a-half miles from the west end, is said to have been broken down and burned into lime; some others have been looked for and not yet found. In some cases, the monuments, as they now stand, are not in a straight line. Those from the 19th to and including the 26th, are quite out of line, and such is said to be the case with those from the 27th to the 31st. The mark for the western end of the line is not described by the commissioners or surveyors. There is a slight mark, a kind of crowfoot, on the rock near the water's edge, at the junction of the Delaware and the Neversink, which is said to be the end of the line.

On account of the lost monuments, the obvious crookedness of the line through those which are standing, the ease with which they can be moved, and the enormous value of some of the property along the line, its true location as run by the commissioners has become a matter of question. And serious cases of State jurisdiction may arise at any time, in regard to it.

From all this, it is evident that something should be done to determine the present condition of the line and its monuments, and to so describe and record the successive monuments that they can be verified easily and without delay. A careful survey of the line according to the monuments should be made. The exact latitude and longitude of the western end should be determined; and with the latitude and longitude of the eastern end, which is now known, the bearing and length of the line could be computed, and any errors in the present one made to appear. And should it be found desirable, some joint action could be had with the State of New York, and the line again traced out, marked and recorded.

IRON ORES.

MAGNETIC IRON ORE.

The mines of magnetic iron ore continue to be worked with vigor, and the number of localities furnishing ore are steadily increasing under the impetus from the urgent demands of the furnaces for larger supplies. All of the mines which were included in the report of last year, have been worked a portion if not all the past season, and their number has been increased by the resumption of work at several old mines which had been idle since the close of the war. In the iron districts of Morris county, larger quantities of ore have been raised this year than ever before, the Hibernia mines having furnished a total of 90,000 tons to the Hibernia Mine Railroad for the eleven months of the year; whereas, in 1871, they sent only 80,000 tons. At Mount Hope a large excess is reported over the returns of last year. The shipments of the Ogden Mine Railroad will be about the same as in 1871. The ore tonnage of the Morris and Essex Division of the Delaware, Lackawanna and Western Railroad is 404,832 tons, while that of 1871 was only 232,966 — being nearly one hundred per cent. increase. More than four fifths of this is the product of the mines of this county.

The completion of the New Jersey Midland Railway has given a new outlet to the mines of parts of Sussex, Morris and Passaic counties, and already several of them are sending their ores over this road. The branch of this railroad which is now being constructed in the valley of the Ringwood creek and along Greenwood lake, traverses a district particularly promising, and affords an easy outlet for the rich and extensive ore deposits of Ringwood. Some recent discoveries of large ore outcrops near this new line are reported, so that its prospective tonnage is large, and the addition of the product of this portion of the State to the

aggregate of all our mines may be equal to that contributed by the most extensively worked of the old localities or districts. When it is considered that only one-seventh of the surface of the Highland range lying north of the Morris and Essex Railroad is cleared land, and that, hitherto, small deviations of the compass (or, light attractions) have been regarded as unworthy of further attention or testing, and that ore when found has been of little more value than so much rock from the adjacent strata in consequence of a lack of cheap transportation, it becomes apparent that the mineral wealth of this portion of the State is comparatively unknown, and that here is a field for all interested in the development of its natural resources, or in the mining of iron ore.

In Warren county there has been a great deal of prospecting in the way of surface operations, especially in the vicinity of Hackettstown, and thence southward towards Washington; but, thus far, they have not yielded any very definite results. Ore has been uncovered in many places, but in most instances it has been found as a constituent mineral of granitic and syenitic *dykes* — more rarely in gneissic *strata*. Much searching with the dipping needle has been over such ore-bearing rock, and in some cases it has misled explorers. And in this connection it may be stated that while such rock masses may be closely related to ore beds, the probabilities of their leading to such beds or *veins* are not strong enough to justify much labor or expense in the search after them. This geological feature is not confined to this portion of Warren county, here mentioned, since it can be seen at many points in the gneiss rock formation. But there is a marked distinction between this mode of occurrence and that of the regular ore beds, or veins, as they are commonly called. These latter have definite and well marked walls of rock, and the ore-masses conform to the strata of the rock. The dykes may be conformable to the adjacent beds, but, generally, they are not so, sometimes cutting across the strata. In nearly all cases they are *true*

veins, or dykes, and the distinction between them and the beds of ore, or *veins* as the term is commonly employed, should be more frequently borne in mind by all engaged in such searches, as attention to this phenomenon will save both time and money.

West and southwest of Hackettstown, along the east side of Jenny Jump mountain, the mines opened two years ago have yielded largely, and new outcrops have added to the reputation of this newly-discovered ore belt. The Pequest and Kishpaugh mines have been vigorously worked, and have demonstrated the existence of large and profitable veins where the surface indications were slight, and were for a long time overlooked as not sufficiently marked to warrant any further exploration. Near the northeast end of this mountain range several veins have been discovered on the Howell farm. This lies west of the Johnsonburg road, and between it and the Great Meadows. The diggings are on a white limestone ridge near its northern end. This limestone is mixed with granite, steatite, and other yet undetermined rock species, the relations of which are not fully understood. The Shaw mine, mentioned in "The Geology of New Jersey," is about a quarter of a mile southwest of this Howell farm mine. The ore obtained here is of a superior quality, containing a notable percentage of manganese, some carbonates of lime and magnesia, and very little phosphorus and sulphur. The limestone is mixed with the ore, but not so largely as to greatly reduce the percentage of metallic iron, which is 58.5 per cent.

