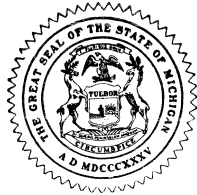


GEOLOGICAL REPORTS of DOUGLASS HOUGHTON

First State Geologist of Michigan
1837-1845

Edited by
George N. Fuller



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CONTENTS

Introduction.....	2
The Houghton Portrait.....	3
Importance of Houghton's work	4
First Michigan Geological Expedition.....	6
Lake Superior in 1840	13
Summary and Synopsis of the work performed by the Geological Survey of Michigan under its first organization.....	22
Geological Reports.....	26
1837	26
Report relative to progress and advantages of the Geological Survey.....	26

1838	29
Report of a select committee of the Board of Regents of a Collection of the State Geologist.....	29
State account with Douglass Houghton	29
Report of the State Geologist.....	31
Communication from the State Geologist to the House of Representatives	48
1839	49
Report of the State Geologist in relation to the improvement of State Salt Springs	49
Report of the Committee on the State Geologist's report in relation to the improvement of the State Salt Springs	52
Report of the State Geologist, in relation to the iron ore, &c., on the school section in town five south, range seven west, in Branch County.....	53
Second Annual Report of the State Geologist.....	54
Report of the committee of the Senate on manufacturers, to whom was referred the communication of the State Geologist, relative to salt springs and the salines of the state	111
Communication from the State Geologist relative to the Geological Survey	112
1840	114
Report of the State Geologist, relative to the improvement of Salt Springs	114
State Geologist's account for the year 1839	116
Third Annual Report of the State Geologist.....	120
Informal report of general progress	156
Report of contracts	159
1841	159
Annual Report of the State Geologist.....	159
Report of the State Geologist relative to the county and state maps	213
1842	215
Report of the State Geologist relative to the State Salt Springs	215
Report of a Select Committee, in relation to the report of the State Geologist	218
Annual Report of the State Geologist.....	219
1843	221
Annual Report of the State Geologist.....	221
Report of the State Geologist, relative to the State Salt Springs	222
1844	223
Annual Report of the State Geologist.....	223
1846	224
Report from Geological Department.....	224

ILLUSTRATIONS

Douglass Houghton.	3
Douglass Houghton Monument at Eagle River.	22
Facsimile of Handwriting.....	48

Map of Calhoun County	89
Map of Jackson County.....	106
Map of Lenawee County	131
Map of Washtenaw County	165
Geological Section near Saginaw Bay.....	192

Introduction

DOUGLASS HOUGHTON was born in Troy, N. Y., Sept. 21, 1809. He graduated at the Van Rensselaer Polytechnic school in that city in 1828, and was soon after appointed assistant professor of chemistry and natural history in that institution, then under the control of Prof. Amos Eaton. In 1830 General Cass, Major Biddle, Major Whiting, and others of Detroit applied to Professor Eaton for a person qualified to deliver a course of public lectures on chemistry and geology. Lucius Lyon, then a delegate in Congress from the Territory of Michigan, on his return from Washington, called on Prof. Eaton to make the proper inquiries. Eaton listened to Mr. Lyon's request, then opened the door to the laboratory, and introduced the boy Houghton to the member of Congress, calling him by the familiar name "Douglass." Mr. Lyon was astonished and could hardly believe Prof. Eaton to be in earnest. Young Houghton did not hesitate, and while retaining his professorship at Troy, came to the border town of Detroit. Thus commenced the career of the brilliant Houghton in the State of his adoption.

Before he was 19 years old he had been admitted to practice medicine by the medical society of Chautauqua County, N. Y. He landed at Detroit before he was 20, a total stranger save the letter he brought, and he had just ten cents in money. He speedily made friends, and his lectures aroused great enthusiasm. Only a few months after his arrival in Michigan he received the appointment of physician and botanist to the expedition for the discovery of the source of the Mississippi, organized under the direction of Henry R. Schoolcraft. Houghton's labors with that expedition were skillfully performed, and his researches did much to extend our knowledge of the flora of the northwest.

Mich. Hist. Colls., IV, 97-99.

From 1832 to 1836 he practiced as a physician and surgeon in Detroit. He was also a skillful dentist. He gained an extensive practice, but never relaxed his studies in science. In 1834, when the cholera visited Detroit with such fearful results, no one could have been more devoted or made greater sacrifices to solace the sick and dying than young Houghton. Among his schoolmates he was a young Napoleon, organizing and leading in many mischievous and dashing enterprises; and the same trait of character led him to stand courageously by the bedside of the cholera patient, and to be a leader in all his undertakings. His social qualities were singularly happy. He could not drop into a store or

office without being surrounded by a group of admiring friends. In his habits he was absolutely temperate. His mind was acute, disciplined, and ready,—not classical, perhaps not polished, but open, frank, and truthful. Its culture had been scientific rather than classic or literary, and it was disciplined by writing and lecturing, and made ready and accurate by a wide and responsible intercourse with men, even before he was 20 years old. He read a great many books and played the flute with exceeding skill.

In 1887 he matured the scheme for a geological survey of Michigan. There were few persons then in the State whose acquirements fitted them to give counsel in a scheme of this kind, hence the labor and responsibility of projecting and maturing such a survey fell almost wholly on him. He proposed to himself a system that should comprise four departments; namely, biology, zoology, botany, and topography, each having an official head, and all united under the general guidance of the State Geologist. The first thing was to bring the matter before the Legislature and get its approval. The members of that body were not familiar with the facts or the value of geologic science, and zoology and botany would appear to them, perhaps of even less practical importance. Michigan had just entered the great family of States. She was inexperienced in public works of all kinds. Her people were sparsely scattered over a wide field of dense forests and oak openings. Through confidence in himself, a knowledge of men, tact, vigilance, courage, and labor, Houghton went before the Legislature and accomplished his purpose.

Governor Mason, on the passage of a law establishing a geologic department, appointed Houghton State Geologist. His able reports of his researches and discoveries are familiar to the public, but the arduous duties and sacrifices which he imposed on himself in developing the geology and the mineral wealth of Michigan can never be known.

As an illustration of his intrepidity in time of danger, Prof. Bradish relates the following incident, which happened in 1840 or 1841. In that open Mackinac sail-boat (the same that was subsequently dashed to pieces) he was making his way along the rock-bound coast of Lake Superior. Night was approaching. Black clouds suddenly overcast the heavens and the darkness of midnight approached. He was opposite the celebrated "pictured rocks," well out to sea, some 15 miles from his destination. His men, obedient to his will, tried hard to keep the boat off shore. But the wind blew a gale. Thunder and lightning added their horrors to the scene. Despite all their efforts, the storm was taking them directly on to the rocks, against which the waters were heard to dash. Houghton saw there was no escape, and the frail barque was speedily sweeping to inevitable destruction.

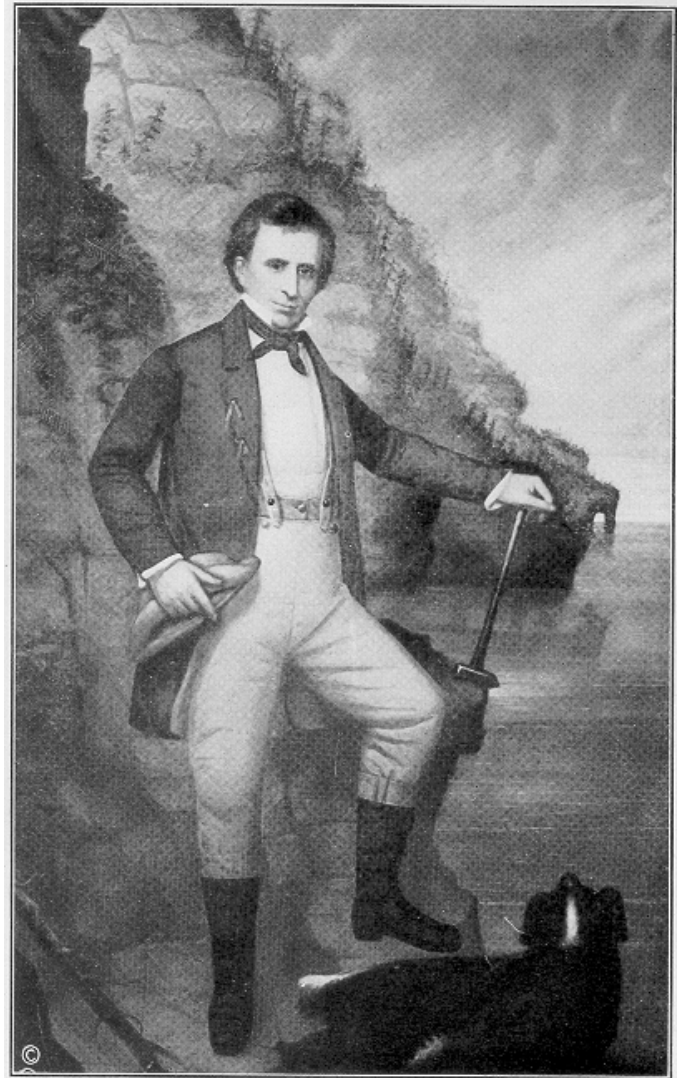
He knew that at intervals along the perpendicular ledges there were narrow breaks or rifts cut away by rivulets. Such a break might, if reached in time, admit of shelter. While the winds whistled and moaned, and the waves

broke in thunder tones, leaping high up the cliffs, the geologist stood firm at the prow of the tossing boat, watching with intense eagerness for one of these slight breaks in the frowning shore. The boat was almost touching the dreaded rocks. Suddenly there came a lurid flash of lightning. Houghton perceived an opening in the rocks, and the frail barque with its precious freight was whirled in and shot up the slope, safe on the gravelly beach.

Labor and hardship had no terrors for Douglass Houghton, and although he died at the early age of 36, he had performed an amount of work rarely excelled, and made for himself a name and fame as enduring as the history of the peninsular State.

It was on October 14, 1845, that Dr. Houghton was lost on Lake Superior. It was ten o'clock at night, and in an open Mackinac sail-boat with five companions he was making his way over the rough waters of that inland sea. They had only a few miles before them to reach Eagle River, where he expected to send dispatches to Detroit in the morning. They were not far from land, a snow storm prevailed, and the wind blew a gale. The leader of the band was anxious to get around a point of rocks, a low, broken promontory that shelved to a considerable distance seaward. He encouraged his men to brave the storm. The waves had increased and were running high. Accustomed to steer his own boat, Houghton trusted to his own judgment, skill, and good fortune, to overcome and master even the elements. His men proposed to go ashore. Houghton encouraged them to proceed, and said, "Pull away, my boys, we shall soon be there; pull steady and hard." Amid the increasing violence of the gale the boat was capsized. They all went under for a moment. Houghton was raised from the water by his trusty companion and friend Peter, who told the doctor to cling to the keel, then uppermost. "Never mind me," cried Houghton; "go ashore, if you can; be sure that I will get ashore well enough." All his valuable instruments and specimens were lost and his notes and papers scattered on the waters.

Very soon the boat was righted and these devoted heroes were all at their oars again. But this bright interval was of brief duration. In a moment after, a wave struck her with such violence that the boat, receiving the blow at the stern, was dashed clear over endwise, and all were again thrown into the fatal waves. Two of the hardy mariners were thrown on the shore in a helpless condition, but the leader of that heroic band went down, not again to rise.



Douglass Houghton.

Douglass Houghton was a man of unusual ability, who made a marked impress on his time and upon his adopted State. The largest inland lake, one of the most wealthy counties, one of the most important towns, one of the most conspicuous mountains, and one of the most picturesque water falls of Michigan received his name. Besides his monument in Elmwood cemetery, Detroit, a cenotaph at Ann Arbor, a memorial window in St. Paul's Church, Marquette, and a full length portrait in the Hall of Representatives of the Capitol of Michigan, preserve his memory.

THE HOUGHTON PORTRAIT

The painter of this portrait, Mr. Alvah Bradish, was a resident citizen of Detroit, as early as 1834, a young man and an artist, closely associated, with Dr. Houghton and on intimate terms with his family. He had unusual facilities for the study of Houghton's countenance and person. The portrait was painted from life and was widely seen and approved by those who knew Dr. Houghton. It is, indeed, the only portrait in oil that he ever sat for. This was before the days of the

daguerreotype or the photograph. A bill for the purchase of the painting was brought before the Legislature in 1879. Prof. Bradish was in the Capitol by invitation of Gov. Croswell. Nearly one thousand petitions had been sent to the Legislature, coming from all parts of the State, urging its purchase. So well persuaded were the leading members of the Legislature of 1879 that this recognition of Houghton's services was just and patriotic, that the bill was promptly passed, and signed by the Governor.

The artist has represented the Geologist as standing on the rocky shore of Lake Superior. Since much of Houghton's

Bradish, *Memoirs*, 98, 300.

severe and perilous labors had been made in that region, and it was there that he closed his brilliant career, it is suitable that he should be represented in the midst of scenes with which he had long been familiar and which his death surrounded with sad interest. His dress here is that of an outdoor geologist, a loose summer coat without vest, leather suspenders, trousers of lighter color, with high-top boots suitable for wading in swamps and crossing deep streams. He seems to be resting, as from severe labor; his attitude easy but emphatic; his looks eager and penetrating; the expressions of his countenance are serene, but his brow and eyes indicate anxious thoughts as of a mind deeply moved by questions of science pressing for solution. One arm is stretched out, the hand resting on the symbol of his profession, the geological hammer; the other holds to his side the crushed, rusty hat that had seen rough service. The rocks are broken and shelve down to the water at his feet; ledges hardly concealed by wild vines and lichens that spring from crevices and drape the rugged wall. Back of the figure are seen the famous Pictured Rocks of Lake Superior, sacred in Indian song and tradition and made classic by the pen of Lewis Cass. These rocky ledges form the main portion of the background of this historical portrait. A cloudy perturbed sky seems to prefigure that fatal storm which in its fury overwhelmed Doctor Houghton, and the expanse of water leads the eye to the distant lowering horizon. At Houghton's feet, looking over the water, stands his famous dog, "Meeme," a devoted friend that always accompanied Dr. Houghton in boat or on land, in sunshine or storm. This faithful companion was with him in the boat on the night that proved fatal to his master, but was washed ashore. An arched rock, headlands, deep rock cuttings, cascades and chasms diversify the scenery of this carefully studied portrait of the pioneer Geologist of Michigan.

IMPORTANCE OF HOUGHTON'S WORK

While Dr. Houghton left an indelible mark upon the history of Michigan, the work of his survey has not made a proportionately deep impression upon geological

progress. Before his death he and his associates had blocked out quite fairly the Michigan coal basin and the beds beneath it; they had called attention to coal, gypsum, marl, peat, iron ore and copper, and had discovered gold. One of the higher shore lines of the Lake Erie had been mapped through three counties, and a higher shore of Lake Superior around the Huron Mountains. Observations had been made on botany, on zoology, on the rise and fall of the Great Lakes, and on magnetic variation, and the outlines of the main formations were pretty well made out. Just how much had been done never will be known.

The reasons for this are manifold. In the first place his labors were broken off by his untimely death, and much of his material was scattered; much of that which remained (valuable engravings of fossils and maps) appears to have been forever lost.

In the second place the reports seem never to have received wide circulation among scientific men. They were not printed in attractive shape, and were not illustrated; for the State of Michigan was desperately poor from wildcat finance. These reports are and always have been very rare.

In the third place other men, Jackson and Poster and Whitney, took up the work where he left it off, employed his assistants,—C. C. Douglass, S. W. Hill, Burt and others,—and made use of his and their work to such an extent that it was impracticable to divide the credit. Considering the compliments which Foster and Whitney pay Dr. Houghton, certainly no one will be inclined to quarrel with their shades for not having burdened their work with innumerable footnotes of credit. A careful examination of their report, and especially of that curious compilation which for short may be known as the "Jackson Report," with its accompanying maps, will indicate to what extent Foster and Whitney are to be given credit.

The director of the United States Geological Survey has stated (*22nd Annual Report*, Part 1, p. 16) that, "The Idea of cooperation in public surveys between the Federal and State governments originated in connection with a plan to make a topographic survey of the State of Massachusetts, and is believed was first suggested by Mr. Henry F. Walling, topographer of the United States Geological Survey, and later elaborated in a paper read before the American Society of Civil Engineers at the Buffalo meeting in 1884." Inasmuch as the idea of cooperation between the United States and the State in survey has been supposed to be of much later origin, it may be worth while to reproduce here, for the first time in print so far as known, the contract between the United States Government and Douglass Houghton, which is as follows:

ARTICLES OF AGREEMENT, Made and entered into this twenty-fifth day of June, 1844, between Tho. H. Blake, Commissioner of the General Land Office, acting for and in behalf of the United States under instructions from, the Secretary of the Treasury ad interim, of the one

part, and Douglass Houghton, Geologist of the state of Michigan, of the other part, to wit:

The said Douglass Houghton, for the consideration hereinafter mentioned, doth hereby covenant and agree with the said Tho. H. Blake in his capacity aforesaid, that he, the said Douglass Houghton, in conformity with the rules and regulations hereunto annexed, the laws of the United States, and such instructions as he may receive from the Surveyor General of Ohio, Indiana and Michigan, will faithfully lay out and survey with reference to mines and minerals, four thousand miles of the township and sectional lines in that part of Michigan south of Lake Superior, including the establishment of the fourth correction line; and that he will complete these surveys and return correct copies of the true and original field notes thereof to the Surveyor General at Cincinnati, by the first, day of January, eighteen hundred and forty-seven (acts of God excepted) on penalty of forfeiture, and paying to the United States the sum mentioned in the annexed bond, if default shall be by him in any respect made.

And the said Tho. H. Blake, in his capacity aforesaid, doth hereby covenant, and agree with the said Douglass Houghton that on completion of the surveys above named, or any portion thereof in manner aforesaid, and the approval thereof by the Surveyor General, at Cincinnati, there shall be paid to the said Douglass Houghton, on account of the United States, as a full compensation for the whole expense of surveying and making due return thereof in manner and form aforesaid, five dollars per mile for every mile and part of a mile actually run and marked, random lines and off-sets not included; Provided, that, not, more than the four thousand miles before mentioned shall be run, marked or paid for under this contract.

In testimony whereof the said parties have hereunto set their hands and seals the day and year first above written.

Tho. H. Blake (Seal).

Commissioner of the General Land Office.

Douglass Houghton, (Seal).

Signed, sealed and acknowledged before us.

Meade Fitzhugh

John Wilson.

KNOW ALL MEN BY THESE PRESENTS, That we, Douglass Houghton are held and firmly bound unto the United States in the sum of forty thousand dollars, lawful money of The United States (being double the amount which would be due by the United States to the said Douglass Houghton, on the completion of the surveys named in the foregoing contract), for which payment well and truly to be made, we bind ourselves, our heirs, executors and administrators, and each and every of us and them jointly and severally, firmly by these presents.

Signed with our hands and sealed with our seals
this.....day of.....1844.

The condition of the above obligation is such that if the above bounden Douglass Houghton shall well and truly and faithfully and according to the rules and regulations hereunto annexed, the laws of the United States, and the instructions of the Surveyor General of Ohio, Indiana and Michigan, make and execute the surveys in the foregoing contract mentioned, and return correct copies of the field notes of the said surveys to the said Surveyor General, in the manner mentioned in said contract, by the first day of January, eighteen hundred forty-seven, then this obligation to be void, or otherwise it shall remain in full force and virtue.

Signed, sealed and acknowledged (Seal)
in presence of: (Seal)

RULES and REGULATIONS for the government of the deputy employed to make the geological surveys of that part of Michigan south of Lake Superior, under the appropriation of twenty thousand dollars provided by the Act of Congress making appropriation for the civil and diplomatic expenses of the government, approved the 17th of June, 1844.

1st. The township lines only will be surveyed in the region designated in the Act, except in those cases where it may be necessary to establish the sectional lines in order more fully to explore and exhibit the bearings, character and boundaries of any mines or mineral deposits, which may be discovered, and wherever this necessity exists, the whole of the sectional lines in any such township must be run, that no detached tracts may remain unsurveyed. The fourth correction line will be extended as far west as may be necessary for these surveys, taking care not to encroach upon the probable boundary of Wisconsin.

2nd. The field books will contain, in addition to the usual and necessary notes of the lineal surveys, memoranda of all such geological and mineralogical developments which may be discovered, as will enhance the value of the lands or be useful to science, together with the dip and bearing of those mineral deposits.

3rd. You will return to the Surveyor General, at Cincinnati, a fair copy of the field notes of survey, authenticated in the usual manner, with sketches of those townships where the section lines have been surveyed, and diagrams of those where the township lines only are run,—exhibiting on those diagrams mid sketches the mineralogical and geological information, which may be obtained, and particularly designating those lands which should be reserved as containing mineral.

4th. In protracting these surveys, all the information thus obtained will be exhibited upon the township plats that can be introduced without confusion; the boundaries of mines or mineral deposits will be laid down in dotted lines, and the geological and mineralogical information will be exhibited in the usual manner, with proper references to the whole.

The surveys in this district of country in all other respects will be made under the laws of the United States now in force on that subject, and such explanatory instructions as may be given by the Surveyor General at Cincinnati.

GENERAL LAND OFFICE.

June 25, 1844.

FIRST MICHIGAN GEOLOGICAL EXPEDITION

I N 1837, the State of Michigan, then in the first year of its young but vigorous existence, organized a State Geological Survey; but the scanty appropriation sufficed only to enable its projector to accomplish, during that year, a limited reconnoissance. This extended, nevertheless, to some degree, into the almost unexplored portion of the lower peninsula.

Salt springs were known to exist, particularly in the vicinity of Grand and Saginaw rivers, and the few facts known of the rocks which constituted most of the coast lines, and made occasional outcrops in the interior, were sufficient to indicate the probability of the existence of coal and gypsum.

It was required, by the act establishing the survey, that an examination and report upon the salt springs should be made at the end of the first season.

It is my intention to relate some of the incidents of a trip—or short campaign, if I may so term it—made in the fall of 1837, for the purpose of an examination of these springs, and such other geological discoveries as might be made, in the country traversed by those great natural highways, the streams tributary to the Saginaws.

The party consisted of four individuals: Dr. Houghton, the State geologist, and three assistants,—Mr. C. C. Douglass, the writer, and—a dog.

The latter was no inconsequential member of the corps, and had, like the rest, his appointed duties to perform. *Dash* was his name; indicative also of his nature.

This was before the day of railroads, although the young State had already projected its magnificent scheme of internal improvements, and for a considerable part of our contemplated route there were no highways but the streams. Our plan was to reach, by private conveyance, some point on the Shiawassee

From Memorials of a Half Century in Michigan and the Lake Region, by Bela Hubbard, Courtesy of G. P. Putnam's Sons, Publishers, New York and London.

River whence we could embark in a canoe and descend to the Saginaw.

Loading into a wagon at Detroit our few traps, which consisted of a tent, provisions, an axe and a gun, in the afternoon of Sept. 13, 1837, we proceeded as far as Royal Oak, where we encamped by the roadside, in the independent mode common to immigrants at that period.

To the writer the situation had the charm which youth always finds in novelty.

I will not detain you with incidents, and will only mention the few villages through which we passed.

Prominent among these was Pontiac. The first settler, Mr. Williams, came to this place in 1817 or 1818, with an exploring party, among whom was Governor Cass. This whole region was then supposed to be an interminable morass, and so wild and dangerous was this expedition thought to be, that the party, before setting forth, took leave of their friends with all the solemnity befitting so grave an occasion.

