

42579



3 0000 004 809 715
LIBRARY OF MICHIGAN

REPORT
IN SENATE,

February 3, 1840.

OFFICE OF STATE GEOLOGIST, }
Detroit, Feb. 3, 1840. }

To the Hon. PRESIDENT of the Senate :

SIR:—I have the honor herewith to transmit to the Hon. Senate, the third annual report and accompanying documents from this department.

I have the honor to be,

Sir, your ob't. serv't.

DOUGLASS HOUGHTON,
State Geologist.

[Senate, No. 8.]

1

of the series of
more than other-

42579



3 0000 004 809 715
LIBRARY OF MICHIGAN

REPORT.

OFFICE OF STATE GEOLOGIST, }
Detroit, February 3, 1840. }

To the Hon. Senate and House of Representatives of Michigan :

I have the honor again to lay before you the progress which has been made in the geological survey of our State, together with the general condition of the department that has been placed under my charge.

I do not propose to enter into a minute detail of all that has been accomplished, for to lay before you *at this time* these undigested and unfinished details would seem to be in a measure unnecessary, from the fact that I am called upon at the close of the work to embody in a connected and uniform report the complete results of all that may be accomplished.

Since the date of the last report which I had the honor to transmit to you, the geological and topographical portions of the work entrusted to my charge have progressed as rapidly and steadily towards completion, as the circumstances connected with the immense labor to be performed, would permit. These labors have extended over a large portion of the organized counties of the State, and of many of these the complete field notes for the surveys have been returned. The minute examinations of these counties has chiefly been assigned to the geological assistants, Messrs. Douglass and Hubbard, and their reports embracing a programme of their labors, for the season, are hereto appended. As these reports refer to many of those practical subjects which would be considered were I to report upon my own labors in these counties, I have deemed it unnecessary at this time to refer particularly to the geology of this ^{mate} series of section of the State. _{on than other-}

NORTHERN OR UPPER PENINSULA.

General description and Topographical features.

In addition to the duties performed in the Southern Peninsula of our State, a portion of the season has been devoted to an examination of the Southern slope of that part of the Upper or Northern Peninsula, extending from the Sault de Ste Marie, to the mouth of Monominee river of Green Bay; a district of country, which, with very few exceptions, is a perfect wilderness, but which, nevertheless, is deserving of all the labor which has been bestowed upon its examination.

A general description of that portion of the Northern Peninsula, lying between the foot of Lake Superior and the mouth of Monominee river of Green Bay, since the country is but little understood, may not be misplaced, though it had been my intention to avoid *at this time*, all details, except such as might be directly connected with the progress of the work under consideration.

The district of country alluded to is, perhaps, more variable in its topographical features, in the composition of its soils, and the character of its timber, than any portion of equal extent of the southern peninsula, and cold and inhospitable as the climate has been wont to be considered by our citizens, there are many of the elements of competence and wealth contained in it.

The very extremity of the peninsula, embracing most of that country lying east of a line drawn from the Sault de Ste Marie, to the island of Mackinac, compared with the more westerly part of the Upper Peninsula, is either flat or slightly undulating, and it embraces marshy districts of large extent. Most of the coast is skirted by islands, giving great beauty to the scenery. The immense number of these islands, skirting the easterly portion of the coast, is beyond conception, for they form, as it were, an almost inextricable labyrinth, giving rise to narrow and intricate channels, and again widening into what may, with propriety, be called small lakes. This feature

of the coast has served to render the published maps of this district more imperfect than those of any other portion of our State, for which reason an unusual degree of labor has been devoted to a correction of these geographical inaccuracies.*

But in no portion of the country is this insular character so largely developed as in that arm of Lake Huron, which forms, as it were, the embouchure of Ste Marie's river. Here are literally hundreds of islands, varying in size from those composed of a mere point of rock, to those of many thousands of acres in superficial extent.

The soil and adaptation of these islands to the purposes of agriculture, is as variable as their size. Yet, while portions of them are adapted to use for agriculture, by far the larger proportion will scarcely admit of this application.

In the vicinity of Pte Detour of Lake Huron, the country is flat, with ridges only slightly elevated, and with intervening marshes; but as we proceed westerly, it gradually becomes more elevated, until (a little east from the island of Mackinaw,) it rises in abrupt hills to a height varying from one hundred and fifty, to three hundred feet, and these hills, in the vicinity of the straits, approach near to the coast.

The range of hills, of which these outliers may be considered the commencement, continue, in a somewhat broken chain, usually at no very great distance from the coast, as far west as Little Bay du Noquet; from whence they bear north-westerly, stretching towards Lake Superior. These hills usually form great undulations, with their sides sloping away gradually, but occasionally naked cliffs of limestone appear. Usually the cliffs are of no great altitude, and at no place did I observe them so largely exposed as upon the coast of Great and Little Bay du Noquet, upon the easterly side of the former of which, they attain an altitude of from one hundred to one hundred and fifty feet.

* In my labors to produce correct maps of this difficult section of country, invaluable assistance was rendered by Jas. L. Schoelcraft, Esq., whose intimate knowledge of the country, and minute observations, recorded through a series of years, have enabled me to reach a much greater degree of perfection than otherwise could have been done.

The bays, just alluded to, forming as they do, deep indentations from the head of Green Bay, give a peculiar feature to this part of the coast. They furnish a complete shelter for shipping, and being surrounded by a country which is mostly well adapted to agriculture, their importance of position cannot fail, eventually, to be appreciated.

The soil of the southern slope of the Upper Peninsula, passes almost imperceptibly, through all the shades of variety, from a whitish siliceous sand and sandy loam, (not unfrequently mixed with gravelly limestone,) to that composed wholly of pebbles of limestone. Clay soil is exceedingly rare, and when it does occur, contains a very large proportion of lime in its composition.

The timber of this district has all the variety which would be looked for on soils of so changeable a character. It varies from the scrubby pines which characterize the pine barrens, to beautifully timbered tracts of sugar maple; the latter timber having almost invariably interspersed with it white cedar and spruce, these latter, together with birch, in fact, forming the larger proportion. White pine occasionally occurs, though more frequently in the westerly than in the easterly portion of the country alluded to. As a whole, the western portion is much more favorable to agriculture than the eastern.

The upper portion of the Peninsula being of no great width, furnishes but few streams of any considerable size. Among these, the Monominee, Monistique and Menecockien rivers are more particularly deserving of notice. The two former, from their greater size, together with the peculiar advantages which exist at their points of embouchure, will only be considered.

The Monistique river, which enters Lake Michigan near its north-westerly angle, at a distance of about thirty-five miles north-easterly from Pte Detour of Green Bay, has its place of embouchure in a small bay, that serves to afford a partial protection from the heavy surf of the lake. The stream, at its immediate mouth, has a width of a hundred and twenty

feet; but this width is subject to considerable variation in consequence of the sands which are subject to drifting, from the effect of the currents of the lake and river. Ascending the stream but a few rods, it suddenly expands into a beautiful sheet of water, giving rise to a small lake, that has a length somewhat exceeding half a mile, and a width varying from one fourth to one third of a mile. This small lake, which furnishes a safe and convenient harbor for vessels, is surrounded by moderately elevated and undulating sandy plains, sustaining a sparse growth of small yellow pines. The channel of the stream will admit the entrance of vessels drawing from seven to seven and a half feet water. Monistique river enters this small lake at its northerly end, and has here a "rapid" over limestone *in place*, which will furnish a fine hydraulic power, so situated that it may be nearly approached by vessels, and which cannot fail eventually to be of vast importance in advancing the settlement of the surrounding country.

The Monistique river has its source in the highlands north-easterly from its mouth, and its sources interlock with the head waters of the Tonquoinenon river of Lake Superior. In its course to Lake Michigan, it frequently expands into small and beautiful lakes. It passes through a country, a large portion of which is well adapted to the purposes of agriculture, and which, at those points where the soil has been cultivated by the Indians, produces abundant crops of corn, potatoes, &c.