Between this and the Kishpaugh mine, ore has been found at a number of points, but the localities are not yet sufficiently developed to require any further notice. Apparently on this same long line of outcrop is what is termed the Redell mine, about a mile and a half northwest of Oxford. Here the crystalline limestone is but a few rods from the ore, and this, too, contains manganese. So that, these outcrops may be said to be characterized by the presence of manganese and their association with crystalline

limestone. Towards the northeast a manganiferous iron ore occurs at the mine worked some years ago by the Glendon Iron Company, and hence known as the Glendon mine. This is about two miles southwest of Andover. Near the latter village is the noted Andover mine, and a little further eastward is the Roseville mine, at both of which the same association of minerals may be observed. Still further to the northeast are the iron ore mines at Franklin Furnace. Corresponding with this line of ore outcrop, there is the longer line of white or crystalline lime stone, extending from Mounts Eve and Adam, in Orange county, New York, to Marble mountain at the Delaware river, and skirting the northwest border of the Azoic formation throughout its whole length. The age of this limestone, and the rocks of this northwest border, as compared with those of the Highland range further to the east and southeast, is unsettled. Whatever it may be, the association of this ore with the limestone and the almost universal presence of manganese, are remarkable, and indicate the possibility of finding some order in the distribution of the iron ore beds throughout the gneiss-rock formation of our State.

It is impossible at this time to get sufficient returns of the ore carried by the railroad and canal lines from stations within the State, and so to get at the total product of the iron-ore district; but from data received from some of the companies, and from estimates by those well acquainted with the mining operations of the State, the aggregate amount for 1872 may be put at 600,000 tons. At five dollars per ton, this would give $3,000,000 as its value at the mines. As compared with the other States of the Union, New Jersey stands fourth, being exceeded by Pennsylvania, New York, and Michigan. And yet as large as this may appear, it is considerably less than the present capacity of the mines as now working, and far below what might be done under more comprehensive plans, which would result from more extended examinations as to the extent of the veins, or which would follow from the consolidation of

interests or a co-operation in mining operations. In many instances, these could be very much simplified, and the capacity of a vein greatly increased by uniting the management. The heavier the interests, the more work in the way of exploration becomes possible, and then follows, as a natural sequence, the adoption of more comprehensive and economical modes of mining. In view of these facts, and the probable constancy of the large veins even beyond workable depths, the acquisition of mine property and the consolidation of interests, is a subject that should attract the attention of capitalists, more particularly in these days of high-priced iron. And as a matter which favors the development of our resources, it is here recommended as worthy of consideration.

HEMATITES.

The total product of the hematite mines of the State is greater than it was in 1871, but the localities where such ore has been mined are the same as given in the annual report of that year. In Sussex county, the Pochuck, Cedar Hill and Edsall mines have been worked a part of the year. At the Pochuck mine a tunnel is being driven through the narrow ridge east of the old openings, so as to afford an easier and more expeditious mode of getting the ore to the railroad. The workings are under ground, and the deposit resembles that of some of our magnetic iron-ore beds in its gneissic rock walls, which dip at a high angle towards the southeast. The recently opened Cedar Hill mine is a short distance northeast from the old mine, and on the east side of the ridge. Here the rock, west of the ore, is the white crystalline limestone, which forms the mass of the ridge, while under the ore, on the southeast, a siliceous conglomerate, consisting of white quartz pebbles, in a greyish matrix, also siliceous, crops out. Further work will show the true relations of these rocks and the ore at this interesting locality. Both of these mines are owned and worked by the Franklin Iron

Company. The early completion of their large blast furnaces during the coming year will create a demand for the ore of these mines, and stimulate the search for additional sources of supply.

The hematite mines, near Beattyestown, in Warren county, have been idle most of the year. Quite recently, they have come into the possession of the Musconetcong Iron Works, and a more vigorous working of this deposit may be expected in the future. South of the property held by these companies, and on adjoining farms, this ore has been found in workable quantities. These discoveries, with the results of borings made on the lands of the companies above mentioned, indicate an extensive bed or deposit of ore. It lies between the outcrops of the limestone and the slate, and deeper excavations will no doubt show that it rests upon the limestone. From these mine holes, southward as far as Pennwell, in the deep valley of the Musconetcong creek, hematite has been found at intervals both in trial pits and in the surface stratum, but, so far, not in sufficient amounts to lead to any mining operations. These occasional appearances indicate the existence of larger bodies or deposits in the neighborhood, although some of them may be of diluvial origin—that is, boulders and boulder masses.

In the Pohatcong valley, near New Village, there is a hematite locality near the site of some old diggings for this ore. The Carpenterville mine, near the Delaware river at Carpenterville, is the only deposit of this ore in that part of the county, which is worked.

In the last annual report, reference was made to a discovery of hematite in German Valley, near the Hunterdon county line. During the past season the localities were twice visited, and the following data collected: The explorations were made under the superintendence of Isaac Hummer for J. Taylor & Co., of High Bridge. They were confined to the central and eastern portions of the valley, close to the public road which runs northward from Cali-

fornia into Morris county, and at the foot of the Fox Hill range. The mode of search was by test pits or wells sunk in the overlying earth, mixed clay, and ore deposits, from fifteen to forty feet deep, and having a diameter of from two and a half to three feet. A pick and a spade, with handles about a foot long, were the only tools necessary in digging in so narrow a space. The hoisting of the materials was in buckets holding about fifty pounds of dirt each, and was done by the aid of a windlass made so light as to be easily moved from pit to pit by a couple of men. With these helps two men were able to do all the work. The cost of digging these pits, aside from the tools and hoisting gear which were furnished the laborers, was twenty-five cents per vertical foot. And here it may be stated that in the Lehigh Valley the contract for digging such pits or wells, two and a half to three feet in diameter and up to fifty feet in depth, ranges from fifteen to twenty-five cents per foot, being more expensive the greater the depth. At this apparently low cost laborers make good wages, an experienced man being able, under favoring circumstances, to go down twenty feet in a day. Such an easy, and, comparatively, inexpensive mode of search, is admirably adapted to explorations for hematites, ochres, clays, or other earthy materials where there is no solid rock or indurated earth to be encountered, and is here recommended to all desirous of testing ground for such minerals. In German Valley, about a hundred such holes were sunk, and in most of them ore was found. A few on the upper or eastern side of the road struck the gneiss only a few feet beneath the surface. One west of the stream, and in the valley flat, sunk to a depth of forty feet, was in blue limestone, after passing through the covering of earth. The ore found in these holes was in small masses or concretions, mixed with yellowish earth and a white sandy clay, such as generally accompanies hematite. All the holes in which it was found stopped in it, one of them showing a thickness of twenty-five feet of ore. From these explorations, it appears probable that the