At the time of my visit, Pontiac was a pretty, business-like place. It had been settled 13 years, but had just received incorporation by the Legislature. It has always retained its bustling character, while growing rapidly from a thriving hamlet into a beautiful and well built city.

The surrounding country seemed to our eyes far enough removed from the gloomy morass which wild imagination had depicted it, 20 years before. It appeared to me the most beautiful the sun ever shone upon. It was of the character then beginning to be classed as “openings,” characterized by a gravelly soil and a sparse growth of oaks and hickories, I speak in the past tense, because, though the rural beauty of the country is still unrivalled, little remains of the original character of the openings. This is a result partly of the process of cultivation, and partly of the thick growth of small timber that has covered all the uncultivated portions since the annual fires have ceased, which kept down the underbrush.

Elevated 400 feet above Detroit River, broken into hills and knobs, which rise frequently 100 feet and more above the surrounding surface, with intervening vales and hollows, forming basins for lakes of the clearest water; in the midst of a park of nature's sole forming inimitable by the hand of art, this lake region of Michigan deserves its celebrity.

But at the period I allude to, no straight-fenced roads shut in the highway, and travellers might wind at will through the superb natural park, trampling down only the flowers that in many places created glowing parterres; catching many a bright reflection from the limpid lakes, and sometimes stealing distant sight of a herd of deer, scarcely more wild than the peaceful landscape over which they roamed. Climbing a tree on one of the most elevated knobs I had a view over probably the whole of Oakland County; seven lakes lay at my feet; on the north and west undulations, like heavy swells of the sea, and on the east a level plain, stretching to the horizon like an ocean's verge.

Byron, in the south-east corner of Shiawassee County, was the termination of our wagon journey. The name had long occupied a prominent place on all the old maps of Michigan—at that time a decade was antiquity—held out to the newcomer the promise of a large and thriving village. The reality was disappointing. I t possessed—all told—a mill and two houses. Pentonville, though of

more recent origin, had outgrown it, and boasted a tavern, a store, and several frame tenements. At Byron we exchanged our wagon for a canoe, and commenced a descent of Shiawassee River.

From Byron to Owosso[sic], about twenty miles direct (but many more by the course of the stream), our way lay mostly through land more heavily timbered, but varied with openings and occasional plains. Through this part of the county, roads had been opened, and settlements had made rapid progress.

We were now to make our way by the aid of the current, but this meant not all plain-sailing nor luxurious enjoyment. The river was interrupted by numerous rapids, of difficult if not dangerous navigation, and over these shallows we had

Owosso is spelled "Owasso" in this story.

to drag the canoe. As this necessitated getting into the water, we were provided with water-tight boots, that turned up to the thighs.

At the approach of night a favorable landing was selected, and a new division of labor took place. While one cleared the spot and pitched the tent, another cut wood for the fire, and a third prepared the evening meal. Your humble servant, being installed into the ancient and honorable dignity of cook, had this duty to perform. Any one who has sweetened his food with the sauce of hunger knows how little culinary art is requisite to satisfy famishing guests. Indeed, a piece of fat pork, fried upon a stick over the camp fire, after hours of labor in the wilderness, is a morsel sweeter than any which the pampered epicure knows. To this standard dish our one gun enabled us to add such small game as we chose to take the trouble to obtain.

But my position involved also a duty which might be supposed of less easy accomplishment; viz., the cleaning of the dishes. Fortunately, I was permitted to make free of the assistance of the fourth member of our family. Dash, being properly educated to this service, was not allowed his own dinner until he had thoroughly and impartially scoured our the plates and sauce-pan; in which duty, I must do him the justice to say, he proved a skilful adept. Indeed, after long experience, I am prepared to recommend a dog's tongue as more effectual than any dishcloth, with all the aids of hot water and soap. After this process, a simple rinsing in the clear water of the river constituted all the additional operation that the most fastidious could demand.

Several years had passed since the extinguishment of the Indian title to the lands of the Chippewas, who had claimed this part of the peninsula. But many and extensive reservations lined the Shiawassee and other of the tributaries of the Saginaw, and the natives had as yet felt too little of that fatal spell which falls upon them with the very beginning of the white settlements to have abandoned much of their old habits.

As we followed down the stream, memorials of the present and recent Indian occupation were frequent.

Sometimes we passed huts, constructed of poles, and thatched with bark, but only a few squaws and children were visible. At one place on the bank were ten graves, over which a sort of tomb had been erected, built of logs. Trails were frequent, and on one of these we came upon a tree containing an Indian symbolic epistle. There were figures of men and horses, but we were unable to decipher the meaning. At another place was a cache or pit for hiding provisions.

Many of the Indian clearings stretched for several continuous miles, and many acres bordering the river were covered with the luxuriant maize,—the chief cultivated food of the natives. These plantations receive the name of villages, because they are resorted to by the tribes at the periods of cultivation and harvest. But, in fact, these people had no fixed habitations, but wandered, like the Arabs—their Eastern cousins—from place to place, in patriarchal bands, finding such subsistence as the woods and waters afforded, and pursuing the occupation of trapping and barter with the Indian traders.

At this time, also, they were much scattered by the small-pox, a disease recently introduced by the whites, and which had proved very fatal to the aboriginal inhabitants of this part of Michigan.

Indian trading-houses were a frequent feature, that served to connect the wildness of savage life with the incoming civilization.

Five miles above Shiawassee town was a small Indian village, upon what was known as Knaggs' Reservation, and at a short distance was the house of a trader—Beaubien. Williams, the first settler, came here six years before (1831), and opened a trading-store, as an agent of that extensive enterprise—the American Fur Company. A frame house had since been erected, and a few acres cleared,—the small beginning of one of those invasions of the Saxon upon the Savage which, in an incredibly short period, will leave the latter not even his grave.

Shiawassee town, at this time, contained a dozen log cabins, and as many frames unfinished. One of these was of quite superior construction, and indicative of the era of speculation through which the country had passed. It was three stories in height, and designed for a hotel. The whole village was under mortgage, and was advertised to be sold at public vendue.

Corunna, the county seat, we found to consist of one log house, situated upon the bank of the river, and occupied by a Mr. Davis, who, a year before, and soon after the organization of the county, had made an entry here. A steam mill was in process of erection. About twenty acres of land had been cleared and planted; and never did crystal stream have a more fertile soil.

Three miles below was "located" the village of Owasso, already a thriving settlement, containing a dozen log buildings, one frame one, and a saw-mill.

With the exception of a few scattered settlers upon the plains, south of the line of the present Detroit and Milwaukee Railway, such constituted the entire white population of Shiawassee County.

In the early part of the season, during the progress of the geological survey, beds of bituminous coal had been discovered in the bank of Grand River, in Ingham and Eaton counties, and the rocks met with through the central part of Shiawassee—belonging to the “Coal measures”—gave hope of finding an outcrop. Prospecting was accordingly commenced by us at Corunna, but, with the slender means at command, did not prove successful. Yet sufficient was determined, from the character and dip of the rocks, and other indications, to warrant a recommendation to the settlers to continue the investigation. The result was the finding of coal at Corunna, soon after; which, though not of very remunerative thickness, has been used to considerable extent ever since.

I will add, that the year’s explorations determined the boundaries of the southerly half of the coal basin of Michigan. Its extent to the north yet remains a problem, to be solved by the hardy pioneers and explorers, who, for a few years past, have been at work so determinedly to bring into the markets of the world that rich and important portion of our State.

A mile below Owasso we passed the last of the white clearings, and made our night’s encampment within Big Rock Reservation, twelve miles below that village, and twenty miles from Saginaw.

We had now entered upon the wild and primeval forest, extending in a solitude unbroken by any human sight or sound, except the cabin of the natives and the hut of the Indian trader to the shores of the upper lakes. For the first time I was startled in my slumbers by the “wolf’s long howl,” mingled with the hooting of an owl.

Hitherto we had encountered at every few miles the cabin of some adventurous pioneer, for whom the forests had no terrors, but now we were alone with Nature. We could appreciate, in its full extent, the solitude, the boundlessness, the sublimity of this earliest of earth’s offspring.—the grand, old, untutored forest.

He who has only traversed woodlands where, at every few miles, he meets a road leading to civilized belongings, knows little of the sense of awe inspired by a forest solitude that has never echoed to the woodman’s axe, and where every footstep conducts only into regions more mysterious and unknown.

The woods of this part of Michigan comprised a very mingled growth. Oaks, not gnarled and spreading, as in more open lands, but at once massive and tall, and centuries old; the elm, that most graceful and majestic of trees of any land; the tulip or whitewood, magnificent in size and height above even the Titans of the forest; the broad and green-leaved linden; the clean-bodied beech; the saccharine maples, so superb in their autumnal dresses, dyed like Joseph’s coat of many colors; the

giant sycamore, ghost like, with its white, naked limbs;—these are the common habitants of the forest; with other kinds, each possessing its peculiar grace, and a use and beauty almost unknown in other lands.

We had reached, too, the latitude of the evergreens, which from hence northward, to the farthest limits, become a distinguishing feature of the Michigan forests, imparting to them a more wonderful, variety and majesty. Many a towering pine, 150 feet in height, now began to lift its head above its fellow inhabitants, green through youth and age, through verdure and frost. In many places the desert gloom was deepened by the dense, and sombre shade of hemlocks, which bent their graceful spray to the earth, and almost shut out the light of day.

We took the measure of a white oak that stood at the border of the timbered land and the openings, which I here note as worthy of record. It was thirty-five feet in circumference,—nearly twelve feet diameter. A very respectable tree to be found out of California.

No kind of travel can be imagined more romantically charming than that of floating down the current of one of these large and rapid streams that water this portion of Michigan, piercing the heart of the trackless wilderness. The trees along the banks, instead of forming upright walls, exhibiting the naked trunks of the fall woodland monarchs, throw out thick branches to the sunlight, which bend gracefully to the water, as if to form a screen to the forest depths. Wild fowl are easily approached at almost every bend, affording an ample supply of fresh food without the fatigue of hunting, and at night the camp is made beneath the leafy arches, and lulled by the murmur of the stream or the roar of the wind in the pine tops.

Descending now a wider stream, with a smooth and gentle current, we passed, successively, the mouth of those long feeders to the greater stream,—the Flint, the Cass and the Tittabawassee,—and on the 23d September were opposite Saginaw City.

The last few miles had presented to our view the first irreclaimable marsh we had seen, and here there was plenty of it. The “City” occupied what seemed to be the only considerable elevation for many miles, being about thirty feet above the river. . . .

The general Government erected a fort here in 1820, and at the same time was established a centre of Indian trade, by the American Fur Company. The country had been visited by General Cass the year previous, and a treaty effected with the native chiefs, by which the lands of the Chippewas were ceded to the United States.

The oldest settlement for farming purposes was made about 1829, and the present site of Saginaw City laid out in 1835. This was just before the height of that mad fever of speculation into which so many plunged wildly, and which built in the wilderness many prospective cities, most of them existing only in the privileged future or on paper plots. Saginaw was one of the few that had good

foundation for its celebrity; though as yet there had been little realization of its dreams of future greatness.

My notes record that the city comprised nearly fifty frame houses, four stores—one handsome dry goods and grocery store, on a large scale—two warehouses, and another in progress, a small church, two steam sawmills, and, in process of erection, a large edifice, to be called the “Webster House”; this already made a slightly appearance, being 60 by 80 feet. All were of wood. The stockades of the fort still remained; they were some ten feet in height, and surrounded about an acre. I believe that the abandonment of this fortress was occasioned by sickness among the troops, in 1824, three-fourths of the garrison being ill at once of the fevers of the country.

I can add but few to the list of names illustrious in the Saginaw annals, but I met there, and I well remember, the Littles—Norman and William P.; Hiram Miller and James Fraser, Judge Riggs, Mr. Watson and Mr. Lyon;—men to whose energy and practical wisdom the valley owes so large a share of its prosperity.

It has been stated that the mill known as Emerson’s was erected in 1834. I have no recollection of any mill on the east side at the date I record and the distinguished individual whose name it bears was, at that time, still delighting the happy citizens of Detroit by his curt and vehement eloquence. If three mills existed at Saginaw in the fall of 1837, they were certainly the only ones (with one exception) upon that river, as the “City” was the only settlement, if we except a few solitary cabins.

Where now the busy and populous cities of East Saginaw, Bay City, Winona and Portsmouth, numbering their many thousands, stretch almost into a continuous village, for twenty miles below, where the clangor of a hundred mills mingles with the puff of steamers and the scream of the locomotive, and a scene of industry, enterprise and thrift is exhibited which few spots on this earth can rival was at the period of my visit a solitude, resonant only with the grand, still voices of Nature. Beyond the settlement immediately about the “City,” extended the untrimmed forest, as vast and almost as undisturbed as when, to the eyes of De Tocqueville, it was “a real desert.”

Hawing advanced so far with my narrative, I ought, perhaps, in the manner of story-tellers,—though mine is no fiction,—to give a description of the personal appearance of my personages.

Though nearly a generation has passed since the death of Dr. Houghton, no doubt most of those here present well remember the peculiar characteristics of one not easily forgotten;—his diminutive stature—his keen blue eye,—his quick, active motions,—the strong sense and energy of his words, when dealing with matters of science, and his indomitable perseverance in carrying out his designs. They will remember, too, his love of fun, and his hilarious manner of telling a comic story. Of such he had a large fund, and a happy way of using; preserving a grave countenance until he got through, and then joining in the laugh with a peculiar

cachinnation, so contagious as to be alone sufficient to set every one in a roar.

He was no carpet knight of science, and on his geological excursions never flinched from hard work and exposure.

On these occasions he usually wore a suit of gray, the coat having large side-pockets, and hanging loosely upon his small frame. The hands and feet were very small, but the latter were incased in boots that came almost to his thighs. His shocking bad hat was broad-brimmed and slouched, almost concealing his face, and his whole appearance was that of a battered, weather-worn backwoodsman.

I remember meeting him a few years later, when his scientific mind and energetic body had unravelled the mysteries of the mineral region of Lake Superior, and when the new fame of that region had called hosts of scientists to those yet wild shores. He had just landed at Eagle River, fresh from one of his rough expeditions, and was immediately hailed and surrounded by men known over the whole land for their scientific learning, to whose figures and bearing his own presented a striking contrast. Yet these men bowed to his superior knowledge,—sagacity I might term it; and one of them frankly said in my hearing that the little, rough-looking Doctor carried more true knowledge in his cranium “than all the big heads put together,”

I am the more reminded of the personal appearance of our party by an incident which occurred on occasion of our return to Saginaw from a similar expedition, in the following spring. We happened to be there at the time of the marriage of a sister of Mr. Little, and were among the distinguished guests invited to the wedding. Now it chanced that one of the corps—I will not say who—had, with false economy, donned for the expedition a suit of old clothes, which proved to be unequal to the rough usage imposed upon them. When we reached Saginaw he was literally in tatters. A hole garnished each elbow; another became visible when either arm was raised. I have already alluded to the uncouth boots we wore. They were outside the pantaloons, and when not on river service, the wide tops were turned down from the knee. The soles had uncommon width, the rule which regulated surveyors’ boots being that these shall project so far beyond the uppers that a mouse might run around on them.

As the other members of the corps were in little better condition—none of us having a wedding garment,—we would gladly have tendered our regrets, but the persuasive words of our host were not to be withstood.

When I say that we went, I shall only add, that although an apparition so unusual, among a company of well dressed Indies and gentlemen, might well have occasioned remark, the good sense and true politeness of our host and his guests saved us mortification, and left no cause to repent the venture.

As I have undertaken to describe the personnel of our party, I must not omit some further mention of its fourth member. Dash was of spaniel breed, and fond of the water, in the supply of our larder he performed the service of bringing to our boat the wild-fowl that we occasionally shot, and which were abundant in these waters. Nature had furnished him with capacious jaws, which no game could escape, when once within their grip. He had a habit of coming upon game with his mouth wide open.

On one occasion, seeing what he supposed to be a bird floating, he swam towards it, with mouth stretched as usual, and making a grab, his jaws came together with a sudden and loud snap over a piece of foam. Never was dog more puzzled. He looked about with an air of great amazement, and returned, very sheepishly, to be drawn into the boat.

I will relate another anecdote, as showing how he improved in his scientific education. On a future occasion, being sent out for a wounded "diver," and not comprehending the resource of that active and sharp-witted fowl, on the dog's near-approach the duck suddenly dived out of sight. Dash was in evident bewilderment, and unable to account for the sudden disappearance. But he was not a dog to be discouraged by so difficult a problem, and after the trick had been several times repeated, a glimmer of the true state of the case entered his canine brain. This accomplished, he was equal to the emergency; for when the diver again went down Dash followed, and both were for some time out of sight. But the dog came up victor, with the bird in his mouth.

As it was in our plan to inspect the salt springs on the Tittabawassee, we had forwarded to Saginaw from Detroit supplies of biscuit, relying upon the country for our pork. But none was to be had, and we were compelled to resume our journey as destitute of that important item as were the poor inhabitants themselves, who, with a large stock of merchandise, and the great name of City, were awaiting the arrival of a schooner to obtain the common necessities of life. It was to be hoped they were better off for intellectual food, for the place supported a public journal.

Having obtained an order for a more suitable canoe and a guide, we bade temporary adieu to Saginaw (September 25), but were forced by a heavy rain to seek shelter at the house of a Mr. Gardner, a short distance above, where, fortunately, we procured a few pounds of pork. Here, at evening, a few neighbors dropped in, and we consumed the time pleasantly in tales of hunting adventures and fearful Indian murders!

The next day found us at a village of the Chippewas sixteen miles from Saginaw. It consisted of a few lodges, mostly deserted, small pox having nearly exterminated the band.

At the forks of the Tittabawassee and Pine rivers we found several log cabins, one of which had been occupied as a trading post. They were inhabited by half

breeds. A Frenchman, with his two Indian wives, occupied the trading-house.

It was still common enough to find, along the shores of the great lakes and rivers, which had been so long the highways of those lawless rangers,—the *Coueurs de bois*,—during the flourishing period of the fur trade, the cabin of a Canadian, who, with his Indian wife or wives and a troop of half-breed children had completely adopted the native habits. He lived a half-vagabond life, depending upon fishing and trapping, and sometimes finding employment as a voyageur.

A fair specimen of this class was our guide, Pierre Gruet. Of mixed French and Indian blood, it was hard to tell of which character he most partook. Equally at home in the Canadian cabin and the Indian wigwam, he seemed to be acquainted with every individual of either race that we met, and had a world of talk to unburden himself of whenever we passed a lodge or met a canoe. French joviality was in him united with savage wilfulness. Well enough when confined to his profession of guide and interpreter; as a worker, one American was worth a dozen of him.

Opposite these forks of the river had been "located" the village of Midland;* but it was a village without inhabitants.

Ascending to Salt River, we completed such examination of the springs as the heavy rains of the season permitted. The year following, the State commenced a boring for a salt well near this point, but after a season's labor, with favorable results, the many discouragements attending the work caused its abandonment. Not the least of these was the necessity of sending to Detroit with long delays and great expense, for everything needed, even for repairs of the augers. It was not until many years afterwards, and when along these vast watercourses populous towns had sprung up, that the conclusions of science were brought to a full practical test, by the establishment of salt wells on the Saginaw; with what success you are all familiar.

I will only say, that in strength and purity the salt of the Saginaw Valley is fully equal to the celebrated article so extensively made in Central New York; that it can be more cheaply manufactured; and, with the increasing facilities for market, is destined to be a very important part of the wealth of Michigan. Already Saginaw furnishes a supply one-half as large as the famous Onondaga.

*Now a flourishing city of four thousand inhabitants (1885).

We had now penetrated into the wilderness, many miles beyond the most remote of the settlements of the Anglo-Saxon. Wild game was very abundant, but we had not the time nor means to pursue it. Besides deer, we had often seen along the shore, tracks of the elk, and sometimes of the moose,—an animal almost extinct. Occasionally an otter raised his head above the water, or plunged into it from the bank. We found fresh marks of the labors of the beaver,—that most interesting

creature, once existing hereabouts in immense numbers, and now quite hunted to the death. We had shot a snow-owl and driven an eagle from his eyry, and had been regaled with bear's meat, furnished us by the Indians.

How lovely, to our unaccustomed eyes, did nature appear in these solitudes! The first frosts had fallen, and tinged the maples with yellow, orange and crimson; and beech was beginning to assume its russet coat, and the hickories their brilliant yellow, gleaming, in the softened autumn sun, like towers of gold! The river banks, densely wooded, and overrun by the scarlet ivy, were truly magnificent. In strong contrast with these brilliant colors of the autumn was the dark green-almost black, in the shadow of the thick woodland—of the hemlock and fir, amid which shone the white bark of the silver birch, and above all reared the verdant heads of many a lofty pine.

As yet no lumberman's axe had sought to desecrate these glorious shades, nor the speculator to count the dollars that lay hid in the hearts of these mighty pines.

But marvellous changes were in the not distant future.

The traffic in lumber, in the region watered by the Saginaw and its tributaries, which had hardly its beginning a decade after the period I am describing, has in our day reached dimensions of which the wildest brain could not then have dreamed. The main river, for twenty miles from the city of Saginaw to its mouth, is lined with mills. Mainly from this source of wealth numerous cities have sprung into vigorous existence, and five hundred millions of feet of lumber are sent annually, by water and rail, south, east and west, thousands of miles. Michigan pine is in demand, even within the sound of the lumber woods of Maine and Pennsylvania.

I recently visited Midland, not, as before, by the slow progress of a little boat propelled by hands, but in the magnificent cars of the Flint & Pere Marquette Railway, transported by the wings of steam. Where, in 1837, was laid the wilderness city of Midland,—a site without an inhabitant, and approachable only by the river,—now stands the busy, prosperous county seat. A railway connects it with Saginaw, and is rapidly bearing its ironshod feet far beyond, and joining hands with those vigorous pioneers on our western coasts, that are rapidly pushing on to the Straits of Mackinac. A street of shops, hotels and public buildings, parallel with the river, forms the centre to a town which covers, scatteringly, a mile square, with its churches, mills and comfortable homes.

I passed forty miles further on to the northwest. The scene was a revelation. We are accustomed to regard the railroad as a creation that follows in the wake of man's progress. Here it is the pioneer, the precursor of civilization. It has pierced the heart of the hitherto unbroken wilderness; cutting for itself a narrow path, where, on either side, tall pines and other trees rise into a straight and lofty wall, admitting no prospect, except the narrow line of light that diminishes to a thread in the distance. No time has been allowed for clearings and

the ordinary attendants of cultivation. These are all to follow. But saw-mills have sprung up along its magic path, and line the road so thickly that, for nearly the whole distance, I might count an average of two mills to every mile; and all this accomplished within little more than a year.

Having accomplished our river explorations, we prepared for an expedition attended with some danger at that late season, for the month of October had come. This was a coasting voyage, from Saginaw to Port Huron, performed in the canoe which had been procured at the Chippewa Reservation. It was a "dug-out" of wood, thirty feet long, but so narrow, that, seated in the line of the centre, we could use a paddle on either side. In this puny craft we were to undertake, in the middle of autumn, a lake journey of 150 miles.

We descended the Saginaw, which then exhibited few indications of its coming greatness.

East Saginaw had no existence. The village of Carrolton had been plotted, four miles below Saginaw City, and consisted of a two-story log house, used years langsyne as a trading-post.