Monominee river of Green Bay, one portion of the defined boundary between our own State and Wisconsin, is a much larger stream than that just alluded to. Its embouchure into Green Bay is by a broad mouth, that may, in fact, be regarded as a narrow lake, which has a width varying from forty to one hundred rods, and a length somewhat exceeding one and a half miles. The shores, at the immediate mouth of the stream, are flat and marshy, with narrow ridges of sand, but at a distance somewhat more than half a mile above, they begin gradually to rise, until they finally attain an elevation of from ten to twelve feet above the water of the river.

At a distance of somewhat more than one and a half miles from its mouth, the stream, which is here much diminished in width, forms a "rapid" over a ledge of limerock, having a fall of ten to twelve feet in a distance which may be estimated at half a mile, thus giving rise to an amount of hydraulic power, which, at this point, cannot fail to be of great value.

Above these rapids, the river, for a distance of twenty-five miles, has a width varying from two hundred and fifty to four hundred feet. The bottom is chiefly composed of gravel, but there are occasional rapids over limestone *in place*.

The soil in the vicinity of the mouth of the stream, is chiefly composed of a dark colored sand, or sandy loam, largely impregnated with lime, and it produces good crops of wheat, barley, rye, oats, potatoes and corn. The extensive Indian fields, now mostly uncultivated, show this to have been the residence of a numerous band of Indians, and that they must have depended largely on the products of the soil for subsistence. The miserable remnants that remain of these original proprietors of the soil, have almost completely abandoned its cultivation, having placed their dependence for subsistence, through most of the season, upon the fish which are taken abundantly in the stream.

Upon the Wisconsin side of the Monominee river, two saw mills have been erected, one of which has been in operation for several years and two or three families of whites are resident there. Extensive fields have been put under cultivation and have not failed to yield an abundant return of crops.

The bar at the mouth of the Monominee river may be passed at ordinary stages of water by vessels drawing from seven to eight feet, and after this bar be passed, the largest class of vessels may ascend nearly to the rapids before mentioned.

The many advantages existing at the mouth of this stream, taken in connection with the pine timber that occasionally skirts its upper portions, cannot fail eventually to render its mouth a place of much importance.

Most of the smaller streams occurring between Monomi-

nee river and Mackinac, have brisk currents and furnish abundance of hydraulic power, but with one exception this is, as yet, unapplied. A saw mill has been erected on the Escconnauby river of Little Bay du Noquet, and here are the only signs of civilization between the points mentioned, being an extent of more than two hundred and fifty miles of coast.

In laying before you this hasty outline of a portion of the upper peninsula of our State, I cannot refrain alluding to the immense wealth that may be made to flow from the fisheries by which it is surrounded.

The inducement offered by this branch of industry for a handsome return of profit must, I feel assured, eventuate in the direction of a large amount of capital to this business, and will no doubt exert a powerful influence upon the settlement of the more favored portions of the coast. It is well known that while the waters of the whole line of coast alluded to, furnish white fish and trout more or less abundantly, there are, nevertheless, many points which, from their peculiarly favorable location, yield a more abundant return.

A portion of that coast, lying between point Seul Choix of Lake Michigan, and Little Bay du Noquet of Green Bay, offers many exceedingly advantageous situations for conducting this branch of enterprise, and these "grounds" appear to have been wholly neglected, or at least none of the usual evidences of its having been appropriated to this purpose, exist.

In connection with this important branch of industry, which has for the last few years been so steadily, yet imperceptibly increasing, extending as it does around the areas of both our peninsulas, it may not be misplaced to call your attention to the immense importance which it must eventually hold in our State. As yet all knowledge of its returns depends upon vague rumors, for no accurate data of its value or extent have as yet been made. The census to be taken during the current year offers a favorable opportunity, if the proper measures be taken, to obtain all the statistics which may be required on

this subject, and these statistics, if obtained, may be the means of enabling the State hereafter to extend to this branch of industry the fostering care which its importance deserves.

GENERAL GEOLOGY OF THE SOUTH AND SOUTH-EASTERLY PART OF THE UPPER PENINSULA.

The rocks of the district of country under consideration are but little varied; the separate portions, occupying, for the most part, an extensive range, and in chemical and mechanical composition, bearing a close analogy to each other. They chiefly consist of a series of well defined limestones and shales, that occupy the complete range from Drummond's Island, of Lake Huron, to Monominee river of Green Bay.

These limestones and shales are less perfectly developed in their easterly prolongation; or in other words, the separate portions of the formations thin out as they approach the primary region of the Ste Marie's river. As we proceed towards the northern declivity of the Upper Peninsula, the red sandstone of Lake Superior, makes its appearance, underlying the groups of limestones and shales before mentioned.

These sandstones, together with the series of overlying limestones and shales, are bounded on the east by a range of hills composed of primary rocks, chiefly of quartz, hornblende and greenstone. The boundary between the primary and sedimentary rocks is very nearly defined by the course of the Ste Marie's river, which stream, through nearly its whole course, passes very near to, or directly along the line of junction of these rocks. Thus it will readily be perceived, while the limestones, shales, and sandstone fall mostly within the United States, the primary rocks are chiefly embraced within the British possessions.

PRIMARY ROCKS.

It has already been stated that the development of the series of primary rocks, falls chiefly easterly and north-easterly, without the region of country under consideration; for which reason such allusion only will be made to them as will aid in

more clearly understanding those rocks embraced within our own territory.

Commencing with the main land at the first, or lower point of contraction in the Montreal channel of the Ste Marie's river, (which contraction is formed by the near approach of the island of St. Joseph, to the main land, and is the lowest point at which any observations were made,) these primary rocks stretch in a westerly direction across the northern part of the island just mentioned; when curving northerly, they appear on the south-easterly end of Sugar Island, from which point they pass to the main land, north, and skirt the easterly side of Great Lake George, forming here a somewhat elevated range of hills. This range of hills, after reaching the head of Lake George, pursues a westerly course, departing from the river, until it reaches Gros Cap of Lake Superior.

The immense primary region of which the line described may be considered as it were, a single point, stretches nearly continuously many hundred miles north-westerly, skirting a portion of the shores of Lake Superior, and in conjunction with the trap rocks constituting the highlands between that lake and Lake of the Woods. From these highlands it stretches a little east of Lake Winnipeg, far to the northwest, finally constituting the immense "barren grounds" of the British possessions. It is also well known that this range of primary rocks, stretches in an easterly direction through the interior of the upper province of Canada.

The primary region of the Ste Marie's river and its vicinity, is characterized by the occurrence of rounded knobs and hills, usually of no very great height, though sometimes attaining an altitude of several hundred feet, frequently including basins which usually contain more or less water, thus giving rise to a multitude of marshes, ponds, and more rarely to small lakes. Portions of the rocky surface are absolutely destitute of soil, the otherwise bare rock being usually more or less covered with a variety of lichenes, among which the reindeer moss, (*Cenomyce rangeferina*.) most largely abounds. The soil occurring

in the lower portions of the basins intervening between the knobs of rock, is some times composed of vegetable matter, mixed with siliceous sand and gravel, washed from the higher levels; while that upon the hills is more usually made up of a coarse, siliceous sand, arising from the disintegration of the rocks, and is of a very unproductive character. These soils are covered more or less densely with a forest, in which evergreen timber largely predominates.

This primary district, as a whole, is of a most forbidding character, and in it the agriculturist would find little of interest; for the constant succession of bare rocks and barren soils, form a striking contrast with the country of transition rocks lying south from it.

At that point in the Montreal channel before alluded to, the first perceptible current was noticed, and this may, therefore, in reality be considered as the termination of this arm of Lake Huron, as well as the commencement of Ste Marie's river. The stream is here divided by a great number of islands, and these islands continue to form an almost inextricable labyrinth for a distance of many miles.

On the main land at these "narrows," and extending for several miles, the knobs are composed of compact greenstone, occasionally partaking of a sub-slaty character, and under which circumstances, the rock bears a close analogy to some of the varieties of primary argillite.

Minerals are of rare occurrence in this green stone. Occasional minute crystals of quartz, feldspar, imperfect asbestos, with some indistinct traces of carbonate of copper, were only observed.

