

## SOUTHERN OR LOWER PENINSULA

*Clay Iron-stone of Branch county, and Bog ores of Kalamazoo, Jackson and Oakland*

For an abstract of the labors performed in the southern peninsula of our state, I would refer you to the accompanying reports of the several assistants, hereto appended. I have deemed it unnecessary, *at this time*, to add more than to call your attention to a single subject, which, by an act of your honorable body, I was instructed especially to examine, viz: the "iron ore on section sixteen, town five south, range seven west, in the county of Branch."

Agreeably to those instructions, I proceeded to the examination directed, but a series of untoward events, together with the very urgent duties devolving upon me during that portion of the season which would admit of the continuance of these labors, has thus far prevented the completion of the work. I was desirous to defer the completion of the examination until the survey in that and the adjoining counties had been so nearly brought to a close, as to enable me to judge with certainty, of the real character of the formation in which the ore is embraced. These surveys are now so far advanced, as to enable me to arrive at satisfactory conclusions upon that point of the subject, and but little remains to bring the examination to a close.

In that portion of Branch county, to which my attention was called by the instructions, and over many miles of the surrounding country, a stratum of what usually appears as a grayish brown clay, rises to the surface, or is reached by removing the superficial soil by which it is covered. An examination of the ravines and banks of streams cutting through this indurated clay, shows it to be regularly stratified, and also, that the lower exposed portions approach in character very nearly to an argillaceous sandstone. It is in this stratum that the clay iron-stone under consideration, is imbedded, and upon it the sandstones lying north as well as easterly, rest.

Although these clays of the ironstone formation are more largely developed in this portion of Branch county than in any other position where they have been observed, portions of the stratum have nevertheless been traced through other parts of Branch, as well as through a portion of Hillsdale and Calhoun counties.

On the section (sixteen) alluded to, broken pieces of kidney ore were found in abundance, mixed with the soil, or more frequently lying directly upon the clay and covered by the superficial soil. As nearly as could be determined, the clay underlays the complete "section," but the opportunity offered for its examination is not as favorable as that upon some of the adjoining sections, for the reason that the surface is more uniformly flat, without any considerable ravines, while on the others, the formation is frequently exposed in the ravines and streams.

In order to determine more satisfactorily than could otherwise be done, the arrangement of the ore in the formation, as well as the quantity contained in a given area, an excavation was made in the westerly bank of Coldwater river, near the line between sections nine and ten, and but a short distance from the corner of section sixteen where the banks are elevated about twenty-two feet above low water of the river. This excavation, which was continued from the top of the bank, exposed the whole strata of the formation, as low as the water of the stream. About eighteen inches of clayey soil, containing numerous broken fragments of ore, caps the clay, after which the strata continue regular, each descending layer increasing in compactness, until at the base, as was before stated, it has almost the compactness and character of an argillaceous sandstone.

The masses of ore, although distributed partially through the whole of the clay, are usually arranged in partial layers, separated from eighteen inches to two feet from each other, and by far the largest portion of it, as well as that of the greatest purity, occurs in the upper half of the bank. As we

approach the harder and more siliceous portions of the clay formation, the character of the nodules of ore gradually changes, in consequence of the mixture of siliceous and aluminous matter with the iron, thereby rendering them nearly worthless.

After raising between five and six tons of the ore, I became satisfied of its existence at this point in sufficient quantity to admit of being profitably raised, and numerous partial excavations in the surrounding country, led me to believe that at least for a distance of more than half a mile, the relative quantity continues much the same.

This ore which, as has already been stated, is of that variety known as kidney iron ore, is of the same character as that so extensively used for reduction at many of the furnaces in Ohio, and it does not suffer by comparison with that which occurs in that state. The beds which have been so extensively and profitably worked in vicinity of Zoar, Ohio, occur under very similar circumstances, and the ore produced by an equal amount of excavation would probably be about the same at that place and the point alluded to in Branch county. At Zoar, the argillaceous stratum in which the nodules are imbedded, has a slaty structure, for which reason the labor of excavation may possibly be less than it would be with the more compact clays in Branch county. This variety of ore in Ohio, yields, "in the large way," from thirty to thirty-seven per cent, of cast iron.

Much of the clay with which this argillaceous ore is associated in that portion of our own state alluded to, is so nearly destitute of lime, and of so homogeneous and fine a structure, as to be well adapted to the manufacture of stone ware and fire bricks, and it cannot fail, ere long, to come into extensive use for these purposes. For the manufacture of these important articles, none of the numerous clays which have been noticed in the state will compare with those of this formation.

The investigation of this subject, as directed, will be continued upon the first opening of spring, with the view of bringing to light all the facts connected with this interesting and valuable deposit.

The peculiarly favorable situation of the surrounding country for supplying the materials required for the reduction of iron ore, renders it exceedingly desirable that the whole facts respecting this deposit, be known. With an abundance of hydraulic power, situated in heavily timbered lands, yet surrounding by plains and prairies, in the immediate vicinity of the flourishing village of Union City, situated at that point to which the St. Joseph may be made navigable by improvement, and withal, possessing agricultural advantages second to none in the state, if it be satisfactorily determined that the raw material may be found in sufficient abundance to warrant, it is presumed that capital would not be slow in seeking an investment which would promise so abundant a return of profit.

In connection with this subject, I cannot refrain alluding to the fact, that we have not as yet a single furnace for the reduction of ore in our state, and while there is abundance of the raw material, requiring a comparatively small amount of capital invested for its manufacture, we are annually sending abroad an immense amount of money for those very articles, enhanced in value by the cost of transportation, which should be produced upon our own soil. Thus, while the rich bog ore of Kalamazoo, Jackson and Oakland counties are yielding their owners no profit, the very citizens who should be supplied from these sources, are transporting castings, by land carriage, at an expense, which, at this season of embarrassment, they are little able to bear.

The extensive bed of bog iron ore in the immediate vicinity of the village of Kalamazoo, alluded to in the first annual report from this department, and described in the accompanying report of Mr. Douglass, in consequence of the richness of the ore, together with its peculiarly favorable situa-

tion upon the banks of the Kalamazoo river, offers inducements for the investment of capital, that would appear to be in no wise appreciated; and it is sincerely to be hoped that ere long, sufficient drafts will be made upon it, to supply at least the inhabitants of that portion of the country, with all the iron which their wants may demand.

The valuable deposit of bog iron ore upon the land of Isaac N. Swain, Esq., near the village of Concord, Jackson county, referred to in the accompanying report of Mr. Douglass, should not be suffered to lie idle, and it is to be hoped that the enterprising citizens of the county in which it occurs, will not allow another year to pass by, without applying to use, that source of wealth which is now yielding profit to no one.

#### *Gypsum and Marl*

Closely connected with the iron ores of our state in importance, is the subject of calcareous manures. Our citizens are already annually importing from the neighboring states, large quantities of plaster, and this import must have a rapid increase unless means be taken to open the stores which are found within our own state. There is no point now known where gypsum can be so readily obtained, and where it is at the same time so advantageously situated for distribution over the surrounding country, as at the rapids of Grand river. Here is an extensive deposit of this important mineral, which in quality is not exceeded by any in our Union, yet thus far it has been entirely neglected. This should not be, for the time has now arrived when it is required for use, and no contingency should be allowed to arise that will cause it any longer to lie dormant.

The *marl* beds that are distributed at such short intervals over our state, appear thus far to have been wholly neglected by our agriculturists. These marl beds may be made to yield an inexhaustible supply of calcareous manures, which, judiciously applied upon proper soils, will be found scarcely in-

ferior to plaster itself, and with the advantage that the marls are always close at hand, and may be procured at an expense which, compared with that of gypsum, is trifling.

The appended reports of Messrs. Hubbard and Douglass, serve to show the immense deposits of this mineral embraced within the organized counties of the peninsula, and to those reports I would refer you for more particular information on this important subject.

#### ZOOLOGICAL AND BOTANICAL DEPARTMENTS

In conformity with the provisions of "An act relative to the geological survey," approved March 22, 1838, creating the Zoological and botanical departments of the geological survey, these departments were duly organized by the nomination by the head of this department, and the appointment by the governor, of the several assistants contemplated by the act.

Reports of the duties performed by the heads of these departments and of the progress which had been made in the work assigned them from the time of their appointment until January 1, 1839, were duly transmitted with the second annual report which I had the honor to lay before you.

Immediately after the adjournment of your honorable body at your last session, the resignation of the several assistants in these departments, caused a suspension of this portion of the contemplated work, since which time it has not been in my power to select persons competent to the task who would willingly accept the trust.

The resignation of the heads of these departments, and the suspension of work which necessarily followed during the complete season for labor in the field, has operated exceedingly unfavorable to the interests of these portions of the survey, and while I had hoped to see the zoology and botany of our state under the guidance of the able assistants in whose hands they had been placed, rapidly approaching to completion, comparatively little advance has been made, and the subjects re-

main very nearly where they were left at the date of my last report.

In order to preserve from absolute loss, what had already been done, and to make such advance as the circumstances might admit, a single sub-assistant, Mr. Geo. H. Bull, retains his situation, and by his assistance I have been enabled to place the botanical portion of the work in such condition that it may be of use in the final and connected reports which are required to be made.

It will be borne in mind that the several assistants, in the departments under consideration, are made by law, *state officers*, and that their salaries are fixed by that law; for which reason it will be perceived that the expenses incurred during the past year, must of necessity, have been reduced the amount of the salaries of the several assistants and sub-assistants, who have handed in their resignations.

In the present condition of the zoological and botanical departments of the survey, it will be impossible, under any contingency, to complete the work in the manner directed within the time assigned, while the work in the geological and topographical departments is drawing rapidly towards a close. The time which remains for the completion is so short, that I feel assured, no competent man would be willing to hazard his reputation in attempting, *within the space allowed*, to complete either the botany or zoology of our state. Again, if the time for the completion of these subjects be extended, they must necessarily, in the end, be separated from the general work, which will require no such extension.

#### GEOLOGICAL AND TOPOGRAPHICAL DEPARTMENTS

The plan of organization adopted in these two departments of the survey is such, as to render them so mutually dependent upon each other, that they can scarcely be considered separately; for the field duties in each are performed by the same assistants, and it is not until the field notes are returned to the office, that the geological and topographical portions

are finally separated. The labor of the assistants in these departments, as well as a portion of my own time, has been devoted to a continuance of the surveys of the organized counties of the state, and the work, although still in many parts incomplete, has, nevertheless, made rapid advances towards completion.

For an abstract of the progress that has been made in the topographical part of the survey, I would refer you to the report of the principal assistant in that department, hereto appended. The services of the topographer have been constantly occupied in reducing to form, the field notes, as they were returned from the geological department proper, by which arrangement, the contemplated maps of the separate counties of our state have been brought much nearer to completion than could have been anticipated.

For an outline of the plan adopted for county maps, as well as for the arrangement of this portion of the work, I would refer you to the second annual report from this department, and, in order to render this subject more intelligible to you, an outline map, representing the scale and general plan adopted for the separate counties, is hereto appended.

In connection with this subject, I would again respectfully call your attention to the importance of a sub-division of the northern portion of the southern peninsula into counties, for the reasons set forth in the report before alluded to.

Although a vast amount of labor yet remains to be done in the field in order to complete the work that has been commenced, will, nevertheless, with the present organization, be enabled, I trust, to complete the geological and topographical parts of it within the current year, being the time originally assigned by the act authorizing the survey. It will, however, be impossible, under any contingency, to complete the zoological and botanical portions of it within that time, and under the aspect which the subject has assumed since your last session, I have been led to believe a suspension of this portion of the work would be in consonance with your views. Should

this be deemed desirable, no very great injury will now be sustained by the other portions of the survey, while the expense will be reduced nearly one-half.

In addition to the labors yet required to be performed, an abstract of which will be seen by reference to the report of the topographer, there yet remains to be surveyed the whole of the northern slope of the upper peninsula, extending from the rapids of the Ste Marie river, to the westerly boundary, at Montreal river, the complete line of coast from the foot of lake Superior to the most westerly boundary, will require to be triangulated for the use of the topographical department, as well as for the correct delineation of the geography and geology. The uneven character of a portion of this country, will serve to render the topographical duties of those engaged in the geological survey, of the most arduous kind.

The geology of that district extending from Keweena point to, and including the Porcupine mountains, and stretching far into the interior, will require much minute examination, for it is within this district that the rocks containing the copper ore of lake Superior, are embraced. Were it not that I have already examined this country sufficient to know to what point to direct particular attention, it would be impossible to accomplish a work, involving such immense labor and hardship, within the time specified by the act of organization; but as it is, aided by the efficient and industrious assistants connected with the department, I can safely say, that the whole will be accomplished within that time.

DOUGLASS HOUGHTON,  
*State Geologist.*

REPORT OF S. W. HIGGINS, TOPOGRAPHER OF GEOLOGICAL SURVEY

*Detroit, January 12, 1840.*

*To Douglass Houghton, State Geologist:*

Since the date of my last annual communication to you, my whole time has been occupied in the drafting office, mostly in compiling and adapting to the scales of the proposed maps, the details of information furnished to this department in the progress of the geological survey, and the United States linear surveys.

The mutual connection, established by act of the legislature of 1838, between the geological and topographical departments (of the survey,) has not only enabled the latter to proceed with greater rapidity, but has furnished to this office through the assistance of those engaged in the *geological* department, an immense amount of topographical information which it would have been impossible otherwise to collect. The details returned by the geologists are platted, or roughly drafted by them while in the field, upon maps of single townships, on a scale of two inches to the mile. This scale admits of the utmost minuteness necessary in laying down the results, as well of the geological as the topographical investigations; and these *township plats*, thus executed, and returned to me, from time to time, are then applied by this department, to the reduced scale of two miles to the inch, which has been adopted for the several county maps.

The interest which of late has been manifested to ascertain the boundaries of lands held in dispute, where the parties were enabled to exhibit evident claims, has induced me to attempt a full collection of the patents issued by the United States to lands claimed by the inhabitants of the territory, and to construct a map which shall include all the necessary references as to the extent and boundaries of each separate tract, and the quantity of land contained therein.

Having thus stated the character of the duties which have occupied the officer of this department during the past season, I proceed to lay before you the

*Progress of Maps under construction*

Those maps which were mentioned in my report of last year, as being in a state of forwardness, have progressed towards a state of final completion.

Of the thirty-four counties whose boundaries have been established by law, the topography of the following sixteen has more particularly been examined, and laid upon them, viz:

Wayne,	Livingston,
Jackson,	Washtenaw,
Lenawee,	Ingham,
Calhoun,	Eaton,
Branch,	Hillsdale,
St. Joseph,	Monroe,
Cass,	Oakland,
Berrien,	Genesee.