Portsmouth contained a steam mill, four log cabins and two board shanties, lying just above high-water mark.

Lower Saginaw—now Bay City—occupied somewhat higher ground, and boasted a pretty frame office used as a chapel, and two or more log huts. It was an infant of one year. In preparation was the frame of a hotel, which, in accordance with the usual custom of the flush times—already sadly gone,—was large enough to accommodate half the county.

I must here mention a fact which I have never seen alluded to; viz., that at several places along the river, and sparingly on the Tittabawassee, were apple trees. They produced agreeable fruit, and some were apparently of a century's growth. I will not speculate upon their origin; whether the seeds were brought here in the fruit, and accidentally planted, by the voyageurs and coureurs de bois, from the French orchards of Canada, or whether they have a date still more remote. It is curious to notice that some of the earliest travellers allude to orchards, then in profuse bearing upon islands in the Detroit River. I leave the problem to the antiquary.

Emerging into the bay we encountered, at the Kawkalin River, the last trace of civilized footsteps which we were to see for many days. It was a camp of United States surveyors, —the Rousseaus,—where we were entertained for the night, with all the hospitality which it is common to find among those who dwell beyond the pale of "good society." Unfortunately for our appreciation of these good fellows, it subsequently appeared that the returns of these surveyors were so made-up and false that entire townships had to be re-surveyed by the Government. Corruption in places of public trust is not alone of modern origin.

Memorials of the native inhabitants were still frequent. Upon a swelling knoll overlooking the bay, in the midst of

a tract of country from which all the timber had been burned, was a spot which seemed to have been dedicated to the evil Manitou. Here an altar was erected, composed of two large stones, several feet in height, with a flat top and broad base. About were smaller stones, which were covered with propitiatory offerings,—bits of tobacco, pieces of the, flints, and such articles, of little value to the Indians, as, with religious philosophy, he dedicates to his Manitou. The place had witnessed, doubtless, many an Indian powwow.

In the interest of the scientific object of our tour I will here observe⁴, that near An Gres River we discovered, beneath the clear waters of the Bay, a bed of gypsum. Subsequently, an outcrop of this mineral was found on the neighboring land, and has been long quarried with profit.

Some islands lay several miles from shore, upon our approach to which, immense numbers of gulls, that had here their secure retreat and breeding-places, wheeled about us, uttering loud cries. The young ones were easily caught, and we found a few eggs. Here also sport of an unusual kind awaited us. In the waves that broke among the boulders along the shore, sturgeon were gambolling. So intent were they upon their play, and so ignorant of man's superior cunning, that, springing in among them, after a vigorous tussle we threw one ashore, with no other aid than our hands. It stocked our larder for several days with its variety of meat,—fish, fowl and—Albany beef.

Of our further voyage, until we rounded Point Aux Barques, I have nothing to note, beyond the usual adventures and delays that attend mariners in so perilous a craft, upon the treacherous waves of Saginaw Bay. The toils of the day were compensated by the sweetest of slumbers, when, having supped on pork and hard bread, wrapped each in his blanket, we fell asleep beneath the soft influence of the Pleiades.

At the point alluded to the coast is iron-bound, affording no harbor, and being thickly wooded with evergreens, its aspect was forbidding and gloomy. Add to this, that the waves are incessantly lashing the rocks, which receive the whole fury of the sea, whether the wind be from the lake on the right or the broad bay on the left. This action of the waters has caused channels to be worn through large masses of the friable sandstone, which, tumbling into the lake, form small islets.

In doubling the cape, the voyageur is struck with the singular appearance of two projecting masses, detached from the main, and covered with timber. They bear close resemblance to the bows of vessels, with the hulls exposed down to the keel. The bowsprit and sides are nearly perfect. They are about 50 feet in the beam, and 16 to 20 in height. Nature seems often to delight in such mimicry of the works of man. The name which was bestowed by the French, at an early day, continues still significant of the mimic resemblance.

Near White Rock, on the Lake Huron coast, 50 miles from its outlet, at the boundary of the then surveyed

portion of Sanilac County, we found a settler,—the first we had met since leaving Saginaw River. Mr. Allen had been here three months, and, with five hands, was erecting a saw-mill on a dashing little brook that had nearly swamped us in entering. He had no neighbor, but the mistress of the house informed us they had been all summer in expectation and promise of the settlement at White Rock City of 200 families.

The annals of this place constitute one of those chapters of romance, of which the records of 1835 and 1836 are so replete. Before the rage of real-estate speculation was at its height, and all through that wild fever, we had known of "White Rock City."

Maps, executed in the highest style of the topographic art,—displayed in hotel bar-rooms and other public places, where congregated the thousand seekers after the fortune that courted the happy possessor of valuable lots and water privileges.—had announced its unrivalled situation and advantages. They depicted the magnificent harbor, at the mouth of a large stream, into which steamboats were entering. Sawmills were converting the forests into houses. Around the Public Square clustered a Court-house, churches, and other public buildings, not omitting the inevitable Bank, and the air of prosperity which pervaded the place was evident at a glance. Auctioneers had sounded its praises, and struck off its lots, at, popular prices, to eager buyers. None of the rising cities for which Michigan had become famous had so wide a celebrity, and distributed stock so liberally.

And now we were to see, with our own eyes, this western marvel, or at least its ruins.

A large white boulder in the lake marked the entrance, and gave name to this modern Karnac. We found the entering river. It hardly admitted our log canoe. Harbor there was none. Churches, houses, mills, people,—all were a myth. A thick wilderness covered the whole site. Excepting Mr. Allen, it was 40 miles to the nearest inhabitant. Where the Public Square had been depicted stood several large beech trees. On one of these we carved the names of our party, who were thus registered, for the benefit of future visitors, as the first guests of the "White Rock Hotel."

It may serve more fully to show the adventurous character of our expedition, if I close this narrative by some detail of our last day's experience,—perhaps not a very unusual one in canoe navigation. It may serve, too, to illustrate the risks incurred by our daring chief; sometimes too rashly, and, alas! once too often!

On the night of October 11, we encamped 22 miles from Fort Gratiot, and congratulated ourselves on the near conclusion of our journey. For this there was reason, as our provisions were gone and the weather was stormy. Here a hard wind detained us a day, and the morning succeeding showed the waters risen several feet, and rolling in huge breakers. To proceed by water seemed impossible, but there was no travelled road to Black River, and our provisions were exhausted. For several

davs we had been on rations, and our poor canine friend, who at the outset could not eat duck meat, was glad to swallow a wing, feathers and all. A council of war decided to trust once more to the boisterous waves, which our frail craft had hitherto borne us over in safety.

Raising the boat upon rollers, we packed in tent and bags—the latter now heavy with “specimens”—so arranged as to make three partitions, established Dash in his place, while the rest took each his station. Thus appointed, we ran rapidly out into the water, leaped aboard, and pulled from the land. The launch was neatly effected, but danger was ahead. Encountering the breakers we at once shipped a sea, which completely filled the foremost division. This was occupied by the Doctor, who cried. “We are swamped.” But a pail stood ready to each hand. The Doctor bailed while the others pulled stoutly on their paddles, and we were soon beyond the breakers. Return was now impossible. The temperature was at freezing, and we received a ducking from many a white-cap that chilled us to the marrow. Our little boat was a morsel for the waves, and when one of those huge swells—the three sisters, as sailors call them—lifted us up, we seemed hurrying inevitably to the shore, and when it receded its crest concealed everything but, the sky and the watery horizon. We could not raise sail without danger of running under, and many a wave-crest must be beaten back with our paddles, and our pails were seldom idle.

But “the longest day will have an end,” and after five hours endurance, wet, exhausted and hungry we landed at the lighthouse. Thence we descended to Black River, two miles below, where the village of Fort Huron was in the second year of its infancy. From here a steam-boat conveyed us to Detroit.

Thus ended our adventurous journey, “by flood and fell.”

LAKE SUPERIOR IN 1840

AMONG the pleasantest of all my reminiscences of travel is that of the exploration, in connection with the geological survey of Michigan, of the coasts of our upper peninsula in 1840.

The party for this expedition was composed of the State geologist, Dr. Douglass Houghton; his two assistants, C. C. Douglass and myself; Fredk. Hubbard, in charge of instrumental observations; and, for a part of the way, H. Thielson, a civil engineer, and Charles W. Fenny, a young merchant of Detroit, supernumeraries.

We left Detroit, in the steamer “Illinois” arriving at Mackinac, May 21. Here two boat crews were made up, consisting of six Canadians. These belonged to that class so famous in the palmy days of the fur trade and the French régime, now extinct, and known to history as “*coureurs de bois*.” They were of mixed blood, in some, the French, in others, the Indian, predominating. Bred to the business, they would row without fatigue from daybreak until dark, twelve or fourteen hours,—unlade the boats, pitch the tents for the *bourgeois*, pile up the

baggage, prepare the evening meal, and then creep under their blankets in the open air and enjoy the sound sleep that labor bestows.

The principal dependence of these voyageurs for food—we had no leisure for hunting and. little for fishing—was upon a soup of beans, with a most liberal supply of water, into which a piece of pork was dropped. A cake of hard-bread was allowed to each.

The boats for the passage of the Sault were each about twenty feet long by four broad, lightly constructed of pine and cedar, with sharp bows, and were drawn out of the water at night. At the Sault, to which provisions had been forwarded, one of these boats was exchanged for a “Mackinac barge,”

Written in 1874. From Bela Hubbard, *Memorials*, 21-62.

sufficiently large to carry two months' provisions and all our baggage.

A voyage to and upon our great lake at the time of my story was by no means the easy journey it is now. North of Mackinac, no steamers and no regular line of sail-vessels traversed the waters. The ship-canal around the waters of the Sault had not then been projected. Furs and fish constituted the only commerce, and the latter found too few customers to make the trade profitable. The American Fur Company had its headquarters at Sault Ste. Marie, where was a village of some twenty or thirty houses, mostly of logs, and the United States maintained a garrison. On the opposite shore was a small English settlement, consisting of a few white-washed cabins and Episcopal and Baptist mission establishments. Here also the Hudson's Bay Company had a post.

At L'Anse had been established for many years a factory of the American Fur Company, the only buildings being a log house, storehouse, and barn, and near by a Baptist mission, consisting of a dozen neat huts of logs and bark. Near the extreme west end of the lake this company had another factory or trading-post at La Pointe.

These were the only white settlements on the south shore of this great lake. At two or three points, transient fishing-camps might be met with. Else, all this region was wild and solitary almost as when a century earlier, it was traversed by the canoe of the Jesuit missionary or echoed to the rude songs of the wild employees of the fur traders. To a large part of the country, on the southern border, within the territory of the United States, the Indian title had not been extinguished. But the settlements of the aboriginal race were rare; probably the whole region did not number 1000 souls.

Apart from the scientific animus of the expedition, our party, in the ardor of youth, could not but look forward to the new and strange scenes which awaited us with somewhat of the enthusiasm that inspired the first explorers of this region of vast forests and inland seas. We were to voyage almost in the same mode as those

travellers, to witness scenes as yet little changed, and partaking of the same character of solitude and mystery.

Though I wander from my narrative, I must linger a moment over the impression produced by the romantic island which was our starting-point, Michilimackinac.

Connected with the story of the early wanderings of the French, their perilous missions in the far wilderness, the fur trade, with its fort, its agents, its *coureurs de bois* and numerous employees, its bustle, show, and dissipation, its traffic and its enormous profits, and with the numerous native tribes which were rendezvoused,—no place in the Northwest possesses greater historic and traditional interest. The town retained, as it still does, much of its old-time character. The crescent bay in front was still a lounging-place for the American Ishmaelite, whose huts often covered the beach; and this was the last place on the frontier where the Mackinac barge might be manned and equipped, as a century ago, by a motley crew of half-breed voyageurs.

The natural beauties and wildness of the island, its situation, enthroned at the apex of the peninsula of Michigan and embracing magnificent views of water and island, its lake breezes and pure cold air, and the excellence of its white-fish and trout, have long made it one of the most attractive of watering-places. The proposal to conserve it as a national park is worthy of its character, and it is to be hoped that thus its natural beauties, and what remains of its woods, will be preserved forever to the nation.

On the morning of May 20 we took our departure from Mackinac, with a moderate breeze and a clear sky,—a thing to be noted where fogs are so frequent,—and coasting by St. Martin's Island, entered les Cheneaux.

The river, or more properly Strait of Ste. Marie, is a series of channels, winding amid innumerable islands. Some of these, as St. Joseph and Drummond, cover many square miles, but the greater number are much smaller, and often occupy only a few acres. They line the whole northern coast of Lake Huron, and are occasioned by the junction between the Silurian lime rocks and the Azoic or primary rocks of Canada.

These islands are but little elevated above the water, and are wooded to the edge with cedar, fir and birch. The evergreen trees are completely shrouded in a tapestry of parasitic moss. This is a true lichen, and is not allied to the great Southern epiphyte which it so strongly resembles. It hangs in long festoons, giving the woods a fantastic and gloomy appearance, but the effect is very beautiful. What are called "les Cheneaux" are passages among islands of this description. They are seldom wide enough to admit any but the smallest craft, and so intricate as to form a perfect labyrinth, where any but the practised mariner might wander long, "in endless mazes lost."

To the north and east of St. Joseph Island the Ste. Marie parts the two systems of rocks, and an instant change takes place in the character of the scenery. Instead of

low, timbered shores, the islands rise in abrupt cones, rounded and water-worn, to the height of twenty to one hundred feet, presenting bare knobs of hornblende and quartz. The surfaces are worn smooth, by the action of glaciers, and are frequently colored with a thick carpet of lichens. Among these is, in profusion, the beautiful reindeer moss. A few miles to the right, in Canada, hills of granite rise to a height of 500 to 1000 feet, and form a background to the view.

To the geologist these low hills and rounded knobs have an absorbing interest. Agassiz tells us that America has been falsely denominated the new world; that "hers was the first dry land lifted out of the waters; hers the first shore washed by the ocean that enveloped all the earth beside." The antiquary finds in this portion of America a very respectable antiquity. To its known civil history he adds evidence of the existence of a race of men familiar with this region ages before its discovery by the French, who were by no means despicable cultivators of the arts, and he infers a human history—could he but gather the full record—possibly as ancient as the pyramids. But science points to a period infinitely more remote. We had reached and stood upon what was the skeleton of our earth, when but a crust above the seething fires beneath, not only ages before man had a being upon its surface, but probably ages before what we call the "Old World" had been raised by the forces of nature above the universal ocean. Here was antiquity unmeasured by any human standard. Time itself was young then. This backbone of the earliest continent still stretches unbroken from the Atlantic to the western plains. During the unnumbered years in which the surface of the earth has been changed by successive upheavals and depressions it has stood unmoved.

Around the base of these low granite and metamorphic hills, in the bed of the river, lies a sandstone rock, which we shall find rising into cliffs along the coast of the lake above. It is the lowest of the Paleozoic series, the first rock which brings to our eyes evidence of life upon this continent, and, if geologists speak truth, the first which bears witness to the dawn of life upon our earth. Of the earliest forms of organic life two only have with certainty been found in this rock, the *lingula* and the *trilobite*. And these, in the perfection and adaptation, of their structure, equal the most perfect beings of their kind which exist at the present day. Thus the first record of the earliest life, upon the most ancient sea beach which the earth affords, is in apparent condemnation of the development hypothesis of Darwin. Are they then evidence of sudden and independent creation, or must we believe that these forms had their origin in some yet more remote and obscure past, and that we behold in these Silurian rocks only their perfect development?

Following the northerly channel, the Ste. Marie soon expands into a broad and lovely sheet of water, twelve miles long, called Lake St. George. We have escaped from the labyrinth of rocky isles, the southern shores are again densely wooded, while the Azoic rocks are seen on the Canada side, stretching off to the north-west, and

terminating in a series of mountainous knobs,—the vertebrae of the world before the Flood. To this lake the Narrows succeed, and here for the first time the Ste. Marie assumes the appearance of a river, being contracted to less than 1000 feet, with a current and occasional rapids.

We passed frequent memorials of the Indian inhabitants. It is not to be wondered at that this region abounds with them, since with an eye to natural beauty this poetical race selects the loveliest spots for the resting-places, both of the living and the dead. The graves were close cabins of logs, thatched with bark, and the places selected are among the most beautiful and elevated sites, as if the souls of the departed braves could hear the echoing paddle and watch the approach of the distant canoe. The burial-place of the chief is designated by a picketed enclosure, and here it is customary for the voyaging Indian to stop, kindle his camp-fire at the head of the grave, and, on departing, to leave within the enclosure a small portion of the provisions he has cooked, for the use of the occupant. A flat cedar stake at the head exhibits in red paint the figure of some bird or brute,—the family totem of the deceased. Often is seen a small cross, erected as an emblem of his faith in Holy Catholic Church, while close by, in strange contrast, is that evidence of his unalterable attachment to the creed of his fathers,—the basket of provisions that is to support his journeying to the land of spirits.

The camping ground of the voyageur has been that of the Indian from time immemorial. The wigwam poles are recognized from a distance, in some open glade along the shore, left standing after the vagabond inmates have departed. And there is often to be found an old canoe, a camp-kettle, a cradle swinging from the poles, and invariably a litter of picked bones and dirty rags, completely covering the spot, with the burnt brands and ashes of the cabin fire in the midst. Sometimes we meet a rude altar of stones, on which are laid bits of tobacco and other petty offerings to the Manitou. Sometimes the scene is varied by the cabin of a Canadian Frenchman, who, unable to resist the charm of savage life, is bringing up his family of half-breed children in a condition little akin to civilization.

Early on the morning of May 30 we reached the Sault, and proceeded to encamp at the head of the rapids. This required a portage of several rods. The remainder of the day was spent at the village, in witnessing the novel mode of fishing, and other sights pertaining to this remote frontier post.

Preparations for our lake expedition being completed, on the first of June we took our departure from the head of the rapids. Here lay at anchor a beautiful light brig belonging to the American Fur Company, and which bore the name of its founder, John Jacob Astor. Close by its side was a schooner, which had been built by the Ohio Fishing and Mining Company, at Cleveland, and had just made the portage around the rapids. Another vessel was preparing for a similar transportation. With

three such crafts floating on its bosom, our great lake seemed to have already lost something of its old-time character, when, a wide waste of waters, it was traversed only by the canoe of the Indian and voyageur. Its importance as a great commercial highway had thus begun to be foreshadowed, but, in fact, its waters still laved a savage wilderness.

Some natural phenomena pertaining to a high northern latitude had begun to exhibit what were marvels to our unaccustomed eyes. One of these was the lengthened twilight, the sun continuing to irradiate the horizon with a bright flash, until nearly midnight. In fact, it was quite possible to tell the hour of the night at any time, by the light which indicated the sun's position. The Auroras, too, were surpassingly brilliant; often the electric rays streamed up from every point of the horizon, meeting at the zenith and waving like flame. I note these simple and common phenomena because they were novel to us, and it is only those who travel and encamp in the open air who enjoy to the full such scenes of beauty and wonder.

A summer temperature had now set in, and we witnessed another characteristic of this high latitude,—the sudden advance of the season. During the three days of our stay at this place, vegetation, which a week before had hardly commenced, sprung into active life. Trees then bare were now in full leaf. This phenomenon though common to our side of the Atlantic, we had nowhere else seem so conspicuously displayed.

Space will not permit a narrative of our journey, a two-months' coasting voyage along the whole southern side of Lake Superior. Nor can I write, except briefly, of the beauties of the scenery, most of which is now so well known; of Gros Cap and Point Iroquois, those rockbuilt pillars of Hercules that guard the entrance, and

Like giants stand,
To sentinel enchanted land;

of White-fish Point and its surroundings; of the grand, wild and varied rocky coast: of the many beautiful streams, flashing with cascades, and filled with the speckled trout; or of our scientific researches and observations. I will venture only to relate an occasional incident, and to delineate some features of the coast scenery which seem to me, have been too little noticed or too imperfectly described by others.

Westward from White-fish Point stretch for many miles broad beaches of sand and gravel, backed by hills clothed with Norway pines, spruce, hemlock, cedar, and birch. These beaches form extensive fishing-grounds, of which parties had already availed themselves. Every one knows the superiority of Lake Superior while fish, in size and flavor, over those of the lower waters. Yet in relating the following experience I am aware of the risk which I run of being set down as the retailer of a "fish story."

As we were rowing along the beach, some object was descried at a distance, making out of the water. All, at

once, gave vigorous chase. On our near approach, the animal, which proved to be an otter, dropped upon the sand a fish which he had just hauled out, and retreated into the lake. This fish, which was scarcely dead, was of a size so extraordinary that it might truly be called—the fish, not the story—a whopper! It measured two and a half feet in length, and one foot five inches in circumference. We had no accurate means of weighing but its weight was fairly estimated at fifteen pounds! The flesh was delicious in proportion, and made our whole party several capital meals.

These beaches terminate at a deep harbor called the Grand Marais. Hitherto the hills or dunes of sand have been of no great elevation. But now occurs a phenomenon which, though it seems not to have been classed among the wonders of this region, nor described in any books of travel, so far as I am aware, may well be called extraordinary, and worthy a place among the scenic wonders of America. It is a miniature Sahara, several miles in extent, and in many of its peculiar features resembling those lifeless, sandy deserts which are so distinguishing phenomena in some parts of the world. It is known to the French voyageurs as “Le Grand Sable.”

Sleep cliffs are first observed rising from the wafer with a very uniform face, of about 200 feet in height, beyond which are visible barren dunes, rising still higher in the distance. On our approach the whole appeared like lofty hills enveloped in fog. This proved to be nothing less than clouds of sand which the winds were constantly sweeping toward the lake, and which formed a mist so dense as to conceal completely the real character of the coast.

On ascending these steep and wasting cliffs, a scene opens to view which has no parallel except in the great deserts. For an extent of many miles nothing is visible but a waste of sand; not under the form of a monotonous plain, but rising into lofty cones, sweeping in graceful curves, hurled into hollows and spread into long-extended valleys. A few grass roots and small shrubs in some places find a feeble subsistence, and are the only vegetation. But thrusting through the sand are several tops of half-buried pines, barkless, and worn dry and craggy by the drifting soil while below the surface their bodies appear to be in perfect preservation. To our imagination they seem the time-worn columns of an antique temple, whose main structure has long ago tumbled into dust, or been buried, like the ruins of Egypt, beneath the drift of many centuries.

The surface sand is mostly packed quite hard, and may be trod as a solid floor. This, in many places, is strewn thickly with pebbles; the deep hollows present vast beds of them. Among these are a great variety of precious stones common to the rocks of the country; agates, chalcedony, jasper, quartz of every shade of color and transparency, with horn stone, trap, and other minerals. All are worn smooth, and often beautifully polished by the sharp, drifting sands, and many rich specimens were obtained. We were reminded of the valley of diamonds

in the Arabian tales, which it was the fortune of Sinbad to discover, in a scarcely less singular depository.

In the rear of this desert, about two miles from the coast, timber is again met with. Here, just at the edge of the wood, a small and beautiful lake lies embosomed; on the one side a rich tract of maple forest; on the other, barren and shifting sand. It broke on our view, from amidst the realm of desolation, as did the unexpected fountain to which Saladin led the weary cavalier, Sir Kenneth, over the sandy plains of Palestine, as told in the magic pages of Scott. We named it not inaptly, I think, “the diamond of the desert.” Around this sheet of water we found snow, on the tenth of June, in large quantities, buried beneath a few inches of sand.