ore occurs in a bed or deposit quite narrow, but extending for some distance lengthwise the valley near the western base of the gneissic ridge. At present, the nearest railroad to this ore deposit is at Chester, seven miles away, in a direct line. High Bridge is about the same distance, or a very little further. With a railroad traversing the valley and connecting these points, this deposit would, according to present prospects, yield largely. And here, the statement of the report for 1871 in regard to the occurrence of hematites may be repeated, viz: "As ore is most generally found near the borders of the limestone outcrop, either between the gneiss (or *grey rock*) of the bounding ridges and the limestone, or between the latter rock and the overlying slate, searches should be confined more particularly to such lines of outcrop. Explorations should, however, extend over the whole breadth of these valleys, as it is sometimes found resting upon the limestone strata, covered by quite thick beds of ferruginous loam, clay, or other earthy matter." And in such searches recourse may often be had to boring instead of digging. This is much quicker and cheaper, and preferable in not disturbing so much of the soil or any crop growing upon the ground. Stony strata, or those containing cobble-stone or large boulders, cannot be readily penetrated by an auger, but such stony beds are not common over hematites, or, if so, they constitute a thin, superficial, drift layer, and, in such cases, the boring could be started after a pit has been sunk through this top stratum. Generally, the covering consists of earthy beds, containing much clay, and an auger can easily be driven through these materials.

The increasing demand for iron ores will undoubtedly lead to the examination of much ground hitherto unnoticed, and to the discovery of additional localities where hematite may be obtained in workable quantities. And the great extent of magnesian limestone outcrops in the valleys of Warren and Sussex counties, offers a wide field for such discoveries. In all cases due attention to the character of

the surface is necessary, as the presence of loose pieces of *float ore* in the soil is one of the first features to be determined before the digging of trial-pits or boring is attempted.

BORING AS A MODE OF SEARCHING FOR MINERALS.

The exhaustion of old and long worked mineral deposits, and the demand for additional supplies of raw materials, require more systematic and detailed examinations, not only of territory known to contain these, but also of those more extensive areas hitherto regarded as barren or unproductive. While there are certain general characters drawn from the geological features of the ground that may guide us in the direction which our searches are to take, indicating the probable presence of this or that mineral, the demonstration of the fact of its existence seldom comes until the miner's pick has uncovered the deposit. In the examinations for magnetic iron ore, the dipping needle furnishes sufficient directions for the removal of the overlying earth. But with the ores of the other metals not only is this unavailable, but the deposits themselves are in *pockets* or *veins*, and not in the form of strata or *beds*. In such cases, as also in iron mining, the safest rule and the one generally followed, is to stick to the bed or vein. But this is often impracticable, as the vein may grow too small for profitable working, or its course may be broken by numerous faults or offsets. Besides, companies with large capital invested in such operations, and using great quantities of raw material, need to look out for the future and to direct their work accordingly. Hence the necessity for cheaper modes of examination which may be satisfactory without being too expensive. One of these is the use of the rock drill or borer. Of such there are many styles, and some of them, as the diamond drill, work very rapidly. And although none of them can be said to work very cheaply, it may also be stated, on the other side, that every company owning extensive mines owe it to the community and the State to

employ a small fraction, at least, of their income in exploring. In the oil regions of Pennsylvania, this method of testing strata has had a very extensive application. There it has been a necessity. It has also been used in the determination of the extent of coal beds in the same State, and in one instance it was seen the past season employed in fixing the limits of a large iron ore deposit. In New Jersey very little of this kind of work has been done, excepting some fruitless attempts thereby to find coal or petroleum. But in not a single case known to the survey has any boring ever been done to determine the extent of any of our iron ore beds. Every year mines are abandoned because of veins "pinching out," while others are worked on a wasteful plan on account of the uncertainties of the future. All agree that an accurate knowledge of the extent of material before the miner would warrant a more comprehensive and economic mode of working than that now followed. In view of these facts, why should we not know the limits *downwards*, or the workable depth, at least, of some of these large veins. Great folds or basins may be here as in Pennsylvania, or thin and irregular veins at and near the surface may be leaders from large and persistent deep beds. At present all is ignorance, and we have only the constancy of the past to serve as a probable hope for the future. Some of our veins may be uniform, as now opened, to a depth of 2,000 feet, or as deep as it is profitable to hoist the ore. Such an extent at a moderate dip would divide the ownership of many of our large veins, even at a depth of 1,000 feet. At these times, when ore is in such demand, this is a matter of interest to all mine owners, and to those owning property near large and continuous veins. But it is not so much a question for this latter class as for the mine proprietors. Besides so much would be added to the sum of our geological knowledge, and thereby assist in the explanation of many phenomena not now plain. Every year large sums of money are spent in fruitless, and in many cases in foolish, surface operations, looking for new veins. Not that these,

when cautiously conducted, are of no value, or destitute of results, for facts alone prove the contrary. But if large results are demanded, and startling discoveries are desirable, the most promising field is in boring on some of these large and steady veins. A single boring might develop the existence of more ore than is mined in the whole State in the course of a year. These statements are based upon the firm belief in the continuity of our iron ore veins downwards, or on the line of their dip, as well as on the line of strike. In Europe boring is common as a mode of search, and some of the discoveries, particularly in Germany, have been very remarkable for the extent of deposits so tested. Its more general application in this country, and at this time in the iron districts of this State, is desirable, if not necessary to the future growth of our iron industry.