Explorations have been made of Ionia, Kalamazoo and Van Buren, but want of time has prevented the further execution of the maps of these counties.

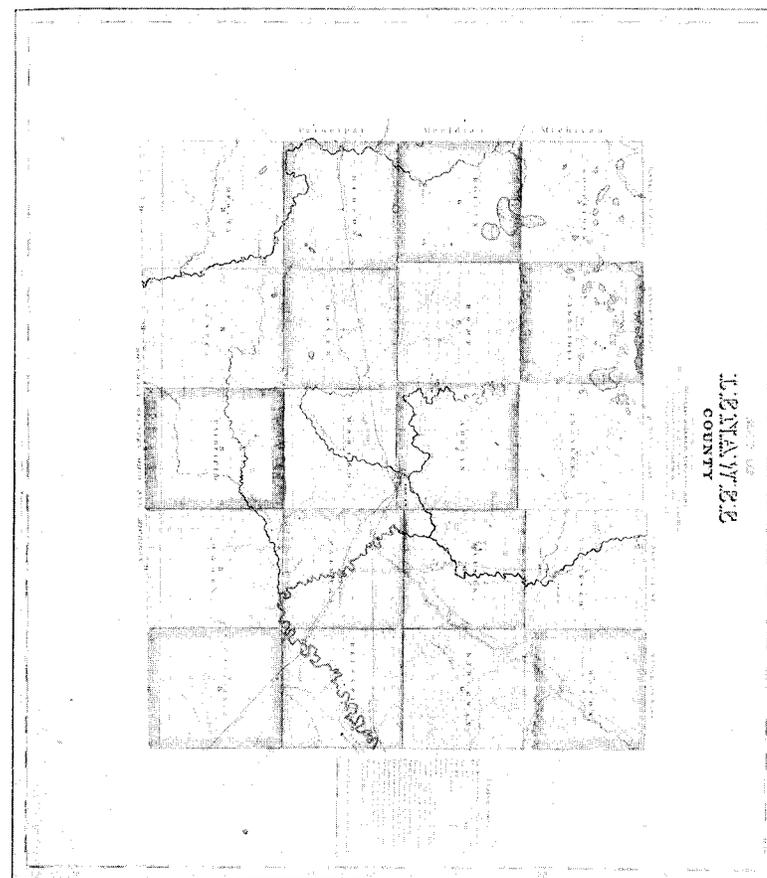
Limited portions only, of the counties enumerated below have been explored, it being intended to resume that work in the proper season.

Lapeer,	Clinton,
Saginaw,	Allegan,
Kent,	Shiawassee.
Ottawa,	

No investigations have been made as yet, in the following counties, viz:

Barry,	Macomb,
Sanilac,	St. Clair,
Midland,	Gratiot,
Isabella,	Oceana.

The northern parts of Kent, Ottawa and Isabella, and the whole of Oceana, were unsurveyed at the time of establishing their boundaries, but since they have been sub-divided, along with much of the remaining portion of the peninsula, it



would now be a proper time to determine any alterations to be made, and also to establish the boundaries of new counties over that portion of the state.

Oceana and Ottawa are greatly disproportioned in size, to all the other counties of the state, except Oakland, the former having an area of thirty-six by sixty miles, and the latter twenty-four by thirty-six; while Branch, Cass and most others have an area only of twenty-four by eighteen miles.

In progressing with the topographical maps, regard has been had, in connection with the geological survey, to a speedy publication of them, with as little delay as possible, in order to place in the hands of our citizens, as well as of the emigrant, who may require a more accurate knowledge of the country, the information which they contain. Much solicitude at the present time is shown in many of the eastern states for similar maps, presenting such a delineation of their territories as will develop their own resources, and as may tend to the prevention of that tide of emigration which has set westward for the last few years.

Aided by little else than common report, and information furnished by surveyors, of the richness of our western lands, the spirit of enterprise induced constant emigration to our state, and were further means used to extend information in regard to the remainder of those lands recently surveyed, and lying north of Grand river, and, indeed, in every other part of the peninsula, not yet bought up, they would be much more speedily settled upon and improved.

For want of the means of a better knowledge of the country, it is believed that the north and west have been neglected, where selections might be made, equal to the best in quality and extent, and comparable with any other districts on the peninsula.

To prevent Michigan from being a mere thoroughfare for emigrants, who, having embarked for states and territories in the west, are seeking the most direct passage into Illinois, Wisconsin and Iowa, while the best portions of our state are

passed by, justice to the former reputation of our soil demands a description, the correctness of which would more than maintain its former and deserved estimation.

"If the benefits of correct topographical maps are not obvious to the minds of all, they are none the less real. The durable reputation of the state is too deeply concerned," to leave to circumstances merely, or to fortuitous information, the decision, whether a residence in *Michigan* is preferable to one beyond it; nor can we expect that without the information which such maps afford, the country will be either known or appreciated.

#### *Maps of lands donated by the United States*

I have now in my possession, copies of almost all the original patents, and have advanced so far in the construction of the map, as to approach completion. No labor in this department has been more arduous; at the same time none has given me more satisfaction, or appeared to offer greater advantages to those interested. This is the more evident, since there exists no map of these surveys, which can in any manner be depended on, and those which do exist, are too much mutilated for use, and are both few and erroneous.

It is well known, that in very many cases these surveys made by Mr. Greely, upon which patents were granted and confirmed, will greatly affect the proprietorship of fractional lots lying in connection, inasmuch as instances occur where the section lines of surrounding surveys, made six years afterwards, are found to pass through and are closed upon the interior lines of patents, and portions of such patents, being actually sold in fractions as public lands.

An instance of this kind occurs about nine miles west of the city of Monroe, on patent No. 538, survey No. 428, containing 61,364 acres, originally donated to McDougal and Ruland.

While it is barely possible in any other of the surveys of the state that these conflicting claims can occur, on account

of the regularity and method observed, almost endless litigation is likely to be the consequence of a re-survey and establishment of the boundaries of these donated tracts.

The consequent utility, therefore, of a correct map of these donations, can be little less than that of a true description contained in a title to the property at stake. The period should not be further prolonged, for the public to be in possession of this work, and to secure the important advantages to be derived from it.

#### *Extent of donated Lands*

The number of acres comprised in these patents, as near as I can now state, is about 130,000 acres; 52,165 of which lie in the neighborhood of Monroe, viz: between the riviere aux Vase and riviere aux Loure, or Otter creek, 3,980 acres; between the riviere aux Routre and Plaisance creek, 1,167; between Plaisance creek and Fleurisance or Plumb creek, 2,143 acres; between riviere Raisin and Mason's run, 267 acres; between Mason's run and riviere aux Sable, 1,958 acres; between the riviere aux Sable and riviere aux Roche, 1,280 acres; and on each side of the riviere Raisin, the balance 41,368 acres.

Leaving the riviere aux Roche, or Stony creek, an interval of undonated lands occurs along the remainder of the shore of lake Erie, with but few exceptions, until reaching the Ste Cosme, at the mouth of the riviere Ecorces on Detroit river. From thence, for the distance of forty-five miles to Anchor bay in lake St. Clair, the lands are held by donation; thence again at not unequal intervals, to the shore of lake Huron.<sup>38</sup>

In short, much of the frontier included between the Maumee river, at the south-west end of lake Erie, up to lake Huron, was given to the inhabitants when this territory last changed rulers, and became a member of the Union. The inhabitants being few in number, required the fostering care of the

<sup>38</sup>For a history of the early transactions of the territorial government, and the commissioners appointed to settle land claims, vide American state papers, public lands, vol 1, and Woodward.

government. At that period no human foresight could have predicted the immense value which these lands have since acquired; indeed, until the last few years, many important facts, relating to their ownership, were passing away; and in all probability, in a few years more, cases would have occurred, where nothing would have been left, except such little information as tradition might have recorded.

#### *Additional number of Peninsula Lakes*

The number of these was stated last year, as far as was then known, to be 1,425; this year the additional number which have been meandered, and otherwise known, amount to 872. The final number, probably, will not prove less than 3,000; thus the Indians have most aptly designated *Michigan* as *the land of lakes*.

Lake Lemen, in Switzerland, undoubtedly merits all that has been bestowed upon it by the thousand travelers who take occasion to visit that region. It would require, however, but a very limited knowledge of almost any district in this state, to find it surpassed; and the praises so liberally published and sung from "*note books*" and "*scraps*," "*journals*," "*residences*," "*reminiscences*" and "*pencillings*," would no more be heard in defence of a comparatively small expansion of a river.

Our inland peninsular lakes far exceed in number and beauty all others, perhaps on the globe. There are many, too, of the twenty-four hundred, already explored, dotting the surface of the country at every elevation, that for combination of all that is required in a finished picture, can never be excelled; hundreds of them present, what art has long endeavored to imitate in older countries, investing them with lawns, interspersed with orchards of a noble growth of oaks, and frequent prairies, flush as at the dawn of their creation. No eye, however sated, nor mind, however perverted, can contemplate a landscape so rich and varied, without yielding to the impression of its loveliness.

The outlets as well as inlets, of many of these lakes, are subterraneous; no surface stream being apparent, but the source of their supply may, with little examination, be discovered, in the numerous springs around their margin; which are usually indicated by clumps of willows and other bushes, and not unfrequently by masses of tufa.

The rise of water in all the peninsula lakes, was co-incident with the late rise in the great lakes, and originated from the same cause.

Wells sunk in their vicinity, particularly when the sand rock has been excavated, have an ebb and flow occasioned either by rains, or change of wind, affecting the level of the lakes with which they communicate.

#### *Roads and Highways*

The roads and highways of our State claim a remark, as excelling in many particulars those of the east, both in respect to their uniform grades and their passable condition at all seasons of the year. The cause of the first mentioned superiority is common to most of the western country, viz., the even and level nature of the surface, which is at most gently undulating or rolling, with the total absence of mountains or high hills. The second arises from the nature of the soil, it usually containing much sand and gravel in its composition.

The roads in the openings and plains offer to the traveler a variety of routes, with the choice of diverging at pleasure, the scattered oaks leaving sufficient space between for the passage of horses or carriages, while the prairie is one wide, unbounded highway, where no obstacle is present for pursuing whichever course curiosity may direct. These roads require the expenditure of little or no labor to keep them in repair.

The only exception to the above remark is found in those roads which, commencing at the different frontier towns on the eastern coasts, lead across a low, timbered belt of country

for the distance of six, ten and fifteen miles, and where the soil, as in some other districts, is clay. In these districts they require to be worked at no inconsiderable expense, to keep them passable during the wet periods of the fall and spring.

*The Chicago Turnpike or Trail*

Among the most noted of the highways of the State, the "Chicago road" claims a particular notice. It was formerly to the western tribes of Indians, the Sauks, Foxes, Winnebagoes, Menomonees, Potawatamies, etc., what the national road from Cumberland to St. Louis now is to the whites. They were constantly traversing it in periods of war and peace, or when treaties were negotiating and different and distinct tribes were to be represented.

The Sauks from the Mississippi, in great numbers, in late years were accustomed, by this route, to reach Fort Malden to receive their annuities from the British government.

There were no parallel trails across the peninsula, and the trails from the Potawatamies in Indiana and Illinois, and from the Foxes, and Menomonees, &c., of the northwest, all joined near the south bend of Lake Michigan, and uniting into one led directly to Detroit.

Persons even well acquainted with the appearance of an ordinary Indian path are astonished at the width and depth of the track which is visible in places to this day.

Such was the directness and facility of this route that the United States made an appropriation some time after the erection of a territorial government for the northwest, causing a survey to be made of it from Detroit to Chicago, and letting it in sections for the construction of a turnpike.

This trail is supposed to be as long as any other within the territory of the United States, being two hundred and forty miles from Detroit to the point where it received those diverging trails from the south and north-west, and the length of some of its branches cannot be less than three hundred miles

further, while numerous smaller ones enter from different directions, by which means the early pioneers of the west easily threaded their way through these regions, and into the valley of the Mississippi beyond.

*Natural Woods of Michigan*

The arrangement which this subject calls for properly belongs to the department of botany. Nevertheless, without attending to the details which should accompany a catalogue of an entire flora, it will be sufficient to exhibit generally the geographical boundaries of such of the larger productions as are required for constant use, either in farming, building, or for the market.

Oak is the predominant growth of the peninsula. Among the varieties, the white is in the greatest abundance.

The shingle or laurel oak, and the red oak, are next abundant. And the burr oak, though not usually found intermixed in common with the other varieties, abounds, notwithstanding, over extensive areas, not unfrequently to the exclusion of other kinds.

The surest indication of a good soil accompanies the last mentioned, and the finest and largest crops of wheat are there produced, for the reason that the soil contains a larger amount of calcareous matter.

Dividing the peninsula by an east and west line, nearly corresponding to that of the northern railroad, a botanical map would represent the northern portion as having by far the greatest burthen of timber, possessing a proportionable quantity of the different varieties found elsewhere in the State.

Marked limits may be given to those districts in the southern portion, where a few groves of pines are found. Their localities are in the vicinity of the water courses of Kent and Ottawa counties, and among the timbered lands of Allegan, extending in comparatively small tracts along the borders of Lake Michigan, nearly to New Buffalo, in Berrien.

In crossing the State through the interior counties none are met, until reaching the central parts of Genesee, Lapeer and St. Clair. Here they are again found in the same range of northern townships, where they first occur, in the counties before mentioned.

North of this belt or zone, which is the natural boundary between the oak openings and plains of the south, the forest abounds promiscuously with the white, yellow and Norway pine, white cedar, tamarack, ash, oak, birch, sugar maple, sycamore, beech, lynn, elm, white wood, black walnut, &c., &c.

There are, however, extensive districts nearly continuous from Ottawa, Kent and Ionia counties, northward, of openings and small prairies, particularly a few miles inland from White River, and from Great and Little Sable points. But on ascending the Maskego River until reaching its source, thence north, on both sides of the principal meridian, extensive tracts occur, in many instances free from a mixture of other timber, while in other places the sugar maple and beech are not unfrequently found commingled with pines of immense girth.

The fact of the white wood and black walnut accompanying the sugar and beech, as seen occupying the districts inland, from the Sable points, in towns thirteen, fourteen, fifteen, sixteen and seventeen north of ranges fourteen, fifteen, sixteen, seventeen and eighteen west, would, to the most ordinary agriculturist, demonstrate the superiority of the soil, and, when taken in connection with the limited tracts of oak openings and the great amount of the most valuable timber, it seems difficult to determine any preference of the southern over the northern portions of the State.

The soil is not considered of so good a quality on the eastern side of the peninsula, immediately along the shore of Lake Huron, owing to its low, level and sandy qualities, consisting chiefly of the debris of sand rock. Consequently the timber is generally stunted, and consists, in greater proportion, of birch, tamarack and cedar.