From the diamond lake, issues a small stream, which, after making its way through the sand, reaches the clay that constitutes the base of these dunes, and tumbles a perfect cascade into the greater lake. This rivulet separates the dense maple forest which lies on the east from cliffs of driven sand, which rise abruptly to a height that far overlooks the woodland, and are the commencement of the grand and leafless sables.

The view on ascending these is most entrancing. On the one side stretches beneath, and far away, the verdant forest; while, by a transition as sudden as it is opposite in character, on the other side every feature of the landscape seems as if buried beneath hills of snow. The desert surface might be likened to that of an angry ocean, only that the undulations are far more vast, and the wave crests more lofty than the bellows of the sea in its wildest commotion. Looking upward from one of these immense basins, where only the sand-wave meets the sky the beholder is impressed with a sublimity of a novel kind, unmixed with the terror which attends a storm upon the Alps or on the ocean. The scene, wild and unique, may well claim this brief praise, though hitherto unsung, and lacking the charm of historical association,—“the consecration and the poet’s dream.”

Twelve miles beyond this singular region the beaches terminate, and the sand-rock makes its appearance on the coast, in a range of abrupt cliffs. These are “The Pictured Rocks.” They have been often described, but no description that I have seen conveys to my mind a satisfactory impression of their bold, wild, and curious features. In attempting to convey some clear comprehension of them, I can only hope to impart a faithful, though it be a feeble conception of the peculiar features of this marvel of the Northern Lakes.

These cliffs are composed of the same gray-and-red sand-rock which I have alluded to as the lowest of the paleozoic or silurian rocks. It appears in many places on the coast, and probably forms a large part of the bed of the lake. The cliffs here rise into a mural precipice, springing perpendicularly from the deep waters to the height of from 80 to 250 feet; and for the distance of fifteen miles, except in one or two places, are destitute of a beach upon which even a canoe may be landed. So dangerous is the coast, that vessels all give it a wide

berth passing at too great distance for accurate view. A small boat that lingers runs imminent risk, from the liability of this lake to sudden gales, and the traverse is attempted only during a perfect calm. The sand-rock lies in thick strata of varying degrees of hardness, from a coarse crag of the hardest cemented pebbles to a friable rock of aggregated sand. The predominant color is gray, sometimes light, often dark and rusty, and stained by oxides of iron and copper, with which the materials are charged. Hearing in mind these characteristics, the variety of aspects and the strange forms that these cliffs assume will find a ready explanation.

The great diversity of hues that give so beautiful and variegated an appearance to large portions of the surface, and from which the cliffs derive their name, is owing to the metallic oxides which have filtered through the porous stone in watery solutions and left their stains upon the surface. Beautiful as is the effect, it is due to candor to say that to my eyes there appeared but very imperfect representations of those various forms in the vegetable and animal kingdoms which figure in some highly-colored and fanciful descriptions in travellers' tales. Too extravagant an idea could scarcely be conveyed of the exceeding brilliancy of the coloring; but in regard to what artists style the "laying on," the picture presented a much closer resemblance to a house-painter's bucket, upon the outside of which paints of all colors have trickled down in tapering streams. They represent not so much the picture which Nature has painted, as the palette upon which she has cleaned her pencils. Every hue of the rainbow, besides black and white, and in every possible circumstance of shade and alternation, are drawn in long lines, covering thousands of feet of surface. Near the western extremity of the range, these colors assume a surpassing brilliancy, with a metallic lustre. Streaming over a gracefully curved surface, having an area of several thousand yards, they mimic, on a gigantic scale, the stripes on our national flag, as it waves in the breeze; or, passing down a fractured ledge, are contorted into long zigzag lines.

Upon close examination, these colors are found to proceed from slimy exudations, and to retain their brilliance only while fresh. When the face of the cliff has become dry, they possess a more faint and often mottled appearance. Then may sometimes be found depicted, upon a background of white, yellow or dun, as if rudely dabbed in by the artist, those vague similitudes, in which the imagination may realize verdant landscapes or fierce battle scenes; perhaps, if sufficiently vivid, a full set of Raphael's Cartoons. As a whole, the general effect of the coloring is so striking, that the appellation conferred upon these cliffs is well deserved. Thus strangely drawn, upon as strange a canvas, they add, at least, wonderful beauty and effect to the greater wonders which Nature has here displayed.

But color is far from being the most notable feature of the Pictured Rocks. The disintegrating material of which the rock is composed renders it very susceptible, to the effects of the elements. These cliffs present indubitable

evidence that the lake once washed them at a height many feet above its present level. And as the strata are of differing degrees of hardness, they have been worn by the waves into a variety of forms. Huge cavernous fissures penetrate the massive wall, often to the distance of several hundred feet, piercing through its great projecting buttresses, and leaving the solid mountain supported by bare pillars. These, in turn, are worn by the eddying waters into cylindrical columns, connected by arches that, sometimes spring with great regularity to a vast height.

An immense angular projection of the cliff, known to voyageurs as "La Portaille," exhibits on its three sides arches of this construction, one of which springs to a height of about 150 feet. The openings form passages into a great cavern, or more properly a vestibule, the roof of which is beyond the reach of our longest oars and which conducts through the entire projecting mass,—a distance of not less than 500 feet. Entering with our boat into this natural rock-built hall, its yawning caverns and overhanging walls strike a sudden awe into the soul. Echo gives back the voice in loud reverberations, and the discharge of a musket produces a roar like a clap of thunder. "Even the slight motion of the waves," writes Governor Cass, "which in the most profound calm agitates these internal seas, swept through the deep caverns with a noise of distant thunder and dies upon the ear, as it rolled forward in the dark recesses inaccessible to human observation; no sound more melancholy or more awful ever vibrated upon human nerves. Resting in a frail canoe, upon the limpid waters, we seemed almost suspended in air, so pellucid is the element upon which we floated. In gazing upon the towering battlements which impended over us, and from which the smallest fragment would have destroyed us, we felt, and felt intensely, our own insignificance. No splendid cathedral, no temple built with human hands, no pomp of worship, could ever impress the spectator with such deep humility, and so strong a conviction of the immense distance between him and the Almighty Architect." Enthusiastic language! and yet it cannot be deemed exaggerated.

The number and perfection of the wave-created pillars meeting the eye at every turn,—and which seem formed to support the immense weight above,—the various forms of the arches and of the overhanging rock, bear a close resemblance to the orders of human architecture. The rotundity of the columns is, in general, well preserved, and their tops swell into capitals. The supported mass, which is seldom less than 100 feet in thickness, often assumes characteristic forms, corresponding to the mock design. In one instance, for nearly half a mile, it resembles a vast, entablature, of which the cornice,—jutting at least 20 feet, with a curve whose grace is not excelled by the best sculpture, the pictured frieze, the mouldings, metopes, medallions, and other of those forms which pertain to Grecian architecture, are struck out, with a master, but giant hand, in magnificent relief, and with a perfection truly admirable. A portion of the structure had fallen, and lay

at the base in heaps of ruins. But even the imperfections appear as if due to the gradual process of decay. It requires little stretch of file imagination to conceive the whole fabric to be an enormous edifice, the grandest of man's construction, of which the main body has by some convulsion been sunk and engulfed in the waters. We thought of these monuments of ancient art which the volcanic rain of Vesuvius had overwhelmed; but such a temple as this would have enclosed half of Pompeii!

The mind naturally inquires. Are the beautiful forms of ancient architecture the result of long and laborious study, or was some marvel like this exhibited in that distant era, from which cunning sculptors borrowed those designs that immortalize the Parthenon? And if—as the learned have supposed the marble structures of that age received the addition of a coat of glowing colors,—of which time has left some traces,—we here view the prototype, not only of the graceful forms upon which they labored so successfully, but of the overlay of colorings, in the glory of their original freshness!

These are but single features in the scenic display. The line of cliffs is not; uniformly regular, but curves gradually to the southwest, and presents many angles and projecting points. Passing on to harder portions of the rock, the voyageur may encounter at the next angle a vertical and unbroken wall, rearing its solid front from the bed of the lake to the height of from 200 to 300 feet above the surface. The sharpness of the angular projection equals that created by the square and plummet; while the immense thickness of the strata causes the wall to appear as laid in immense blocks, a hundred feet in length. No such blocks were built into their mausolea by the proudest of the Pharaohs.

New changes present themselves as the traveller proceeds. Suddenly he is before the walls of an impregnable fortress, complete with glacis, bastion, and towers. The western cape of Miner's River exhibits a curious display of this kind. It resembles the dilapidated tower of some time-worn gothic castle. The base rests upon a series of short columns, connected by groined arches, through many of which a boat may pass with ease. There are eight or ten of these pillars; several have large entrances above, and the tower rears its broken battlements to the height of 120 feet.

Among the characteristic features none is more extraordinary than one to which the French voyageurs have appropriately given the name of "La Chapelle." Thin rock was originally part of the solid cliff, of which the greater portion has been swept away, causing a valley about half a mile in breadth, through which a considerable stream enters the lake, falling over the rocks in a sheet of foam. Close by, reared upon the rocky platform, about twenty feet above the lake, and conspicuous from its isolation, stands the chapel. It consists of a tabular mass of sandstone, raised upon five columns, which capitals swell into a uniform arch and support the ceiling or dome of the edifice. Its whole height is 56 feet. The pillars are somewhat irregular in

form and position; including their bases, they are about 25 feet in height, and from 4 to 6 feet diameter in the swell. Regular proportions are not altogether preserved, for in most of them the central portion has the smallest diameter, like an hour-glass. Two uphold the front, and from these the arch springs to the height of 300 feet, allowing to the roof a thickness of five or six feet. The span of this arch is 32 feet, as viewed from the water, in which direction the spectator looks completely through the temple into the woodland beyond. The strength of the roof thus upheld must be considerable since it is clothed with timber, and from the very centre shoots, spire-like, a lofty pine. The cliff on which the edifice stands forms a proportionate pedestal, ascending from the water in steps, which may be easily mounted.

This solemn natural temple might contain a congregation of several hundred persons. Nor are the usual accommodations for the preacher wanting. A column, the upper half of which has been broken, projects from a recess in the walls, and is worn into a curve behind, like the half of a letter S, creating a stand which would serve the purpose as admirably as it strikingly resembles the old-fashioned pulpit, the base of the column affording convenient steps.

Upon the cliff, just without, a column stands detached, and worn into the form of an urn, no bad representation of the baptismal font.

At what epoch of the world, or for what class of worshippers, this almost perfect temple was created, we might ask in vain of geologist or theologian. Certainly it is well designed to raise in the beholders thoughts of adoration for its all-skilful Architect, while they assign to it a chief place among the wonders of his workmanship.

An urn-shaped mass, similar to the one here observed, of great regularity and beauty of form, and not less than 50 feet in height, may be seen at another point of the coast. Several rills of water leap from the very top of these precipitous cliffs, and add much to the charm of the view. Indeed, taken in connection with the wide-sweeping lake, the distant mountain ranges, and the woodland, crowning the cliff, the scene presented is of the most picturesque and wildest character.

"Where'er we gaze, around, above, below,
What rainbow tints, what magic charms are found!
Rock, river, forest, mountain, all abound,
And bluest skies that harmonize the whole;
Beneath, the distant torrent's rushing sound
Tells where the volumned cataract doth roll,
Between those hanging rocks, that shock yet please the
soul."

Against, these huge ramparts in the hour of the storm the bellows of this impetuous lake dash with terrific fury, rumbling beneath the open arches, until, from the hollow caverns within, the sounds return like distant echoes, and at times their spray is thrown to the very summits of the cliff. Woe betide the bark that is overtaken by the tempest before these hopeless barriers!

But when the winds arc down, lulling the lake to gentlest murmurs, the cautious boatman plies along the lone rampart, and with beating heart ventures to explore its awe-inspiring recesses, those

Worn and wild receptacles,
Worked by the storms, yet work'd as it were planned,
In hollow halls, with sparry roof and cells.

From this sketch some correct idea may perhaps be gathered of a few of those strange forms which Nature, in her sportive hours, has here carved out of the solid fabric of the globe, as if in mockery of the efforts of man, gigantic monuments of that immeasurable Power who formed the winders of the universe.

Thirty miles west from the Pictured Rocks, at Chocolate and Carp rivers, we first met, in their approach to the shore, the axoic or primary rocks, which from here onward constitute so interesting and important a feature in the geology of the country. Of their scientific or their economical character it is not my purpose to speak, further than to say that to them belong the iron beds, which are such a mine of wealth to our State. Here, a few years after our visit, sprang into the busy and thriving city of Marquette. But at the time of which I speak, all was a solitude.

From hence to Keweenaw Bay ranges of granite knobs rise into considerable hills, and around them lie a series of quartzites, slates, and metamorphosed sandstones. The granites are pierced by dykes of trap, which in some cases form straight, narrow, and often lofty walls, in others have overflowed in irregular masses. Here Pluto, not Neptune, has been the controlling spirit, and has left the witness of his rule upon the face of the country. Ascending the knobs of granite and quartz, the change is most striking. To the east the eye embraces a tract lying in immense broad steppes of the sandstone, extending beyond the Pictured Rocks; while to the west are seen only rolling hills and knobs, terminating in the Huron Mountains.

I can add nothing to what is so well known of the mineral riches of this part of the country. But there is in its building-stones a wealth that is hardly yet begun to be realized. No more beautiful and serviceable material than the easily-worked and variously-tinted sandstone is found in the West; and her granites, already broken by natural forces into convenient blocks, and as yet untried, will command a market in the time coming, when the solid and durable shall be regarded as chief requisites to good architecture.

Following our westerly direction to Point Keweenaw, we find the dominion of Pluto established on a most magnificent scale. Not only is his energy displayed in the stern and rock-hound coast, but in the lofty ranges of trap, which rise into rugged hills of from 400 to 900 feet above the lake. Within these are secreted, but scarcely concealed, those wonderful veins of native copper, here quarried rather than mined, in masses such as the world has nowhere else produced.

But of all this wealth nothing was then known, except that traces of copper were visible at a few places along the coast, and that a large mass of the native metal lay in the bed of Ontonagon River, long revered by the Indians as a Manitou, mid mentioned in the relations of the early French historians.

I will but add, as the result of this season's explorations, that the report of the State geologist, published the ensuing winter, unravelled the whole subject of the mode of occurrence of the copper and its associated minerals, in the most complete and scientific manner. It first made known the immense value, which Michigan possessed in its hitherto despised Upper Peninsula: and its immediate effect was to arouse an interest in this then wild and uninhabited Indian territory, which has led to the opening up of its mines, and its present teeming prosperity.

On the third of July we encamped at Copper Harbor, and spent several days in exploration of the surrounding country, and, in blasting for ores. Several blasts were got ready for the great national jubilee, which we commemorated in the noisy manner usual with Americans, by a grand discharge from the rocks. We succeeded in producing a tremendous report, and the echo, resounding from the placid water as from a sounding-board, pealed forth in corresponding reverberations for several minutes. Later in the day we retired to our camp and partook of an equally grand dinner. It consisted of pigeons, fried and stewed, corn and bean soup, short-cake and hardtack, pork, and—last but not least—a can of fine oysters, which had been brought along for the occasion. Truly a sumptuous repast for a party of wilderness vagrants, even on a Fourth of July anniversary!

At the Ontonagon, an adventure befel, which it becomes a true knight-errant to relate. It was our purpose to pass up this river to the large mass of copper already alluded to. As we landed at the mouth there were noticed, on the opposite side of the river, several Indian lodges. As soon as we had dined, a few of the occupants crossed over in canoes, shook hands with us, giving the usual greeting of "Bo jou," and received a small gift of tobacco and bread. Accompanying were half a dozen young boys, some of whom had remarkably fine features. We could not but notice as an unusual circumstance, that several of the men were painted black. One athletic fellow in particular, in this grimy coloring, and naked except the cloth, made a very grotesque though savage appearance. The devil himself, however, is said not to be so black as he is painted, and this fellow seemed rather to act the buffoon than the noble warrior.

The party proved to belong to the Buffalos, whose chief we had met at River Tequamenon, near the eastern end of the lake, and were under the command of the son of their chief. The latter was a resolute-looking fellow, of about 26 or 30 years of age. His face was painted red, and he wore a medal bearing the likeness of John Quincy Adams. We paid little attention to the Indians, although aware that on several occasions exploring

parties had been stopped at the mouth of this river and turned back.

We had made but two or three miles progress up the stream when the rapid stroke of paddles was heard, and a canoe, manned with Indians, shot quickly around a bend below and came into sight. The savages were seated, as their custom is, in the bottom of their bark so that only heads and shoulders were visible. As each applied his whole strength the canoe skimmed over the surface like a young duck, while the dashing of so many paddles caused her to seem propelled by a water-wheel.

Our leader's boat, which was ahead, immediately lay to and raised her American flag. "If they want to fight," said the Doctor, "we'll give them a chance." Our two boats moved into line, and the doctor's assistants armed themselves, one with a revolver, the other with a rusty shot-gun, our entire military resource. The canoe was soon alongside, and the heads and shoulders proved to belong to the bodies of eight stout natives, headed by the young chief. Dr. Houghton held out his hand to be shaken as before. He then asked, through an interpreter, if the recollected the man who had put something into their arms when they were sick, a number of years ago. This something was a vaccine for the small-pox, Doctor H. having accompanied the Schoolcraft expedition, in the capacity of a physician and botanist. To this the chief, who doubtless well knew, made no reply, but demanded our errand up the river, and said that he and his men had been stationed at the mouth by his father, the head of the tribe, with orders to allow no boat to pass up without that chief's permission. He added further, that we had not paid him, the son, the respect that was his due, by calling at his lodge and leaving a present. Our leader replied that he was sent hither by their great Father, whose instructions he should obey; that he should ascend the river as far as suited him, and that he did not recognize in them any authority to stop him.

Chief. You must wait at the mouth until the Buffalo comes up. Else I and my band shall go with you, and see that you take nothing.

Doctor. I have been here before, and shall go now, as I am ordered by your great Father. I know the country and do not need a guide.

Chief. This country belongs to us.

Doctor. I know that the country is Indian territory, but the treaty of 1826 allows citizens of the United States to visit it. Neither shall I ask consent of the chief to take what I please. But, being acquainted with the Buffalo, I have no objection to showing him what I bring away.

At this stage of the altercation another canoe came in sight, which proved to contain the boys. But this time, two of the Indians had made free to step into our small boat, where they seated themselves with great appearance of familiarity. The affair would have had enough of the ludicrous mingled with its serious aspect to warrant us in making light of it, and holding no further

parley, but for two considerations, which we could not afford to overlook. Owing to the numerous rapids, the barge which contained our whole stock, could be got up only ten miles, while we had to proceed to the forks, twenty miles further, in our smaller boat, and thence live miles by foot. And in case of a trial of strength with the Indians, no dependence could be placed upon our hired voyageurs, most of whom were allied to the opposite party, both in blood and training. Pointing to a bend in the river, our detainers now said, "We are determined that you shall not go beyond that point tonight." This audacious order determined us to at once break off all conference, so asserting our intention to be no longer hindered or delayed, we prepared for immediate departure. After some consultation among themselves, the chief answered, that if we would then and there make them a present of a keg of pork and a barrel of flour we would be allowed to proceed, but should be expected to bestow a further present to the head chief on our return.

To this bold demand, which plainly appeared to be a levy of blackmail, an act of piracy. Dr. Houghton replied that he would give them as a present such things as they stood in immediate need of, but nothing more. Nor should he recognize the shadow of a right to demand even that. Accordingly, a bag filled with flour, and some, pork and tobacco were offered and the leader agreed to accept his present in powder, lead, and provisions at La Pointe, whither we were bound.

The parley being at an end, we drew off and pushed up the stream. The hostiles remained awhile in consultation, and then withdrew in the opposite direction. A few miles above we encamped for the night.

It was a necessity, as I have stated, to leave our barge behind with all our stores, while the exploring party were absent for two days and a night. Of course this dilemma was known to the enemy. Holding a council of war the next morning, it was resolved to leave with our goods four of the men, together with the gun. They received most positive orders to fire upon the first Indian who touched the baggage, in case any of them should return, as we had reason to expect. And our captain added with solemn emphasis, that if any man failed in fidelity, his own life should pay the forfeit. Having thus played upon their fears, we pursued our laborious journey, reached the Copper Rock at nightfall, and, tired with the day's toils, laid down beneath the cover of the forest and slept soundly.

The next morning we proceeded to the difficult task of detaching portions of the metallic mass, which was successfully accomplished, and we brought away about twenty-five pounds of it. I will here add, that this copper boulder was, a few years afterwards, removed through the agency of Mr. Eldred, of Detroit, and taken to Washington, where it enriches the museum of the Smithsonian Institution. It is now no novelty to see very much larger masses brought down and landed on the dock at our smelting works.

But to conclude the narrative: on reaching camp, on our return, we learned that the chief, with several of his band, had been then, but had touched nothing, and according to his own account, had taken the trail for Lake Flambeau, in order to join a war-party, then organizing, of the Chippewas against the Sioux. Notwithstanding this story we fully expected to meet these fellows again at the mouth, and to whip them there if we could. But when we reached the place all was silent, and the lodges deserted.

I will only add to this long story, that our captain's order was never presented. We learned further, on reaching La Pointe, that the party which waylaid us had known of our journey from the first; that they had "smoked over it," had dogged us the whole way up the lake, subsisting themselves by fishing, and that when we met they were nearly starved.

A few days brought us to the islands called by Carver "The Apostles." On one of the largest of these, Madeline, at La Pointe, is located a general depot of the American Fur Company, for all the western parts of the lake, and the chain of lakes and rivers leading into it. It had become, in consequence, an asylum for all the old traders of that part of the country, and the temporary abode of great numbers of Indians. After pitching our tents on the beach, in front of the fort, amid a crowd of Indians and equally idle half-breeds, we were welcomed by the company's factor, Dr. Borup, Mr. Oakes, the factor from Fond-du-lac, and Mr. Bushnell, the Indian agent, and invited to all the hospitalities of the place.

During our whole voyage from the Sault we had not seen the face of a white man, except at the mission of L'Anse, and a casual fishing party. But here, at the end of our wandering, far from what we had been accustomed to consider the limits of civilization, we were greeted in the families of these gentlemen, not only by features to which we had been so long strangers, but all the attendant civilized refinements. The dress and manners of the East, the free converse with friendly voices of our own and the gentle sex, the music of a piano, the sound of the church-going bell and Christian services, seemed to us rather like a return to our homes than the extreme of a two-months' journey in the wilderness.

It may interest my hearers to know in more detail what composed a post so remote, and which was to me so much a surprise.

La Pointe at that period was one of those peculiar growths known only to an era which has long passed away, or been banished to regions still more remote. What is called the company's "fort" consisted of two large stores painted red, a long storehouse for fish, at the wharf, and a row of neat frame buildings painted white. The latter were occupied by the half dozen families in the company's employ. These dwellings, with the two stores, formed opposite sides of a broad street, in the centre square of which was planted a large flag-pole. Upon this street also clustered sundry smaller and unpainted log tenements of the French and half-breeds.

Half a mile from the fort were the Protestant and Catholic missions. The former boasted a good frame mansion of two stories, attached to which was a school, numbering thirty scholars. The Catholic mission had a large number of followers, including the French and Indians. In all, the settlement contained about fifty permanent tenements. Besides these were perhaps an equal number of Indian lodges, irregularly disposed in vacant spaces, and adding to the size and picturesque character of the village. Several hundred Indians usually found constant employ in the fisheries at this place.