In ascending the river, this greenstone was observed to pass, by almost insensible degrees, into a well defined hornblende rock, which was noticed to form low hills upon the main land, as well as several of the islands in the stream.

On the northern part of the island of St. Joseph, a fraction of the south-eastern part of Sugar island, and a portion of the main land on the east, the place of the hornblende rock is supplied by

granular quartz rock, usually white, but sometimes passing to a reddish or deep red color. In character, it varies from a sub-crystalline rock, translucent at the edges and breaking with a conchoidal fracture, to a granular or almost conglomerate quartz rock. Small quantities of hematitic iron ore, and rarely micaceous oxide of iron, were the only simple minerals noticed associated with this rock.

In the range of hills bounding the easterly side of Great Lake George, talcose slate was observed, but to what extent it exists, I am unable to say.

The only district occupied by this primary range, within the line of boundary between our own territory and that of Great Britain, is that before mentioned, upon the south-easterly part of Sugar island. The rock is, here, a light colored, granular quartz, and it occurs, forming a few low knobs, that occupy but a very small extent of surface, and that, at the very extremity of the island. For the most part it is hidden from view by detrital matter mingled with large angular blocks of quartz rock, and nearly the whole tract is clothed with a dense growth of timber.

SEDIMENTARY ROCKS.

The district of country stretching westerly and southerly from the primary tract alluded to, is characterized by the occurrence of the red sandstone of Lake Superior, on the north, and the series of overlying limestones and shales heretofore mentioned on the south. The contrast, in general contour, between this and the primary region, is, in all respects, characteristic of the different formations. Thus, while the predominant feature of the primary region is that of a rugged, knobby, and for the most part, barren country, the district south and south-westerly from it, rises in gradual swells or undulations, covered with a heavy growth of forest trees, and possessing many tracts of soil which are inviting to the agriculturist.

Lake Superior Sandstone.

Although but a small angle of that country, which is referable to the red sandstone formation has been examined during

the past season, yet, in order to a better understanding of its range and extent, it may not be misplaced to refer to the fact that a large portion of the northern slope of the upper peninsula, is referable to this rock formation. Its continuity upon the southerly shore of Lake Superior, being only broken by the occurrence of a comparatively limited range of primary and trap rocks.

This Lake Superior sandstone, in its easterly prolongation, rests against and upon the primary range of the Ste Marie's river, before described, while on the south, it is seen to pass beneath the limestone at the Nebeesh rapids of the Boat and Canoe channels of that river. The rapids or falls of Ste Marie's river are formed by the passage of the waters over the outcropping edge of the sandrock, which inclines or dips from this point southerly; thus passing *conformably* below the limestone before alluded to.

No cliffs of sandrock occur in the immediate vicinity of the Ste Marie's river, nor was it noticed, at any point, to rise many feet above the surface of the water. In fact, no opportunity offered for a satisfactory examination of the rock except in the vicinity of the Sault, at which point, a "race" for conducting the waters to a saw mill, has been excavated, in part, through it. The rock, here, varies from a light gray to a brick red color, not unfrequently being gray, with red or reddish spots, and in structure it varies from a compact sandstone, occurring in layers of several inches thickness, to that of a shelly or sub-slaty character. Through this sandrock a large portion of the contemplated canal around the falls must be excavated, and occurring, as the rock does, in strata of no great thickness, but little difficulty will be encountered in the excavation, and the work, when once completed, will be of a permanent character.

This sandrock, as a material for the structure of works exposed to the action of the elements, is of an inferior quality, and will, without doubt, undergo more or less rapid disintegration when exposed to the conjoined action of moisture and frost.

As a material for the construction of ordinary walls, it will answer a good purpose.

I allude to this subject the more particularly, at this time, for the reason that a great amount of rock, of a suitable shape for the construction of the walls of the locks required for the Ste Marie's canal, will be thrown out during the process of excavation, and which may appear to be an inducement for its use in that work. In a climate like that of the Sault de Ste Marie this error should be carefully avoided; for if the sandrock be used for that purpose, but few years will elapse before the locks will require reconstruction. An example, illustrative of the effect of moisture and frost upon a rock of similar composition, is exhibited on the Erie Canal, of New York, in the old aqueduct over Genesec river, and in several of the locks upon that great work. During the few years which have elapsed since the construction of these structures, the disintegrating action of the causes alluded to, has been rapidly at work, and some of those expensive structures are in so precarious a condition as already to require reconstruction.

In the immediate vicinity of the surveyed line of the Ste Marie's canal, transported masses of granite, hornblende, sienite and quartz rocks abound, and they may be economically employed for the construction of the proposed locks and will make an enduring structure.

The Lake Superior sandstone, in its easterly prolongation, does not attain a very great thickness, but in proceeding westerly this thickness is vastly increased, attaining on the south shore of Lake Superior to several hundred feet.

So far as my examinations during the past year have extended, the rock is destitute of fossils, and in fact after a careful examination, (several years ago,) along its whole line of outcrop, on the southerly shore of Lake Superior, I have never been able to detect in the rock a single contained fossil.

Limerock and Shales..

Passing from the sandstone of Lake Superior to, or near to the southerly slope of the Upper Peninsula, we come up-

on a series of limestones and shales, resting upon and concealing the former rock. These limestones and shales along the whole line of coast, from Drummond's island of Lake Huron to Monominee river of Green Bay, have a slight inclination to the south, or more nearly to the south south-east. Thus while these rocks dip, in such a manner as to form the basins of lakes Huron and Michigan, their upraised edges form, as it were, the barrier that sustains the waters of Lake Superior at their present level.

The Nebeesh rapids of the Ste Marie's river, at least in the two westerly channels, is in part over the very lower portion of these limestones, and by far the larger proportion of the small streams along the coast, intervening between Pte Detour of Lake Huron and Monominee river of Green Bay, have a more or less rapid descent over some portion of the limestone series, usually at points not very far from their place of embouchure.

The limestones and shales will, in the following descriptions, be separated into two groups, reference being had to their constant embraced fossils and chemical character. The immediate line of junction between these groups is usually not particularly distinct, but in the main they are readily distinguished by the most hasty glance.

Lower Limerock and Shales.

Without, at this time, attaching to that portion of the limerock series that immediately overlies and rests upon the red sandstone of Lake Superior, any characteristic name, the rocks as a whole, will be considered simply with reference to the *position* they occupy in relation to the overlaying and more southerly limerocks; nor will the several beds into which the group may be divided be considered separately.

The lower limerocks and shales in the district of country under consideration, occupy a comparatively small portion of the district, and do not appear upon the coast except at very few and distant points. The complete group may be described

as a series of compact and shaly limestones, with interstratified, argillaceous, blue colored shales; the shales, more particularly in the western prolongation, forming a large proportion of the whole mass. The group is more or less fossiliferous through its whole range, being characterized by the presence of several species of the genera, *Orthis*, *Atrypa*, *Delthyris*, and *Strophomena*, and more rarely by *Calymene*, *Asaphus* and *Encrinurus*. In the western prolongation of these lower limestones and shales, as has before been mentioned with respect to the Lake Superior sandstone, the thickness becomes very much increased; while in their near approach to the primary of the Ste Marie's river, on the east they thin out and nearly disappear.

The lower portion of a range of hills stretching along parallel to and not far distant from the southerly side of Little Bay du Noquet, in consequence of their somewhat abrupt termination at the bay mentioned, expose a series of rocky cliffs of exceeding interest. The immediate line of this coast is bounded in part by perpendicular or overhanging cliffs, not usually having an elevation of more than thirty to forty feet. The rocks of these cliffs are referable to the lower group of limestone and shales, while the hills rising abruptly immediately inland are capped by the overlaying or upper limestones. The cliffs immediately bounding the bay are made up of a series of argillaceous limestones in thin strata, with intervening soft argillaceous slate of a blue color; this slate constituting by far the larger proportion of the cliffs. These shales which are rapidly disintegrated by the action of moisture and frost, have been thrown down, and swept away by the waters below, while the harder and more compact strata of limestone having resisted the action of these causes, are left in projecting and overhanging cliffs. Some portions of the layers or strata of limestone are almost wholly composed of congeries of fossils, of the genera before mentioned, while in others, no fossils have been detected. The same remarks respecting the fossils may also apply to the slaty portions of the group.