Where pine occurs it is mostly too small to be profitably made use of. But at every advance inland both improve.

The fact of the country throughout the northern interior is high and rolling, or undulating, and appears to one acquainted with the southern part of the peninsula to bear a close resemblance in its general contour.

It may be considered, then, as a question fully decided, that more than one-half of the State is heavily timbered, in that part lying above the northern railroad; that the sugar and pine are here the most common, as well as the most valuable timber; that the other kinds are found in situations equivalent to their occurrence further south, upon streams and bottom lands, or upon plains and openings.

No tree is held in higher estimation by the Indians than the sugar maple, and no source of complaint is more grievous than a separation from it by removal to places where it is not found.

The pine, if not wasted or wantonly destroyed by fire or otherwise, will furnish an abundant supply for a long time to come.

#### *Variation of the Magnetic Needle*

The surveys of Michigan were intended to correspond with the true meridian, excepting those of Mr. Greely, before mentioned, which were made without an observation to determine the true north. There appears, however, a variation between his first and last surveys of about 1°.

This difference is palpable on tracing the lines along the first donation lands, to the rear of the "back concessions," so called, but the time which elapsed between running the front and rear lines may account for this in some measure, being about three years, during which, it is well known, there must have been a greater or less alteration in the magnetic meridian. The needle, in this instance, was attracted westward.

Mysterious as the movement of this instrument is accounted to be, were greater attention devoted to an examina-

tion of the causes that effect it, instead of diminishing confidence in many of its results, its habits, though governed no doubt by a subtle influence, would be intimately known, and its uses appreciated accordingly. The rights of our citizens to their property is closely connected with this inquiry.

Columbus, in his first voyage to America, first noticed the deflection of the needle, and since that time the subject has engaged the unceasing attention of the scientific, particularly for the last few years, insomuch that measures are now taken, both in Europe and America, to investigate fully the causes which are known constantly to affect it.

In 1835 the line of no variation was known to run longitudinally through about the middle of Lake Huron, the variation on the shore twelve miles above the foot of the lake was 6' east; on Pointe aux Barques, in lat.  $43^{\circ} 51' 36''$ ; seventy miles from the foot of the lake it was  $1^{\circ} 38'$ ; twenty miles west of Pointe aux Barques on the same parallel it was  $2^{\circ} 6'$ ; farther west, at the mouth of the Saginaw River, in lat.  $43^{\circ} 36' 30''$ ,  $2^{\circ} 19'$  east; at the same time it was  $2^{\circ} 10'$  at Detroit, lat.  $42^{\circ} 18'$ .

This line of no variation, has had, for the last eighteen years, a slow and perceptible movement westward, whereby continual changes are observable in the magnetic meridian.

The rate of movement, from 1810 to 1822, was from  $2^{\circ} 48'$  to  $3^{\circ} 13' 22''$ , equal to  $25' 22''$  increase of east variation. From 1812 to 1828 a decrease from  $3^{\circ} 13' 22''$  to  $2^{\circ} 50'$ ; (yearly difference, 4 4-10) and for the last twelve years, up to 1840, a decrease  $2^{\circ} 50'$  to  $2^{\circ}$ ; (yearly difference, 4' 10")  $2^{\circ}$  being the variation at this time at Detroit, where the above observations were taken.

The progress made in the surveys of the public lands during the last three years has further developed this subject.

In 1837, on Lake Michigan, near the mouth of Grand River, the variation was  $4^{\circ} 30'$  east; thirty miles north, on the south side of Little Point aux Sable, it was  $6^{\circ} 15'$  east; and twelve miles further, on the north side of the same point,  $6^{\circ} 00'$ ; at

the mouth of Pierre Marquette River, seventy-eight miles above Grand River,  $4^{\circ} 34'$  east.

In 1838 the north boundary of town twenty-four north, range 16 west, on the shore of Lake Michigan, ninety-nine miles above Grand River, in lat.  $44^{\circ} 31'$ , it was  $4^{\circ} 30'$  east; thirty miles east on the same parallel,  $2^{\circ} 50'$  east; sixty miles east on the same parallel,  $2^{\circ} 45'$  east; ninety miles east, same parallel, at the principal meridian,  $2^{\circ}$  east.

The magnetic meridian of Detroit, then, would pass at this time diagonally across the State, having a bearing from Detroit to the mouth of Saginaw River, thence to where the township line number twenty-four intersects the principal meridian, passing off the northern boundary of the State into Lake Michigan near the Little Traverse Bay, and intersecting the western extreme point of Wabashance.

Further data could be furnished were it thought necessary, but the foregoing is presumed to be sufficient to call the attention of practical surveyors to the importance of accurately making and recording their observations.

#### *Diurnal Variation*

Besides the absolute variation, a daily motion has been observed constantly to accompany the needle.

The amount of this variation corresponds to the temperature, and therefore at the period of the united heat of the earth and atmosphere the diurnal variation will be greatest. This variation tends to increase the *absolute* western, and decrease the eastern variation, because the north end of the needle in this case invariably points to the west.

Messrs. John Mullett and W. A. Burt are the only gentlemen who have communicated to me their observations. These were made without a thermometer to determine the degree of temperature, yet during several summers, the correspondence of their observations, with those made elsewhere, agree as to the amount of variation, the mean of August and September,

being 14'. Mr. Burt found the maximum for one day 40', but it is probable that other causes were in combination.

*Errors arising from incorrect observations*

The known inaccuracy of the first public surveys, undoubtedly arose from errors in making observations to ascertain the variation, and shows a recklessness to obligation, which was probably induced by the newness of the country, and apparent distance of detection.

The fairest portion of the state was subdivided with this evident want of skill, and with a carelessness in the first surveyor<sup>39</sup> which has already resulted in a vast amount of trouble and absolute loss, to a portion of our citizens.

The area embraced by these surveys may be traced on the map, commencing at the south boundary of the state; thence northward forty-eight miles to the base line; thence fifty-four miles up to town number nine north; thus passing along the meridian of seventeen towns, of six miles square. Range lines, intersecting these meridians at right angles, were also begun at the southern boundary of the state, at the principal meridian, and closing on the eastern border of the State.

The lines throughout this whole tract were run at a variation differing but little from 4° 39'.

The error lies in a too great variation of about 1° 30', as is proved:

1st. By platting these surveys in connection with those since made, where a convergency, too great, of two miles is observable on a meridian of fifty miles.

2d. By the incorrect manner in which the surveys themselves close; in many instances, a difference of 2° and 3° being necessary to meet the exigence.

3d. From the records of actual observations, made both before and since.

4th. From the improbability of the variation ever having been so great at or near Detroit.

<sup>39</sup>Mr. Wampler.

In 1810, Col. Jared Mansfield record the variation at Detroit, at 2° 48' 00" east.

In 1822 Messrs. Mullett and Lyon record the variation at Detroit at 3° 13' 22" east.

Between the time of the above two observations, during the years 1816, 1817 and 1818, the error was committed, and if Mr. Wampler, who performed the surveying, was right, then from 1810 to 1816 the variation had increased from 2° 48' to 4° 39', making a difference of 1° 51' in six years, or equal to 18' 30" each year, an unheard of phenomenon on this meridian, when it is further considered that in 1828 it was reduced to 2° 50', decreasing in a ratio of 4 4-10' per year only, and 4' 10" being the average annual decrease since that time.

I am inclined to attribute the error to a neglect of observing the motion of the north star at the time of observation. This star revolves around the pole once in twenty-three hours and 56 minutes, and when at its greatest eastern or western elongation is 1° 34', nearly, from the pole. The western elongation was, no doubt, substituted for the meridian, which it was intended to observe, whereby the error occurred.

Little, if any, attention was afterwards manifested to correcting this error, and it is doubtful whether a suspicion existed in regard to it, for being satisfied with having obtained an observation at one point at the beginning of the survey, three years were afterward consumed in establishing town lines, without an alteration of 5' of a degree, advancing with each line westerly over a space of one hundred miles, as in the instance of towns Nos. 17 N.

Now, so far as the best information collected up to this time, in regard to the increase of magnetic variation, (which is stated by Prof. Loomis in the American Journal of Science, Vol. 34, to be about 1° in sixty English miles), these lines on the western boundary of the survey should have been run at a variation of 1° 40" greater than on the eastern. Hence arises the cause of that series of fractional townships adjoining the principal meridian, throughout the extent of this survey.

*Decrease of elevation in the waters of the Lakes*

All that is necessary to observe on this subject, is, a notice of the decrease in the level of the waters of the great lakes during the past year.

It is a question, I believe, satisfactorily determined at the present time that there exists no perceptible tide in them which can be referable to planetary influence, yet for a long time to come, it is presumed, the ordinary fluctuations produced by atmospheric agency will be considered a *tidal wave*, nor will the persuasion be easily dismissed that so great an expanse of water can remain unaffected at least to some degree.

The question is also as fully determined as to their general rise for a succession of years, and then their general subsidence to a certain minimum, the actual degree of which as well as the maximum, were not recorded previous to the year eighteen hundred.

Their elevation in 1838 was given in my report of last year. The waters had then attained to five feet three inches. This proved to be a greater flood than had occurred within the last century.

*Table of elevation and depression in the waters of the lakes, compared with that of June 1, 1839.*

	Fect	Inches	Fect	Inches
August 21, 1838, highest stage,			5	03
September, do. decrease,	0	03	5	00
October, do. do.	0	09	4	03
November, do. do.	1	00	3	03
December, do. do. same,			3	03
January, 1839 do.	1	08	1	07
June 10, do. increase,	2	01	3	08
July 31, do. do.	0	03	3	11
Sept. 20, do. decrease,	0	09	3	02
Oct. 28, do. do.	0	09	2	05
Nov. 27, do. do. same,			2	05
Jan. 30, 1840, do.	1	08	0	09

*Future prospects of the Peninsula*

It would not be difficult, from its topographical features, to predict the future condition and prospects of the peninsula.

It is conceded that most of the soil is peculiarly adapted to the production of wheat and other grains; and that at present, after disposing of a quantity equal to the whole product of any other state, the surplus which remains would equal in amount that already disposed of.

No district will ever be exclusively manufacturing, even though the coal in the central counties will in time be an article of common use.

The necessity which compels the erection of manufacturing establishments propelled by steam elsewhere, is the want of hydraulic power; no such necessity exists throughout our whole peninsula; were it otherwise, and a resort be had to steam, the coal region will furnish an abundant supply for all purposes which any other state can boast.

Hence it is, that so common are the facilities for the erection of mills on our streams, that there are no less than three hundred and eighty-six for flouring and sawing, in thirteen counties; Oakland and Lenawee each have fifty-one, and Washtenaw fifty-eight.

With equal facilities for making lumber, the pine of the north has already become an article of export from our shores.

Already such is the pursuit after the wealth which lies stored up within the lakes, that public attention is turned to the establishment of extensive fisheries on their distant shores and islands, and it will require but a few years for the development of this field of enterprize, and realization of its lucrative returns.

Michigan is a maritime state, having the advantages of the commerce of immense inland seas on every side; add to this the agricultural resources of which she is capable, and within the last twelve months has given an earnest, in her interior lakes and rivers, her resources in lumber and minerals, and an estimate may be formed of her future prospects and

wealth; in the exportation of her products, the establishment of manufactories, in lines of internal improvement, and in the independence of her citizens.

S. W. HIGGINS,  
*Topographer to the Geological Survey.*

*Report of C. C. Douglass, Assistant Geologist*

*Detroit, Jan. 12, 1849.*

*To Douglass Houghton, State Geologist:*

*Sir*—In compliance with your instructions, I have the honor herewith to transmit to you the general results of so much of my geological and topographical examinations, made during the past year, as are of practical utility.

In addition to the geological examinations, specimens have been collected, illustrating the geology, mineralogy and soils of the counties examined, and in accordance with your instructions, by which the assistants in the department of geology were required to perform the additional duties of assistants in the topographical department of the survey, field notes for the construction of accurate topographical maps of nearly every township examined during the past season, have been returned to that office.

My time during the past year has been chiefly occupied in making a detailed examination of the northern and western counties of the state.

In order to avoid, as far as may be, that repetition which would necessarily result from a consideration of the counties separately, I have grouped in a single district, the counties of *Jackson, Calhoun, Kalamazoo, Eaton, Ionia and Kent*, and comprised in a second group, the lake counties, *Ottawa, Van Buren and Allegan*. The geological features of the first group of counties would be extremely interesting, containing as it does the principal coal series of the southern part of the state, were it not for that almost universal covering of di-

luvium and ancient alluvion, varying in thickness from a few inches to several hundred feet, beneath which they are to a great extent concealed.

*General remarks on the counties of Jackson, Calhoun, Kalamazoo, Eaton, Ionia and Kent*

In their topographical features, these counties, as a whole, may be described as gently undulating, with frequent level tracts of land, and occasional irregular knobby ridges.

The major part of Jackson, Calhoun and Kalamazoo counties, presents black oak, white oak, and hickory openings, interspersed with plains of white, black and burr oak, and hickory; while there are numerous tracts of heavily timbered land and prairies.

Ionia and Kent counties are nearly equally divided between oak openings, plains and heavily timbered land. Eaton county is mostly heavily timbered with beach, maple, &c.

The soil of these counties, as a whole, [does] not appear to have resulted from the disintegration of the rocks upon which they are based, but to have had their origin chiefly from the transition and primary rocks lying farther to the north. Intermixed with these, is not unfrequently a proportion of the debris of the coal bearing rocks, or the rocks of that series which forms by far the greatest portion of the district under consideration. Boulders of primary rocks, are not of unfrequent occurrence, and in some places occur in very great abundance.

The soil derived from these sources, presents all the varieties, from a siliceous sand to a stiff clay; nevertheless, the most meagre of these soils contains the mineral and organic elements which are necessary to the growth of vegetation. As if to supply these soils, which may have been naturally meagre, or may have been rendered so by exhausting crops, nature has deposited inexhaustible quantities of manures, almost universally, throughout the counties, in the form of

decayed vegetable muck, shell and tufaceous marl, marly clays, limestone and gypsum.

Marl, which is more universally distributed than any other of the calcareous manures of this district, and which will, in consequence of this fact, admit of a more universal application, is in itself more valuable for this purpose than limestone, since it generally contains vegetable and animal matter in combination, and its effects are more immediate. It exists in a state of minute sub-division, and is in a condition prepared to become directly a constituent of the soil; while it is necessary that limestone, as well as gypsum, should first be reduced to powder.

#### *Marl*

Deposites of marl were found in nearly every town in the counties under consideration, occurring in the beds and banks of lakes and streams, in marshes, as well as occasionally, on the more elevated and dry lands, at a considerable distance from water.