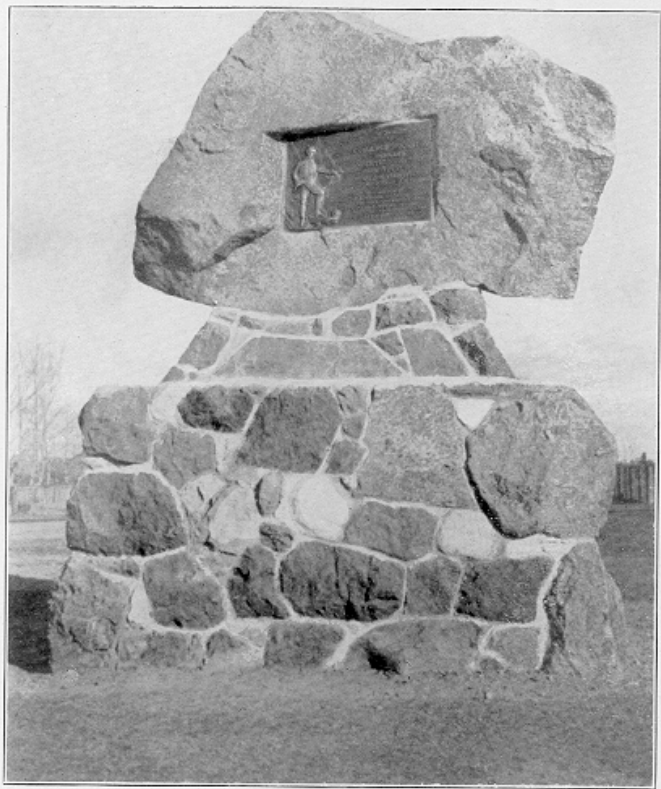
This was the oldest, as well as most remote, of the Jesuit missions in the Northwest, having been established by Father Allouez, in 1665. It was then a gathering place of many Indian nations, and was hundreds of miles from the nearest French settlement.

It has additional interest from the fact that it witnessed the youthful and zealous labors of Pere Marquette, who came, in 1669, to take the place of Father Allouez, among the Ottawas, Hurons, and other tribes of the neighborhood. It was at La Pointe that Marquette planned that voyage of first discovery, exploration and missionary enterprise down the Mississippi which has rendered his name illustrious.

In the families I have mentioned might be detected an intermixture of Indian blood, which detracts little even from the fairness of the daughters, and the ladies as well as the gentlemen are intelligent and highly educated. Their lives, when not occupied in business, are spent in reading and music; and during the long, cold winter, frequent rides are taken on the ice, upon which they pass from island to island in sledges drawn by dogs.

I could not but picture to my mind, outside of this intelligent circle, the festivities which marked this distant post, at that season, in the more palmy days of the fur trade; when it would be crowded with the hangers-on of such an establishment, returned from their sojourn in the trapping grounds, or their toilsome voyages to and from Montreal and Quebec, bent on lavishing away their season's earnings in days of idleness or debauch, and in "long nights of revelry and ease."

Much of this old-time character still remained. The motley population, the unique village, the fisheries and furs, the Indian dances and pow-wows, the mixture of civilization and barbarism, the isolation, broken only by occasional and irregular arrivals from the world below,—made up a scene for which we were little prepared, which will not be easily forgotten, but of which I can give only this meagre description.



Douglass Houghton Monument at Eagle River.

SUMMARY AND SYNOPSIS OF THE WORK PERFORMED BY THE GEOLOGICAL SURVEY OF MICHIGAN UNDER ITS FIRST ORGANIZATION

THE original Act for the organization of a State Geological Survey was approved by Governor Mason, February 23, 1837. (*Laws of Michigan*, 1837, p. 14.)

It provided for the appointment of a State Geologist, and it appropriated annual sums, increasing from \$3,000 the first year to \$12,000 the fourth year.

Dr. Douglass Houghton received from Governor Mason the appointment, and his first report was made to the Governor, January 25, 1838 (37 pages). It sets forth that at as early a day as a sufficient corps could be organized the geologist proceeded to a rapid and general reconnoissance of such parts of the State as the limited time would permit.

These examinations had chiefly for their object the determination of the rock formations, their extent and order of superposition.

Of the annual reports which he is called upon to make he proceeds to say, that they should only embrace a brief abstract of such facts as may be deemed of immediate practical importance or tend to a general development of the resources of the State, or as may serve to show the progress of the survey, for which

reasons these portions which may be considered of a strictly scientific character will be omitted until the final report will be made."

The report then proceeds to describe the general character of the peninsula, particularly of its northern portion, about which much misconception prevails. It then briefly describes the rocks of the lower peninsula, the superficial extent of country occupied by them, so far as determined, and their places of outcrop. These pages are followed by a particular account of the brine springs of the State, with sundry analyses

Bradish, Memoir, 134-287 passim.

and comparisons with the springs of other States, and some practical conclusions; it then alludes to the beginning made in the departments of zoology and botany, under the direction of Doctor Abram Sager, and of the topographical map of the counties which were in progress, being reduced from the original returns of the United States Survey.

This preliminary report was followed February 1, 1838, by an Appendix containing, "with a view to facilitate the progress of the survey, certain queries proposed to the people of the State, with suggestions to the proprietors of lands that they forward to Detroit specimens of minerals, rocks, marls, peat, petrifications and soils," all of which was intended to interest the people and draw out facts for future investigation.

REORGANIZATION AND REPORT

During the winter of 1837-8 the survey was reorganized on a larger basis (*Laws 1837-8*, p. 119), and with particular reference to the provision made, in addition to the geological department proper, for zoological, botanical and topographical departments, it appropriated the annual sum of \$12,000 for the years 1838 to 1841. The following corps of officers was appointed by the Governor on the nomination of the State Geologist:—

Douglass Houghton, Geologist.

Abram Sager, in charge of zoological department.

John Wright, in charge of botanical department.

Sylvester W. Higgins, topographer and draughtsman.

Columbus C. Douglass, assistant to the geologist.

Bela Hubbard, assistant to geologist.

William P. Smith, in charge of mechanical zoology.

On the 22nd of March, 1838 (*Laws 1837-8*, p. 119), a new act received the approval of the Governor, reorganizing the survey on a more comprehensive plan, and with more detailed provisions. Under this Act January 1st, 1839, the State Geologist sends to the Legislature a report (8 pages) in relation to the improvement of State salt springs, under the provisions of an Act approved March 21, 1838. In this the Geologist refers to his visit to the principal salt wells of Ohio, Pennsylvania and Virginia, for the purpose of

comparison and analogy, "those of New York being so very differently situated, geologically, that a satisfactory comparison with them can scarcely be instituted at this time."

He describes the model of occurrence of our salt springs, the probable depth of the boring required, and the best method of improvement. Details are given of the preparatory work done on Tittabawassee River in Midland County, and the embarrassments which beset operations, owing to the unsettled state of the country, the distance from supplies, and the sickness of those employed, and the small amount of the appropriation for this purpose, also to the necessity for the presence of the State Geologist in person at other and remote points, all which caused temporary abandonment of the work.

SECOND ANNUAL REPORT

The second annual report was made to the Legislature, February 4, 1839 (38 pages). It mentions the organization of the geological board, in accordance with the Act of March 22, 1838, "in such a manner as to constitute* a geological and mineralogical, a zoological, a botanical and a topographical department."

That, "the heads of the departments took the field at an early day and continued their arduous duties until the inclemency of the season compelled a suspension of labor, since which time they have been busily engaged in arranging a great amount of information which has been obtained in such a manner as may eventually be made available."

The individual labors of the State Geologist had been chiefly devoted to an examination of the coast of those portions of our State bordering on Lakes Huron and Michigan; also to a general examination of some of the central and southern counties, preparatory to the more minute examination, which has been commenced and which it is proposed to renew with the first opening of spring."

This report of the Geologist details the topographical and general character of the northern portion of the peninsula west and north of Saginaw Bay, a portion then but imperfectly known, and also the general character of the rocks of that portion, showing their line of bearing, and the connection of our geology with that of the neighboring States.

Special remarks follow upon the clays, marls and gypsum of the peninsula.

An interesting portion of the report is devoted to a consideration of the change of elevation in the waters of the Great Lakes, which were then at a higher point than had been known for many years, a subject of great interest practically in connection with lake harbors and with the agricultural interest of the State." Dr. Houghton distinguishes the then high stage of the waters from the fluctuations due to annual and temporary causes. Many facts are stated, going back to the beginning of the century. In leading to his conclusions, viz., that the

increase is due to increased rainfall, he points out the fact that the waters of the interior lakes and streams have also risen, and that these changes have not been peculiar to Michigan, but manifested over the whole western country. He refers also to the succession of cold and wet seasons which prevailed in 1838.

This whole subject had been heretofore clouded in much mystery and theory, and the data and reasoning of Dr. Houghton were the first to throw light on the real causes.

Reference is made to the progress of the geological and the botanical departments, and to the collections made for the University.

In the topographical department, maps of the several counties had been projected on a scale of two miles to the inch, a size which enables him to place upon them most of that information which will be required for the use of town and county officers, as also the complete geology and topography of the country. "Upon these skeleton plats the assistants were required to fill up the deficiencies, and return the same with the streams carried out across the interior of the sections; the soils, marshes, timbered lands, openings, prairies, woods, etc., etc., as well as the geology and topography accurately delineated."

THIRD ANNUAL REPORT

This report (30 pages) was made to the Legislature February 3, 1840. It gives a general description of the topography and geology of the southern slope of the upper peninsula, to which the formal attention of the State Geologist was principally directed during the season of 1839. This embraces the numerous and intricate islands and channels skirting the north shore of Lake Huron and in the St. Mary's River, and the range of hills extending westwardly from this river as far as Bay De Noc. In this district of Michigan is embraced that interesting group of limestones and sandstones now included within the Paleozoic times, as upper and lower silurian rocks. The limestones are characterized by abundant fossil remains, of which a large collection was made. The lowest rocks of this series is the Lake Superior sandstone.

The true position of this rock has been subject of dispute among geologists, but it was shown by Dr. Houghton to rest upon the primary or azoic rocks, and to be referable to the Potsdam sandstone of New York.

A few pages of the report are given to the clay ironstone of Branch County, and the bog ore of Kalamazoo and other counties, which the State Geologist was particularly instructed to examine. The gypsum and marl beds of the State are again referred to, and a general reference to the geological and topographical departments, which in the plan of organization are mutually dependent.

The Geologist refers to the departments of zoology and botany, which unfortunately, owing to the failure of adequate appropriation, consequent upon the

embarrassed condition of the State finances, had become suspended by the resignation of the assistants in those departments.

* * *

On Jan. 9, 1840, the State Geologist presented a report relative to the improvement of salt springs (7 pages).

The subject details the steps which had been taken for the erection of the machinery required for the borings at the State salt wells; the contract made with a practical mechanic from Kanawha, Virginia; the failure of the contractor to fulfil his undertaking, in consequence of assigned fears as to the health of the country, and he details embarrassments which beset the prosecution of the work, and the onerous duties devolving on him as State Geologist, which prevented absolutely a personal direction of the improvements in progress.

After giving an account of the condition of the buildings, shops and engines at the Tittabawassee and Grand River borings and the extent of the borings accomplished, and explaining that a point had been reached where the expense in future would be comparatively small, he states that in consequence of the embarrassments existing in the Internal Improvement Fund, and in the failure to receive the installments of the appropriation, which compelled the Geologist to provide means from his private resources, it became necessary to suspend operations in the month of September. He prays a release from the duties and responsibilities connected with the superintendence of the improvement of the salt springs, as incompatible with the proper discharge of the duties imposed upon him as State Geologist.

FOURTH ANNUAL REPORT

This report bears date Feb. 1, 1841 (88 pages). The Geologist states that his "individual labors during the past season, 1810, had been chiefly devoted to surveys connected with the northern slope of the upper peninsula, and regrets that the hardships to which he has been exposed in conducting the field work over the wilderness portion of our State have so far impaired his health as to render it impossible to enter into so minute details as had been anticipated." He then enters upon a general description and topographical features of the upper or northern peninsula.

* * *

January 5, 1812, the State Geologist sent to the Legislature a report; relative to the State salt springs (6 pages), in which he states that the work which for more than eighteen months had been arrested had been again commenced, and up to a very recent day has been continued according to the provisions of the contracts; that it will be indispensable to continue the borings until the shafts shall have passed very nearly through the lower salt rocks, before brine of the maximum strength can be looked for. At the point selected for the State well, on Grand River, it is estimated that the shaft shall

be sunk to the depth of 700 feet, and at Tittabawassee River to a depth in round numbers of 600 feet; that at the State salt springs on Grand River the upper salt rock had been perforated, followed by an abundant supply of salt water, but that no attempt had yet been made to separate the salt water from admixture of fresh; that at 300 feet the amount of salt water flowing from the nine inch tube was by actual measurement found to be 130 gallons per minute, an amount almost incredibly large, and unequalled by any rock boring in any other portion of the United States. Analysis of this mixed water shows that 110½ gallons contains a bushel of salt. These facts sustain the original position assumed relative to the salt deposits of our State.

After comparing the strength of the brine at the State wells with the best salt wells of New York, Virginia and elsewhere, the Geologist adds: "The improvement of our State salines has now progressed so far as to satisfy the most sceptical of actual success. And it is hardly necessary to call your attention to the great importance or the necessity of speedy completion."

FIFTH ANNUAL REPORT

On January 27, 1842, was sent to the Legislature the fifth annual report of the State Geologist (6 pages), which states that the communication will be confined almost exclusively to the condition and wants of the department; that the field work of the geological and topographical surveys upon the plan originally contemplated is mainly completed; that in consequence of the small amount of funds applicable, the amount of work accomplished has been less than that of the preceding year; that the labor so applied has been chiefly devoted to the westerly portion or mountainous district of the upper peninsula; that in connection with duties assigned to the State Geologist relative to the boundary line between Michigan and Wisconsin, he has been enabled to complete a very perfect geological section of nearly 180 miles in length, crossing from the mouth of Montreal River to the mouth of Menominee River of Green Bay.

"In addition to several geological sections completed, all the rivers entering Lake Superior have been carefully examined to their very sources, and the Porcupine Mountains have been traced out through almost the entire range. The results of these surveys have served to add confidence to our previously expressed opinion respecting the value of that part of our State. The copper ores associated with the altered conglomerate and sandstone rocks in this portion of the range have been found to be more extensive than has been originally supposed."

In speaking of the limits of the southerly range, within which falls the lead district of Wisconsin and Iowa, the report says: "It should be recollected that the outer or northern range of mountains of Lake Superior constitute what has been called the true copper district, and that in this district no lead and none of the ores of which

sulphur is a constituent have been noticed, while in the southern range in Michigan the ores are almost entirely sulphates, and lead occurs more abundantly than copper. Thus far I have been unable to trace any portion of the great limestone formation of the upper peninsula to any near proximity to this range, where the same traverses that portion of Michigan, and in tracing the range westwardly no considerable deposits of lead have been found until the lower rocks are covered by heavy deposits of limestone, which would lead to the inference that these upper deposits have performed an important part in arresting and fixing the minerals referred to (minerals associated with the lead ores), and which minerals may fairly be inferred to have had their origin from the lower rocks to which reference has been made."

The report; alludes to the very great assistance derived from the Honorable William A. Burt, who during the last two years has been engaged in surveying the United States Township lines.

Of the drafting from the field notes, Dr. Houghton states, that since in the topographical department there has been only a single assistant, the amount of drafting has continued to accumulate upon his hands, and there yet remains an amount to be done which can scarcely be accomplished in an entire year. The fund applicable to these objects being absorbed, there will be required a small appropriation. He enumerates six comities of which maps have been engraved, and says that had not the state of the Treasury made it impossible, these, with thirteen others would have been published before this date.

STATE SALT SPRINGS

On January 27, 1843, the Geologist makes a report relative to the State salt springs (6 pages), in conformity with an Act approved February 1, 1842, which appropriated \$15,000 for the improvement of the State salt springs.

At the State salt springs on Grand River, Kent County, the work has been nearly completed. The depth obtained is something over 800 feet, and is on the lower salt rock. Since the date of last report the quantity of water discharged has very considerably increased, and now exceeds 200 gallons per minute. As the water now flows from the iron tube, it is mixed with all the fresh water entering the well above the upper salt rock, a difficulty which will be overcome by proper tubing. In continuing the work it is of the utmost importance that the borings be carried entirely through the lower salt rocks, and then, and not until then, can the capacity of the well be fully determined. He adds, that it is now satisfactorily shown that the place of the salt water in the sub-carboniferous rocks is as originally set forth, and that the supply of water is abundant, and further that the character of the brine is such as will admit of the manufacture of salt at such rates as will enable our citizens to compete with that manufacture abroad.

At the State salt well on Tittabawassee River, no further progress has been made, the reasons for which suspension are contained in section 708 of an Act relative to the State salt springs, approved Feb. 16, 1842.

SIXTH ANNUAL REPORT

This report bears date February 10, 1848 (5 pages). It sets forth the condition and progress of the geological survey of the State towards completion.

"Since the date of my last report I have been chiefly engaged in arranging and putting in. shape the immense amount of details, both geological and topographical, which have accumulated; in analyzing and studying the immense collection of specimens illustrating the geology and mineralogy of our State, and in the chemical analysis of our soils, minerals and rock specimens." He announces the field work for the entire survey as now completed, with the exception of a few points where the work still wants connecting.

In the topographical office during a portion of the year the work was suspended in consequence of the absence of the topographer, who was engaged several months in locating lands for the State. Notwithstanding, the work of drafting is so far advanced that a large portion is ready for the hands of the engraver.

The publication of State and county maps as directed by the Legislature was long ago commenced, and the engraving of several of these maps had been completed before the date of my last report, but the inability to procure such funds as would purchase the paper has caused delay and in fact has for a time virtually suspended all action upon the subject." He adds—"This series of State and county maps, it is hoped and believed, will be more full and perfect than any which have heretofore been published of any equal portion of our United States, and there can be no doubt but when once placed before the public they will do much to disseminate a knowledge of the immense capabilities of our State and the advantages which she offers to the emigrant; and that they will in that way afford sufficient aid towards increasing her population. When the maps already engraved shall have been thrown before the public, it is hoped and believed that a sufficient amount will be received from their sale to enable us to proceed with the engraving and publishing of the balance without further embarrassment, and that they will more than pay the expenses incident to their publication.

"The engraved plates of these maps will remain nearly as perfect after the proposed edition shall have been worked off as they were at first, and as other editions may from time to time be wanted, the names of newly organized towns, new roads, etc., may be added without difficulty, at a mere nominal expense, and without interfering with the method adopted for exhibiting on them the soils and timber, and the geological and topographical features of the country."

The report thus concludes: "The geological and topographical surveys of our State, which have been carried forward by a corps few in number compared with that furnished by any other State, and extending over an area greater than that claimed by any of them, has been a work of immense labor. To accomplish the end desired the most constant and untiring industry has been required, added to which it has been necessary during protracted periods in the wilderness country to dispense with the ordinary comforts of life, but the labor has been rendered light with the hope that in aiding to develop the resources of our State, in placing upon maps her geology, topography, and the character of her timber and soils, her settlements might be increased and something added to her prosperity and wealth."

SEVENTH ANNUAL REPORT

This report was sent to the Legislature February 15, 1844. It states that "a portion of the season has been devoted to connecting the work on the upper peninsula and completing the skeleton of the surveys of that part of the State, but by far the greater amount of work has been performed in the office, in compiling and arranging the materials for the final report, and in the completion of the maps, together with the figuring of sections and fossils illustrative of the several groups of rocks of our State.

"The drafting of the county maps according to the plan directed has mainly been performed, and excepting some slight addition, these are now ready for the engraver. Of the county maps four have been struck off and are now in the market. Ten additional counties are to be placed in the engraver's hands, and I hope to be able to lay the maps of these fourteen counties, together with the State map, before the public at an early day in the ensuing spring.

"An appropriation of \$1,000 to \$1,500 will cover all that will be required to be paid out of the treasury before a sufficient amount will be realized from the sales to enable the work to progress without further demand upon the treasury, and I confidently believe that the proceeds of the sales of these maps will fully refund to the State the cost of their publication.

"In addition to the ordinary duties of the survey, the extra duty required at your last session of furnishing the State land office with township maps, has been performed so far as calls have been made by the State commissioners.

"The engraving of the geological sections, fossils, etc., will occupy some time, and it is desirable in order to prevent delay that this portion of the work of the final report should be commenced at the earliest day possible. In order to hasten this the Geologist adds: "I have made a temporary arrangement for the wood cuts with a wood engraver who is fully competent, and who is now engaged in this duty, but in order to continue this work some provision will be necessary."

Dr. Houghton thus refers to the results which he hoped to accomplish by means of the connected geological and linear surveying which he had projected: "While in the survey of the upper peninsula it is very desirable that the grand outlines should be filled up with more minuteness than has hitherto been done, to develop its topography, geology and mineralogy, in such a manner as its great importance and the intrinsic value of its mineral treasures make desirable, it would require a larger amount of expenditure than our State is well able to appropriate to that object. The United States linear surveys afford a fine opportunity for accomplishing this in a way which will render the work exceedingly perfect, and at the same time will be attended with little expense. I hope to perfect such an arrangement (the connecting of the United States surveys with the geological surveys of Michigan) through the co-operation of the commissioners of the General Land Office, as will enable me to provide more perfect geological and topographical maps of the upper peninsula than have ever been constructed of the same extent of territory in our United States. In addition to such provisions as you may see fit to make for the engraving of the several county maps, the wood engraving and publication, there will be required for current expenses of the survey during the ensuing year an amount not exceeding \$400.

GEOLOGICAL REPORTS OF DOUGLASS HOUGHTON

1837

REPORT RELATIVE TO PROGRESS AND ADVANTAGES OF THE GEOLOGICAL SURVEY

From manuscript collection, University of Michigan)

Geological Department
Detroit Dec. 1, 1837.

*To His Excy. Stevens T. Mason,
Governor of Michigan.*

Sir,

In accordance with your instructions of the 20th. ult., I transmit you the accompanying informal report—I find it impossible, at this time, to answer your question satisfactorily to myself, in consequence of the crude condition of the materials from which I am necessitated to generalize.

1. "The general progress and extent of the Geological Survey."

The Geological Survey of the past season, has necessarily been of a, general character—Much time and labour has been devoted to determining the extent of our rock formation, and their general contents, together with the extent of particular kinds of soils. This course has been taken preparatory to use more minute examination which is proposed for the coming year, and

in following out this plan, some one of my party has visited nearly every county in the state. My own time has been chiefly devoted to an examination of the northern and sparsely populated counties and has been attended with fatigue and hardships of the most severe kind.

The Botanical and Zoological departments have received due attention and larger collections of specimens have been made than could have been anticipated. Our state furnishes a rich field for investigation in this department of natural history and they are certainly deserving of more attention, than, with the limited number of assistants attached to the geological corps, I have been able to give them.

In accordance with what was conceived to be the spirit of the act authorizing a geological survey, much time and labor has been devoted to procuring and preserving botanical and zoological specimens with a more particular reference to enriching the cabinet of our State University. When the importance which these subjects are daily assuming, together with the fact that there is no institution in our country where they can be advantageously pursued by students, is taken into consideration, my motives for this course can be appreciated. Our University at a trifling expense, may be placed in a condition to offer vastly greater inducements for students in these departments than any other in our country. But as these subjects were minor or incidental ones in the survey, sufficient provision was not made for placing them on the footing which they should occupy; and if carried out upon the plans which has been commenced, a more liberal appropriation will be indispensable.