ZINC ORES.

The mines at Stirling and Mine Hills, in Sussex county, continue to yield an abundant supply of rich zinc ore. As the working of these mines goes forward, the extraordinary size of the veins is more and more apparent, and there is probably no other place in the world where so large an exposure of zinc ore can be seen as at these mines at the present time.

BUILDING STONE, SLATE, FLAGSTONE, MARBLE.

The most extensive operations in quarrying marble have been carried on by the Warren Marble Quarry Company, at Lower Harmony, in Warren county. The quarry is at the north end of the village and at the west side of the road. It is already a large opening, exposing nearly an acre of the crystalline limestone. Although so much surface has been uncovered, the rock has not yet been penetrated further than about fifteen feet. The stratification is quite indistinct, but appears to be steep towards the southeast, to which direction the slope of the ridge conforms. The original

rock surface was exceedingly uneven, in consequence of the unequal weathering of the calcareous and hornblendic portions of the mass. Most of the stone has a greyish shade, but in places it presents a banded appearance, due to alternations of lighter and and darker laminæ or lines. Nodules and irregularly shaped masses of foreign minerals, mostly hornblende and steatite, are scattered through the calcareous matrix. There is some graphite, and a very little pyrite in some parts of the quarry. The deeper excavations show a more solid and homogenous stone, quite free from these foreign minerals. The company is fully equipped with all the necessary machinery for cutting, sawing, dressing and polishing the stone at the quarry, and is filling orders mostly from Pennsylvania.

ROSE CRYSTAL MARBLE QUARRY.

This is on a subordinate ridge belonging to the Jenny Jump mountain range, and at the corner of the Hope and Danville road and the road running northward along the Great Meadows. There are two openings, but thus far nearly all the stone has been taken from that on the south side of the Hope road. This is about fifty yards long, fifty feet wide, and at the deepest twenty-five feet down. The dip of the strata is 80° N., 75° W. The rose-colored beds as exposed measure thirty feet across the strike. On the west of these the stone is pearl-grey in color. The stone is mostly calcareous, the calcite being white, flesh-colored and rose-colored. With this there occurs a greenish black hornblende, black mica, and here and there crystals of black tourmaline. But the calcite largely predominates, so much so that it could be used for burning into lime. The stone polishes well, and these foreign minerals give it a beautiful variegated appearance.

Many of the larger blocks on the bank will measure 8x3x2 feet. They are free from seams or jointage flaws. On the opposite side of the road a trench has been dug down to the rock, exposing the strata for 100 feet or more across the

strike. Here it is the ordinary white limestone and none of the colored varieties are seen. A large number of blocks have been shipped from this quarry to Philadelphia, where they have been used for interior ornamentation of public buildings. This fact may be better appreciated when it is considered that they had to be hauled seven miles by teams to Hackettstown, where they were shipped by rail to their destination.

Another marble quarry in the State is at the southwest end of Marble Mountain, near the Delaware river, and on the east side of the river road. This is a dark grey stone, the calcite being mixed with mica and hornblende. The strata seems to conform to the adjacent gneiss, both dipping 55° N., 30° W. The quarry was worked for material used in building the new Episcopal church in Easton, Pennsylvania. Since that time nothing further has been done here. The locality is interesting, geologically, but it is doubtful if it ever becomes of great practical importance.

SANDSTONE.

A new quarry for sandstone, or rather of quartzite, has been opened at the New Jersey Marble Company's quarry, on Kanouse Mountain, about a mile east of Newfoundland. There are two openings, about half way up the west side of the ridge. The southernmost, and largest of the two, forms a drift cut about 50 feet into the side of the mountain, having a breadth of about 25 feet and a depth of 18 feet. Near the surface the rock is brownish red, becoming lighter in color as the strata are penetrated, and consists of quite small grains of quartz, cemented together by a siliceous paste. The dip of the beds is 50° N., 35° W. A very regular system of joints traverses the strata nearly at right angles to their strike. These, with the stratification flaws, which are from three to fourteen inches apart, furnish long, flat stones, some of them ten feet long and three feet wide. The stone although very hard is said to dress well. The deeper portion of the quarry shows a more solid stone than

that of the surface ledges. For curbing, or for lintels, posts, &c., this stone may do admirably, since it is very hard, firm, and not likely to be affected by the weather. Should it prove to be of permanent value the supply will be found to be practically inexhaustible, as not only Kanouse, but also Copperas, Green Pond, Bearfort and Belvale mountains are largely made up of this rock. And it may be possible to find other localities more accessible and nearer railroad transportation.

SLATE.

NEWTON SLATE QUARRY.

This has attained considerably larger proportions than it had in 1868, when noticed in the Geology of New Jersey. It is now about 60 feet deep, and measures nearly 70 feet on each side. The walls are vertical, being natural joints running northeast and southwest, with a second system nearly at right angles to the first set. The dip of the strata, as shown by the ribbons, is gently towards the north, while the cleavage planes descend at an equally small angle towards the south. The slate is unusually hard but splits well, requiring, however, a little more time and care in the splitting. A peculiarity of this quarry is that the stone can be "scalloped" or blasted indifferently in any direction. The stone not used for roofing slates is sold for flagging. When visited it was worked by Ramsden & Co. This quarry has furnished a great deal of material for roofing large buildings in Newton and elsewhere, and the slate has given general satisfaction.