This latter position is not unfrequent, but marls found in this situation, invariably show that they occupy what has heretofore been the bed of some lake or pool. Thus the marl does not seem to be confined to any particular soil or geological position.

For further particulars, respecting the origin and formation of marl, I refer you to Mr. Hubbard's report.

#### *Local details of Marl. Jackson County*

Shell marl occurs more or less abundantly in the town of Napoleon, on sections twelve, fourteen, fifteen and nineteen, and other deposits of minor importance, were also noticed in this town.

In the town of *Columbus*, marl occurs, forming a very extensive deposit in the vicinity of Clark's lake. It also occurs abundantly on sections eight, nine, thirteen, nineteen, twenty-eight and twenty-nine, in the same town. Several of these deposits have an area of more than one hundred acres.

Several very extensive beds of marl were noticed in the town of *Liberty*, on sections eleven, thirteen, twenty-three, twenty-four and twenty-seven, as well as in the bed of Powell's lake and its vicinity.

The town of *Spring Arbor* abounds in very extensive beds of marl, which were more particularly noticed on sections twenty-one, twenty-eight and twenty-nine.

*Hanover*. A bed of marl having an area of more than one hundred acres, was noticed, forming a portion of the bed and banks of Farwell's lake. Inexhaustible deposits of shell and tufaceous marls occur near a lake which forms the head of Kalamazoo river.

Town of *Sandstone*. Marl is not unfrequently met with in making excavations in the marshes of this town. It was noticed near the village of Barry, and also on the farm of the Hon. Mr. Gidley.

*Pulaski*. Marl occurs in abundance in many of the lakes and marshes of this town. A very extensive bed of shell and tufaceous marl was noticed on the farm of Isaac N. Swain, section two, occupying an area of more than sixty acres, and having a thickness exceeding six feet. An extensive bed was also noticed on section twenty-five.

*Rives*. A somewhat extensive deposit of marl occurs on section nine.

*Leoni*. Marl, in inexhaustible quantities, occurs near the outlet of Wolf lake, and also upon sections four, eleven, twelve, twenty-two and twenty-three.

Town of *Jackson*. Marl occurs in this town, in abundance, on sections twenty, twenty-one, twenty-six, twenty-seven and thirty-one, (town three south, range one west,) and also on section thirty-one, (town two south, range one west.)

*Concord*. Several extensive beds of marl occur in this town which were more particularly examined on sections eight and nine. Also in the bed and banks of the Kalamazoo river.

*Grass Lake*. On sections thirteen and twenty-nine, in this town, extensive beds of shell marl were examined.

*Springport.* An extensive bed of marl occurs on section fifteen.

*Tompkins.* An extensive bed of shell marl was examined on section seventeen, in this town.

#### *Eaton County*

*Kalamo.* Several very extensive beds of marl were observed on sections twenty-two and twenty-five, (town two north, range six west,) and on section nineteen, (range five west.)

#### *Kalamazoo County*

*Texas.* Shell and tufaceous marls occur in the beds of several lakes in this town. Also on sections thirty-one and thirty-two, of the same town, is an extensive deposit of this mineral.

*Alamo.* On sections one, nine, twelve and twenty-four, extensive beds of marl were examined.

*Cooper.* Marl is not unfrequently met with in the alluvial lands in the vicinity of the Kalamazoo river.

*Ross.* Marl was noticed in several of the lakes and marshes of this town.

*Kalamazoo.* Tufaceous and shell marls occur in a large marsh and in the valley of a small stream north-west from the village of Kalamazoo.

*Chester.* Extensive deposits of marl abound in this town, on sections four, nine, ten, eleven, twelve and twenty-four.

#### *Calhoun County*

Marl occurs at intervals through this county in the alluvial lands of the Kalamazoo river, and pebbles and boulders are not unfrequently seen in the bed of the stream, incrustated with a thick coat of tufaceous marl.

*Milton.* Marl was observed in this town on the farm of Hon. S. McCamly. It also occurs in several of the small lakes and streams.

*Marengo.* Marl is of very frequent occurrence in this town. An extensive bed was observed on sections one and two.

Marl was observed in the town of *Marshall*, near the Hon. Mr. Pierce's mills. Also, in comparatively small quantity, in the low lands between the village of Marshall and the Kalamazoo river.

#### *Kent County*

Town six north, range nine west. Tufa occurs in this township in the bed of Flat river, on section twenty-six, in a very extensive deposit.

Marl was observed on sections three and eight, township six north, range twelve west.

Extensive deposits of shell marl occur on sections twenty-two and twenty-three, township seven north, range ten west.

Marl was examined in township eight north, range eleven west, on sections thirteen and fourteen, in a dry burr oak plain.

#### *Ionia County*

Tufaceous marl occurs in inexhaustible quantities in the vicinity of Lyon, town of Maple. Incrustated in some portions of this tufa, are quantities of leaves, recent shells, and in one instance have been found the vertebra and other remains of a large snake.

Marl occurs on section one, township six north, range five west; its extent unknown.

Extensive beds of shell and tufaceous marl exist near Mr. Dexter's mill, in the village of Ionia. Also, in the bed and banks of several of the small streams west of Ionia village.

Extensive beds of marl occur in sections ten, eleven and twenty-two, township eight north, range eight west.

This abstract of the locations of this valuable mineral only includes some of the most extensive deposits. It is sufficient, however, to render it apparent that marl is distributed in sufficient abundance to afford a ready supply for use as a manure, as also for the manufacturing of quick lime. It is

within the reach of every man to obtain this restorative for his soils or a lime for economical purposes; an article of which, otherwise this country would be nearly destitute.

#### *Peat*

This combustible alluvium is not unfrequently met with in the counties under consideration, in considerable quantities. That which has been examined, is chiefly of a coarse and fibrous character at the surface; while at a slight depth, its compactness is much increased. It will afford a tolerable article for fuel, when the wants of the country shall require it. This substance will, if properly prepared in compost heaps, prove of great value to the farmer, as a manure for enriching his land, and occurring as it does in abundance, this must eventually become a subject of great importance.

#### *Clays and Sands*

Sands and clays forming portions of the diluvial and alluvial deposits are found in occasional somewhat extensive beds, in various parts of the counties under consideration, and may be found occupying positions, from the lowest sink to the summit of the highest elevation, apparently having no regular order of place but appearing in the form of irregular deposits.

*Sand*, suitable for moulding, brick making and for mortar, occurs in great abundance, and is usually composed of grains of quartz, hornblende and debris of other primary minerals. It sometimes appears in a stratified form, and this stratification more frequently assumes an oblique direction to the plane of the horizon.

Many portions of the soft and disintegrating sandrock may be made to furnish a good material for the manufacture of glass; and its freedom from impurities renders it peculiarly adapted to use for this purpose. The most important situations in which sandrock, most suitable for this purpose, occurs, are at Jackson, Barry and Concord, Jackson county; also

at the village of Marengo, and on the farm of Mr. Bagg, section seventeen, town of Marshall, Calhoun county.

*The clays* of these counties may be described according to their predominating colors, viz: red, gray and blue clays. The red and gray are by far the most abundant, and may be made to enter largely into use, for economical purposes. By far the greater portion of these clays is contaminated by the admixture of lime, but since the marly portions of the clay usually form beds in the deposits, the manufacture of bricks, if sufficient care be used to separate the different portions of the mass, is enabled without much difficulty to obtain a clay well adapted for the uses to which it has been applied. The marly portions may readily be known by the application of a simple test, which is always at hand; for if a small piece of clay containing carbonate of lime be thrown into vinegar, effervescence will take place, or, in other words, bubbles of carbonic acid will rise to the surface, and this will take place, more or less actively, according as the proportion of the contaminating marl or lime is greater or less. This simple test, which is within the reach of every individual, may frequently, if applied, save much disappointment and expense.

Blue clay is but rarely seen in these counties. In Eaton county, in township two north, range five west, a blue clay not unlike the clay in the vicinity of Detroit, was penetrated in digging a well to the depth of twenty feet. It contains primary gravel and pebbles.

#### *Boulders*

Numerous water-worn fragments of the primary rocks are found scattered through the counties under consideration. They were noticed as particularly abundant on some parts of the territorial road between Jackson and Marshall; also in the vicinity of the Grand and Kalamazoo rivers. But few of these were of lime or sandstone. Among the lime boulders, a few were seen of several tons weight. They contain numerous fossils characteristic of an older rock than any found *in place* in the south part of this state.

*Bog Iron Ore*

Deposites of bog ore occur in limited quantities in many places, its presence being apparent in the highly ferruginous spots of earth. The most extensive deposits were noticed in Pulaski, Jackson county, and at Kalamazoo and Prairie Ronde, Kalamazoo county. In the town of Pulaski, is a bed of this ore, having an area of not far from five acres, and is deposited chiefly near the source of several copious chalybeate springs, on the farm of Isaac N. Swain, section two. The ore is chiefly shot and ochreous, with intermixed masses of ore; the whole being mixed with tufaceous lime. This bed has been examined to a depth of more than five feet without penetrating through the bed. The ore is of a light yellow color, being what is technically known as live ore. It may be easily excavated, having but a slight covering of earth, and is also well situated for the manufacturing of iron, being in the vicinity of hydraulic power, wood, tufa and sandstone, and is by far the most extensive bed examined in Jackson county.

It may be considered as sufficiently extensive to warrant the erection of a furnace for its reduction.

Ore occurs in the vicinity of *Prairie Ronde*, on section twenty-one, in beds varying from a few yards to several rods in extent, distributed over an area of fifteen to twenty acres, with an average thickness of six inches. It is of a dark color, and rests on peat and tremulous muck or decayed vegetable matter.

*Bog Ore of Kalamazoo*

This ore is chiefly of a light yellow color and occurs mostly in masses of several pounds weight, but also in the form of shot and ochre. It occurs in separate beds forming ridges, and these beds vary from a few rods to several acres in extent, over an area which may be estimated at from eighty to one hundred acres. It varies from a few inches to four feet in thickness. This ore is situated on and contiguous to the banks of the Kalamazoo river, and from half a mile to one

and a half miles from the village of Kalamazoo. This is the most extensive and valuable deposit of bog ore I have examined in the state. It is well situated and will warrant the erection of an extensive foundry for its reduction. An analysis of one hundred grains of this ore gives the following mean results:

Peroxide of iron.....	Grains
Silicia and alumine.....	78.45
Carbonate of lime.....	7.95
Water.....	1.10
	12.50

*Kidney Iron Ore*

The stratum in which this ore is imbedded appears in the slightly elevated bank of Nottawa creek, on section twenty-four, in the town of Athens, Calhoun county. In character and quality, this ore is not unlike that at Union City, Branch county. The clay in which it occurs is well adapted for the manufacture of brick or pottery.

*Gypsum*

Gypsum or plaster, occurs in Kent county, forming the bed and banks of Plaster creek, near the junction of that stream with Grand river. It makes its appearance in two or three places in the banks of the stream. After a careful examination of the surrounding country, I am led to conclude that this mineral exists in distinct beds extending at intervals, over an area of several miles. The precise limits I was unable to define on account of the almost universal covering of sand and gravel, by which it is concealed from view. The beds of gypsum rest upon, or are embraced in the limerock of this district, and are surrounded by a gypsous marl, usually of no very great thickness. The gypsum is of the fibrous variety, and is well adapted to all the uses to which this valuable mineral is applied, and it cannot fail to prove of inestimable

value to the agricultural interests of the surrounding country, as well as to the other parts of our state.

## ROCKS

The rocks of the counties under consideration, are not numerous and these are so universally enveloped by the diluvium as to present but few points which allow of satisfactory examinations.

They may here be considered under two divisions; the rocks which overlie or which are associated with the coal, and those which lie below the lowest of the coal beds. The latter division occupies the south part of Jackson, the south part of Calhoun and a large part of Kalamazoo counties; as well as a considerable portion of the adjacent counties on the south, which are comprised within Mr. Hubbard's district, and were examined conjointly with him. As the series comes more fully to view in the latter district, and in order to avoid repetition, it has been deemed advisable so to blend the reports as to leave to Mr. Hubbard the full consideration of all the rocks lying below the coal.

*The coal bearing rocks included in the first division*, embrace a series of alternating layers or apparently irregular beds of sandstone, shale, coal and limestone, holding the following order of place:

1st. *Upper coal strata*; consisting of layers of coal, shale and sandstone.

2d. *Limestone*; found in limited and apparently irregular beds.

3d. *Sandstone*; light grey and red.

4th. *Lower coal strata*; embracing as above, alternating layers of coal, shale and sandstone.

These will be treated of separately in ascending order, commencing with the strata which are found *next overlaying* the coarse, quartzose sandrock, mentioned by Mr. Hubbard as occupying the highest place in the series of rocks embraced in his report.

I shall preface my remarks on the lower coal strata, by some observations on the range and extent of the coal formation of this state.

The result of my labors in tracing the extent of the coal basin during the past season, has been more satisfactory than I could have anticipated, when the many obstacles that constantly retard such examinations are taken into consideration. The thick mass of detrital matter which covers a large portion of the rocks of the coal bearing group, is an effectual barrier to the examinations of their character except at those distant points where the several rocks make their out-crop. The rapidity with which many of these rocks disintegrate and become covered with debris not unfrequently so effectually conceals them from view as to leave us in many places ignorant of the underlying strata, except so far as deductions may be drawn from general principles. These are a few of the difficulties that I have had to contend with in reducing to anything like accuracy the general results of the scattered local information collected.

In conducting these examinations, I found it necessary to pass over parts of the country previously examined, in order to determine with more accuracy the probable limits of the coal basin.

These examinations have led to the conclusion that the coal basin extends over a much larger area than had before been assigned to it. Most of this basin is so covered with the superincumbent strata of sandstone, sand and gravel, as to prevent the "working" of the beds, at very many points, except by the sinking of shafts for that purpose.

## RANGE AND EXTENT OF THE COAL BEARING ROCKS

The following is the nearest approximation that our present knowledge of the subject can furnish towards the extent of the coal series of rocks in the counties under consideration. The rocks of the coal-bearing group, in their most southerly extension, occur at Napoleon, Spring Arbor and Concord, in

Jackson county; and at Albion, Calhoun county. From thence the line of junction between these and the rock below passes through the town of Marengo, and the north part of the town of Marshall; thence it continues westerly through the town of Pennfield, into Barry county; through which county the line of junction has not been traced. Rocks of this group are again met with at the rapids of Grand river and its vicinity.

On the east, the group of rocks appears in the towns of Leoni and West Portage, in Jackson county; and in the north-east corner town of Ingham county, in the bed and banks of the Red Cedar river.