Between Little Bay du Noquet and Drummond's island, the lower group was not noticed *upon the coast*, but in ascending the Ste Marie's river, it is seen at the Nebeesh rapids, Sailor's encampment island, and also on the easterly end of the island of St. Joseph. Nearly, if not the whole of the more elevated parts of the island last mentioned, are composed of the *upper lime-rock*.

In pursuing the course of out-crop of the lower group, from the Nebeesh rapids, where, after thinning out as has been before stated, it is seen in the bed of the river resting immediately upon the sandstone; it stretches in an easterly direction across Great Sailor's encampment island, and the Boat channel, and still further easterly it no doubt comes in direct contact with the primary rocks of the southerly part of Sugar island, as well as those of the northerly part of St. Joseph island. After leaving Little sailor's encampment island, this rock disappears beneath the highlands of the St. Joseph, but again reappears in close proximity to the primary, on the easterly side of that island, about five miles below Bear's encampment island and of the Montreal channel. The rock, as observed at these points, is not only reduced very much in thickness, but has also lost nearly the whole of its associated shales.

At Sailor's encampment island, where the rock scarcely rises above the water, it has the character of a calcareous sandstone, with comparatively few fossils; while on the easterly part of St. Joseph, where it rises to a height of about five feet above the water, it takes the character of a flaggy bituminous limestone, of a dark brown color, and is composed almost entirely of a mass of those fossils which characterize the formation.

Upper Limerocks.

Upon the group of lower limestone and shale, and differing from it not only in continued fossils, but also in physical character, rests a series of limerocks, extending from the Manitoulin islands of Lake Huron, to, and including the southerly cape of Green Bay. A *strict* consideration of the sub-

jects connected with this extended group of rocks, would perhaps call for a division of the mass into three parts, viz: the lower, or Pentamerus portion; the middle, or Polypyferous portion, and the upper, or Mackinac and Manitoulin portion. But for all the purposes of the present report, it is sufficient to consider these separate rocks as a single group.

The most casual observer of the maps representing the northern and eastern parts of Lake Huron, can scarcely fail to notice the immense numbers of islands that are there represented. The larger of these, and in fact nearly the whole of them, are composed of limerocks, referable to the group under consideration.

Commencing with that group of islands known as the Manitoulin chain, of which Drummond's Island may be considered the termination westwardly, the upper limestone is observed to pass to the main land, forming the bed of the lake in the intermediate space, and to appear at intervals upon the coast, as we proceed westwardly. The upper portions of the rock form the base of that group of islands, east from Mackinac, known as the Cheneaux, as well as the island of Mackinac and the range of hills extending westward on the main land, commencing with the bare point of rock, known as the Sitting Rabbit.

The middle and lower portions of the group appear at many points along the coast, forming the head of Lake Michigan, as well as at Great Bay du Noquet, and also cap the hills upon the easterly side of Little Bay du Noquet, of Green Bay. They also give rise to the islands at the entrance of the bay last mentioned, and compose at least the whole upper part of the elevated cliffs forming the southern boundary of that bay.

It will thus be observed, that the line of bearing of the upper group of limerocks, is very nearly east and west, while the general inclination, as has been before stated, is south, or perhaps more nearly south south-east. The inclination of the whole of the rocks described being southerly, offers a sufficient explanation for the fact, that in proceeding northerly from the

coast, we soon pass from the upper to the lower limestone and shales, and by continuing still farther north, we come upon the red sandstone of Lake Superior.

Drummond's island, the only island of the Manitoulin chain that falls within the territory of the United States, is composed of the lower and middle portions of the upper limestones, and the characters which are applicable to it here will sufficiently characterize it through its whole range.

At Collier's harbor, (the site of the old British fort,) near the western extremity of the island, the lower portion of this series is seen to form the bed of the lake. The rock rises almost imperceptibly to the surface, forming the immediate shores of the small bay mentioned. The rock, which here rises only a few feet above the water, is exceedingly compact, of a light brown color and sub-granular structure, and is nearly destitute of fossils. Its surface is indented with numerous small, and somewhat regular spherical cavities, which give to it a very singular appearance.

After leaving Collier's harbor, the rock is concealed by detrital matter until we reach the central and elevated part of the island, where a rock belonging to the middle portion of the group and overlaying that before noticed, appears. This rock differs widely in appearance and composition from that at Collier's harbor. It has a coarse granular or sub-crystalline structure, and is of a light buff color, which at times approaches nearly to whiteness. The rock is usually compact, though it sometimes partakes of a slatiness of structure.

This last rock constitutes the range of hills stretching in an easterly and westerly direction across, and forming the elevated portions of the island, attaining an elevation varying from eighty to one hundred and twenty-feet.

The middle rock of the group is here characterized by the abundance of its contained fossils, chiefly *Polyparia*, which also mark its complete range westerly. The most abundant of these, embrace several species of the genera *Calamopora*, *Catenipora*, *Syringopora*, *Aulopora*, and *Strombodes*, together with

several species of *Orthocera*. This limerock appears at intervals upon the coast, in the direction of Mackinac, but always at a very low level.

The rock which constitutes the island of Mackinac, as well as the range of hills stretching in a westerly direction, on the main land, belongs to the upper portion of this group, and since it was more particularly noticed in the second annual report from this department, will be passed by with this simple notice.

Westwardly from the straits of Mackinac, this upper portion of the limestone continues to cap the hills, while the middle and lower portions of the same group appear at short intervals upon the coast along the northern end of Lake Michigan to Point Detour and Great Bay du Noquet of Green Bay, along the easterly side of which bay they form abrupt and perpendicular cliffs, varying from forty to one hundred and twenty feet in height. The lower rock of the series, as has been before stated, caps the elevated hills on the easterly side of Little Bay du Noquet.

Economical Geology of the upper and lower limestones and shales.

The two groups of limerock under consideration, may be made to furnish an abundance of material, admirably adapted for use as a building stone, and also for the manufacture of quick-lime.

On the easterly part of Drummond's island, the elevated range of hills which traverse that island, terminate abruptly in a series of cliffs elevated from one hundred to one hundred and twenty feet. Portions of the limerock forming these cliffs are admirably adapted for use as a building stone, as well as for the manufacture of lime; and from the fact that vessels may approach almost directly to the coast, and load with safety, its value is much enhanced. Near by, and in fact, almost in contact with the rock, is a small perfectly "land locked" harbor, that has been rendered secure from storms by a narrow "spit" of gravel, which is covered with forest trees.

The cliffs at this point of Drummond island are made up of a series of strata, as follows, *in ascending order*:

1. A brownish, light colored limestone, of extreme fineness, and separating into layers, varying from one to four or five inches in thickness; well adapted for use as a flagging stone, and for the manufacture of lime. Rises to a height of about twelve feet above the water.

2. Resting upon this flaggy limestone is a compact, light buff colored, granular, occasionally sub-siliceous limestone. It separates into layers, having a thickness of from five to six feet, and blocks may be obtained of almost any required size. This rock occupies about sixty feet in height in the bank, and is so situated as to admit of being quarried with the utmost facility. As a material for building, it is of superior quality, being well calculated to resist the action of disintegrating agents, and when the thickness of the separate strata, with the ease with which the rock may be quarried, together with its peculiarly advantageous situation, are considered, I trust the great value of this quarry may be appreciated.

3. Above, and resting upon the granular rock just described, is a fine grained, light colored, compact limestone, occupying about twenty feet of the hill side, above which the rock was so covered with detrital matter as to prevent observation. This limestone is of a somewhat flaggy structure, and, unfortunately for its application as a building material, it separates into irregular masses: were it upon the ground where required for use, it would answer tolerably as a rough building stone, but will scarcely bear transportation for that purpose; it may, however, be advantageously used for the manufacture of lime.