The only other slate quarry in the State which is now in operation, is the one near the Delaware Water Gap. This is sending a large amount of superior slate into the market,

and the experience of the past few years proves that it is among the best quarried in this country.

The same belt of slate in which this and the numerous quarries about Slatington, Pennsylvania, are located, extends from the Delaware river along the southeast foot of the Kittatinny, or Blue mountain, to the New York line, a distance of over 30 miles in New Jersey, and at almost any point in this long outcrop it may be possible to find good roofing slate. The great drawback at present is the lack of railroad facilities over most of this ground. Slate of good quality is said to have been found on the lands of the late John Rutherfurd, near Culver's Gap, but the place has not been visited.

FLAGSTONE.

The only quarry outside of the red sandstone formation which has been worked during the past year, is that on Flagstone hill, 3 miles north of Deckertown, Sussex county, The ease with which these stones can be taken out, their uniformity in texture, their smooth surfaces and large size, and the nearness to railroad (1½ miles west of the New Jersey Midland), renders this a valuable quarry, and with so many towns and cities on the line of this road, it ought to find a ready sale for all it can furnish. Newer openings show a great extent of valuable stone on the same hill. The rock belongs in the Hudson river slate formation of the Kittatinny valley; and other localities in the broad outcrop of this rock may be found where it has the same valuable characters as at the above quarry.

Another probable supply of good flagstone is in the thin-bedded grey sandstones of the Bearfort mountain and its foot hills, in the township of West Milford, between the Midland Railroad and the State line. The strata are nearly vertical, and in the ledges the tendency to split up into thin, smooth-bedded slabs is seen everywhere. With the railroad facilities for transportation which the two Midland railroads provide, the stone in this locality should find a ready way to market.

MISCELLANEOUS PRODUCTS.

MICA.

A mine of mica has been opened on the mountain side, about a mile north of Broadway, in Warren county. The mineral occurs in granitic veins, which cut across the strata of gneiss. The mica is in enormously large crystals, and the feldspar, in which it is imbedded, is decomposed and quite soft, so that it is easily mined. The plates of mica split very perfectly, and some of them are more than a foot across. The color is rather darker than is desirable, but the quality is good; it stands fire well, and is finding a ready sale among the stove manufacturers. H. W. Merrill & Co., of Paterson, are the owners of the mine, and they have worked it during the past season. The vein is irregular, but it promises to yield a large quantity of this valuable article. The gneiss rocks here dip towards the W. N. W. 60°, and the vein in which the mica is found runs almost square across the strata. The veins have been uncovered for nearly 200 feet, and in a strip about 30 feet wide, and at the deepest part 30 feet down. It is surprising to see so large an exposure of the thin flakes of this bright and glistening mineral. The drift which covers the surface at that place has when it moved produced some remarkable disturbances and flexures in the mica, and some of the plates are bent across so that the two parts form an acute angle with each other.

On the east side of the valley and near the Broadway station mica has also been found, and it is said to be in workable quantities.

The mine near Stewartsville, which was described in last year's report, has not been in full operation this year.

OCHRE.

A bed of yellow ochre near Upper Harmony, in Warren county, has been worked a portion of the year. The open-

ings are at the side of the Roxburgh road, on lands of Adam Ramsey, and about a quarter of a mile north of the village. The deepest of these is 18 feet, of which from three to six feet at the top consists of gravel, earth and sand, with a few small boulders. The ochre as seen in the bank is light buff to ochre yellow in appearance. Occasionally small masses of rotten rock, originally a slaty limestone, are seen imbedded in it. The material is first sorted then washed, in which operation the earth, sand and stone are removed. The finely divided silt of the vats is dried, ground, or rather crushed between rollers to a fine powder. It is then packed for market. Work had been going on at intervals for two years, up to last July, when operations were suspended, in consequence of some business troubles of the party working it. Up to that time about 400 tons had been prepared, and most of it had been sold, giving good satisfaction and gaining the reputation of a superior article. From surface indications there is a strong probability that the deposit is of great extent.

WHITE CLAYS, FIRE-SAND, AND FELDSPAR.

The deposits of rich white clay about Woodbridge, Perth Amboy, South Amboy and Washington, are worked more and more extensively every year. Their quality is such that the demand for them is steadily growing, and they are finding their way to places more remote. Manufacturers of fire-brick, of alum, of wall paper, of pottery, &c., find these clays to be of better quality and more accessible than any others in our country, and they will yet find them superior to many clays brought from abroad and sold at higher prices.

It is difficult, if not impossible, to get accurate statistics of the business done in this branch of our mining industry.

The geological map of the State defines accurately the limits within which this clay is to be found. It is in regular layers, and has a southeasterly dip, and underlies a large extent of country. The beds which have been opened are

upon the outcrop of this formation, and are popularly thought to be of limited extent. In some cases the superficial drift material has cut away the clay formation and filled the cavities with gravel and sand, and in other cases has covered the clay with heavy bodies of earth, gravel and sand. Hence the necessity of testing the depth of the overlying earth, and the thickness of the layers of clay by boring. This method of searching is specially applicable in all the intervals where the ground is yet undeveloped. And even in the midst of the clay workings there has as yet been very little systematic exploration. To those interested, especially the owners of clay lands, a thorough exploration of their property may be of great value, and we refer them to the paragraphs on boring for clay, as the process is described on another page, for information upon this subject. The importance of this will be appreciated when it is understood that an acre of good fire-clay may yield from 10,000 to 40,000 tons—worth from $3 to $5 a ton.