Beyond this it has not yet been carefully traced, but its boundary is known to stretch north-easterly across the Shiawassee and Flint rivers, including the village of Shiawassee-town, Corunna and Owasso, within the basin; while the village of Flint, in Genesee county, will probably be found to fall a short distance without, and south-easterly from it; thus bringing within the limits of the coal rocks, parts of Genesee, Shiawassee, Ingham, Jackson, Calhoun, Barry and Kent counties, and probably the whole of Eaton, Ionia and Clinton counties.

#### LOCAL DETAILS OF THE LOWER COAL GROUP

*Jackson County.*—In the N. E. corner of the town of Spring Arbor, along the valley of Sandstone creek, the coal makes an out-crop, owing to the removal of the superincumbent rocks, and has only a slight covering of diluvial sand and gravel. This coal was exposed in digging for the foundation of a mill, on section one, and an amount estimated at one thousand five hundred bushels has been raised. The influx of water from the creek prevented those engaged in the work from sinking through the bed; it was, however, penetrated at one point, to the depth of three feet. This coal has been used in smithing, and found to answer a good purpose.

This is probably the lowest stratum of coal in the state. There can be little doubt that the bituminous shale discovered

at Jackson, belongs to the lower coal stratum, and that coal might be procured at that place by sinking a shaft.

The embraced beds of coal appear to thin out as we approach the south edge of the basin; thus, a well, three-fourths of a mile north from Spring Arbor, has exposed, at a depth of fifteen feet, the lower bed of coal reduced to a thickness of about nine inches.

*Calhoun County.*—Although no coal *in place* was met with in this county, the neighborhood of the coal bed is indicated at a few points. Thus, at Albion, I was led to this impression by the presence of its associated sand-rocks, and of coal thrown out of the stream in the bursting of the mill dam on the Kalamazoo, as also by the loose angular bits of coal found imbedded in the soils.

In the town of Pennfield, I observed several large angular pieces of loose coal taken from Battle creek. These evidently had not been transported far, and thus I inferred an out-crop of the coal bed farther up the stream.

*Ingham County.*—In the north-east corner town of this county, the coal crops out in the banks and bed of Red Cedar river. Here it is embraced in a succession of shales and friable sandstone, which constitute an overlaying bed of from five to ten feet thick. After penetrating to the depth of more than two and a half feet, I was compelled, for the want of suitable implements, to abandon farther investigation, without having ascertained its full thickness. The coal at this point is very accessible, and must, ere long, prove of great importance. It is situated on a stream that may be made navigable for flat bottomed boats and perogues, with comparatively small expense, during a considerable portion of the year, and opening a direct communication with lake Michigan.

#### LIGHT GRAY SANDSTONE

The rock found next, superimposed upon the lower coal group just described, is a sandrock, mostly of a coarse quartzose character, and of grey or yellow color. It is dis-

tinguished from the quartzose rock further south, and which lies below the coal group, by its containing impressions of the coal plants. It is rather friable when first quarried, but hardens by exposure. In the vicinity of the village of Jackson, clay iron-stone is disseminated through the upper parts of this rock, but not in sufficient quantity to be of any practical value. Impressions of plants, chiefly referable to the genera *Lepidodendron*, *Stigmaria* and *Calamites*, together with thin masses of carbonaceous matter, were noticed at quarries both north and south of that village.

It is of this light grey sandstone that the penitentiary and court-house at Jackson, are built.

Numerous kettle shaped excavations, similar to those produced by pebbles when set in motion by the action of a strong current, occur in this sandstone, and not unfrequently at a distance from the river, and at an elevation of some twenty to thirty feet above it. Similar excavations were noticed in the lower sandstone series, at a considerable elevation above the Kalamazoo river, near the villages of Marshall and Marengo, Calhoun county.

This rock occurs more abundantly in such situations as to admit of being economically quarried, in portions of the counties of Jackson, Calhoun, Eaton, Ingham, Shiawassee, Clinton and Genesee. When first quarried it is, as before stated, rather soft, but it soon hardens upon exposure, and forms a durable material for building, when not employed in such situations as to expose it to excess of moisture. In many places it also furnishes a good material for the manufacture of grindstones.

#### UPPER LIME ROCK

This rock usually appears at the surface, in detached beds, extending over an area varying from a few acres to two or three sections in extent, and having a thickness, so far as could be ascertained, varying from one foot to sixteen feet. It is superimposed upon and usually appears near the out-cropping edge of the light colored sand rock. This lime rock

usually occurs in flat, irregular masses, and with but slight marks of stratification; most of it, when burned, produces a superior lime, and some portions will afford a good building material. The rock is usually of a light grey color, and exceedingly compact, but it varies in composition, some of the thinner portions, partaking of an arenaceous character. Although numerous perforations of lithodomous molusca were observed in the less arenaceous portions of the rock, I was unable to find any perfect specimens of fossils, except in the most sandy portions. The greater number of these were found at Bellevue, Eaton county, and the Grand rapids, Kent county.

This limerock was noticed on the sections designated in the counties as follows:

#### *Jackson County*

*Town of Spring Arbor*, on section eight, nine, eleven, twelve, seventeen and twenty.

*Town of Sandstone*, on section thirty and thirty-one.

*Parma*, on section twenty-three, in low land.

The limestone was examined on sections one, twelve and thirteen, town of *Jackson*, where it has been extensively used for the manufacture of quick lime.

*West Portage*. The limestone occurs on section six and seven.

#### *Eaton County*

The limestone occurs in the town of *Bellevue*, on sections twenty-seven and twenty-eight, where it is extensively burned for quick lime, to supply the surrounding country.

The out-thinning edge of the lime rock was seen superimposed upon a friable sand rock, on section nineteen, town two north, range five west, having a thickness of about twelve inches.

#### *Kent County*

The lime rock is again seen on the west part of the state, at the rapids of Grand river, a point where, judging from the

general inclination of the strata, its outcrop would be looked for. It is here identified with the rock of Bellevue, Eaton county, in its contained fossils and composition. Lime is manufactured from the rock at this place, for the supply of the surrounding country.

LOCAL DETAILS OF THE UPPER COAL GROUP

On comparing the results of my examinations of the two past seasons, it is apparent that the north part of Eaton county, described in my report of last year, and parts of the adjacent counties, are occupied by alternate beds of sandstone, clay shale, coal and argillaceous iron ore, which are wholly wanting in the more southern counties. This gives a greater thickness to the coal basin than had before been supposed, and also proves what has been previously suggested, that the Grand and Maple rivers, and the Tittabawassa and its tributaries, occupy the synclinal line of the state, thus accounting for the most copious saline springs being found through that range of country.

The subjoined sections will serve to show the manner in which the coal occurs, associated with the shales and sandstone in the upper coal group.

*Section of rocks near the mouth of Grindstone creek, Eaton Co.*

	Thickness	
	ft.	inch
1. Soil.....		
2. Brown sandstone.....	8	0
3. Argillaceous iron ore.....	0	7
4. Sandstone.....	3	0
5. Argillaceous iron ore (in beds).....	0	5
6. Slaty sandstone, containing impressions of plants and coal.....	9	0
7. Coal.....	0	10
8. Friable slaty sandstone.....	5	0
9. Coal.....	1	8
10. Sandstone containing impressions of plants, occupying the bed of Grand river.....		

The strata of this rock are not continuous, but soon blend together, and are seen at no great distance, to embrace thick beds of bituminous clay shale, and thin layers of coal, the whole having a north-east dip.

About one mile from the mouth of Grindstone creek, the coal appears near the surface, having only a thin superficial covering of soil and broken sandstone.

*Section of rocks taken on Coal creek, eighty rods above its junction with Grand river.*

	Thickness
1. Soil.....	6 ft.
2. Sandstone.....	6
3. Dark blue clay.....	4
4. Bituminous clay shale.....	2
5. Dark colored shale.....	2
6. Blue clay shale.....	6
7. Dark colored clay shale.....	4
8. Dark gray shale, embracing beds of coal, extending beneath the bed of the stream, exposing, however, a thickness of.....	20

The associated shales do not appear to be continuous strata, but only occurring in beds embraced as before mentioned, in the upper portions of the coal series.

Clay shale analogous to this, occurs in township three north, range four west, section twenty-two, in the bed of a small stream. Associated with this clay shale last mentioned, are angular blocks of coal and sandrock.

RED SANDSTONE IN IONIA COUNTY

This rock is well characterized, and is unlike any other rock met with in my district. It crops out on the south side and in the valley of Grand river, on section twenty-two, (township seven north, range six west,) on the land of Mr. Dexter. The rock is of a red color, and composed of quartzose sand, slightly cemented, hardens by exposure, and affords a good building material. The quarry has been but partially opened. I was unable to find any traces of fossil plants.

This rock was again met with in the east of this county and the west of Clinton county, in the bed and banks of Lookingglass river. At this out-crop the rock is more variegated, being filled with white spots and streaks, but in other respects it is not unlike the rocks previously described.

This rock may be regarded as occupying a place intermediate between the upper and lower coal bearing rocks.

#### VAN BUREN, ALLEGAN AND OTTAWA COUNTIES

##### *General Remarks*

The topographical character of these counties varies from that of the counties before described, in comprising no part of the high dividing ridges, and in being included in the more level districts which border on lake Michigan.

The country is high and gently rolling, with the exception of a narrow tract of land on the lake coast; this tract being occupied by a series of recent sand dunes, or hills, varying in height from twenty to two hundred feet. Many of these are composed of sand which is constantly shifting its place from the action of the wind. Such are nearly destitute of vegetation, while others have become stationary, being clad with a stunted growth of pine, and in some instances with oak, hemlock, beech, &c.

These counties are chiefly heavily timbered with pine, beech, maple, lynn, whitewood, ash, hemlock, oak, &c., interspersed with oak openings, plains and pine barrens.

Most of that portion of Van Buren county lying south of the Paw Paw river, and a portion of the eastern townships of Allegan county, consist of oak openings and plains.

#### SANDSTONE OF VAN BUREN COUNTY

Sandstone occurs on the line between Van Buren and Allegan counties, in town one south and one north, range fourteen west. It exhibits a very compact texture, is of reddish grey color, and is composed of quartzose sand, with a sparse inter-

mixture of mica. It occupies a slightly elevated knob, having an area of fifteen to twenty acres, and occurs in large angular blocks. As the quarry has not been opened, it was impracticable to ascertain anything further of importance respecting it, than its composition and general character. I am unable, therefore, to refer to its place in the sandstone series.

#### CRAG OR CONGLOMERATE ROCK

Formations of conglomerate were noticed near the village of Richmond, and on Maskego lake. The conglomerate near Richmond, is apparently extensive, and occupies the sides of deep ravines; in some, appearing not unlike ledges of sandstone, forming mural escarpments many feet in height. From this general resemblance, it has been mistaken by the citizens for the sandstone formation.

It is composed of fine and coarse grains of quartzose sand very strongly cemented with calcareous matter.

The conglomerate of Maskego lake is but slightly elevated above the water, and is composed of coarse and fine sand and pebbles, united with calcareous cement.

This rock, which is of recent formation, resulting from causes now in operation, is of a purely local character, and the circumstances under which it occurs, do not admit of determining its extent.

#### CLAY

A red marly clay was observed in Van Buren, Allegan and Ottawa, underlying a considerable portion of the complete counties, and only making its appearance occasionally at the surface, being mostly covered with sand and gravel, together with some scattered boulders. Clay apparently of the same kind was also seen at the forks of the Maskego river, Montcalm county. This clay bears a strong analogy to that forming the coast of lake Michigan in the vicinity of sleeping Bear, also on the west side of Grand Traverse bay, as mentioned in the report of the state geologist of last year.

This clay has calcareous matters disseminated through it in veins, and is generally free from gravel. It may be considered as belonging to the tertiary deposit, and was the only clay observed in these counties.

Two miles south of the mouth of Kalamazoo river, and at a brick yard half a mile north of the village of Allegan, this clay rests on a blue semi-indurated sand. At this place the clay has a thickness of not far from fifty feet.

Near the village of Richmond it was seen alternating with fine light colored sand. Much of this clay is very unctious and free from grit. This clay was also seen at several places on Maskego lake and rivers, as a sub-soil to a light siliceous soil.

This red marly clay will afford a good manure for the sandy lands.

#### SANDS

Nearly the whole western coast of these counties in the vicinity of the lake, is bordered with a succession of *sand dunes* or hills of sand.

This sand is chiefly composed of grains of quartzose sand, with a mixture of feldspar, hornblend, magnetic oxyde of iron, &c.

A blue semi-undurated clay, as I have before observed, was noticed underlying the red marly clay. This sand contains considerable calcareous and argillaceous matter, and is composed of fine grains.

It is to this sand that the rapid abrasion of the lake coast south of the mouth of the Kalamazoo river may be attributed.

#### LOCAL DETAILS OF MARL

The great profusion in which this deposit is distributed through the counties of Van Buren, Allegan and Ottawa, is deemed a sufficient reason for noticing only a few of the most extensive deposites.

On sections twenty and twenty-one, half a mile north-east from Mr. Newell's steam mill, on Maskego lake, is a very

extensive deposit of shell marl that may be profitably used as a manure on the sandy lands of that vicinity.

Extensive deposites of shell and tufaceous marl, occur in the valley of Kalamazoo river, on sections nine, ten, sixteen and seventeen, township three north, range fifteen west, of more than one hundred acres. Also on sections sixteen and seventeen, township four north, range sixteen west, there is a deposit of shell and tufaceous marl occupying an area of more than seventy-five acres.

A very extensive deposit of marl was examined on sections sixteen and seventeen, township three north, range thirteen west. Some portions of this marl are found to contain too much iron ore to make good quick lime. Care should therefore be had in selecting that portion of the marl which is free from this mineral.

On sections thirteen and fourteen, township two south, range thirteen west, marl of a good quality occurs.

#### SALINE SPRINGS

Several saline springs and deer-licks were examined in the valley and vicinity of Maskego river. The most copious springs occur on the low alluvial land of the stream, where at the time of the examinations they were mostly inundated.

On sections three and four, township ten north, range fifteen west, are several weak, saline springs, which occur in extensive low lands.

My guide informed me that the Indians were formerly in the habit of resorting to these springs for the purpose of making salt.

Also, on section fifteen, township nine north, range fifteen west, are several springs that show the presence of saline matter.

On section thirty, township nine north, range eight west, is a spring yielding a very copious supply, and which may be placed in the second class of the saline springs of the state.

The above are a few only of the springs noticed in the country north of Grand river.

## BOULDERS

Limestone boulders of very large dimensions were noticed in the different counties. In township one south, range fourteen west, was observed a limestone boulder of several tons in weight, that had been mistaken by the inhabitants for rock *in place*. It is sub-chrystalline, and of a milky white color, and contains a few imperfect fossils.

Near the mouth of the Kalamazoo river, several very large boulders of blue limestone were noticed, which had been mistaken by the inhabitants for rock *in place*, and a kiln erected for burning of lime. The rock when burnt, furnished fifteen hundred bushels.