Limestone of good quality may be quarried with facility at many points on Drummond's island, and I may safely venture the opinion, that at no very distant day, the limestones of this island will obtain the celebrity they so justly deserve.

From Drummond's island to Mackinac, the great mass of limerock upon the immediate coast, lies below the level of the

water, and of necessity does not admit of being quarried; but at a few points, quarries may be opened to a limited extent.

The rocks of Mackinac, and the vicinity, were described in a former report. These upper rocks possess less compactness than those lying below, and in consequence of their vesiculated structure, are more subject to disintegration; and added to this, the shattered condition of that on the Island of Mackinac, will prevent its extensive use for permanent structures.

Limestone of better quality belonging to the same place in the group is found on Round island and also upon the main land in the vicinity of Pte St. Ignace.

From the straits of Mackinac to Pte Detour of Green Bay, limestone may be advantageously quarried at many points upon the immediate coast. A low cliff of granular, silicious limerock, attaining an elevation of some twelve to fifteen feet above the water, occurs on the westerly side of Pte Seul Choix, and offers an advantageous situation for obtaining an excellent building stone, in thick strata, at little cost. This rock belongs to the middle portion of the upper group.

Limerock, well adapted for use as a building stone, or for the manufacture of lime, may be quarried in a limited quantity, at the head of the small lake through which the Monistegue river, makes its embouchure into Lake Michigan. Although not of very great extent, it will prove of much value at this particular point.

In the vicinity of Pte Detour of Green Bay, this *middle* limerock may be advantageously quarried at many points upon the coast.

On the easterly side of Great Bay du Noquet, the elevated cliffs belonging to the middle and lower portions of the *upper group* may be made to furnish an inexhaustible supply of good building stone. The rock is compact and admirably calculated to resist the action of disintegrating agents, and may be advantageously and readily quarried, of almost any required thickness. The lower portions are composed of thin strata of a fine grained rock, well fitted for the manufacture of quick lime, while

the upper portions are of a more granular structure, and occur in strata having a thickness of from three to five feet. The cliffs and hills rise here, as we have before stated, to a height varying from eighty to one hundred and fifty feet.

On the easterly side of Little Bay du Noquet the lower limestone and shales may be made to furnish a tolerable building stone as well as a material for the manufacture of quick lime, but of inferior quality compared with those before mentioned, and not as easily quarried.

From this brief outline it will be seen that this portion of the Upper Peninsula, furnishes an abundant supply of a superior material for building as well as for the manufacture of quick lime. Thus, when the soil shall be cultivated, the agriculturist will have an unfailing supply of calcareous manure at hand, and with a soil adapted to its use, by judicious management, he cannot fail to reap an abundant harvest. With these elements of wealth at hand, in addition to the great and important fisheries which surround the peninsula, we may, I trust, lay aside the long cherished idea, that this portion of our State must remain an uninhabited wilderness.

Mineral contents of the Limestones and Shales.

The minerals embraced in the groups of limestones, of the Upper Peninsula, are few, and so far as I have been able to determine, even those few are in comparative small quantities.

Gypsum is found forming thin *veins* in the middle and upper portions of the upper group of limestones, and it has been obtained in sufficient quantity to admit of export; but so far as I, have been able to determine these *veins* are of limited extent and they are chiefly below the present water of the lakes. Veins of gypsum occur in the bed of the lake, near St. Martin's island of Lake Huron, and also at several points on the coasts westwardly from Mackinac.

Calcareous spar, and iron pyrites are occasionally met with, and hornstone occurs still more frequently, sometimes forming thin beds in the upper groups of rocks.

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 Hon. 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 surveys 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 portion 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 ironstone 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 portions 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 con-

sequence 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 coun-

try 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 surrounded 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 situation 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 inferior 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 re-

ports 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 unfavorably 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 remain 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 circumstance might admit, a single sub-assistant, Dr. 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 dependant 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 the 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, we 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's 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 Keweenaw 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 points 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.

DOCUMENTS.

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 the 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,
Ottawa,

Shiawassee.

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.

Map 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 now 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 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 Loutre, 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.*

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 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, so 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 Lemén, 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 "*pencilings*," 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

*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

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 coincident 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, &c., 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 distant 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 Menomones, &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 subjects 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, tamarac, 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 commingling 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 13, 14, 15, 16 and 17 north of ranges 14, 15, 16, 17 and 18 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, tamarac, and cedar.

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

The face 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 deg.

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 examination of the causes that effect it, instead of a diminished confidence in many of its results, its habits, though governed no doubt by a sub-

the 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 min. east; on Pointe aux Barques, in lat. 43 deg. 51 min. 36 sec.; seventy miles from the foot of the lake, it was 1 deg. 38 min.; twenty miles west of Pte aux Barques on the same parallel, it was 2 deg. 6 min.; farther west, at the mouth of Saginaw river, in lat. 43 deg. 36 min. 30 sec., 2 deg. 19 min. east; at the same time it was 2 deg. 10 min. at Detroit, lat. 42 deg. 18 min.

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 deg. 48 min. to 3 deg. 13 min. 22 sec.; equal to 25 min. 22 sec. increase of east variation. From 1822 to 1828, a decrease from 3 deg. 13 min. 22 sec. to 2 deg. 50 min.; (yearly difference, 4 4-10) and for the last twelve years, up to 1840, a decrease 2 deg. 50 min. to 2 deg.; (yearly difference, 4 min. 10 sec.) 2 deg. 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 deg. 30 min. east; thirty miles north, on the south side of Little Pointe aux Sable, it was 6 deg. 15 min. east; and twelve miles further, on the north side of the same

point, 6 deg. 00 min.; at the mouth of Pierre Marquette river, seventy eight miles above Grand River, 4 deg. 34 min. east.

In 1838, the north boundary of town twenty-four north, range sixteen west, on the shore of lake Michigan, ninety-nine miles above Grand River, in lat. 44 deg. 31 min. it was 4 deg. 30 min. east; thirty miles east on the same parallel, 2 deg. 50 min. east; sixty miles east on the same parallel, 2 deg. 45 min. east; ninety miles east, same parallel, at the principal meridian, 2 deg. 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 of Point 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 for August and September,

being 14 min. Mr. Burt found the maximum for one day, 40 min., 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 sub-divided with this evident want of skill, and with a carelessness in the first surveyor* 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 No. 9, N.; 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 deg. 39 min.

The error lies in a too great variation of about 1 deg. 30 min., 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 deg. and 3 deg. 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.

*Mr. Wampler.

In 1810, Col. Jared Mansfield records the variation at Detroit, at 2 deg. 48 min. 00 sec., east.

In 1822, Messrs. Mullett and Lyon, do., 3 deg. 13 min. 22 sec. east.

Between the time of the above two observations, during the years 1816, '17 and '18, 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 deg. 48 min. to 4 deg. 39 min.; making a difference of 1 deg. 51 min. in six years, or equal to 18 min. 30 sec. each year; an unheard of phenomenon on this meridian, when it is further considered that in 1828 it was reduced to 2 deg. 50 min.; decreasing in a ratio of 4-10 min. per year only, and 4 min. 10 sec. 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 round the pole once in 23 hours and 56 minutes; and when at its greatest eastern or western elongation, is 1 deg. 34 min., 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 afterward 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 min. of a degree, advancing with each line westerly over a space of 100 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 deg. in 60 English miles,) these lines, on the western boundary of the survey, should have been run at a variation of 1 deg. 40 min. 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 and 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, 1819.

	Feet.	Inches.	Feet.	Inches.
August 21, 1838, highest stage,			5	03
September, " decrease,	0	03	5	00
October, " "	0	09	4	03
November, " "	1	00	3	03
December, " " same,			3	03
January, 1839, " "	1	08	1	07
June 10, " increase,	2	01	3	08
July 31, " "	0	03	3	11
Sept. 20, " decrease,	0	09	3	02
Oct. 28, " "	0	09	2	05
Nov. 27, " " same,			2	05
Jan. 30, 1840, " "	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 manufacturing, in lines of internal improvement, and in the independence of her citizens.