The quality of our fine clays is unsurpassed. Many of these clay beds yield an article too rich in alumina, or too pure. They are adapted to the making of the finest wares, and it is a mistake to use them for inferior purposes, for which there is an abundance of material quite good enough. Nowhere else in the country is there such a deposit of superior clays, so easily worked, so accessible, and so near our large markets, and hence its national importance. In view of these facts, it should be more highly appreciated by capitalists and manufacturers. The careful sorting of choice portions and the removal of foreign matters by washing is almost unknown. In all foreign countries the clays for the finest porcelain ware are washed. This is done at a single locality only in New Jersey—at Mr. Such's banks, near South Amboy. By means of washing a pure article is obtained from an otherwise inferior clay. The matter should be looked into by our manufacturers and clay dealers.

Some of the more sandy clays dug near Woodbridge, do better than those which are richer for crucibles and glass

pots. They burn without shrinking into a firm and solid mass. This is due to the sand mixed with the clay. A recent analysis by Dr. Pohlé, of New York city, of clay from William B. Dixon's pits shows 3 6-10 per cent. of titanic acid. More recently an analysis made in the survey laboratory of washed clay, prepared by George Such, of South Amboy, shows the composition of these clays and also the presence of titanic acid.

Washed FINE WHITE CLAY, *South Amboy. Sent by George Such:*

ANALYSIS.

Water,	11.95
Alumina,	38.69
Silica,	45 20
Sand (quartz),	.50
Per ox. iron,	1.31
Titanic acid,	1.25
Lime,	trace.
Magnesia,	.14
Alkali,	.30
Phosphoric acid,	.10
Sulphuric acid,	.44
	99.88

Whether this combination of titanium has any value is not known. Its presence in clay has not heretofore been much noticed, and its association with clays of this character is suggestive. Dixon's clay has been found to make the best of crucibles and pots for glass houses, and this may be in part owing to the large percentage of titanium present in it.

Associated with the clays there are quite large deposits of fire-sand, kaolin and feldspar, all of which have an extensive use in making fire-brick and sewer pipes. The latter of these substances, locally known as feldspar, is really a rotten rock, composed of quartz grains and white clay, with an occasional scale of mica. It resembles very closely some of our disintegrating gneisses of the northern part of the State,

and is most probably the result of the decomposition of such rock. It is being more and more used in the fire-brick and sewer-pipe manufacture, and ought to be more appreciated than it is for making such articles.

SEARCHING FOR USEFUL PRODUCTS BY BORING IN THE EARTH.

The auger is available in all borings through strata or beds free from stone, and is, therefore, valuable in searching for clays, marls, glass-sands, peat, hematites, ochres, &c. In the southern half of the State there are scarcely any beds which cannot be penetrated by the auger, aided by a chisel or needle for breaking an occasional stone or layer of *hard pan*. It has been employed for many years in searching for clays about Woodbridge and Amboy, but too often these have been quite superficial, and often without any system. Hence the failure to get results of any value. A large area of territory embraced within the limits of the clay and marl formations has never been touched by the auger. Here, then, is a wide field for future explorations. The beds of marl are remarkable for their uniformity in thickness, strike, dip, and other features, as are, possibly, the beds of glass-sand and clay, while the overlying loam, gravel, sand, clay, &c., which are of more recent origin, are noted for the irregularities of their layers. It is, therefore, impossible to get any definite information respecting the beds they cover, except by digging or boring. But digging is slow and quite expensive. Boring scarcely disturbs the surface, is quickly done, comparatively cheap, and affords us correct knowledge concerning the strata penetrated. For this work augers of various patterns are in use. Generally an ordinary threaded auger with a bit, diameter from an inch to two and a half inches, is used. This is welded on to an iron rod, whose cross section may be square or circular. This is made to screw on a second rod, and that on another, so as to get any desired length. These rods are generally square, and about three-quarters of an inch on a side, but as a rule the size of the rods is proportional to the diameter of the

bit. They may also be spliced together and fastened by a ring shoved down over the two lapping ends. Upon a rod thus constructed a handle is fitted so as to move up and down upon it, and to be fastened by a wedge at any desired point. By means of this the auger is turned, requiring, generally, two men. When the thread is filled the auger is drawn up and the material examined, so that every portion of the strata penetrated can be examined at the surface. Augers are rarely used at greater depth than forty feet, and in nearly all cases this is sufficient to test ground. At such depths, and even at twenty feet, the raising of the auger is a difficult matter, and then a windlass, or better a derrick, with a block and pulley, may be employed. Such a length of rod also requires guides to keep it erect, and for this purpose shear poles set up at the mouth of the boring are necessary. These may be of the same length or a little less than that of the rods. Sometimes strata of wet, running sands, or quicksands, are met with, and this fills the boring, and the auger makes no headway. To counteract this tubing must be used. Sheet iron pipes of the size of the bore are driven down to shut off the sand, and the boring is then resumed inside of the tube. Gravel or small cobble-stones may be broken by a chisel-pointed rod, and then either raised by the auger or pushed to one side. Sometimes the bit is made convex, or spade-shaped, at the bottom. Equipped with these tools, two men can put down several twenty-feet holes in a day, or one (possibly more with favoring conditions), forty-foot boring. Of course, the location of the borings must be judicious. Side hills or sloping ground is always to be chosen rather than summits, or ridges, or flats. In Germany boring is an almost universal mode of searching for brown coal. The strata covering this are earthy, and are such as are readily penetrated by the auger, but the thickness of this covering often exceeds 100 feet. At this, and even greater depths, the auger is employed with success. In Saxony borings having an average depth of 120 feet, cost twenty-seven cents per ver-

tical foot. There the augers are often made with a valve opening upwards to hold the material as it is loosened until raised to the surface. Pod augers, with a vertical slit, or a spiral slit, constitute another form. To break a stone or to push it aside, the bit is made double-edged, or a chisel borer or drill is let fall upon it. The diameter of the bit is sometimes as much as six inches, and then the rods are correspondingly large, and the working of them requires long levers at the surface and increased power. In New Jersey depths of 40 feet are in nearly all cases sufficient, as at greater depths the amount of top earth is too much to be moved, and subterranean mining would be too expensive. For this depth an auger two or two and a half inches diameter, with five-eighths inch rods, is sufficiently large The employment of this comparatively inexpensive mode of searching is earnestly recommended to all interested in the discovery of clays, marls, sands, or other valuable earthy deposits.