Boulders of the primary rocks are more rarely met with in the west part of these counties than in the more central portion of the state.

Under this head of transported boulders, I would barely refer to the immense accumulation of the central nodular masses of clay iron-stone which occur in the vicinity of Richmond. These masses are found distributed through the soil, and accumulated in the ravines and beds of the small streams.

I have thus laid before you so much of the information collected in the district assigned me, as is compatible with the limits of an annual report, and such as may seem to be of the most immediate practical utility. It being presumed to be the main object of these annual reports to lay before the people of the state such practical results as they may profit by, while the work is in progress, and before the complete embodying of the somewhat disconnected mass of materials in the final report.

C. C. DOUGLASS,  
*Assistant Geologist.*

*Report of B. Hubbard, Assistant Geologist*

*Detroit, January 12, 1840.*

*To Dr. Douglass Houghton, State Geologist:*

*Sir*—In compliance with your instructions, my time during the past season, has been devoted to a detailed examination of the southern range of counties, and of so much of the counties east of the principal meridian as could be accomplished before the setting in of winter. The counties completed, and on which I have the honor to submit the following report, are *Lenawee, Hillsdale, Branch, St. Joseph, Cass, Berrien, Washtenaw, Oakland and Livingston.*

A report on the counties of *Wayne and Monroe*, was submitted to you last season.

These examinations have embraced the collection of all facts of a geological and agricultural character which could serve to illustrate the capabilities of the soil, and the general wealth and resources of the country.

More than one hundred varieties of soils for future analysis, and specimens illustrative of all the rocks, have been added to the state cabinet.

In connection with these objects, I have been able to fill up the *skeleton* maps, furnished by the state topographer, of each town in the several counties, in such a manner as to afford at once a complete view of the soils, timber and topographical details, courses of streams, village and mill seats, and all recorded roads of the townships; to correct errors in streams and lakes, arising from inaccurate surveys, and to plat a great number of lakes, streams, &c., which were altogether omitted in the notes of the original surveys. These are now in readiness to be applied to the reduced scale adopted for the county maps. When the arduous nature of the labor thus assumed, in addition to that constant attention required by the minute investigations in the geology proper, is considered, I trust you will sufficiently appreciate the difficult character of the work.

You will necessarily perceive, that in a report embracing the

investigations made over so extensive a district, it is manifestly impossible to include more than a very small portion of even the purely practical information collected, without swelling the report to a much larger bulk than would at this time be desirable. I have therefore selected the most prominent details only. A transcript of my field-notes will be placed in your hands for such general reference as may be important hereafter, for obtaining greater minuteness and accuracy of information.

#### TOPOGRAPHICAL FEATURES

The leading characteristics of the surface of the peninsula, were treated at large in the report of the state topographer, of last year. By reference to that able document, it may be seen at once, what relation the counties mentioned, have to its distinguishing features. "It appears," says his report, "that there is a swell of land which may be called the true *watershed*, running from Pte aux Barques south, 45° west, and passing out of the state into the north-east corner of Indiana, about equi-distant from lakes Erie and Michigan. It attains its greatest elevation in Hillsdale county, seven miles east from Jonesville, where it is 633 feet above the surface of lake Michigan. Its summit, on the central railroad, at the division line between Jackson and Washtenaw counties, fourteen miles east of Jacksonburg, is 437 feet. In the village of Pontiac, in Oakland county, it is 336 feet. It then again rises, and at the head waters of Belle river, in Lapeer county, is 414 feet. From this point it gradually falls off, and with a few rills, descending on its north and eastern slope, sinks to the level of the beach of the lake."

The summit-level of this swell is frequently comprised within two parallel ranges of knobs, or conical hills, generally elevated above the intermediate space, and occasionally taking a somewhat mountainous form; the peaks having an altitude above the actual surveyed levels of 100 to 300 feet. But such peaks occur in the range only at distant intervals.

In the north-west corner of Washtenaw, these parallel ranges are very conspicuous, including a breadth of four or five miles, and have received the name of "Short Hills." The intermediate surface is very rolling and broken, with remarkable basin-shaped depressions. Beyond the ranges of elevated cones which bound the Short hill district, the country continues broken for about a mile, and then subsides to a gently rolling or undulating surface.

Upon this summit level of the peninsula, are situated the greatest proportion of those small lakes, which are so common in the landscape of Michigan, and in these, most of our streams originate.

Similar rolls of land, of much less altitude, but having the same general direction, give an occasional broken aspect to the country for some miles, after descending from the summit. In the main, the surface should rather be classed as undulating than rolling, beyond this peculiar elevated district.

Plains and small prairies, having no apparent order of place, are common, particularly in the counties of the southern range, west of the dividing ridge. Some of these have a perfectly plain surface, as Pigeon Prairie; others lie in gentle swells, like the prairie of Nottawasepe; while others partake of the rolling character of the country adjoining, as do most of the prairies of Cass county.

#### *Extent of Timber*

A continuous tract of heavily timbered country occupies the eastern, and a large part of the southern border of the peninsula. Within this tract, "openings" and plains are found only over limited areas; without it, heavy timber occurs only in isolated tracts.

Commencing on Shiawassee river, the line of timber passes through the southern part of Genesee county, the south-west part of Lapeer, and the western part of Macomb; thence by south-west course through the southern part of Oakland, and eastern of Washtenaw; thence bending westerly, it continues

in a very irregular course through Lenawee, Hillsdale and Branch, when it turns to the south and enters Indiana.

A large tract of heavy timber enters the counties of Berrien and Cass, from the west, and skirts the lake through nearly the whole of Berrien.

#### *Soils*

The soils throughout the districts examined during the past season are so varied, as well as so independent of the rock formations, that no classification of them is admissible. The nature of the deposits which constitute their base will be noticed under the observations on the *geology* of these counties.

Extensive collections of soils were made, of which it is designed to give a systematic analysis when the collections of all the soils of the state shall be complete. Many of these soils have the appearance of barrenness, which, from the salts contained, are, nevertheless, eminently fertile, and unrivalled for the production of the grains most important to man.

#### *Scenery*

The stern rules of science may seem to compel the geologist to take little note of the merely picturesque features of the landscape, yet called as he is to view them in their wildest character, he cannot be altogether insensible to the grandeur and majesty, or the variety and bloom of nature. The sublime mountainous scenery of the eastern states has been often and justly dwelt upon with admiration, by both the geologist and the traveler. Little of the peninsula scenery partakes of the grandeur of primitive and more broken districts, but none can fail to notice one superior charm, which more than compensates, in the eyes of those who are content to overlook the romantic aspect of the land, for the consideration of its solid bounties. To the cultivator of the soil every consideration which its picturesque character presents, will yield before the more practical one of its fertility.

But few could have traversed the varied portions of our state, over which my duties during the past season have led me, and compare their rich scenery with that of more eastern lands, with any feeling of disappointment. The ordinary character of the "openings" is that of a majestic orchard of stately oaks, which is frequently varied by small prairies, grassy lawns and clear lakes. These magnificent groves were, until within a few years, kept free from underbrush by the passage through them of annual fires, allowing successive growths of herbage to spring up luxuriantly, covering the surface with a profusion of wild flowers and verdure.

The variety so essential in a landscape, of woodland, glade and sheets of water, are here combined in a manner which seems the result of art, but which is not less truly inimitable. It is difficult to resist the impression that we are surveying an old abode of civilization and of tasteful husbandry. It resembles those exquisite pictures of park scenery, where the vision roams at will among the clumps of lofty oaks and over open glades, gemmed with flowers; while the distant woodland bounds the horizon, and the velvet-skirted lake gleams upon the eye as it reflects to light from the open prairie, or is faintly visible from the bosom of the glen, reposing in silent loneliness.

Such scenes, it is true, are destitute of the rough majesty of mountain aspects, but they have that all pervading, tranquil *beauty* which forsakes the lofty hill side and the hoary cliff. They present nature in her simple loveliness, without her stern aspect and her masculine attire. She has bestowed her blessing upon the land, and spread over it her robes of beauty.

The limits of an annual report, prevent more than this very meagre notice of some of the characteristics of our peninsula scenery.

#### GEOLOGY

Before entering on a description of the geological structure of the southern counties of our state, it may be useful, for a more general comprehension of the subject, to premise a few

leading facts relative to the geology of the western states generally.

It is well known to those acquainted with the geological character of the states west of the Alleghenies, that a large portion of that vast country, designated as "the valley of the Mississippi," is limerock,—the transition, or sub-carboniferous limestone of European geologists. This extensive rock formation may here be traced over more than a million square miles.

A distinguishing feature, and one which gives character to this whole country, results from the fact that this and its superincumbent rocks have been thrown, by some uplifting force, from a horizontal position, and made to assume the form of vast undulations, like wave following wave. Several immense and distinct basins are thus produced, the sides of which *dip* towards the centre, but at an angle so small as seldom to exceed the fraction of a degree. This characteristic basin form is still farther preserved by the circumstance that frequently the overlaying rocks, (which embrace the carboniferous formation, or *coal measures*,) have been removed from the ridges of these wave-like undulations, or at least are found occupying only the interior of the basins. In following, therefore, from these ridges of limerock in direction of the dip, we come successively upon the next overlaying rock, till we reach towards the centre, the highest rock of the series.

It must not hence be inferred, that the topography of the country always conforms to this basin-like condition. On the contrary, the centre of the basin may be either higher or lower than the extremities, or be cut across by streams, or present an irregular and hilly aspect. The dip and order of succession of the rocks, however, remains the same.

We have thus premised so much of the grand features of the geology of the great valley country, as to render intelligible to the general reader, the remarks which follow, on the rock formation of the above named counties.

Great difficulty has been experienced in conducting the details of geological examinations, necessary for arriving at

general results, from the circumstance of the face of our rocks being almost universally covered with a thick mantle of diluvium. This diluvium consists in part, of the detritus of the upper portion of our coal series, which has been broken up and washed away, and in parts, of sands and fragments of the primary rocks, transported from a more northerly region. Owing to this, the rocks of the carboniferous group but seldom make their appearance at the surface, and the country being little broken by ravines or deep water courses, the outcrop of the rock is not frequent even where we would be led most to expect it. On this account, I have been compelled to inquire out and examine the deepest wells, and the most important results have been obtained in this rather unsatisfactory manner. This circumstance has not only prevented my defining the variety of rock strata with perfect accuracy, but renders it not improbable that strata which actually exist *in places*, were not discovered, in consequence of the thick covering of transported materials. Thus, the rocks which intervene between the great limerock formation and the iron formation of the carboniferous series, (including the shale stratum and sandstones of the Ohio geologists, and the black slate and limestones of Indiana,) are either entirely absent from the southern border of the coal basin of Michigan, or were not visible after the strictest search.

With this qualifying observation, I shall proceed to a brief description of the strata, as far as they could be determined, within the district assigned me.

#### 1. LIMEROCK

The limerock of the south-eastern part of the peninsula, and whose outcrop is seen on the western coast of Lake Erie, is a portion of the great formation described above. Its place is higher in the series than the blue limestone and shales of Cincinnati, but below the black slate, and without doubt is equivalent in position to the "cliff limestone," of Indiana. Inland from the lake the limerock makes outcrops at numerous

points, which are found to be in distinct ranges, having a direction north-east and south-west, across the counties of Monroe and Wayne, and dipping north-westerly.

That portion which occupies the more easterly range is a compact rock, of a color varying from light grey to blue, sometimes veined and occasionally oolitic, and is well characterized by its distinctive fossils. In some portions of it crystals of sulphate of strontian are abundant.

The highest portion of the limerock formation, seen through the western part of Monroe county, is somewhat sparry, geodiferous and bituminous, and characterized by a few fossils of different species.

Intermediate between these two portions of the formation, in this county, is a very siliceous rock, approaching in some instances almost to pure sandstone. It is composed of quartzose grains, easily disintegrating into a beautifully pure and white sand.

As the limerock of Monroe and Wayne was fully described in my report on those counties, of last year, I shall avoid a repetition of *local details*.

#### *Economical considerations*

It will be perceived by reference to the report alluded to, that this portion of our state affords a very great abundance of limestone for several important practical purposes.

*Quick-lime* is extensively made and supplies the wants of this section of country. The limestone which occupies the highest range, (and from which lime is made extensively in the Macon reservation,) has been described as strongly *bituminous*. This character of the stone, owing to a chemical action which takes place in the kiln, renders it very superior for the above purpose. When brought to a red heat, the carbonaceous matter begins to re-act on the carbonic acid, which is a constituent of limestone, and converts it into carbonic oxide, which having no attraction for lime is driven off, leaving the lime of a pure white, and perfectly caustic, with less con-

sumption of fuel and in less time than is required by any other limestone. Being porous, it falls into an exceedingly fine powder by water or exposure; a quality which renders it particularly valuable to the farmer or builder.

*Water-lime*. By experiments made "in the small way," it appears highly probable that some of the strata in the limerock quarried near Monroe, (which holds the lowest place in the limerock series described,) may be tolerably well adapted for a *hydraulic lime*. Should this conclusion be verified by trial in a larger way, this stone will prove of very great importance to the state. For this purpose, the dark blue and the vesiculated or oolitic strata will probably be found best adapted; and in making the experiment, these should be separated and admitted into the kiln without intermixture of other portions.

*Ornamental limestone*. Some of the strata at these quarries are of dark color, and finely veined, like marble; they receive a good polish, and were the beauty of the material better known would, no doubt, be extensively used for chimney slabs and other ornamental purposes.

*Sand for glass*. I would again refer to the singular purity and value of the bed of white sand, occasioned by the disintegration of the very friable, siliceous limestone which is included in the intermediate portion of this series of limerocks, and which has been noticed in former reports. This bed is mostly pure siliceous, and under the microscope, will be seen to consist of perfect quartz crystals, free from any foreign or coloring materials. No sand in the state is so well adapted to the manufacture of glass, and for this purpose it may well be considered unrivalled. Viewing the wants of the state, in this respect, and the eligible situation of this material, six miles from the city of Monroe, this subject is strongly commended to the enterprise of our citizens.

## II. KIDNEY IRON FORMATION

In passing west from Monroe county, no rock is met with through the whole of Lenawee, it being completely overlaid and concealed by diluvium, and those thick beds of clay, which in part cover the rock in Monroe county, and over nearly the whole of Wayne, to a depth of more than one hundred feet. These blue and yellow clays are presumed to be analogous to those which cover the limerock of the adjoining states, and which have been designated by Dr. Hildreth, of Ohio, as "semi-tertiary deposits." They are found almost universally to envelope the limerock in this state as far as to the commencement of the sandstone series. The great accumulation of all these several deposits may be conceived, when it is stated that a rise of two hundred feet is attained, after leaving the limerock in Monroe county, before rock in place is again discoverable.