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

etc

REPORT

Of C. C. DOUGLASS, Assistant Geologist.

Detroit, Jan. 12, 1840.

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 diluvium 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 soils of these counties, as a whole, do 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 silicious 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, marley 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 12, 14, 15, and 19, 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 8, 9, 13, 19, 28 and 29, 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 11, 13, 23, 24 and 27, as well as in the bed of Powell's lake and in its vicinity.

The town of *Spring Arbor* abounds in extensive beds of marl, which were more particularly noticed on sections 21, 28 and 29.

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, sec. 2, occupying an area of more than sixty acres, and having a thickness exceeding six feet. An extensive bed was also noticed on section 25.

Rives. A somewhat extensive deposit of marl occurs on section 9.

Leoni. Marl, in inexhaustible quantities, occurs near the outlet of Wolf lake, and also upon sections 4, 11, 12, 22 and 23.

Town of *Jackson*. Marl occurs in this town, in abundance, on sections 20, 21, 26, 27 and 31, (town 3 south, range 1 west,) and also on section 31, (town 2 south, range 1 west.)

Concord. Several extensive beds of marl occur in this town which were more particularly examined on sections 8 and 9. Also in the bed and banks of the Kalamazoo river.

Grass Lake. On sections 13 and 29, in this town, extensive beds of shell marl were examined.

Spring-Port. An extensive bed of marl occurs on section 15.

Tompkins. An extensive bed of shell marl was examined on section 17, in this town.

Eaton County.

Kalamo. Several very extensive beds of marl were observed on sections 22 and 25, (town 2 north, range 6 west,) and on section 19, (range 5 west.)

Kalamazoo County.

Texas. Shell and tufaceous marls occur in the beds of several lakes in this town. Also on sections 31 and 32, of the same town, is an extensive deposit of this mineral.

Alamo. On sections 1, 9, 12 and 24, 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 northwest from the village of Kalamazoo.

Chester. Extensive deposits of marl abound in this town, on sections 4, 9, 10, 11, 12 and 24.

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 section 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. Incrusted 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 on 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, much of the 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 elevations, 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, hornblend, and the debris of other primary minerals. It sometime 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, grey and blue clays. The red and grey 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 manufacturer 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, hav-

ing 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,
Silica and alumine,
Carbonate of lime,
Water,

Grains.
78.45
7.95
1.10
12.50

Kidney Iron Ore.

The stratum in which this ore is imbedded appears in the slightly elevated bank of Notawa 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 at 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.

2nd. Limestone; found in limited and apparently irregular beds.

3rd. 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 course, 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 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 any thing 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 yet 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 1, and an amount estimated at 1500 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 distinguished 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*, *Stigmara* and *Calamites*, together with thin masses of carbona-

ceous 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 outcropping 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 *lithodomus 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 lime-rock 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.

Palma, 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 sections 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, by 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 been before 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,	8 0
2. Brown sandstone,	0 7
3. Argillaceous iron ore,	3 0
4. Sandstone,	0 5
5. Argillaceous iron ore, (in beds.)	
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 OF IONIA COUNTY.

This rock is well characterised, 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 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 a reddish grey color, and is composed of quartzose sand, with a sparse intermixture 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 any thing 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 Maskegon 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 silicious 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 oxide of iron, &c.

A blue semi-undurated sand, as I have before observed, was noticed underlying the red marley 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 deposits.

On sections twenty and twenty-one, half a mile north-east from Mr. Newel'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 deposits 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 depo-

site 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-crystalline, 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 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 Pt. aux Barques south, 45 deg. 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 Jacksonburgh, 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, de-

scending 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 traveller. 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 compen-

sates 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 under-brush 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 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 the 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 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 Alleghanies, 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 overlying 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 overlying 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 intelli-

gible to the general reader, the remarks which follow, on the rock formations 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 part 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 place*, 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.

I.

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 northeast and southwest, 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 those 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 react 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 consumption 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 silex, 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 100 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 sand-stone series. The great accumulation of all these several deposits may be conceived, when it is stated that a rise of 200 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 sand-stone, 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 sand-rock. 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 any thing 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 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 currents 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 limerock, 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 limerock 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 deposites, 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 overlies the limerock, are in general very gravelly, and contain also a large proportion of carbonate of lime; the blue in particular effervesces 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 also, 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 underground water-courses.

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 county, 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-jambes; 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 considerable 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 the 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 molluscous 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 side of the valley; while copious springs discharg-

ing 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 \$20 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 silicious 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 expe-

riment 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 recognised 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 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 certain 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.

1st. 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.

2d. 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 ferruginous 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 town of Lyon, section thirty, a good lively ore is found, occupying in 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 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 on 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 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. Whittlesy, 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 a 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 proofs 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 region of the lakes, probably cannot be satisfactorily determined. It may be competent, however, to suppose that these apparent "lake ridges" were the boundaries of the ancient sea formed during intervals of rest in the upward tendency of the land. The comparatively quiet state of the elements, and the greater

length of time for which the waters covered the extent described, will satisfactorily account for the uniformity of surface which characterizes the country bordering on the present lakes and those vast plains of the west, which were subjected to the same influencing circumstances.

There are, however, some reasons for concluding that a part at least of this area *was occupied by fresh water*, and to this supposition we shall advert hereafter.

There also exist strong reasons for supposing that the relative levels of the land did not every where remain the same, or that disproportionate elevations took place. Thus appearances warrant the supposition that at several points barriers existed to that free communication which I have assumed of the water of this inland sea with the Atlantic. If we suppose the great Appalachian range of mountains, at any of the points where it meets the St. Lawrence, to have once formed a barrier to that river, a communication through from the ocean in that direction would have been cut off. The "uplifts" at Little Falls, which rise 147 feet higher than Lake Erie, and the "Highlands" of the Hudson might also have interposed barriers to an outlet across the state of New York. A single communication only would then exist with the ocean, viz. through the valley of the Mississippi. That the lakes once discharged their waters in this direction, such additional evidence is furnished by the appearance of the country, that in this our argument but serves to add confirmation to the general opinion.

There is further reason to suppose that a barrier has existed across the strait of Mackinac, cutting off Lake Michigan, and perhaps Lake Superior, from the lower lakes. Now if we supposed that the erection of this barrier, or the continuance of the elevatory movement, closed up the communication by way of the Mississippi valley, a body of water would remain, filling nearly the whole "basin of the St. Lawrence," and receiving constant accessions from the streams which discharge into it.

At this period, we may conclude, the rocky barriers of the Mohawk and Hudson, unable to resist the enormous pressure of the accumulating volume, gave way, discharging the surplus waters with tremendous violence, and thus opening a passage for the present great channels of water communication with the ocean, through the State of New York.

Subsequent to this event, the continued uplifting of the land, or the bursting of the barrier of the Alleghanies, opened a passage for the waters through their present outlet of the St. Lawrence, when Lake Erie and the upper lakes subsided to about their present levels. Then, for the first time, their accumulated waters, confined by the valley of the Niagara, rushed over its "wave-worn precipice," producing that stupendous cataract, which now seems likely, for ages, to emit its unceasing thunders.

The "lake-ridge," of New York, may be considered as the shore of Ontario, after this *parting of the lakes* had taken place, and must necessarily be of subsequent formation to those of Lake Erie. A still further progress of the elevation afterwards, alone, would reduce that lake to its present level, without affecting the levels of the upper lakes.

It is not our design, nor would it come within the scope of this report, to discuss the prime cause of these great changes. We rest here on the assurance that it involves no principle which a geologist, at this day, will deny. A fact is mentioned by Prof. Emmons, in the first geological report of New York, which has so immediate a bearing on the principle here made use of, that I cannot refrain from alluding to it. It is this— "That the waters of the St. Lawrence are declining, or do not appear at so high a level now as formerly, or, what is about the same thing, *the country is rising.*" "The possibility of such a change," he justly remarks, "can no longer be doubted, since it is clearly proved that portions of the continent of Europe are now undergoing the same change. Norway is gradually rising, and Greenland is gradually sinking." Similar

phenomena are also taking place on the western coast of South America. Other facts relevant to this subject might be introduced, connected with the earthquakes in the Mississippi valley, had I not been already enticed to greater length than may seem called for in this place.