It would be nearly impossible, at this time, to specify the precise localities and qualities of the minerals discovered, for the simple reason that, as they have not yet been submitted to the action of chemical test, I might possibly hazard an opinion which would lead to error.

The central portions of our state belong to the coal formation, and sufficient coal has already been found to warrant the conclusion that it exists in abundance on the peninsula.

Iron, in the shape of bog ore, is found in sufficient abundance to satisfy me that it will prove a source of wealth to our state.

Gypsum is also found more abundant (in the northern part of our state) than had been anticipated.

In consequence of its superior importance at this time, most of my minute examinations have been devoted to the Saline Springs of our State and since those of greatest purity and strength occur chiefly in those portions of the Peninsula which are but little settled or known, they have been searched out with the utmost difficulty, and weeks and even months have been, spent in examining the beds of some of our streams, and in pushing my investigation through a perfect wilderness, where the sufferings from fatigue, mosquitoes and want

of the common necessities of life, were almost insupportable.

These investigations have been carried so far as to render it certain that there is a broad belt of country, extending nearly across the Peninsula, which abounds in Saline Springs of sufficient strength and purity to warrant the conclusion that they only require proper attention and improvement, to supply a sufficient quantity of salt for home consumption, as also to make it an article of export.

As our Saline Springs like nearly all those on this continent, are not naturally in a condition to be worked, their whole value will depend upon the system of improvement which may be devised. Should a wise policy be adopted, we may hope soon to see our Salines, like those of New York, furnishing employment for capital and labor, and also a large revenue to the states but a slight misstep might render them of little avail for a long series of years. Whatever policy our state may see fit to adopt, on this important subject, it is to be hoped she will never allow the control of her Springs to pass from her, even for ever so short a time.

"The general advantages of the Geological Survey" may be presented under three somewhat distinct heads:

1. The development of the resources of our State.
2. Its advantages in a scientific point of view, and in furnishing our university with specimens of Natural History.
3. Its incidental pecuniary advantages to the State.

The resources of our State are but little known, and are not duly appreciated in any other than an agricultural point of view. Large sums of money are annually sent abroad for the purchase of articles in which our state abounds, and the manufacture of which, if rightly understood, might furnish opportunities for the lucrative investment of capital; and while our imports might easily be changed to exports, market would be made for the produce of the farmer, of which our State must ere long have a large surplus.

The benefits arising from an accurate (examination of our rocks, coal, salt, iron, gypsum, marl etc. cannot but be apparent to the most superficial observer; but the general advantages arising from the survey, if properly conducted, will appear in a thousand different ways that would, at first hardly be supposed.

The advantages of the Geological Survey in a scientific point of view, may not at first be so apparent, and it is true if we place it upon its actual pecuniary value, this portion would be of little consequence. But aside from the fact that it is only through an accurate knowledge of that portion which may be denominated strictly scientific that we are enabled to arrive at general conclusions; that without this we would be constantly groping as it were in the dark; it is not to be presumed that all that ministers to the mental superiority and enjoyment of man, is to be set aside for mere pecuniary interest. This portion of our

geological survey, which will be least interesting to the general reader, will cost infinitely more labour and research than any other, and in fact than all the others. It is from these purely scientific researches that nearly all the practical conclusions are drawn. It will be by the accuracy of the scientific portions that our survey, abroad, will stand or fall, and without this, the final report would be not unlike the block of marble, untouched by the sculptor; the material might be there, but the chief labor and skill would be required, to bring it to its proper shape and proportions.

In an incidental pecuniary point of view, the benefits arising to the state from the geological survey will for our present peculiar position be immense. The quota of land given us by the act of admission will, in consequence of the course you have so wisely adopted and pursued, be enhanced twofold in value. This may easily be understood when we take into consideration that that portion of our northern country which has not yet been offered for sale, is the most rich in staple minerals.

The lands reserved from sale, under the direction of the Surveyor General, as salt spring lands, have been closely examined, and only three or four found to be of any value for their saline springs, and it may be doubtful whether the interests of the state will be subserved by accepting more than two of these.

As we are given until 1840 to make our selections of the seventy-two sections of the salt spring lands, we may hope in the time which will elapse, to secure those points which are of the greatest value, and which would in all probability under other circumstances be wholly lost to the state. The Geological Survey, examined in this simple incidental point of view, may safely be said already to have more than compensated for the whole appropriation which has been made.

As progress is made in the survey, many things necessary for carrying it forward, and for which no provision was made, appear. Among those of greatest importance at this present moment, I would call your attention to the topography of our country.

Aside from its importance in a general point of view, it is a matter of absolute necessity that I have before me large and accurate maps of all the counties in our State.

If it is impossible to make any satisfactory progress, more particularly in the northern counties, when little or nothing is known of the topography without these maps. The lineal survey is now in progress by the United States, but if we await, the time that these lands will be offered for sale, it may require years to obtain any accurate information of the topography of that interesting section of country. Such portion of the materials as are not now before us, are daily being deposited in the United States General Land office, and an accurate topographical map may be constructed at a very slight expense but not without industry and labor.

So pressing has been my necessity for these linear maps, even of our oldest counties that I have already

found it necessary to place several of them in the hands of a draftsman for construction.

Should it be deemed expedient to appoint a topographer with a view to the eventual construction of full and perfect topographical maps of the State, the maps so constructed during the progress of our geological survey, would receive such additions and corrections as would make them as nearly perfect as the circumstances would admit, and would thereby save the State a large expenditure of money hereafter.

In the location of lands for State purposes, it is absolutely necessary that the State agent be furnished with maps of that section of our northern country now being surveyed in order that returns may be made to the general land office to reserve from sale his selections of lands. Should this be left until the lands are offered for sale, a slight inattention, or any error, would cause a loss of the selections. And in case a preemption law should be passed in the meantime, they would be inevitably lost. In addition to this, it is not improbable that portions of our State in which some of the choicest selections may be made, may not be offered for sale previous to 1840; in which case, should a different policy be adopted, the State Agent would be necessitated to make other selections of less value, in their stead.

The assistance of a topographer will also be indispensable in the construction of the strictly geological maps, and in the great variety of general drafting which will be almost constantly occurring in the department.

Viewing this subject as I do, as one of vital importance to the faithful completion of our survey, I take the liberty of suggesting to your consideration the propriety of making provision at an early day, for the appointment of a topographer to the Geological corps.

The embarrassment which has arisen in consequence of the inadequacy of the appropriation of 1837, has been very great, and the result is a heavy debt has been brought upon the department. This debt unless provision be made for cancelling it from other sources than that of the appropriation for 1838, will cripple the operations of the survey for the coming year, and much of the benefit which would, under other circumstances, be derived from it, will be lost.

I am instructed to give attention to all the departments of Natural History. This cannot be done in a manner which will lead to any important results, without the aid of competent assistants, and in order to accomplish what is required, it will be necessary to add to the present number of my corps before the opening of the coming spring. If this be done, the appropriation for 1838, as it now stands, should no portion be used for cancelling the debt of 1837, will hardly be sufficient to meet the exigencies of the coming year.

In order to accomplish as much as possible within the current year, I remained in the field until as late an hour as I supposed would leave me sufficient time to accomplish my chemical analysis and to complete my

report by the first of January 1838. But the severe labor of the season, has so far impaired the health of my principal assistant, Dr. Sager, and one of my Lab. Assts. McDouglass, that they are unable at this time to render me any aid in their respective departments. The result will be that, a satisfactory report can scarcely be made at so early a day. The chemical analysis, which will require my undivided attention, can hardly be completed in less time than three to four weeks.

Since too little time will occur between the close of our annual labors, and the time my report, is called for, it is desirable that that part of the act which calls for the report on the first day of January of each year, should be so amended as to call for the report on the first day of February of each year.

All which is respectively submitted.
I have the honor to be
Sir, Your obt. Servt.
Douglass Houghton

1838

REPORT OF A SELECT COMMITTEE OF THE BOARD
OF REGENTS OF A COLLECTION OF THE STATE
GEOLOGIST

(House Documents, 1838, No. 1)

The select committee which was required by a resolution of the board of Regents to examine the collection of the state geologist, and report what measures ought to be adopted to preserve that portion of zoological specimens designed for the use of the university, having performed the duty assigned them, ask leave to make the following report:

From an estimate made on data furnished by the State Geologist, the committee have arrived at the conclusion, that in the section of ornithology alone, the state of Michigan will yield from three hundred and fifty to four hundred species. Counting duplicates of these to embrace the sexes, we shall have from seven to eight hundred individuals. Many of these individuals molt twice in the year; hence it becomes necessary to exhibit the same bird, both in its summer and winter plumage. A complete collection, therefore, of Michigan birds, will contain at the lowest estimate one thousand specimens. One-fourth of this number has already been obtained, and the hunters employed are sending in about one hundred and fifty per month.

The committee are of the opinion (as it is necessary for their preservation) that the specimens appertaining to the university, should be stuffed and set up in cases. To do this and go on with the collection of quadrupeds, fishes and reptiles, involves the necessity of a heavy expenditure. We are informed by the State Geologist, that the appropriation heretofore made by the legislature, will not enable him to meet the current expenses of the scientific corps under his direction,

and make the disbursements requisite to keep in service his ornithological assistant. When the committee take into consideration how important it will be to the university to have in its possession a complete collection of the subjects of natural science, and especially of such as are indigenous to the state, and how difficult and expensive it will be to procure it, if we permit; the present opportunity to pass by unimproved, they feel disposed earnestly to urge the board of Regents to cooperate with the State Geologist in the adoption of means to accomplish an object of so much interest to the university and of utility to the public at large.

As there are no funds in the hands of this corporation applicable at this time to the purposes under consideration, the committee have thought it would be expedient to recommend, that this board adopt some mode of expressing to the legislature its conviction of the necessity of placing at the disposal of the state executive a larger fund, in order that the state survey, so well begun, so important to agriculture, to science and the arts, may be concluded in a manner honorable to its projectors, and creditable to the state which has thus far sustained them. In accordance with this view, the committee offer the following resolution:

Resolved, That the president of the board of Regents, be requested in his executive capacity, to communicate to the legislature, the proceedings of this body, on the subject embraced in the foregoing report,

[Signed,] Z. PITCHER.
Chairman of Committee.

THE STATE OF MICHIGAN, ON ACCOUNT OF
GEOLOGICAL SURVEY, IN ACCOUNT WITH
DOUGLASS HOUGHTON

(House Documents, 1838, No. 8)

State of Michigan, on account of Geological Survey. To
Douglass Houghton:

Dr.

1837.

May 1.	To amount expended at sundry times from May 1, to Dec. 31, 1837, by Dr. A. Sager, principal assistant, C. C. Douglass and Bela Hubbard, sub-assistants, and mmysle	\$2,478.25,
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This account involves amount paid for one horse at \$30.00, (the receipt for which was mislaid) traveling expenses for the whole corps, forage for horses, purchase of canoes, small items of outfit of

provisions, &c. when in the woods, postage on letters connected with state business, board of my assistants, and some articles of clothing used by them while in the actual service of the state, occasional small items used in the preservation of specimens, repairs of wagons, harness, instruments, &c; some items of cartage and transportation of specimens, occasional employment of day laborers, and numerous minor items, such as were required to be used, and which, from the small sums in which the payments were made, rendered it inconvenient or impossible to obtain receipts, or when received, appeared to be a useless expenditure of time and money to specify the items; as will be easily understood by reference to the accompanying vouchers.

The amount expended by my assistants, was charged directly over to them, and they were held responsible for its faithful expenditure. The vouchers for the amount expended by each, will be found attached hereto.

Aug. 24	To amount paid Wm. S. Smith, (one of the sub-assistants in charge of the mechanical zoology,) a portion of said sum applying to his salary, at \$1,000 per annum, the balance being applied in compensating a hunter, at \$12 per month, and sundry items necessary in performing his duties,	402.50
May 15.	Amount paid for horse, as per bill rendered,	45.00
May 30.	Paid Wm. C. Sabine, for two sets of harness, halters, &c.	74.25
	Total,	<u>\$3,000.00</u>
	Cr.	
May 5.	By cash,	\$1,500.00
July 1.	Do.	<u>1,500.00</u>
	Total	\$3,000.00

I hereby certify the above account rendered is (errors excepted,) a, faithful account of moneys expended; that I have expended of the amount noted in the first account of expenditures, the sum of five hundred and eighty-three dollars and sixty-six cents; that no portion of said sum has been expended for any other purposes than for actual expenses when in the field, and for purposes connected with the geological survey. I further certify, that no part of my individual expenses, when not in the field, has been charged in account, nor have I received any salary or emolument whatever, either directly or indirectly; that no salary has been paid to either my assistant or sub-assistant, with the exception of Wm. P. Smith, at \$1,000 per annum, and John Hyder, hunter, at \$12 per month; and such day laborers as have been occasionally employed, and in no instance, to my recollection, have those day laborers been paid more than one dollar per day.

I further certify, that I have not been, directly or indirectly, engaged in the purchase of any lands whatever, (excepting to pay a balance, being the amount of an error made in the land office of the Detroit Land District, on a purchase made several years ago,) and that I have not, during the current year, been connected in any manner, directly or indirectly, with the location of any lands, excepting those for the state of Michigan.

DOUGLASS HOUGHTON.

January 1, 1838.

I hereby certify, that I have received from Douglass Houghton, for the state of Michigan, the sum of five hundred and fifty-five dollars and twelve cents, and that the whole sum has been faithfully expended for traveling expenses, while in the service of the state, and for the other general purposes enumerated in the first item of the accompanying account, and also that no part of said sum has been applied in the shape of salary, or otherwise, for my private use.

I further certify, that I have not during the year, purchased or become interested in the location of any lands, in any manner, either directly or indirectly.

A. SAGER.

January 1, 1838.

I hereby certify, that I have received from Douglass Houghton, for the state of Michigan, the sum of one thousand and eighty-six dollars and ninety-one cents, and acting in the capacity of paymaster during a portion of the past year, I have faithfully expended the same for the general purposes enumerated in the first item of the annexed account of expenditures; that I have not appropriated any portion of the sum to my private use, in any manner different from that there set forth, and that I have received no salary whatever.

I further certify, that I have not been engaged in the location of lands in any shape whatever, either directly or indirectly, except for the state of Michigan.

C. C. DOUGLASS.

Detroit, January 1, 1838.

I hereby certify, that I have received of Douglass Houghton, for the state of Michigan, the sum of two hundred and fifty-three dollars and fifty-six cents, which has been faithfully expended for traveling expenses, while in the service of the state, and for the other general purposes enumerated in the first item of expenses of the accompanying account, and also that no part of said sum has been applied in the shape of salary or otherwise, for my private use.

I further certify, that I have not, during my service for the state, purchased or become interested in the location of lands, in any manner, either directly or indirectly.

B. HUBBARD.

January 1, 1838.

I hereby certify, that I have received of Douglass Houghton for the state of Michigan, the sum. of four hundred and two dollars and fifty cents, a, part of which has been applied on my salary of \$1,000 per annum, and the balance has been faithfully expended in the payment of a hunter, at \$12 per month, and other necessary expenses of the department.

I further certify, I have not been engaged in any manner, directly or indirectly, in the purchase of lands during my employment in the service of the state.

WILLIAM P. SMITH.

January 1, 1838.

January 26, 1838
REPORT OF THE STATE GEOLOGIST
(House Documents, 1838, No. 24)

To his Excellency STEVENS T. MASON,

Governor of Michigan:

Sir—In conformity with the requisitions of the act authorizing a Geological Survey of the State of Michigan, the undersigned respectfully submits the following report:

At as early a day after the receipt of my commission, as a sufficient corps could be organized, I proceeded to a rapid and general reconnoissance of such parts of the state, as the limited time which has transpired would permit. These examinations, having chiefly for their object the determination of the rock formations, their extent, and order of superposition, and being subjects of a general character necessary to be understood preparatory to a more minute examination, much of a practical character, which under other circumstances would have elicited particular attention, has, from necessity, been passed by.

It is conceived that the annual reports which I am called upon to make, should only embrace a brief abstract of such facts as may be deemed of immediate practical importance, or tend to a general development of the

resources of the state, or as may serve to show the progress of the survey, for which reason those portions which may be considered of a strictly scientific character will be omitted until the final report may be made. Nor do I deem it advisable to enter into a minute description of the rock formations, which are, at best, but little understood, until further examinations have been made.

That portion of our state usually denominated the Peninsula, while few, if any portions of it, as of so rugged a character as to prevent its use for the purposes of agriculture, is, nevertheless, far from what was once supposed, a level and unbroken plain. Its rocks, consisting for the most part of nearly horizontal strata of limestones, sandstones, and shales, give character to a beautifully varied succession of hills and valleys, as also to a soil admirably adapted to the purposes of agriculture. It is surrounded by a level belt of country, which gradually obtains a greater elevation as we proceed towards the interior, varying in width from five to forty miles, and for the most part covered with a dense forest, while the interior and the more undulating portions give rise to a varied succession of prairies, oak openings and timbered lands.

This general description, which may be supposed to apply more particularly to those counties of the state already organized, will, I have no doubt, apply nearly equally well to that portion of the state not yet surveyed. I allude to this the more particularly, since the opinion is abroad among our citizens, that the northern portions of our state are of little or no value, except for lumber, and that it consists of alternating barren ridges of pine and marsh.

This opinion, so far as the country has been examined, and from the best information which can be obtained on the subject, is far from the truth. For while it embraces, like the southern counties, prairies, oak openings, and lands timbered with hard wood, many of those portions limbered with pine, it is conceived, will eventually prove of great value in an agricultural point of view.

The great number of streams having their sources in the central portions of the peninsula, and discharging their waters in every direction into the lakes by which it is surrounded, give a peculiar feature to the geography of the country. Several of these streams are navigable for boats of light draft, for a, much longer distance than could have been anticipated, and they give rise to an amount of hydraulic power, far exceeding what has usually been supposed, and which will eventually prove of immense value to our state. In pursuing the investigation of the past season, I have found it necessary to examine several of the most important of these streams, through their whole extent, and I could not fail to observe the great purity of their waters, together with the rapidity of their descent. The sloping banks, which are usually of but moderate height, are composed of the richest soil; but occasionally their banks attain, at an inconsiderable distance from the stream an altitude from one hundred to two hundred feet, as at some points in the valley of the Grand river.

Portions of the central and most elevated counties of the peninsula are considerably rough and broken, though it is believed, in few instances sufficiently so to prevent a successful cultivation of the soil. This undulating, or hilly portion of our state, extends through parts of the counties of Hillsdale, Jackson, Washtenaw, Ingham, Eaton, Livingston, Oakland, Ionia, Kent and some portions of the adjoining counties, as also far to the north of Kent county, in the unsurveyed district. The hills do not appear to be disposed with any regularly formed valleys, but consist of an irregular assemblage of somewhat conical elevations and depressions, occasionally attaining an elevation of from one hundred and fifty to two hundred feet, but ordinarily not more than from thirty to forty feet. The topography of that portion of our state, bordering upon Lake Superior, is very different from that of the peninsula. The occasional appearance of primary and trap rocks forming mountain chains, and the great disturbance which has taken place since the deposition of the red sandstone, has given to the whole country a more rugged aspect; and while many of the valleys and elevated plains furnish a rich and permanent soil, covered with a dense forest, the mountain chains of primary rock, have all the meagreness of soil usually attendant on these formations.

Upper Sandstone of the Peninsula

Occupying the central and most elevated portions of the peninsula, and over a large district of country, embracing parts of the counties of Hillsdale, Jackson, Calhoun, Kalamazoo, Livingston, Ingham, Eaton, Barry, Shiawassee, Clinton, the eastern part of Ionia, and probably portions of the adjoining counties, which want of time did not permit me to examine, the outcropping ledge of sandstone is seen, occasionally alternating with shale. Its friable nature is such that the rock soon becomes covered with soil from disintegration and vegetable deposits, in such a manner as to conceal it from view, and thus to have led our early inhabitants to suppose the appearance of rock near the surface to be of rare occurrence, but as the country has become settled, rock has been found near the surface in hundreds of places where it was formerly supposed not to exist, and it may be fairly inferred that as the country becomes cultivated, this will continue to be the result.

This rock formation which is referable to the carboniferous series, will, without doubt, be found to be a continuation of the great coal measures of Ohio, and present appearances would seem to warrant the conclusion, that it extends nearly or quite to the northern termination of the peninsula. I have thus far been unable to arrive at any very satisfactory conclusions as to the thickness or general inclination.

Its superficial extent has undoubtedly been much lessened, for after passing the edge of the sandstone, the soil is invariable found to contain disintegrated portions of the rock, with occasional loose pieces of bituminous coal, the latter appearing sometimes in quantities of several bushels at a single place.

Portions of the sandstone on the western slope of the peninsula, more particularly in the counties of Calhoun, and parts of Jackson and Hillsdale, the formation is much shattered, as if broken by the irregular rising and sinking of small districts of country, a result which could scarcely be conceived to have taken place by any other than rapid and irregular motion. The original continuity of the strata is almost completely destroyed, and so much is the rock shattered, that at several points in Calhoun county; wells were seen sunk through the rock from twenty to forty feet, and where the excavation required but little more labor than would have been required to sink through an equal depth of earth. The masses of rock thrown out. rarely exceed a foot or eighteen inches in superficial extent, and many were of smaller size; still, though so much broken, no portions of the rock were, much inclined, and it appeared to have retained measurably its original horizontal position. The interstices between these portions of rock, not being filled with earth, admit the free passage of water through them, the result of which is, the appearance, at particular points, of large springs of water, and a paucity of small streams upon the surface.

Near Jonesville, in Hillsdale county, several quarries of sandstone have been opened, but not sufficiently to give very much information of their true condition. The upper portions of a loose and friable nature, and the layers from two to four inches in thickness, but where the excavations have been carried to a depth of from ten to twelve feet, they attain a thickness of nearly one foot, and the character of the rock, for economical purposes, is much improved.

At Napoleon, in Jackson county, the sandstone appears at numerous points, having a slight inclination south-westerly. It is composed of angular grains of quartzose sand, united by a very slight calcareous cement. The stone is of good quality for architectural purposes, and admits of being easily quarried. It has already been considerably used for buildings, grindstones, &c.

In descending Grand River, the rock appears again at Jacksonburgh, and over many miles of the surrounding country having a slight dip, like that at Napoleon, south-westerly: Several quarries have been opened in the immediate vicinity of Jacksonburgh, and a finely shaped and tolerably compact and durable material for building, furnished. I here first noticed fossil vegetable remains, chiefly referable to the genera *Lepidodendron*, *Stigmara*, and *Calamites*, together with small masses of carbonaceous matter, associated with the sand rock. A little north of the village, clay ironstone occurs, disseminated through the rocks, and also in thin beds and veins, but not in sufficient quantities to be of any practical importance. Numerous kettle shaped excavations, similar to those produced by pebbles when set in motion by the action of a strong current, occur in the sandstone, and not unfrequently at a distance from the river, and at an elevation of some thirty or forty feet above it.