The clay of the kidney iron formation, is first met with at the very southern extremity of the coal basin in Hillsdale county, town seven south, range four west. Following thence along the westerly border of the carboniferous series, the formation is to be found occasionally over limited areas, through towns six and seven south, range four west, Hillsdale county, and towns six south, range five and six west, and towns five south, range six and seven west, Branch county. In the former county, it is found in close proximity to the overlying sandstone, but in the latter with a considerable interval between, and generally in limited bodies, which appear to be but relics *left in place*, after the destruction and removal of the greater part of the formation.

The ore consists of nodular masses, formed of concentric coats or layers of iron, combined with lime and alumine, and surrounding a hard nucleus which frequently contains fossils. These masses are often of many pounds weight. They are imbedded in a gray, micaceous clay, of very fine grain, and frequently so hard as to have the appearance of compact

sandrock. They are in general arranged in strata, alternating with the beds of clay, but are often found dispersed through the mass. This ore is analogous to that which is worked extensively and with profit in Ohio.

The clay is very free from lime, and of even texture. It is in consequence admirably adapted to all purposes of the kiln or pottery, and is far superior to any found elsewhere in the state.

As a portion of this formation, in Branch county, was made the subject of a special examination, in accordance with an act of the legislature of last winter, it will be unnecessary for me to add anything to those practical considerations which will be as fully exhibited by you, as their importance demands.

No means were presented for ascertaining the thickness of this formation. At the village of Branch, it has been penetrated in a well, twenty-three feet.

## III. FOSSILIFEROUS, FERRUGINOUS SANDSTONES

Next overlying the clay and ironstone, in Hillsdale county, succeeds a series of ferruginous sandstones, containing numerous marine fossils. Though classed in the so called "carboniferous formation," these all occupy a position below the lowest of the coal beds, and a short distance below their associated sandrocks, which present impressions of plants of the carboniferous era.

The following table will exhibit the order and succession of the several strata, so far as could be determined, *in descending order*.

*Succession of rock strata, in Hillsdale county, occupying the southern border of the coal basin of Michigan, below the coal beds.*

	Thickness
1. Coarse, quartzose, yellowish gray sandrock; occupying elevated sides of knolls. A good material for grindstones.....	30 feet
2. Ash colored or brown sandrock, sometimes contains fossils.....	15 feet
3. Dingy green, fine grained, strata. Occasional fossils, and with yellow ferruginous spots.....	40 feet
4. Hard, gray stratum of sandrock, 6 inches to.....	1 foot
5. Dingy green, fine grained, interstratified with slaty sandstone, and apparently with blue clay shale.....	15 to 20 feet
6. Yellow fossiliferous sandrock. Abounds in marine fossils.....	20 feet
7. Green, fine grained sandrock; perhaps.....	10 feet
8. Clay and ironstone.....	

The stratum designated as *yellow, fossiliferous*, is remarkably well characterized, being almost a perfect congeries of fossils. The whole is of a deep brownish yellow, and sometimes a buff color. The same stratum is met with, as appears by the notes of Mr. Douglass, in tracing down the western side of the basin, in the banks of Kalamazoo river, in Calhoun county, and at a level two hundred feet lower than the same rock in Hillsdale. This difference in level, shows a dip northerly not exceeding six minutes of a degree. But this result may be considered as less than the actual amount, from the fact of the two points not being in the true direction of the dip.

No stratum precisely analogous to this has been mentioned in the reports on the corresponding formations of the adjoining states.

By reference to the general topography of the state, it will be seen that the extreme southern termination of the sandstone series, has an elevation several hundred feet higher than any other part of the basin yet examined. This may account for the superior thickness and inclination of the rocks at this

point, and for the circumstance of the clay and ironstone making its outcrop here. In consequence of the greater uplift at this point, several of the series are brought to the surface, which elsewhere are entirely concealed, owing to their more nearly horizontal position.

Most of the sandstones have been used for ordinary building purposes. The coarse grained rock [No. 1,] is usually found eligibly situated for quarrying, and is well adapted both for building and grindstones. Ledges of this rock occur in the town of Somerset, section seven, and Moscow, section twenty-nine, and are numerous through the southern part of Jackson county.

The included stratum, No. 4, (which is reached in general only in wells,) owing to its superior hardness, serves admirably for the above purpose.

The whole thickness of the sandstones, below the lowest of the beds which embrace coal plants, will be found to exceed one hundred and sixty feet.

#### IV. TERTIARY AND DILUVIAL DEPOSITES

It has been already remarked that in general all the rocks are covered with a mantle of clays, fine detritus of the lime and sandrocks, or loose water-worn fragments of still older rocks, swept from the north by the current of a universal ocean and deposited during the general subsidence.

Some evidences of the direction of these currents were noticed in my report of last year. Among these are the diluvial furrows and scratches on the surface of the lime rock, the appearance and direction of which correspond with observations made in some of the more eastern states.

The extensive deposits of blue and yellow gravelly clays, which immediately cover the lime rock in Wayne and Monroe counties, were found also to occupy the whole of the eastern slope of the peninsula. Except in the border counties, these are overlaid by sand and gravel to a depth probably often exceeding one hundred feet.

A corresponding clay was found bordering lake Michigan, through Berrien county, and is said to reach far out into the lake at its southern extremity.

Pertaining to, or associated with these universal deposits, are beds of clay, erratic masses of primary, transition and secondary rocks, and the more recent formations of marl, tufa, peat and bog-iron ore. To these I shall devote some separate practical considerations.

#### *Clays*

The extensive blue and yellow clays which next overlie the limerock, are in general very gravelly, and contain also a very large proportion of carbonate of lime; the blue in particular effervescing strongly in acid. It is, therefore, not well adapted for the kiln. The upper, yellow or brown clay is the least marly and is better suited to brick manufacture. The beds are often stratified and portions may be found more nearly free from this injurious ingredient.

The presence of carbonate of lime may be detected by dropping a small bit of the clay into an acid (strong vinegar will answer,) when, *if the clay be marly*, effervescence ensues, occasioned by the decomposition of the carbonate of lime and escape of the *carbonic acid*, which is always combined with the lime. In this way it will often be easy to distinguish such portions of a bed as do not contain lime in sufficient quantity to impair their fitness for ordinary purposes.

Beds of clay, of a few feet thickness, are often found alternating with strata of gravel and sand among the diluvium, and similar beds, occupying acres of limited extent on the surface, are frequent in the sandy soils of the openings. The latter seldom exceed a few acres in extent and generally are of much smaller dimensions, with a thickness rarely exceeding four feet.

These isolated beds of clay are almost universally *free from any injurious proportion of lime*. In this particular, they are

superior to the clays above mentioned, for making a durable brick. These beds are, however, very siliceous, and indeed, partake of all the intermediate conditions from a stiff clay to merely an agglutinated sand. Proper precautions are not always observed in this particular; for notwithstanding that sand often constitutes by far the largest constituent, an additional supply is not uncommonly added in the process of manufacture, almost to the total destruction of the adhesive property of the material. I may here observe, that *in general, these surface beds contain, without artificial mixture, sufficient sand* to subserve their purpose in the manufacture of bricks.

#### *Erratic, Fragmentary Rocks*

*Boulders of the primary rocks* are found in great numbers, lodged upon the more elevated and broken parts of the country, and imbedded in the diluvial gravels. They comprise a great variety of granites, quartz and hornblende. The hilly region of Ann Arbor affords a fine locality for procuring a set of almost every variety found in the state.

*Large fragments of limestone* are occasionally to be met with, which have been disrupted from the transition and carboniferous limerocks of the peninsula. The largest masses of these were found near the summit of the great dividing ridge, on its eastern declivity. Several masses in the town of Somerset, Hillsdale county, are of such extent as to be easily mistaken for rock *in place*; portions only being visible from beneath the imbedding diluvium. I became convinced, however, by the associated fossils, that they belong to an older formation than the carboniferous rocks of the vicinity.

Boulders of this rock are so numerous in some parts of the country as to afford almost the supply of lime needed for the district.

Masses of native copper, some of several pounds weight, have been found in Berrien and Cass counties, as also in the valley of Grand river, and in several other portions of the

state. These belong to the "erratic group," and are *no evidence of the existence of the ore* in their immediate vicinity.

The same remark will apply to the pieces of bituminous coal, found very generally, through certain districts, imbedded in the diluvium. Though they may be found at various depths and in considerable quantities, no prospect can hence be inferred of finding *coal beds* in any of the counties embraced in this report.

#### *Springs and Underground Water Courses*

The character of the diluvial strata is so varied over different districts, and the formation of surface so diversified, (which might give origin to springs under every variety of circumstances) that it is impossible to establish any general rule governing the depth and directions of the underground watercourses.

Water from the diluvial deposits is usually obtained in strata of quicksand or gravel at very varying depths. But after ascertaining the general characteristics of the surrounding country, some judgment may be formed over particular districts.

A stratum of quicksand producing water, is very generally found immediately overlying the great clay deposits. In the blue clay, at the depth of twelve to twenty feet, a stratum of gravel, yielding a supply of water, appears to be almost universal.

Owing to the calcareous matter contained in the diluvial gravels and sands, as well as in the clays, the water of wells is commonly "*hard.*"

#### RECENT FORMATIONS

##### *Conglomerate*

In the county of Berrien some very extensive formations of this singular rock occur. They are of recent origin, compared with all the other rocks, and both in age and formation,

may be classed with the marls and tufas. A stratum of gravel, cemented with lime, appears to be very universal throughout this country, at depth of a few feet, and extensive masses, strongly cemented, are frequently found exposed in the faces of ravines and banks of streams, appearing like ledges of rock in place.

At Millburg, eight miles east of St. Joseph, a rock of this description was traced along the bank of Blue creek, for half a mile. In appearance, it is a continuous ledge of very hard sandrock, varying in thickness from ten to fifteen feet. It consists of coarse sand cemented by the infiltration of carbonate of lime, unbroken by seams, and which has become exceedingly hard on exposure. It may be quarried by blasting, in blocks of any required dimensions, dresses with facility, and will answer admirably for many economical purposes.

About two miles north-east of Berrien, this rock was seen under similar circumstances, in the bank of a small creek, forming an outcropping ledge, exceeding eight feet in thickness. It is found also at several points higher up the stream, and in the sides of hills in the vicinity. Portions of this ledge are of finer grain than that at Millburg, having a stratified appearance, and are disposed to cleave horizontally. Blocks have been removed and used for fire-jambs; in which capacity they have stood the test of two years' service.

Similar formations occur in town three north, eight west, section twenty-four, in town of Oronoko, at Singer's lake, and in the deep ravines east of New Buffalo. At the latter places the rock bears more the appearance of crag, being composed mostly of coarse pebbles.

The conglomerate, at all these places, is in isolated masses, of local origin, and probably does not extend many feet into the hill sides. Quarries will, therefore, eventually be found to *run out.*

"Hard pans," which may be referred to a similar origin, are not uncommon among the diluvial strata even at consider-

able depths. The cementing material is not unfrequently, in part, a carbonate or hydrate of iron.

A hard pan, of which the cement is no doubt lime, is found to be an almost universal sub-stratum to the rich loam of the prairies. To it the fertility of those soils may, in a great measure, be ascribed, since it serves to retain the moisture which would be quickly swallowed by the porous sands.

Possibly this fact may aid in illustrating the origin, as well as the fertility, of the prairies. This sub-stratum is not commonly met with in the openings.

#### *Marl, or Bog-lime and Tufa*

That variety of mineral which is here designated by the name of *marl*, is chiefly a *carbonate of lime*, or lime combined with carbonic acid. It is frequently argillaceous, and mixed with earthy and carbonaceous matters. Throughout the counties enumerated, this mineral is found only in connection with the gravels, sands and clays which overlie the rocks, and may be defined as an alluvial deposit from waters which have percolated soils charged with lime. On reaching the surface, the water parts with a portion of its carbonic acid, and becomes no longer capable of holding the lime in solution, which is then deposited in the form of a pulverulent, chalky substance, in the beds of lakes or beneath the peat of marshes.

As carbonate of lime is a constituent of the covering of moluscos animals, these circumstances are favorable to the collection of great numbers of shells, so that these not unfrequently constitute even the main portion of the bed itself, which may then receive the name of "*shell marl*."

That form of lime which is called *tufa*, has a similar origin. It differs in external character, being hard, light and porous, and is that which is familiarly known as "*honey-comb lime*." This characteristic difference is the result of circumstances, not of composition. Tufa is formed in situations which allow access of air, when a strong union of the particles takes place.

Marl being always deposited under water, or beneath the peat of bogs, the surrounding fluid prevents cohesion. This condition is that which is very commonly designated as "*bog-lime*."

Thus, according to circumstances, we find a variety of forms assumed by these deposits, from a "*tufaceous marl*," in which the particles have but partially cohered, to a hard "*tufa*," or *travertin rock*, appearing as ledges in exposed hill sides.

All these recent fresh water limes exist in great abundance in most of the counties enumerated, as well as throughout the interior of the state. In the northern part of Hillsdale, and the counties of Washtenaw and Oakland, in particular, so extensive and universally distributed are the beds of this useful mineral, that an attempt to ascertain and enumerate all the places in which it exists, is unnecessary, if not impossible.

But notwithstanding its wide distribution, the uses, and even the existence of this mineral are so little known or heeded, even by those who have most reason to appreciate its value, that I shall adventure some remarks upon its application to practical purposes, and the method of ascertaining its presence.

*For making quicklime*, the value of marl and tufa is already appreciated in those parts of our state which, like the counties under review, are nearly destitute of limerock. Consequently these have supplied the deficiency, and been applied to all the purposes of the best rock lime. Though somewhat inferior in strength, the lime thus obtained is even preferred for particular purposes. It is said, for instance, to be preferable as a wash, owing to its superior whiteness. Its real value is frequently underrated from its not being sufficiently burned; marl being erroneously supposed to require a less degree of heat than limestone.

Some of the largest deposits of tufa I have met with are formed along the banks of the Huron valley, between Ypsilanti and Dexter, at several of which, large quantities of lime are manufactured.

The circumstances which may give rise to the formation of

either tufa or shell-marl, where the same source of supply exists, is here finely exemplified. Ledges of tufa occupy the elevated sides of the valley; while copious springs discharging from its foot, occasion a peat morass between it and the river, beneath which is a body of soft marl several feet in thickness.

Impressions of leaves and branches of trees, and even bones of animals, are numerous in some portions of the tufa, these substances having evidently served as *nuclei* around which the particles of lime were deposited from the water of the springs; thus both giving an interesting character to the bed and illustrating its formation.