It may be added, that the unusually marked character of the ridge on the west end of Lake Erie, is a consequence of the even surface and extent of the limerock, and its overlying clays, which here form its base. It may be doubted whether any similar ridge, at least so distinct, may be traced over the more broken country which circumscribed the eastern limits of the waters in New York.

LAKE ALLUVION.

The facts and suppositions above stated, lead to several important conclusions in determining the alluvial deposits of the peninsula.

Under the name of *diluvium*, were classed all those alternating deposits of sands, gravels and clays, which envelope the upper rock formations of the peninsula. As we descend from the more elevated interior, and come within that area which I have supposed circumscribed by the waters of the ancient lakes, a different character of surface and of soil prevails. The great deposit of blue and yellow clays, since they underlie and extend beyond the ridge, must be of a date anterior to the era under consideration. Nor do they seem to have been much disturbed during that comparatively quiet state of the waters. An evident disarrangement, however, took place among the more loose sands and gravels, which assumed the character of *alluvion*; being subjected to a less disturbed and longer continued action than the diluviums, and deposited with fewer inequalities of surface. This alluvion consists, in the main, of a covering of sand, or of sand ridges, with the underlying clays outcropping at intervals. Boulders are thinly dispersed, and few local beds of clay are found, like those embra-

ced in the diluvium. Most of this alluvion is clothed with a dense growth of timber.

Similar results from the same cause are found strikingly exemplified in the State of New York, over an area described by Mr. Vanuxem as occupying "a portion of Oneida, the northern part of Madison, Onondaga and Cayuga, and the western and southern portions of Oswego." The area included within these limits, will be found to correspond with that which I have supposed occupied by the waters when raised to the assumed level. "Were the whole of this ancient level or area," he adds, "stripped of its alluvial materials, we should find that the surface presented a lake bottom, appearing as though Ontario and Oneida once had a higher level, their waters uniting and covering the whole surface."

Very important practical conclusions are drawn by Mr. Vanuxem from these facts.

It is in this *alluvion* that we find buried trunks of trees, the remains of the mastodon, and fresh water shells, and I am not aware that any of these have been found, under similar circumstances, in the diluvial deposits.

Instances in our State, though rare, are all confirmatory of the position assumed. Bones of the mastodon were two years since found on the Paw Paw river, in Berrien county, beneath twelve feet of sand and gravel. A few of these are preserved in the State collection. In the same manner, trees may be seen imbedded in the gravel which overlies the clays on St. Clair river, at the foot of Lake Huron, and at a depth of ten to twenty feet from the surface. The discovery of *fresh-water shells*, under similar conditions, has been made in Saginaw county, and elsewhere in this State, and in the Niagara valley, at a height far above the present stream.

We do not by any means consider these facts conclusive that this inland sea was one of *fresh water*, nor do we see much difficulty in the way of so important a conclusion. If such was

the case, the *barriers* which cut off the influx of the ocean must have existed during the quiescent state of the waters. For, had the present passages to the ocean been then open, no such accumulation of *fresh water* could have taken place; but we must necessarily suppose the inland sea to have been at the same level with the briny Atlantic. Assuming our theory of the erection of these barriers, as proposed above, we may then conceive the uplifting of the continent to have been still in progress, until the whole became elevated far above the influence of the ocean, and could receive accessions only from fresh water streams.

In conclusion of this subject, the aspect of the surface throughout this region seems to indicate *three great eras* since the formation of the newest rocks:

1st. After the elevatory process had commenced, and land appeared above the surface of the ocean. At this period many of the secondary and tertiary rocks were removed by the agitation of the waters, and the whole covered with that mass of disrupted fragments of rocks of all ages which constitute our *diluviums*.

2d. When the upheaving force became stationary, at long and successive intervals, or when the elevation of mountain ranges had erected barriers against the influx of the ocean. During this period lake *alluvions* would be forming over the area then occupied by the waters.

3d. The era of the present levels; which commenced after the increasing pressure had burst passages successively through the opposing barriers, occasioning sudden subsidences of the waters.

Thus we may suppose that the lakes assumed their present forms in successive order, beginning with the most elevated, until finding their final passage through the St. Lawrence, the chain, as now existing, became complete.

Thus, (whichever assumption be correct,) the "lake ridge" becomes a *record* of one of those great changes which the sur-

face of our world has been ever undergoing, to fit it for the habitation of man.

—

The extent of the district gone over during the season's survey has compelled me to confine this report, in the main, to general observations. No apology, therefore, it is conceived, will be necessary, for the omission of the innumerable details collected, very many of which might be deemed of practical importance, and which are fully laid before you in the returned field notes.

BELA HUBBARD,
Assistant Geologist.

GLOSSARY.

Including the technical terms used in these reports.

Alluvial. The adjective of Alluvium.

Alluvion or Alluvium. Recent deposites of earth, sand, gravel, mud, stones, peat, shell banks, shell marl, drift sand, &c., resulting from causes now in action. This term is generally applied to those deposites in which water is the principal agent.

Alum rock. Rocks which, by decomposition, form alum.

Amorphous. Bodies devoid of regular form.

Amygdaloid. A trap rock which is porous and spongy, with rounded cavities scattered through its mass. Agates and simple minerals are often contained in these cavities.

Anthracite. A species of mineral coal, hard, shining, black and devoid of bitumen.

Anticlinal. An anticlinal ridge or axis is where the strata along a line dip contrariwise, like the sides of the roof of a house.

Arenaceous. Sandy.

Argillaceous. Clayey,

Augite. A simple mineral of variable colour, from black through green and gray to white. It is a constituent of many volcanic and trappean rocks, and is also found in some of the granitic rocks.

Avalanche. This term is usually applied to masses of ice and snow which have slidden from the summits or sides of mountains. It is now applied to slides of earth and clay.

Basalt. One of the common trap rocks. It is composed of augite and feldspar, is hard, compact, and dark green or black, and has often a regular columnar form. The Palisades of the Hudson show the columnar aspect of trap rocks. The Giants

causeway is cited as an example of basaltic rocks, and the columnar structure is there very strikingly displayed.

Bitumen. Mineral pitch, which is often seen to ooze from fossil coal when on fire.

Bituminous Shale. A slaty rock, containing bitumen, and which occurs in the coal measures.

Blende. Sulphate of zinc. A common shining zinc ore.

Bluffs. High banks of earth or rock with a steep front. The term is generally applied to high banks forming the boundaries of a river, or river alluvions.

Bog Iron Ore, Ochre. A variety of ore of iron which has been deposited by water. Chiefly in low, wet ground.

Botryoidal. Resembling a bunch of grapes in form.

Boulders. Erratic group. Lost rocks. Rocks which have been transported from a distance, and more or less rounded by attrition or the action of the weather. They lie upon the surface or loose in the soil, and generally differ from the underlying rock in the neighborhood.

Breccia. A rock composed of angular fragments cemented together by lime or other substances.

Calc Sinter. A German term for depositions of limestone from springs, and waters which contain this mineral in solution.

Calcareous Rocks. A term synonymous with limestones.

Calcareous Spar. Crystallized carbonate of lime.

Carbon. The combustible element of coal.

Carbonates. Chemical compounds containing carbonic acid, which is composed of oxygen and carbon.

Carbonic Acid. An acid gaseous compound, incapable of supporting combustion, and deleterious to animal life. It is common in caves and wells, and many incautious persons lose their lives in consequence of descending, without first ascertaining its presence by letting down a lighted candle. Man cannot live where a candle will not burn freely.

Carboniferous. Coal bearing rocks. This term has been applied to formations belonging to an ancient group of second-

ry rocks which contain coal. The term is now used in a more enlarged sense, and may be applied to any rocks containing coal.

Chalybeate. Impregnated with iron.