In the bed and bank of the river, a little above the crossing of the road at Jacksonburgh, the sandstone is seen to embrace a bed of bituminous shale. The shale is overlaid by two and a half feet of slaty sandstone, and about two feet appear above the surface of the water. Portions of this shale have nearly the appearance of semi-indurated clay, much charged with carbonaceous matter; but at a distance of several rods below, the water, by falling over a dam, has thrown out large quantities of shale, intermixed with very thin layers of coal, and the whole being highly charged with bituminous matter, was first mistaken, by the inhabitants, for coal. These indications were matters of considerable interest, since the shales are well known to be the usual associates of coal, and occurring, as they do, in the coal bearing rock, a reasonable hope may undoubtedly be entertained of the existence of coal in that section of the county.

Near the mouth of Portage river, a few miles north of Jacksonburgh, a stratum of lime rock appears, and what is probably a continuation of the same stratum, is seen westerly at Bellvue, and several intermediate points. This lime rock, which occurs in flat irregular masses, separated by thin coverings of an exceedingly tenacious clay, and without any regular line of stratification, upon burning, produces superior lime, and aside from its irregular shape, would prove a valuable building stone. The stratum must, however, be considered of no great thickness, since the sandstone appears again, at a lower level, a few miles north-westerly. The limestone is of a light greyish color, and exceedingly compact, and although numerous perforations of lithodorous mollusca were observed, after a minute examination, I was unable to detect any fossils.

In descending Grand river, the sandstone is seen at intervals in the bed of the stream, as also sometimes attaining a considerable elevation upon its banks, through the comities of Jackson, Ingham, Eaton, Clinton, and the south-eastern part of Ionia. It was last noticed in the bed of the stream, a few miles above the mouth of Lookinglass river. In general character it bears much resemblance to that at Jacksonburgh, and bituminous shale is occasionally seen alternating with it. In the northern part of Eaton county, the rock is seen at several places in a mural wall of from thirty to forty feet in height.

At many points where the rock was examined in the counties enumerated, carbonaceous matter and vegetable impressions were associated with it. These were more particularly noticed in Ingham and Eaton counties, where very thin beds of coal, varying from half an inch to three inches, and in one instance two feet in thickness, occur in slate, usually underlying an irregular and inconsiderable deposit of clay ironstone.

Sandrock occurs on the Kalamazoo river at Battle creek, and quarries have been partially opened at that place. Portions of the rock which have been quarried, furnish a tolerably good building stone, but from the frequent occurrence of nodular masses of iron pyrites, much care is required in its selection.

Quarries have been opened more extensively at Marshall, and a building stone of good quality is found; but here, as at Battle creek, iron pyrites, though not in so large quantities, occasionally occurs, embedded in it.

In ascending the Kalamazoo river, via, Albion, the sand rock occurs at short intervals, having much the same appearance as at Marshall, as also at numerous points between the latter place and Spring Arbor, in Jackson county.

On the Shiawassee river in Shiawassee county, the sand rock was first seen in the bed of the stream, from four to five miles above Corunna, (the county town of Shiawassee co.,) and continues at intervals as far as four to five miles below Owasso on the same river. The dip is here slightly north or north-easterly. The rock was not seen at any point to attain any great elevation. In general appearance it bears a strong resemblance to that of Jackson county, but much of it contains sufficient mica as to give it a somewhat slaty structure. About one mile above Corunna, upon the right bank of the river, it has been quarried in small quantities, and although loose in its texture, will answer tolerably well for walls. Here numerous indistinct impressions of plants were seen, with small pieces of coal, the latter retaining its general ligniform structure, but perfectly charred. Half a mile below Owasso, the rock appears in the bed of the stream, and is more compact in its structure.

Near Shiawassee town, (above Corunna,) the outcropping edge of a stratum of limestone, similar in general appearance to that at Jacksonburgh, makes its appearance, dipping north easterly. It is evidently a stratum embraced in the sandstone.

GREY LIMESTONE

Underlying the sandstone already described, and occurring near (the borders of the peninsula, is a grey colored limestone, which may, without doubt, be considered identical with the mountain limestone of European geologists.

The outcropping edge of this rock, may be traced from the rapids of Maumee river in Ohio, directly to the rapids of the River Raisin, at the city of Monroe. At the latter place and in the country immediately surrounding, where there is only a superficial covering of earth, extensive quarries have been opened, and limestone of a superior quality for building, as also tolerably well adapted to the manufacture of lime, is procured.

In ascending the River Raisin this rock is occasionally seen as far as Dundee, where it forms the bed of the river. As we ascend the river from Monroe, so far as limited examination enables me to judge, the rock becomes more quartzose in its character, which renders it nearly unfitted for the manufacture of lime, but does not lessen its value as a material for building.

About five miles north-west from Monroe, and two miles distant from the river, this sandy lime rock was seen in a state of disintegration, giving rise to beds of beautifully white quartzose sand, better adapted to the manufacture

of the finer kinds of glass, than any I have seen in our shale.

Between Monroe and Brest the lime rock appears in the beds of the small streams, and occasionally at other points, and in no place is it covered by a great depth of soil. At Stoney Point the rock again appears, and at several points along the coast, or a little in the interior. It also occurs in the vicinity of Gibraltar, and it is last seen on this shore, at Monguagon, fifteen miles below Detroit, at which place quarries of considerable extent have been opened, for the purpose of supplying the city of Detroit with building stone and lime. A quarry has been for many years opened at Grosse Isle, as also on the Canada shore in the vicinity of Amherstburg.

Proceeding north-easterly from Monguagon, the rock soon becomes covered with a considerable depth of superincumbent, earth, and at Detroit, is found to be a little more than one hundred feet below the surface of the river.

Nothing indicating the approach of the rock to the surface was observed in Macomb county; but in the western part of St. Clair, angular fragments of the rock were seen, occurring under circumstance which would seem to indicate the approach of the formation to the surface. The same was also noticed in portions of the counties of Oakland, Lapeer, the northern part of Shiawassee, and in Midland, near the forks of the Tittabawassa river. The rock occurs in a place on Charity islands of Saginaw bay, and also on the northern shore at Point au Gres.

On the westerly slope of the peninsula, a lime rock occurs at the rapids of Grand river, which is undoubtedly identical with that last noticed. About two miles north of Grand Rapids, the rock appears of a superior quality for economical purposes, in a sloping talus from twenty to thirty feet. It also occurs at the rapids of Mashkegon river, and will, no doubt, be found extending a long distance north from the last mentioned stream.

Associated with the rock, we find calcareous spar at nearly all the localities noted; irregular hog-tooth spar at Monroe; sulphate of strontian at Brest and Grosse Isle; tremolite at Brest; sulphate of barytes, brown spar, and gypsum at Grand Rapids, and the latter mineral will, undoubtedly, be found associated at the rapids of Mashkegon, and on the north shore of Saginaw bay.

The rock is more or less fossiliferous at most of the points where it was examined, but more particularly so at Monguagon and Grand Rapids. At the former place thin pieces of carbonaceous matter, as also small cavities filled with bitumen, are occasionally seen, and the rock is extremely foetid. The excavations in the rock have been so slight and so small a portion is exposed, that the opportunities for examining the fossils are extremely limited, and many of those procured for examination, were in so mutilated a condition, as to preclude all possibility of drawing any specific distinctions.¹

The limestone is, for the most part, of a subgranular structure, quite compact, and well adapted to agricultural purposes; and, although at many points it is capable of producing a valuable lime upon burning, it is not unfrequently too silicious to answer that purpose.

LOWER SANDSTONE OR GRAYWACK GROUP

About thirty miles above Fort Gratiot, and on the immediate shore of Lake Huron, a greenish colored clay slate, alternating with compact and slaty sandstone, is seen attaining an altitude of from ten to twenty feet. In coasting along the shore, rocks of a similar character occur at intervals as far as Point Aux

¹The genera *Terebratula*, *Producta*, and *Cyathophyllum*, were observed both in the eastern and western portions of that state; *Orthocera*, *Bellerophon*, *Sarembula*, *Spirifer*, *Natica*, *Encrinurus*, *Gorgonia*, *Madrepora*, *Retepora*, *Calymene*, and *Asaphus* at Monguagon, and *Pecten* at Grand Rapids.

Barques. But at the latter place, and for several miles around, the sandstone is not accompanied by shale.

The sand rock at Point Aux Barques differs materially in general character from that in the central portions of the state: for it is nearly or quite destitute of fossils, and is highly micaceous and flaggy in structure. The sandstone first noticed, as alternating with slate, is of a deep grey color and the cement is mostly argillaceous.

The general dip of these rocks is south-westerly; and although not actually seen in contact with the mountain limestone, there can be no doubt but it passes under that rock formation. A rock stratum which may be referred to the lower portion of this group, is seen in that portion of our state north of Lake Huron, on the St. Mary's river, where it is of a mottled or variegated color. The channel of the St. Mary's river appears to have been chiefly excavated from this rock, precisely at that point where its edge rested upon the primary rocks of Upper Canada.

In ascending Lake Superior, this red sandstone appears at numerous points, and occasionally attains a considerable altitude, as at the Pictured rocks, where it rises in a mural wall of from two to three hundred feet. In the vicinity of Granite Point, it is seen, scarcely disturbed, resting upon knobs of primary rocks; while in the Trap regions of Lake Superior, as in the vicinity of the Porcupine mountains, it is seen dipping irregularly at a high angle from the elevated district of country, and is there of a deep reddish brown color.

These sandstones are, for the most part, sufficiently compact to furnish a tolerably enduring material for building.

COAL

Since that rock formation occupying the central portion of the peninsula, as has already been stated, may be referred to the carboniferous formation, I was early led to conclude that the examinations for coal might be conducted with a probability of success; and as far as these examinations have been carried. I have not been

disappointed in these conclusions. For the reason that the outcropping edge of the rock is almost invariably covered with soil but few points occurring where it can be seen, these examinations are attended with the greatest difficulties;—and, much time will, in all probability, be required to test the question of the existence of very extensive beds. Loose pieces of bituminous coal are found quite universally, in excavating the sand and gravel of the counties enumerated as bounding the carboniferous formation, and no doubt have their origin from the disintegration of the coal bearing rock, and they occur over a district of country considerably more extensive than that now occupied by that formation. Indications of coal were more particularly noticed at several places in Jackson, Ingham, Eaton, and Shiawassee counties, and it was occasionally seen in beds, rarely exceeding two or three inches in thickness. On Grindstone creek, in Eaton county, and in the immediate vicinity, a bed, having an average thickness of eighteen inches, and not exceeding two feet at any point, was examined along the base of the hills for about three-fourths of a mile, where, in consequence of its dipping below the surface, I was unable to trace it farther. This bed is embraced in a succession of compact sandstones, and fissile shales, varying in thickness from be to thirty feet. In consequence of the shattered condition of the sandstone at one point, I was enabled to remove some twenty or thirty bushels of coal, which proved to be highly bituminous, and of a very good quality, though occasional pieces were observed slightly contaminated with iron pyrites. It ignites easily, burns with a bright flame, and leaves only a small quantity of earthy residuum.

The difficulties which surround the investigation of this important subject, it is to be hoped, will in a measure be overcome, as the country becomes more settled; and we may look for much valuable information from the construction of our contemplated internal improvements, and more particularly that of the proposed canal, which will cross the coal formation, at a point where we have reason to hope that beds of this mineral will be brought to light.

GYPSUM

Near Grand Rapids, in Kent county, a bed of gypsum occurs, apparently of considerable extent. It is embraced in a gypseous marl, and overlays the limestone, before noticed as occurring in this neighborhood. Although the gypsum is only seen upon the surface at two or three points, and the beds have never been opened, I became satisfied, after a somewhat cursory examination, that it exists, covered with a few feet of soil, over a considerable district of country, and that it cannot fail to prove a subject of much value to the agricultural interests of this and adjoining parts of the state.

The gypsum is of a fibrous variety, nearly free from earthy matter, and is well adapted to nearly all the uses to which this valuable mineral is applied. The bed is

distinctly stratified, the layers varying from twelve to fifteen inches in thickness, and they are separated from each other by argillaceous matter and earthy gypsum.

Plaster is also known to exist in several other points in our state, but sufficient examinations have not yet been made to throw any light upon the probable extent of the beds.

BRINE SPRINGS

Looking upon every thing connected with the manufacture of salt as of the most vital importance to the interests of the state, and also bearing in mind the necessity of designating those springs selected for state purposes, at as early a day as possible,² most of my minute examinations during the past season, have been devoted to the brine springs of the peninsula, and since the most important of these occur in those counties which are but sparsely populated, the examinations have been

²It will be recollected that by the act of admission, our state was permitted to select seventy-two sections of salt spring lands.

attended with labor of the most severe kind. Little or nothing of a definite character has hitherto been known respecting either the location or quality of these springs, and nothing of the geological circumstances under which they occur.

It has been known, from the earliest settlement of the country, that the Indians formerly supplied themselves with salt from springs occurring on the peninsula; numerous reservations of lands supposed to contain salt springs, have been made by the United States; and many years ago, several unsuccessful attempts were made by individuals to manufacture salt. But after all, the fact that most of the springs reserved by the United States, contain little else than some of the salts of lime and iron, and the failure in the original attempt to manufacture salt had, with much reason, given rise to doubts as to the existence of saline springs, to any extent. In the examinations which have been made during the past season, I have endeavored, so far as has been in my power to determine the southerly boundary of the saline district, the geological and geographical position of the different springs which have come under my observation, together with the comparative strength and purity of their waters. As these examinations, from the short time which has elapsed, have only been partial, and the deductions must necessarily be crude, I shall only offer, at this time, such observations and suggestions as I conceive to be of immediate and practical importance, or as may tend to a better understanding of the general facts connected with the subject.

Saline indications of any importance, have not been noticed south of a line drawn from Monroe, in Monroe county, to Granville, in Kent county, and although there are several indications in Wayne county, if the eastern point were removed to Mount Clemens, in Macomb county, the country lying north of that line would

embrace all of much, or in fact, of any consequence, with the exception of those on Saline river, in Washtenaw county. This will be more easily understood, by reference to the location of the springs, enumerated in Table No. 1, which includes the most important springs examined.

These may be conveniently described as occurring in five somewhat distinct groups. First, those on Grand river, town six north: second, those on Maple river, towns eight and nine north: third, those on the Tittabawassa river, town fifteen north: fourth, those of Macomb county, town three north: fifth, those on Saline river, Washtenaw county, town four south. Several other groups are already known, and some additional springs have been partially examined; but in consequence of the imperfect nature of the present information, the details will not be set forth at this time.

The relative strength and purity of the waters of these springs will be seen at a glance, by reference to the accompanying tables, numbered one and two; but this is by no means to be taken as a standard of the amount of solid matter which they would under ordinary circumstances, be found to contain. The waters, with the exception of those taken from the springs numbered eighteen and nineteen, were invariably taken from the surface, and with the single exception of that numbered fifteen, under the most unfavorable circumstances. In consequence of the heavy rains of the past summer, most of the marshes in which the salines occur, have been deluged with fresh water; the streams have been so high that much difficulty has occurred in procuring even the diluted water, which have been the subject of this analysis, and in more than one instance has the high state of the water compelled me to abandon the examination.

In ascending Grand river from its mouth, we first notice the appearance of brine springs, some three or four miles below the rapids, in Kent county. These indications occur in the small marshes in the valley on either side of the river. The river is here bounded by hills having a considerable elevation, and which give to the country a somewhat rugged aspect.

It has already been mentioned that the bed of the river, at the rapids, is of lime rock, and it does not lie at any great depth in the neighboring portions of the valley. The gypsum, before noticed, occurs in the immediate vicinity of the more important springs.

Since the springs numbered four, five six, seven and eight, in Table No. 1, (although of a superior quality,) may be taken as the type of the others, my descriptions will be confined to these alone. From these the Indians in the surrounding country are reputed to have procured their salt, at an early day, and these springs have been known from the earliest settlement of the country.

These salines occur separated only a few rods from each other, near the edge of a marsh containing about twenty acres, and their waters are discharged from small tumuli, in general appearance not unlike flattened ant

hills. They are almost completely surrounded by an exuberant growth of Chara, upon the roots and stems of which is a pulverulent deposit of lime, which is usually considerably colored by iron. The calcareous deposit has not produced any induration, and the marsh is so completely softened in the immediate vicinity of the springs, that they are only approached by using the utmost caution. Small streams of water are constantly discharged from these several springs, which uniting at a short distance, and being joined by numerous springs of fresh water, give rise to an inconsiderable but permanent brook which enters Grand river, at a distance of a little less than eighty rods. Upon examining the several springs more closely, they are found to have a variable depth of from a few inches to two or three feet, and to vary in diameter from two to three feet. When the bottom is not concealed by the loose vegetable and ferruginous matter, which is sometimes retained by the exuberant growth of plants by which these springs are surrounded, it is seen to be composed of yellow sand with comminuted shells chiefly of Lymnea, Melanea, and Pupa, portions of which are kept in constant and rapid motion by the jets of water. This yellow sand is found to be based upon, or to contain, numerous boulders of primary rocks, at a very slight depth. The water discharged is perfectly transparent, with a slightly bluish tinge, and contains sufficient carbonic acid to give it a flavor not disagreeable. In only one spring was sulphuretted hydrogen observed, and it was in that instance regarded as purely accidental. The temperature of the different springs was found to range from 48° to 51° Fah., while the springs of fresh water in the vicinity would not vary much from 52°.

The salines being situated at a lower level than most of the surrounding country, must necessarily be liable to great variation in strength and purity, according as the lateral springs are more or less increased or diminished. The sandy soil with calcareous gravel being superimposed upon lime rock, and containing small quantities of both sulphuret and carbonate of iron, must be a constant source of contamination, more particularly during, and immediately after heavy rains; and to this admixture of substances perfectly foreign, must be ascribed the great variation shown by the analysis, to exist in the mineral contents of waters taken at a distance of only a few rods from each other, and evidently having a common source.

Slight indications of saline waters are seen in the valley of Grand river near Ionia, but none were observed on that river above that point.

In ascending Maple river, saline indications were first observed in town eight north, range four west, and were seen to occur at distant intervals between that point and what may be considered as the head of navigation of the stream, not far from the line between ranges one and two west. The Maple river between these two points is a sluggish stream, having so slight a current as to resemble a succession of narrow lakes, while the alluvial shores, scarcely rising above the water, even when

lowest, are covered with a dense forest of soft maple, giving to the whole stream, at first, rather a forbidding aspect. But in passing from this valley, which varies from half a mile to two or three miles in width, we come upon a beautifully elevated and undulating country, for the most part heavily timbered, and well adapted to the purposes of agriculture. The bottom of the stream is seen to be composed of yellowish sand, as is also the alluvial deposits which bounds it on either side, with which are frequently seen boulders of primary rocks, but no rock was seen in place at any point upon the river.

In Clinton county,³ and where by a somewhat sudden turn, the river approaches near to the elevated boundary of the valley just described, saline indications of a decided character appear in the narrow marsh or alluvial bottom which bounds the river upon its northern side. Two marshes scarcely elevated above the surface of the river, and partially separated from each other occur, in the lower of which no distinct spring can be said to exist, but the water is seen at several points oozing through the sandy soil in connection with the water of the river, and although no means could be devised for preventing the constant accession of fresh water and foreign matter, it will be seen by reference to spring 14, Tables No. 1 and 2, a much more favorable result was obtained than could, under those circumstances have been anticipated. At the upper marsh an excavation had been made to a depth of a few feet, but not sufficient to prevent the free ingress of fresh water. There was a constant discharge of water in small quantities perfectly transparent, and having a temperature of 46°, and, as was also the case with that at the lower marsh, having a slight odor of sulphuretted hydrogen. The result of an examination of the water, taken under these unfavorable circumstances, is given in Tables No. 1 and 2, spring No. 13.

Since my visit to that place, I am informed, a shaft has been sunk through alternating beds of sand and coarse gravel, to a depth of about forty feet, and has been attended by a considerable increase of the saline contents of the water.⁴

³Town eight north, range four west, section fifteen.

⁴Since writing the above, I have received, through the politeness of Messrs. Parks and Warren, the proprietors of the spring, several bottles of the water taken since the shaft was sunk. One hundred cubic inches (three and a half wine pints, nearly) of the water subjected to the analysis, give the following results:

Muriate of Soda.....	143.88 grains
Muriate of lime.....	4.30
Muriate of magnesia.....	12.83
Carbonate of lime.....	6.23
Carbonate of iron.....	.09
Sulphate of lime.....	13.47
Total solid matter.....	180.80 grains

By a comparison of this analysis with that numbered 13, in Table 1, it will be seen that there has been an increase of 92.42 grains of solid matter, and 77.05 grains of salt in one hundred cubic inches of the water, in consequence of the shaft which has been sunk.

As we continue to ascend the Maple river, indications of saline waters occasionally appear, until we arrive near the source of navigation of that stream, in Gratiot county, some fifteen or twenty miles above those already

described. Here two saline marshes occur, one upon each side of, and scarcely elevated above the water of the stream at its medium height. That upon the northern side was estimated to contain between forty and fifty acres. They are similar in appearance, consisting of sand, intermixed with vegetable matter. Numerous small pools of brackish water are irregularly distributed over them, and the soil is apparently saturated through their whole extent with it; but as the looseness of the earthly material admits the free percolation of the water of the river, the results of the analysis given in Tables No. 1 and 2, springs 11 and 12, can only be looked upon as an approximation to the present strength and purity of the surface water. In a single instance, on the southern side, and where the soil becomes slightly argillaceous, the water was seen rising to the surface, and running off in small quantities; but after minute examination, I was led to infer that a large amount of water, which would under other circumstances rise to the surface, is discharged laterally through the sand and gravel, into the river. These marshes are the favorite resort of wild animals, and paths, deeply worn by deer, were seen in every direction.

On the Tittabawassa river in Midland county, numerous indications of the existence of brine springs were noticed, extending from near the mouth of Chippewa river as far as I ascended the former stream, being a few miles above the mouth of Salt river. Upon either side of the Tittabawassa, between the points noted, small pools of brackish water were observed, is also, occasionally, springs discharging a similar water in small quantities; and although an examination showed the waters to contain large quantities of the salts of lime, and occasionally of iron, they were never destitute of more or less salt.

Springs of a more decided character, occur in the vicinity of the mouth of Salt river. The first observed occurs in the stream, near the right bank of the Tittabawassa, a little below Salt river, and at the time of my visit was covered by some two to two and a half feet of water. After much labor, by partly encircling the spring with two rows of stakes, and filling around with earth, I was enabled so far to exclude the fresh water as to make an imperfect examination; but the loose nature of the material composing the bed of the stream, (it being sand and gravel,) together with the imperfect manner in which the crib surrounding the spring was constructed, did not prevent the constant accession of considerable quantities of fresh water, for which reason the result of the examination given in tables No. 1 and 2, spring No. 1, must be considered as nothing more than an approximation to the real quantify of solid matter the water would contain, were it taken under more favorable circumstances.

The spring was found by actual admeasurement, to discharge about seventy gallons of water per hour, free from all sedimentary matter, perfectly transparent, and to leave a temperature of 47°, while the temperature of the river was 51° Fah. A small quantity of some gaseous

matter was discharged at intervals of several minutes, which (although I had no means of determining to a certainty) was supposed to be carburetted hydrogen.

Nearly a mile above this spring upon the same bank, and elevated from eight to ten feet above the water of the river, is a second spring, discharging a somewhat larger quantity of water. Its general appearance and temperature are precisely the same as in that already described: but in strength it is inferior, as will be seen by reference to table No. 1, spring No. 2.