FERTILIZERS.

MARL.

The green sand marl continues to be used in large quantities for enriching our soils. The different marl companies are transporting it by railroad to places farther and farther off from the marl beds, and it is gradually proving itself a valuable fertilizer on all soils. Its effect on grain crops is not very striking, and on the better class of soils it does not show such surprising action on the growing crops as it did on poor and exhausted soils where first used. But persistence in its use finally shows its power to permanently enrich soils. Its best effects are seen upon clover and grass lands, though in the marl region it is most valued for growing potatoes. Its effects on corn and grain are secondary, it causing clover to grow, and clover making the corn crop.

LIMESTONE FOR LIME.

In the progress of the field work of the past season another outcrop of the pure or fossiliferous limestone (of the Trenton period most probably) was observed. It is on the farm of John Durling, two miles northeast of Johnsonburgh, and near the Sussex county line. This rock is seen cropping out on the western slope of a low ridge which runs parallel to the Johnsonburgh and Newton road, about fifty yards west of it. It can be traced for nearly a half mile on the line of its strike from northeast to southwest. On the crest and eastern slope of the same low ridge the magnesian limestone shows itself, while on the west, across a slight depression, there is a slate ridge. So that, geologically, its position is between these two rocks—which corresponds with the relations observed at all the other points where it has been seen. The most northerly outcrop here is in the road leading to Durling's house. No fossils were found at the time of our visit to this locality, but from the close resemblance of the stone to that quarried near Stillwater, and to that cropping out near Belvidere, at both of which there is an abundance of fossils, there is every probability that more careful examinations will be successful in finding them here also. A specimen of the best stone, as obtained from the surface ledges, was analyzed, and found to contain 1.6 per cent. of sand and foreign matters, 93 .23 per cent. of carbonate of lime, and a little magnesia. Some of the slaty portions of the ledges are not quite as good as the more crystalline specimen which was analyzed.

This fossiliferous limestone is also seen a short distance southwest of Newton. A specimen sent to the survey laboratory by William P. Nicholas, of that town, gave the following result on analysis, viz:

Quartz and insoluble matters,	12.70
Oxide of iron and alumina,	1.60
Carbonate of lime,	84.90
Carbonate of magnesia,	0.45
Total,	99.65

Localities and other analyses of this fossiliferous stone are given in the "Geology of New Jersey," pp. 131-133 and 396-399.

The white, or crystalline, limestones of the State are gradually coming into use for making lime, both for agricultural and building purposes, and everywhere with satisfactory results. One of these recently-opened quarries is that of the "Warren Marble Quarry Company," at Lower Harmony. This is properly a *marble* quarry, but the refuse stone is burned into lime at the side of the quarry. The lime from it has gained a good reputation, and some say that it is superior to the blue stone lime, as it makes a stronger mortar, and in large doses it does not "kill" the ground.

ROADS.

There is an increasing interest shown in the construction and repair of our roads. With a rapid increase of population, and the filling up of desirable locations with new comers, the value of good roads is seen in the higher price and more ready sale of adjacent lands. Wherever improved roads have been made, even if against the wishes of many people, and if paid for by taxes, they have at once caused the property affected to rise in price by a sum more than equal to the cost of the roads.

The graveled roads in all the southern half of the State, and in the country roads everywhere, are doing much to benefit the lands through which they pass. The turnpikes of this kind in Middlesex, Mercer, Monmouth, Ocean, Burlington, Camden, Gloucester, Salem, Cumberland, Atlantic and Cape May, are all successful, and have been of incalculable service to the districts they pass through, They cost from $1,000 to $3,000 a mile, according to the expense of draining, forming and graveling. It would be a great benefit to the State if some more general plan of laying out, constructing and repairing roads, could be put in operation.

In the northern part of the State Telford roads are exciting a good deal of interest. They are on trial in Newark, Orange, Bloomfield, Montclair, Plainfield, Elizabeth and Bergen Point, and are giving great satisfaction. They are made of broken stone, are smooth and solid in all kinds of weather, are very little subject to wear or damage, are easily repaired, not noisy, and are less expensive than any other stone road of good quality. The Essex road board has begun to lay out a system of roads for the county, in accordance with its business interests and its prospective growth. Spacious avenues are projected which shall start from Newark and radiate in nearly direct lines through the important towns and villages, and so on to the extreme borders of the county. The avenues to Springfield, Orange, South Orange and Bloomfield, are already constructed for several miles out from the city. They are covered with the Telford pavement, and are successful for the objects of the board and very popular.

We have an abundance of the best material for these roads in all the trap ridges of Central New Jersey, and there is not a doubt that every community that will use these materials in making hard and solid roads, will lay the foundation for substantial and permanent growth.

ON SOILS AND THEIR PRODUCTIVENESS.