Chert. A siliceous mineral, approaching to chalcedony, flint and hornstone. It is usually found in limestone.

Chlorite. A soft green scaly mineral, slightly unctuous.

Chloritic Slate. Slate containing chlorite.

Clinkstone. A slaty feldspathic or basaltic rock, which is sonorous when struck.

Cleavage. The separation of the laminae of rocks and minerals in certain constant directions. They are not always parallel to the planes of stratification, but are often mistaken for them.

Coal formation. Coal measures. These terms are considered synonymous, and refer to the great deposit of coal in the older secondary rocks, which has been called the "independent coal formation." There are, however, deposits of carbonaceous matter in all the geological periods, and several of them might also be called coal formations.

Conformable. When strata are arranged parallel with each other, like the leaves of a book, they are said to be conformable. Other strata lying across the edges of these may be conformable among themselves, but *unconformable* to the first set of strata.

Conglomerate, Crag, or Puddingstone. Rocks composed of rounded masses, pebbles and gravel cemented together by a siliceous, calcareous, or argillaceous cement.

Cretaceous. Belonging to the chalk formation.

Crop out and out crop. Terms employed by geologists and mining engineers, to express the emergence of rock, in place, on the surface of the earth at the locality where it is said to crop out.

Crystalline. An assemblage of imperfectly defined crystals, like loaf sugar and common white marble.

Delta. Alluvial land formed at the mouths of rivers.

Denudation. A term used to express the bare state of the rocks over which currents of water have formerly swept, and laid the rocks bare, or excavated them to form valleys of denudation.

Deoxidize. To separate oxygen from a body.

Detritus and *Debris.* Broken and removed portions of rock which have been operated upon by waters or the atmosphere; frequently transported by currents to great distances.

Dykes. A kind of vein intersecting the strata, and usually filled with some unstratified igneous rock, such as granite, trap or lava. These materials are supposed to have been injected in a melted state into great rents or fissures in the rocks.

Diluvium and *Diluvion.* Deposites of boulders, pebbles and gravel which many geologists have supposed were produced by a diluvial wave or deluge sweeping over the surface of the earth.

Dip. Where strata are not horizontal, the direction in which their planes sink or plunge, is called the direction of the dip, and the angle of inclination, the angle of dip.

Dolomite. A magnesian limestone belonging to the primary class. It is usually granular in its structure, and of a friable texture.

Dunes. Sands raised into hills and drifts by the wind.

Earth's Crust. The superficial parts of our planet which are accessible to human observation.

Embouchure. From the French, signifying mouth or entrance, (of a river.)

Eocene. The strata deposited during the oldest of the tertiary epochs, as, for example, the Paris basin.

Estuaries. Inlets of sea into the land. The tides and fresh water streams mingle and flow into them. They include not only the portion of the sea adjacent to the mouths of rivers, but extend to the limit of tide water on these streams.

Exuvie. In geology, fossil remains.

Fault. A dislocation of strata, at which the layers on one side of a dyke or fissure have slid past the corresponding

ones on the other. These dislocations are often accompanied by a dyke. They vary from a few lines to several hundred feet.

Feldspar. One of the simple minerals, and, next to quartz, one of the most abundant in nature.

Ferruginous. Containing iron.

Fluviatile. Belonging to a river.

Formation. A group of rocks which were formed during a particular period, or which are referred to a common origin.

Fossils. The remains of animals and plants found buried in the earth, or enclosed in rocks. Some of these are but slightly changed, others are petrified and the organic replaced by mineral matter; some have decayed and left the impression of the bodies, while others have been formed by mineral matter deposited in the cavities left by the decay of the organic body. These last are called *casts*. The term petrification is applied to those cases in which organic matter has been replaced by mineral substances. The form and structure of the original body both remain. In casts the exterior form alone is preserved. Fossils are also called organic remains.

Fossiliferous. Containing organic remains.

Galena. An ore of lead composed of lead and sulphur.

Garnet. A simple mineral, which is usually red and crystallized. It is abundant in most primitive rocks.

Gneiss. A stratified primary rock, composed of the same materials as granite, but the mica is distributed in parallel layers, which give it a striped aspect.

Geode. *Geodiferous.* Geodes are small cavities in rock, generally lined with quartzose or calcareous crystals.

Geology. A science which has for its object to investigate the structure of the earth, the materials of which it is composed, the manner in which these are arranged, with regard to each other; and it considers the action of all natural causes in producing changes, such as the effects of frost, rain, floods, tides, currents, winds, earthquakes and volcanoes.

Economical Geology refers to the applications of geologi-

cal facts and observations to the useful purposes of civilized life.

Granite. An unstratified rock, composed generally of quartz, feldspar and mica, and it is usually associated with the oldest of the stratified rocks.

Graywacke, Grauwacke. A group of strata in the transition rocks; but the term has been so indefinitely applied, that other names will probably be substituted.

Greenstone. A trap rock, composed of hornblende and feldspar.

Grit. A coarse-grained sandstone.

Gypsum. A mineral, composed of sulphuric acid and lime, and extensively used as a stimulant manure, and for making stucco and plaster casts, &c. It is also called Plaster of Paris.

Hornblende. A mineral of a dark green or black color, and which is a constituent part of greenstone.

Hornstone. A siliceous mineral, approaching to flint in its character.

Hydrography. A science which considers the waters of the globe, principally as relates to navigation, tides, currents, soundings, charts of coasts, &c.

In situ, In place. In their original position where they were formed.

Kidney Ironstone. A variety of ore of iron which receives its name from the somewhat kidney shaped masses in which it occurs. It accompanies the rocks of the *carboniferous group*.

Laminae. The thin layers into which strata are divided, but to which they are not always parallel.

Lacustrine. Belonging to a lake. Depositions formed in ancient as well as modern lakes, are called lacustrine deposits.

Landslip. It is the removal of a portion of land down an inclined surface. It is in consequence of the presence of water beneath, which either washes away the support of the superincumbent mass, or so saturates the materials, that they become a slippery paste.

Line of Bearing, is the direction of the intersection of the planes of the strata with the plane of the horizon.

Linear survey. A plan of surveying adopted by the United States government, by which the public lands are divided into rectangles, by straight lines.

Lignite. Wood naturally carbonized and converted into a kind of coal in the earth.

Littoral. Belonging to the shore.

Loam. A mixture of sand and clay.

Magnetic Meridian. A great circle passing through the magnetic poles of the earth, if not otherwise varied.

variation," is

of the true

Mural

cal like

M

mer

and capable of being split into very thin elastic leaves or scales. The brilliant scales in granite and gneiss are mica.

Micaceous, in part composed of scales of mica.

Mica Slate. One of the stratified rocks belonging to the primary class. It is generally fissile, and is characterized by being composed of mica and quartz, of which the former either predominates, or is disposed in layers, so that its flat surfaces give it the appearance of predominating.

Other names. One of the deposits of the tertiary epoch. *Greenstone*. In the *eocene*, and older than the *pliocene*. spar. "Animals as shells."

Grit. A coarse-grained sandstone.

Gypsum. A mineral, composed of sulphuric acid strata, of and extensively used as a stimulant manure, and for the coal stucco and plaster casts, &c. It is also called *Primate*. Paris.

Hornblende. A mineral of a dark green or black color, which is a constituent part of greenstone. salt

Hornstone. A siliceous mineral, approaching to flint in its character.

Hydrography. A science which considers the waters of the globe, principally as relates to navigation, tides, currents, soundings, charts of coasts, &c.

In situ, In place. In their original position where they were formed.

Kidney Ironstone. A variety of ore of iron which receives its name from the somewhat kidney shaped masses in which it occurs. It accompanies the rocks of the *carboniferous group*.

Laminae. The thin layers into which strata are divided, but to which they are not always parallel.

Lacustrine. Belonging to a lake. Depositions formed in ancient as well as modern lakes, are called lacustrine deposits.

Landslip. It is the removal of a portion of land down an inclined surface. It is in consequence of the presence of water beneath, which either washes away the support of the superincumbent mass, or so saturates the materials, that they become a slippery paste.