*The use of marl in agriculture* is little appreciated, and may even be said to be wholly unknown to the great body of the farmers of our state. Hitherto so small has been the demand for stimulant manures by soils that have been for a few years only in the service of agriculture, that few farmers have brought themselves to reflect whether before many more years, the new soils they have adopted may not become like the old ones they have forsaken.

But, although many of our soils are even found to improve under the first few years of cultivation, they must eventually wear out under a process which gives no returns for the demands made upon them. This result is already becoming perceptible upon the older farms, and their cultivators are brought to the necessity of husbanding manures to renovate their exhausted soils. Considerable quantities of gypsum (plaster) are annually imported and used with most obvious success upon soils that have not been half a dozen years under cultivation.

Gypsum and marl are constituted of the same basis, *lime* under different states of combination: *sulphate of lime*, (sulphuric acid and lime), composing the former; *carbonic acid and lime* composing marl and the other carbonates. The sulphate, possessing greater stimulant properties, has a somewhat different and more speedy operation, but it is doubtful whether its effect be either so decided or so lasting as that

of marl, if applied in the required proportion. I have to regret the inability to institute such a comparison of their several operations upon our soils as could be desired, having been unable to learn of a single instance of a fair trial of marl in the state. Notwithstanding, I do not hesitate to urge its use with full confidence, upon all who can be persuaded to make use of so simple a means to sustain their soils.

Besides the stimulant property common both to gypsum and the carbonate of lime, in giving increased activity to vegetation, the lime effects a change in the character of the soil itself. No soil can be considered perfect without a large proportion. Lime enters largely into the composition of many crops; such as *wheat*, which it is well known vegetates most vigorously where this abounds, as in many of the gravel and limestone soils. While a farther advantage results from the decomposition of the marl, in consequence of the separation of the animal matter contained in the shelly portions of it. In short, gypsum can hardly be productive of benefit where *marl* might not be profitably applied. Add to this, what comes home to the reason of every farmer, that while he must pay for *imported plaster* at the average rate of twenty dollars per ton, the *marl* may be had for digging.

Nature, ever bountiful, has indeed laid up in those marshes and ponds which seem, at first appearance, almost valueless, a provision of incalculable worth for her future maintenance. It may well be considered an untold treasure, stored close at hand, costing little to procure, *requiring no preparation of grinding or burning*, and which will be resorted to for years to come, to sustain and replenish the fertility of our soils. In applying this manure, we do but restore to the soil that with which it was originally endowed, since the soils themselves supplied the material of the marl beds. These seem left by nature for future restoration by the art of man, and apparently with design, are deposited in greatest abundance in the vicinity of those siliceous soils upon which they will be most needed.

If even the enormous price paid for plaster is never regretted, most certainly I may be allowed to urge the simple experiment of giving a fair trial to so cheap an article as the marl. By such actual experiment, every man, for himself, will best learn the proportions which his soils need, as well as the comparative results. Trial will, at least, furnish a satisfactory test of the truth, and we feel the more inclined to urge it from the fact, that if successful, nothing in the whole range of agricultural economy will exhibit more strongly the policy of availing ourselves of our native resources.

After this recommendation of marl, it may be expected that I advise under what circumstances to look for it. Marl is frequently to be recognized by its light ash color, about the margin and occupying the shallows of lakes. In general, the marl which is most easily obtainable, will be found overlaid by *peat* or muck of the marshes, often at a depth of several feet. Sometimes its presence, under these circumstances, is indicated by a slight coating of lime visible upon the vegetation on the surface. The *growth* of the marl bed often causes the overlying bog to swell up into a protuberant form. But such indications are not always visible, and then trial may be made by thrusting down a pole or rod through the peat, when sufficient of the marl, if there be any, will adhere, usually, to make known its presence.

Every farmer ought to examine well his marshes with this view, and if there is reason to believe marl exists there, to test the question fully by digging.

It may be advisable to raise the marl in the fall and subject it to the action of the winter's frost, in order to bring it to a pulverized state previous to use upon the land.

#### *Peat*

This *combustible* is found in very great abundance in most of the marshes. It is that which supports the luxuriant crop of grasses they afford, and is itself a mass of grass roots and

half decomposed vegetation. This variety of peat is called *fibrous*. It is so universally distributed, and in such quantity, that my notice of it will be in general terms.

Most of the beds of peat, in this state, are comparatively shallow, seldom exceeding four feet in thickness, and they in general want that compactness which is esteemed a requisite in the peats adapted for fuel. I shall, therefore, allude only to its value and application *as a manure*.

Few soils will endure many years continued cultivation without requiring to be replenished, not altogether with mineral manures, such as gypsum and marls, but with those vegetable or animal products which afford the real sustenance to its crops. The time will just as surely come when the soils of our own state, though now fresh and unexhausted, will need the same support. The farmer will then rejoice at the opportunity to procure manures of this description, and I do not hesitate to say that *peat* will then rank among the most prominent, as it is now the most abundant.

Peat being almost wholly a mass of vegetable matter, affords precisely that which is yielded by the most fertilizing manures. But as found, it is in a more or less undecomposed state, and consequently not in that condition in which alone plants can receive it, to be absorbed into their substance. Should it be spread as a manure is often applied, its dry, spongy fibres will not readily become converted into that soluble matter which is required by the conditions of vegetable organization. To exact its full benefit, then, some art seems necessary. In the absence of actual experiment, such as would most properly determine the mode of its application, I shall only suggest the simplest means. The compost heap affords the readiest process for effecting those chemical changes which are necessary to convert peat into nutriment for vegetation. This will be facilitated by an intimate mixture of animal and other refuse matters, and of marl or lime. With the latter the vegetable substance of peat enters into new combinations, forming cer-

tain soluble salts, which are then ready to be taken up as food by plants.

We have already seen how frequently peat and marl are found in connection, and in what abundance the latter may be procured. In peat and marl combined, we have, therefore, all that could be required to make of those numerous marshes which intersect the country, immense receptacles of vegetable nutriment. The lime performs to the mass of raw organic matter of the peat, the office which the cook does to the larder. Conjoined, they furnish both provision for the nourishment of plants, and the means for preparing it.

Some contrariety of opinion exists on the use of calcareous manures, (gypsum and limes,) from the supposition that they eventually wear out the land, leaving it poorer than before. Now such a result may happen from either of two causes, neither of which implies any injurious quality in the mineral.

1. From the too excessive use of this manure, or its application to soils, the composition of which was not understood, and where lime may have already formed an abundant element.

2. From the use of mineral manures solely, under the mistaken supposition that *they* furnish the necessary nutriment to vegetation. Now, as has just been shown, these chiefly serve to *prepare* the food which has been furnished from other sources. So far from supplying the place of vegetable and animal manures, they only render necessary fresh supplies of the latter. By giving increased activity to vegetation, they of course cause a quicker consumption of the fertilizing principles. It will thus very easily be seen from what mistaken practice this "impoverishing of the soil," by the use of mineral manures, results, and also where may be found the proper corrective.

#### *Bog Iron Ore, and Ochre*

All our bog ores are a product of the diluvial or alluvial deposits, the mineral being originally contained in the fer-

ruginous sands or clays. It is taken up in solution by rain-waters, and afterwards, like the marls, deposited in low grounds.

Sands highly ferruginous, and beds of sandy *ochre*, of a bright red or yellow color, are not uncommon, though in general of small extent. Some considerable beds were observed in Lenawee county, ranged along the east side of the *ridge* or beach of the former lake, (which will be hereafter noticed,) and in the same manner as we often find *iron sand* washed up and deposited by the waves. A little west of Palmyra, one of these deposits stretches along the beach ridge for half a mile, having a width of a few rods, and a thickness of eighteen inches.

After much fruitless examination during the past season, I became convinced that no formations of ore exist in the counties examined, which will compare in extent with those from which iron is manufactured in Indiana, near the border of this state. Beds of it, indeed, occur, some of which may be considered as of practical value.

Although the kidney ironstone makes its appearance at several points which might have been deemed favorable to the depositing of a bog ore, resulting from the mineral in those beds, none was found associated with it. I was led to search for bog iron in this vicinity, more particularly from the circumstance that a mixture of the two forms of ore is usually made at the kidney ore furnaces, in order to facilitate smelting. Some deposits of bog iron in the southern part of Branch county, in fractional town of Algansee, are of sufficient extent to be valuable for this purpose, should a furnace be established, at the kidney ore beds of that county. One of these deposits was traced over more than an acre.

Along St. Joseph river, in St. Joseph county, small beds of ore and ferruginous sands were found, and also in town five north, range ten west, section nine. These are mentioned, as they may be of value from their vicinity to the beds of kidney iron in this part of the state. But should it be ascertained

that the chief benefit of a mixture of the two ores results from the carbonate of lime supplied by the former, the *marl beds*, which abound throughout this district, will furnish a ready and cheap flux to facilitate the operations.

The most considerable beds of bog iron ascertained during the past season, were in *Oakland county*. The following are worthy of notice:

In the town of Lyon, section thirty, a good lively ore is found, occupying on the whole, several acres.

Town of Orion, section twenty-four, deposits were traced at intervals over an extent of twenty acres. The richest and most abundant form of the ore was in the state of a yellow ochre.

In the town of Groveland, numerous beds of ochre are collected around the heads of Duck creek, and are frequent over an area of half a square mile.

In *Washtenaw county*, bog ore has been found at several places in town of Augusta, and considerable beds of red ochre in town of Sharon.

The ochres may serve a very good purpose as an ordinary red or yellow paint. This may be obtained in a cheap manner, thus: stir the sand in water, then after allowing a few minutes for the siliceous grains to settle, pour off the liquid and obtain the colored sediment which is held in suspension.

#### ANCIENT LAKE RIDGE

At about twenty-five miles, inland, from the shore of lake Erie, and following a nearly parallel course to the lake and Detroit river, a *low, gravelly ridge* may be traced, corresponding in its character to that upon which the celebrated "ridge road" runs, along the southern shore of lake Ontario. Except where broken through by streams, this ridge is very continuous, and of nearly uniform size; so much so indeed, that I have been able, without difficulty, to distinguish it from all ordinary undulations of surface at whatever point it has met my observation, and to trace its course for more than sixty miles.

The ridge has a breadth of several hundred feet, and rises with a gentle curve into a somewhat conical form, to the average height of about twelve or fifteen feet above the flat lands of the lake side. It is composed of layers of coarse and fine gravel and beach sand, reposing upon the clays which constitute the sub-soil of the contiguous country.

From its resemblance to the beaches bounding the waters of the present lake, as well as from the relative character of the country on either side, no doubt remains in my mind that this ridge once constituted the boundary of an immense expanse of water, which became afterwards circumscribed to the dimensions of the present lakes.

The ascent of the land on the lower or lake side is much more gradual and uniform than on the upper, and the "ridge" may be said to form here a boundary to that belt of level country which borders the peninsula. This belt of land, as already described, is mostly clothed with a dense growth of timber, and a dividing line drawn between this and the light growth of the sandy openings very nearly corresponds with the course of the ridge.

The elevation of the ridge, its uniformity, and the gravel of which it is composed admirably adapt it for a highway. Roads have consequently been run upon it through a large part of its course in Wayne county, bearing north-east and south-west, from the village of Plymouth, and also through the town of York in Washtenaw county, to Ridgeway in Lenawee.

Divergences sometimes occur in this ridge, like those described by Mr. Hall, in the geological report of New York, for 1838, and the branches again unite; or after being diverted by the valleys of entering streams, it again resumes its former general parallelism to the present shore of the lake.

The state topographer of Ohio, Col. Whittlesey, mentions the fact of a "succession of low, gentle undulations, like a broad turnpike or wave, running parallel to the shore" of lake Erie, in that state. He says they vary in number from one to three, and are distant from the shore from half a mile to five miles,

and he supposes that they differ in height from ninety to one hundred and twenty feet above the lake.

"External appearances," he remarks, "certainly indicate that the waters of lake Erie once stood one hundred feet higher than at present; but there is not as yet, evidence enough to decide this interesting question. It would be difficult to find natural barriers for a sea which should have elevated itself to that height."

From a series of levels, taken during the surveys of the public works of Michigan, I have ascertained the ridge to have here a *uniform elevation* of one hundred and seven or one hundred and eight feet above lake Erie, which, it will be perceived, agrees nearly with the estimate of Mr. Whittlesy. The uniformity of this elevation furnishes an additional proof of its having once been coincident with the level of the lake waters.

The proof[s] of a former submergence of this whole country, are so abundant that the general fact seems well established. It is also plain that this *ridge* could not have been formed during that turbulent state of the waters which brought upon the rock-covered surface of the country its immense deposit of diluvium, but must have resulted from a quiescent state of the waters.

Let us then, for a moment, consider "this interesting question" solved, and proceed to inquire how far the results to which we are brought by the supposed elevation of the lake waters, one hundred and seven feet above the present level of lake Erie, accords with repeated observations made throughout the lake region. Supposing the characteristics of the land to have been relatively the same as now, the great lakes, which at present are but links of a connecting chain, would become merged in one immense irregular sea; their breadth being increased many miles on either side, while their connecting bands are lost in the wide expanse. The northern part of our peninsula becomes an island, or separated by only a narrow neck across a wide frith, following the valleys of the

Saginaw and Grand rivers. The western and eastern tier of counties are flooded, and the Maumee country as far as Fort Wayne. West of lake Michigan, the spread of the waters is still wider; embracing, perhaps, with the exception of some islands, more than half of Wisconsin, and the whole of the immensely broad valleys of the Illinois, Ohio and Mississippi rivers. Upper Canada assumes the form of an island in the wide spread waste. The roar of Niagara is drowned beneath the rolling billows of a broad and deep inland ocean, having a breadth at this point of more than sixty miles. While stretching off to the east, the waters involve a great share of Lower Canada, the whole of the Genesee country of New York, with most of its chain of lakes, and a communication is made with the ocean, both by way of the St. Lawrence, and the valley of the Mohawk.

It will be apparent, then, that the great "basin of the St. Lawrence", within which all the present basins of the lakes are included, as well as the immensely broad and fertile "valley of the Mississippi", become one continuous sea, in which whatever of the present land remains are as islands in the deep.

The difficulties which oppose this supposition are, the almost unlimited supply of water required to furnish a basin of such extent, and the want of barriers to confine its discharge into the ocean. But one theory presents itself competent to solve difficulties of such magnitude. The supply of water must have come from the ocean itself. Consequently, the surrounding and interior seas must have had the same level, and the greater elevation of the lakes relatively to the surrounding land was the result not of their increased *actual* elevation, but of the actual diminished elevation of the land itself. In other words, the land has been subsequently subjected to an upheaving force, which at last has elevated the whole far above the influence of the sea.

Whether the upheaving of the land was general at this era, throughout the continent, or was mainly operative in the