It has been considered an important part of this survey to examine the soils of the State; to search out and describe our available fertilizers, and to make such investigations and suggestions in relation to agriculture, as may best call attention to our resources. The object of analyzing soils has been greatly misunderstood. It is supposed by many intelligent people, that if a soil is analyzed and its constituents set down, its deficiencies will at once appear, and that the farmer need only supply these and he will make a good soil. Unfortunately, this notion is not sustained by the experience of those who have tried to carry it into practice. Taken by itself it fails utterly. So differently are the important

elements of good soils combined, and so various are they in their degrees of fineness and tendency to decompose, and also in their other physical properties, that their chemical composition gives only a small part of the information needed in order to judge of their productiveness. And so many attempts to draw instruction from the bare analyses of soils have failed, that a wide-spread impression prevails that soil analyses are useless. The true object of soil analyses is not so simple as the above hypothesis would indicate; neither is it so worthless as others have concluded. The characteristics of the soils in different parts of the country are distinctive. They are formed, to a large extent, from the rocks which underlie them, and so are classified in the same way with the geological formations upon which they lie. Analyses of these classes of soils will help to explain the peculiarities of their management and productions, and guided by their chemical composition the intelligent and skillful farmer will plan his rotation of crops, apply his manures, and manage his tillage, so as to bring out and to economize all the natural riches of the soil. As the intelligence and skill of our farmers increase, they will be able to profit more and more by knowing the composition of the soils they till. We have already reached the point where the analysis is made useful in guiding farm plans and practices, and it promises to do much more in the future. A large number of soil analyses are now ready for publication, and are only awaiting the preparation of the details of successful management and productiveness.

We have a warm and easily tilled soil, which responds most generously to high cultivation, a climate mild, salubrious and invigorating, and a location, in regard to markets, superior to any other of the United States. We have superior facilities for obtaining fertilizers with which to enrich the soil. A dense population and a mixed industry supply the highest possible stimulus to the farmer to improve his advantages, and to make the most of his means. To do this best there must be more skill, intelligence and enter-

prise put in the business. At the last session of the Legislature a law was passed to "organize a State Board of Agriculture," whose object should be to develop the principles, to improve the art, and to foster the interests of agriculture in New Jersey. This board is composed of the board of managers and the superintendent of the State Geological Survey, the president and two of the professors of the State Agricultural College, three members of the board of visitors of the Agricultural College, and the president or other representative of the State and county agricultural societies which may be in correspondence with the Board of Agriculture. This board met in September, and organized by electing Governor Parker president, and George H. Cook secretary, arranging business for a public meeting of the board, and adjourned to meet at the call of the president, in the State House, at Trenton, at some time during the coming session of the Legislature. Some papers and reports upon topics of interest to our farmers will be presented at that meeting, and business matters affecting the development and improvement of our agricultural resources will be discussed.

It may be worthy of consideration whether the matters relating to the analysis and properties of soils, which are now in charge of this board, should not be transferred to the Board of Agriculture, and there discussed in connection with those practical results which are reached by our successful farmers.

HUMAN BONES FOUND UNDER ROCK.

The Salem Standard says: "One day last week [in November] as the laborers were digging limestone, on the Amos Peasley farm, in Mannington, they came across the remains of an Indian at the depth of six feet below the level earth. The bones, it is supposed, were those of a warrior, inasmuch as several darts were found with the remains, it being the custom of the race to bury the imple-

ments of war with the deceased brave. The remains were not discovered until a greater portion had been thrown out with the stone, but those saved, though considerably broken, are in good condition; a part of the leg bones and of the teeth especially, being in almost perfect state of preservation. *They laid under a layer of solid limestone six inches thick, which must have formed since the remains were deposited there, perhaps hundreds of years ago.*" My friend David Petit, of Salem, sent me notice of the finding of these bones, and of their location in regard to the rock, as I have shown by italicizing part of the above quotation. On account of the interest expressed by students of geology upon all questions relating to the antiquity of the human race, it was thought best to visit the place where they were found, and to see the fragments that were preserved, and on exhibition at a store in Salem. The bones were very much broken, and many of them were missing. There seemed to be no question but that they were Indian bones; there were three very perfect stone arrow-heads found with them; there was also a fragment of a prong of buck's horn, and a piece of bone 5 or 6 inches long ground to a point at one end. The bones were tender, and some of them much decayed; their color was reddish, and the small portions of earth adhering to them were of a bright salmon-red color. On the inside of the fragments of the skull some pieces of roots were observed closely adhering and fitting. They were about the size of a fine knitting needle, and evidently had grown and attached themselves to the bones while the latter were in their place of burial.

The locality where they were found is on the farm of James J. Petit, Esq., of Mannington, on the south bank of a small run which empties into Mannington creek. The bank is 8 or 9 feet high, and quite steep. It appears to be composed of sandy loam, but from 2 to 4 feet beneath the surface the light-colored limestone and lime-sand of the marl formation is found in place. The formation in that place consists of nearly level layers of limestone, which are

from 5 to 10 inches thick, and separated from each other by layers of lime-sand, which are from a foot to a foot and a half thick. Both these substances are of the same kind of carbonate of lime, and they contain the same kinds of shells and other marine fossils, and differ only in that one part has hardened to stone, while the remainder is still soft, like sand. The layers of limestone are not in an unbroken sheet, but are traversed by joints or fractures, which divide the stone into pieces of from a few pounds to a ton in weight. The bones were found six or eight feet back from the surface of the bank, and covered by 5 or 6 feet of earth. The men engaged in getting out this limestone, say they found the skeleton under one of these large flat stones, which appeared to be in its proper place among the others, though very near the edge of the layer. They did not notice the bones until they had thrown a good many of them out with the waste sand, the material in which the bones were being of an ochrey red color, more like the earth than like the light-colored lime sand.

I do not think there is any evidence that the limestone has formed since the bones were deposited there, or that there is anything extraordinary in their location, or the time they have been buried. The case is presented only to correct any misapprehension that may have been produced by the published statements.