Near by, but at a greater elevation, several small springs, of brackish water, were seen issuing from the sloping bank of the river, which upon examination, were found to contain a notable quantity of salt.

At the distance of about three-fourths of a mile from the locality last mentioned, and some forty rods from Salt river, on its left bank, several brine springs, closely resembling those before described, as occurring near the rapids of Grand river, are seen to issue from a marsh of about an acre in extent. The quantity of water discharged from these springs is small, but when considered in connection with those already noticed, they become matter of considerable interest, since they serve to show that the salines are not confined to one or two springs, but are widely dispersed over a large district of country. By reference to spring No 3, Table 1 and 2, the strength and purity of one of the springs, occurring in this marsh, will be seen; but since the marsh, from which this water was taken, had been completely deluged by the rains that had fallen the night before, perhaps no greater allowance should be made for any water that was analyzed, than for this.

Brine springs are known to exist, near the mouths of Flint and Cass rivers in Saginaw county, as also in Sanilac county, but as they occur in a flat section of the country, the unfavorable season compelled me to defer examining them until some future time.

On the eastern declivity of the peninsula, in the counties of St. Clair, Macomb, Wayne, and the eastern part of Oakland, numerous indications of saline water occur; but the waters are in most instances weak and much contaminated with salts of lime, magnesia and iron. The only exceptions to this, (among those which have been examined,) will be seen by reference to springs numbered 16, 17, 18, and 19, in Tables 1 and 2.

The *quantity* of water discharged from the brine springs, (so far as examined,) is much greater upon the western and northern, than upon the eastern declivity of the peninsula.

The solution of this difference may be looked for, chiefly, from the difference in dip of the rock strata; but it is also, probably, dependent in part upon the earthy superstratum through which the waters reach the surface. Thus, while the springs enumerated, as occurring upon the western and northern declivities, rise to the surface through a sandy soil, those in the counties last mentioned, chiefly, find their way to the surface

through beds of tough clay, with occasional interstratified beds of sand and gravel, though not unfrequently, for a slight depth, the soil may be sand and loam. A little reflection upon this subject, will serve to show the manner in which the water in rising to the surface, may follow the frequently inclined direction of these beds of sand and gravel, and appear at numerous points where least resistance will be offered to its ascent, and not unfrequently at some distance from the real source of the spring. This source of perplexity, which must necessarily at times lead to erroneous conclusions, would be less liable to occur were the earthy matter superimposed upon the rock of a homogeneous character so far as texture is concerned. For this reason, as also for the others connected with the position of the rock strata, the certainty of obtaining salt water by boring, must be looked upon as less upon the eastern than upon the northern and western slopes of the peninsula.

From the earliest settlement of the country, brine springs have been known to exist in Macomb county, on Salt river, a small stream which is discharged into Lake St. Clair; and many years ago, an attempt was made to manufacture salt from one of them. But although salt was manufactured in small quantities, the water did not prove of sufficient strength to render it a source of profit, in consequence of which, the attempt was abandoned. When I visited the spot, an old gum of hollow sycamore, sunk to the depth of a few feet, near the edge of the stream, marked the spot from which the water was taken, and a few remaining bricks the site of the furnace.

No attempt appears to have been made to improve the water, any farther than by simply excluding that from the stream, the gum was so far decayed as to permit a free communication with the water of the stream, and that near the surface in the gum was to the taste apparently free from saline matter, but a bottle sunk to the bottom, about five feet, brought up the water which was the subject of the examination noted as spring No. 16, Tables 1 and 2. No estimate could be formed of the quantity discharged, but it was inferred to be inconsiderable. The temperature of the water at the bottom of the gum was found to be 50°, while that of the stream was 66° Fah.

On the opposite side of the stream, and only a few rods from that last described, a very small quantity of saline water issued from a bed of clay. That numbered 17, Tables 1 and 2, was taken from this place. Numerous similar indications occur in the immediate vicinity.

South-west from the springs last noticed, and about twelve miles distant, indications of a very similar character appear on a small stream which discharges into the middle branch of Clinton river. Here, upon a bed of clay, and scarcely elevated above the small creek which passes through it, is a tremulous marsh, in which brackish water is seen at numerous points. A shaft has been sunk here, through strata of clay, sand and gravel, to a depth of twenty-three feet, and from this the water which was the subject of the analysis, numbered 18, in

Tables 1 and 2, was procured. The water rose in the curb surrounding the well about one foot above the level of the stream, and had a temperature of 50° Fah. The quantity of water discharged is small, and does not appear to have been materially improved by the slight excavation which has been made, except so far as the curb may serve to exclude the surface water.

About four miles north from that last noticed, and in a small marsh, where there does not appear to have been any distinct spring, but simply brackish water upon the surface, a shaft has been sunk fifty feet through clay, sand and gravel. The water which was subjected to this analysis, No. 19, Tables 1 and 2, was taken from this shaft. Although the water stood at an elevation of about one foot in the tube, there did not appear to be any discharge of water from it.

In the valley of Saline river in Washtenaw county, near the village of Saline, brine springs, closely resembling those already noticed in Macomb county, have long been known. They are seen issuing from a bed of silt, superimposed on clay, at the bottom of a somewhat deep valley, and giving rise to several small pools and marshes, as also appearing in one or two instances in the shape of springs, which discharge small quantities of water. That from which the analysis numbered 15, Tables 1 and 2, was taken, appears to be of the most importance.

In a communication from an intelligent gentleman of Saline, on the subject of this spring, he says: "From the stories of Indians and reports of the old French inhabitants, both of Detroit and Monroe, we are assured, that at an early day, salt was manufactured here in considerable quantities. And from the condition in which the spring was found when we first explored the country, we have good reason to place confidence in these reports.

"When I first visited this place, in 1823, the spring was about sixteen feet deep, firmly set around with, pickets of logs, and the surrounding water excluded by an embankment. This spring is now filled up, the pickets destroyed, and the embankment trod down by the cattle, or washed away by the operation of the water."

Thus having described, perhaps somewhat more minutely than the subject under ordinary circumstances would have called for, the principal brine springs examined during the past, season, it becomes a matter of primary importance to inquire what practical conclusions can be drawn from these examinations. The question will naturally present itself under two somewhat distinct heads; first, will the water, from either of the springs examined (by the simple exclusion of the surface water,) contain sufficient salt, and is it discharged in sufficient quantity to enable a profitable manufacture to be carried on; secondly, can the water be improved in strength, purity and quantity?

The first of these questions involves so few considerations, as to admit of a ready and positive answer; for, although the strongest of our brine contains

nearly two-thirds as much salt as would be contained in an equal quantity of sea water, (taken at a distance from the coast,) and by a simple exclusion of the surface water might, undoubtedly, be obtained of a strength fully equal, and of much greater purity, from our proximity to extensive manufactures where water of a superior quality is used, and with the facilities for transportation which now exist, we would be enabled to procure our salt from abroad, at a cheaper rate than it could possibly be manufactured at home. And again, no spring, which was examined, discharges a sufficient quantity of water, to warrant the erection of works; although, in several instances, that objection might possibly be removed by a simple and very slight excavation.

In order to arrive at satisfactory conclusions, upon the second question, it may not be misplaced to institute a comparison between those springs which occur on the peninsula, and those in other sections of the United States.

The springs of New York, which are perhaps more universally, and deservedly, known than any others, and which have been to that state a source of so much wealth, are so differently situated that we can scarcely institute a satisfactory comparison, between them and our own. Emanating as they do, from the direct outcropping edge of the rock, forming a great saliferous basin, their waters possess all the requisites of purity, strength and quantity, without any other than superficial excavation. Thus, while the springs of New York are discharged directly from the edge of the saliferous rock, those of our peninsula, *so far as examined*, rise to the surface through a superincumbent mass of limestone, sandstone and shale. In this, the brine springs of the Ohio and its tributaries bear so close a resemblance that it could scarcely be mistaken by the most superficial observer; for which reason an examination of these latter springs will be of much assistance in obtaining correct notions of our own.

The brine springs of Ohio have so gradually attained their present importance by a judicious and laborious system of improvement, that their real value is less known than those of New York. Less accurate knowledge of the country, and experience, having been required to put the latter in operation.

The manufacture of salt on the tributaries of the Ohio was first commenced on the Kenhawa river, where a large "buffalo lick" was known from the earliest settlement of the country.⁵ "At this spot several hollow logs or gums were found, sunk into the gravel at the margin of the river, and probably placed there by the Indians, as they had every mark of great antiquity. In the same manner the early settlers sank gums into the bed of the river, six or eight feet deep, in which was collected a very weak water, and from which they made a little salt for their own use."

"Operations were first commenced about one hundred yards above the lick, where there was no appearance of salt water. Having selected a gum or hollow sycamore

trunk, about eighteen feet long and three feet across the cavity, they, with great labor and difficulty, sunk it into the gravel and sand, at the margin of the river, to the depth of fourteen feet, to the smooth sandstone rock, which forms the bed of the river. Here the process of boring was commenced with an auger or chisel. When they commenced, they little expected to obtain a supply of water by merely boring a hole in the rock, having never heard of such an attempt before: but in this they were agreeably disappointed. At seventeen feet they struck a vein of salt water, the first indication of which was a bubbling or

⁵For many of the facts connected with the brine springs of the Ohio, I am indebted to an able article from the pen of Dr. Hildreth, one of the geologists of that state.

hissing of gas in the hole. This water, though requiring three hundred gallons to make a bushel of salt, was then thought to be very good. The well was sunk to a depth of twenty-six feet, when they left off boring, the first of October, 1807.

When the wells were only twenty-six feet deep, they afforded water for only two furnaces; but when, in the second year, they were deepened to sixty and ninety feet, the water was sufficient to supply four furnaces of sixty kettles, holding thirty to forty gallons each, making from fifty to sixty bushels of salt, every twenty-four hours."

Since that time, for many miles, both above and below the lick mentioned, wells have been sunk, in the rock, from three hundred to five hundred feet, and the water so far improved, that only seventy are now required to make a bushel of salt, and the quantity of water discharged has been vastly increased. The amount of salt manufactured at these salines in 1834, was estimated by the inspector at one and a half millions of bushels.⁶

I am not informed as to what were the original indications of salt in the valley of the Muskingum, but borings have been made with perfect success to a depth of more than nine hundred feet. Some of the wells at: these salines, are sunk more than three hundred feet below the present surface of the ocean, and the salt rocks, generally, through the valley of the Ohio, lie below tide water. The excavations finally terminate in a white sand rock, and in which the only strong and lasting supply of brine is found, it is porous and full of cavities, affording a free circulation to the water; the auger sometimes dropping several inches, at once, into these cavities.

The water from which the analysis shown in the tables numbered three and four, spring No. 5, was made, was taken from the lower salt wells, of the Muskingum, where borings had been carried to a depth of about nine hundred feet.⁷ Fifty gallons

⁶The salt which was originally manufactured on the Ohio, was of an inferior quality, but the manufacture has now been so far improved, that an article is furnished equal to any in our country.

⁷The sulphate and carbonate of lime are not given in the analysis.

only are required for the manufacture of a bushel of salt, and the water is represented to be superior to any other yet brought into use, in the valley. By comparison of this analysis with those numbered one, two, three, and four, in the same tables, it will be seen that it does not suffer materially by the comparison.

Salt wells, similarly situated, and from which large quantities of salt are manufactured, are sunk at numerous points in the valley of the Ohio and its tributaries.

The general resemblance between the geology of the valley of the Ohio and that of our own state, has already been noticed; but from facts which it is unnecessary to detail at this time, I am led to infer that the rock formations of our saliferous district, are somewhat lower in the series than those occurring at the principal salines on the Ohio. If this inference is correctly drawn, it would follow that the salt bearing rock would lie nearer the surface here, than at the points mentioned in Ohio, and that the borings would not be required to be carried to so great a depth in our own as in that state.

In pursuing this subject, we may arrive at some general conclusions by a comparison of the *surface* waters subjected to analysis and of which the results are given in tables, numbered one and two, with that which was first used on the Kenhawa, and of which a general description has been given. It has already been stated that the making of salt was commenced on the Kenhawa when the borings had been carried, *in the rock*, to a depth of twenty-six feet, the gum occupying a space of fourteen feet of superincumbent sand and gravel, and that three hundred gallons were required to manufacture a bushel of salt. If fifty-six pounds be taken as the standard weight of a bushel of salt,⁸ it will be found, by calculation, that it will require of the water numbered 1, in Table I, and which it will be recollected was taken under most unfavorable circumstances, three hundred and thirty-seven gallons, nearly, to produce that

⁸The legal weight of a bushel of salt in the state of New York, by the act of 1797; but the measured bushel will greatly exceed this.

quantity. Now since this water was taken, where the water of the river was from two to two and a half feet deep, and under such circumstances that the free access of large quantities of fresh water could not be prevented, I think it will be safe to say, that the waters of this spring are quite equal to that first used on the Kenhawa, even after the excavation of forty feet, which had been made at the last mentioned salines.

The importance of this comparison is much enhanced by the striking similarity of circumstances under which the salines of our own state and those of Ohio appear; but aside from these comparisons, when the geological relations of those portions of our state in which these springs occur are considered, we cannot fail to look upon them as capable of being vastly improved, and as being subjects of vital importance to the state. It will be recollected that at the spring mentioned on the Kenhawa, where originally three hundred gallons of the

water were required for the manufacture of a bushel of salt, seventy gallons are now sufficient to produce that quantity. As on the Ohio and its tributaries, shafts are required to be sunk to unequal depths, and water of very unequal strength and purity is obtained, so in our own state we may look for great variation in this respect.

We can only hope to obtain a permanent supply of brine, of sufficient strength, from the springs of our state by sinking shafts through the rocky strata, until the salt bearing rock be reached, be the distance more or less. If judiciously conducted, a reasonable doubt could scarcely be entertained but this, would be attended with success, and that our springs might be made to produce a supply of salt more than sufficient for the wants of the slate. But if must not be imagined that. this will be unattended by difficulties; for after the most minute examinations of our salt region have been made, and those points which offer the most reasonable prospects of success selected for the commencement of operations, no little skill, labor and expense will be required to sink such shafts as may be of any permanent benefit. I allude to this subject the more particularly, since excavations are not unfrequently commenced by individuals, without “counting cost”, under the delusive expectation that a simple superficial excavation is all that is required. The result is a failure to attain the object sought, and a distrust of the whole matter. Since it is not yet known to what depths the boring will require to be carried at any of the points in the salt district, and the sinking of a shaft to any great depth being attended with considerable expense, individuals should enter upon these experiments, (for they must be looked upon in this light,) with extreme caution. When the depths to which shafts must be sunk are fully determined, the expense and probability of success may be calculated with considerable certainty; but it is not, by any means, to be presumed that water will be procured of equal strength and purity at all points which have been enumerated, or that operations might be commenced at all those points with prospects of success.

Comparatively little is yet known of the minute geology of our salt district, or even of its geographical extent, and since we may reasonably hope to find those portions, yet to be examined, rich in brine springs, the policy of immediately commencing the improvement of those which bid most fair to produce a strong brine of sufficient quantities, demands serious consideration. While it is of vital importance to the state that operations be commenced with the least possible delay, it; is also desirable that the very best points should be first selected, and that the subject should be as perfectly understood as circumstances will permit; but should it be deemed advisable to take the steps preparatory to this improvement, I do not hesitate to give it as an opinion, drawn from a careful examination of the subject, that points may be selected where these operations may be conducted with the strongest prospects of eventual success.

In regard to the adoption of a policy for the general management of our state salines, much information may be gained by an examination of that so widely adopted and pursued by the state of New York. The present time is not a suitable one, to enter upon a consideration of this subject, but I cannot omit referring to the fact that that state has adopted the policy of furnishing the water (fixtures being erected at her own expense,) to those to whom the adjacent grounds are leased, and of taxing the salt manufactured. The accompanying schedule will serve to show the amount of salt manufactured in that state, and also the revenue derived, after deducting the expense of superintendence, &c, for the years from 1831 to 1835, inclusive:

	Bushels of salt.	Amount of duty.
⁹ 1831,	1,441,559	\$ 122,769.86
1832,	1,652,986	179,096.46
1833,	1,838,646	227,860.05
¹⁰ 1834,	1,943,250	160,782.98
1835,	2,222,694	118,364.62

The course adopted by that state is conceived to prevent any great monopoly in the manufacture of salt, as also to prevent any great fluctuation in the price of the article, while it insures the largest possible revenue to the state.

Whatever course may be determined upon with regard to those springs which have already been or may be hereafter selected for our state, it is to be hoped that she will not, under any circumstances, lease or in any manner encumber the more important of them in an unimproved condition.

⁹Tax 12½ cents per bushel.

¹⁰Tax reduced to 6 cents a bushel.

TABLE NO. 1
Showing the solid contents of one hundred cubic inches of the different Saline Waters of Michigan, so far as examined.¹

	No. 1	No. 2	No. 3	No. 4	No. 5
Location	Tittabawassee riv. 80 rods below Salt R., Midland co. T. 15 N., R. 1 W., sec. 25.	Tittabawassee R. half mile above Salt R., Midland co. T. 15 N., R. 1 W., sec. 24.	Mouth of Salt R. of the Tittabawassee, Midland co. T. 15 N., R. 1 W., sec. 25.	Kent co., three miles below Grand Rapids. T. 6 N., R. 12 W., sec. 3.	Kent co., three miles below Grand Rapids. T. 6 N., R. 12 W., sec. 3.
How owned	State of Mich.	State of Mich.	State of Mich.	State of Mich.	State of Mich.
Temp. of the spring	47° Fah.	47° Fah.	50° Fah.	48° Fah.	52° Fah.
Specific gravity	1.0132	1.0103	1.0124		
Muriate of soda	413.36 grains	340.47 grains	390.07 grains	147.76 grains	159.77 grains
Muriate of lime	23.88 "	8.37 "	20.78 "	17.06 "	13.53 "
Muriate of magnesia	31.90 "	12.05 "	26.86 "	18.05 "	16.01 "
Carbonate of lime	3.93 "	6.84 "	1.91 "	1.76 "	12.72 "
Sulphate of lime	19.35 "	23.68 "	27.55 "	22.34 "	17.09 "
Carbonate of iron	.00 "	.00 "	.00 "	.10 "	.00 "
Solid matter	492.42 "	391.41 "	467.17 "	207.07 "	212.12 "

¹Equal to three and a half wine pints, nearly.

TABLE NO. 1.—(Continued)

Location	No. 6	No. 7	No. 8	No. 9	No. 10
	Kent co., three miles below Grand Rapids	Kent county, near Grand Rapids	Kent county, near Grand Rapids	Kent county, near Grand Rapids	Kent co., Grand Rapids
	T. 6 N., R. 12 W., sec. 3.	T. 6 N., R. 12 W., sec. 3.	T. 6 N., R. 12 W., sec. 3.	T. 6 N., R. 12 W., sec. 10.	T. 6 N., R. 12 W., North side Grand River.
How owned	State of Mich.	State of Mich.	State of Mich.	Private Prop'ty	State of Mich.
Temp. of the spring.....	48° Fah.	48° Fah.	48° Fah.	51° Fah.	50° Fah.
Specific gravity.....	1.0091	1.0079	1.0050		
Muriate of soda.....	187.40 grains	135.12 grains	87.99 grains	179.84 grains	59.47 grains
Muriate of lime.....	22.06 "	14.52 "	13. "	29.24 "	5.05 "
Muriate of magnesia.....	13.74 "	23.06 "	13.55 "	3.72 "	6.83 "
Carbonate of lime.....	7.65 "	3.33 "	5.72 "	2.38 "	9.76 "
Sulphate of lime.....	24.20 "	25.97 "	16.10 "	12.09 "	19.84 "
Carbonate of iron.....	.00 "	.00 "	.00 "	.00 "	.05 "
Silicic acid.....					
Solid matter.....	255.05 "	202.00 "	136.36 "	227.27 "	101.00 "

TABLE NO. 1.—(Continued)

Location	No. 11	No. 12	No. 13	No. 14	No. 15
	Gratiot county, Source of navigation of Maple river, N. side.	Gratiot county, Source of navigation of Maple river, S. side.	Clinton county, Maple river, Clinton salt works, lower marsh.	Clinton county, Clinton salt works, lower marsh.	Washtenaw Co. Saline.
	T. 9 N., R. 2 W., sec. 20.	T. 9 N., R. 2 W., sec. 27.	T. 8 N., R. 4 W., section 15.	T. 8 N., R. 4 W., section 15.	T. 4 S., R. 5 E., section 12.
How owned	Private Prop'ty	Private Prop'ty	Private Prop'ty	Private Prop'ty	U. S. Reserv'tn
Temp. of the spring.....	51° Fah.		46° Fah.		
Specific gravity.....	1.0028	1.0053	1.0025	1.0026	1.0052
Muriate of soda.....	67.56 grains	97.76 grains	66.83 grains	67.76 grains	113.80 grains
Muriate of lime.....	4.55 "	3.21 "	1.29 "	1.22 "	9.19 "
Muriate of magnesia.....	18.22 "	14.89 "	5.16 "	5.54 "	10.81 "
Carbonate of lime.....	3.43 "	9.41 "	7.40 "	8.45 "	6.95 "
Carbonate of iron.....	.05 "	.07 "	.08 "	.04 "	.18 "
Sulphate of lime.....	8.43 "	20.30 "	7.62 "	7.13 "	1.48 "
Vegetable matter ¹²	1.29 "	6.06 "	.00 "	.54 "	.00 "
Silicious and aluminous matter.....	.00 "	.00 "	.00 "	.22 "	.00 "
Solid matter.....	103.53 "	151.50 "	88.38 "	90.90 "	141.41 "

¹²Foreign.

TABLE NO. 1.—(Continued)

Location	No. 16	No. 17	No. 18	No. 19	No. 20
	Macomb county, Salt river of Lake St. Clair.	Macomb county, Salt river of Lake St. Clair.	Macomb Co., Frankfort.	Macomb county.	Wayne county.
	T. 3 N., R. 14 E., section 2 & 11.	T. 3 N., R. 14 E., section line between 2 & 11.	T. 3 N., R. 13 E., Sec. 31.	T. 3 N., R. 12 E., Sec. 13.	T. 2 S., R. 9 E., section 2.
How owned	State of Mich.	State of Mich.	Private Prop'ty	Private Prop'ty	Private Prop'ty
Temperature.....	50° Fah.	52° Fah.	49° Fah.	58° Fah.	
Specific gravity.....	1.0057		1.0054		
Muriate of soda.....	139.06 grains	123.58 grains	125.61 grains	89.18 grains	38.47 grains
Muriate of lime.....	3.35 "	3.02 "	5.72 "	2.75 "	7.07 "
Muriate of magnesia.....	9.29 "	10.83 "	18.37 "	10.81 "	1.57 "
Carbonate of lime.....	3.53 "	5.41 "	.75 "	2.75 "	1.64 "
Sulphate of lime.....	3.72 "	3.32 "	.30 "	.47 "	.25 "
Carbonate of iron.....	.14 "	.29 "	.60 "	.10 "	.05 "
Vegetable matter ¹³	.00 "	.00 "	.15 "	.00 "	.55 "
Silicic acid.....					
Solid matter.....	159.09 "	146.46 "	151.50 "	106.06 "	50.50 "

¹³Foreign.TABLE NO. 2
Showing the constituents of one hundred grains of solid contents.

No. of the spring ¹⁴	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Muriate of soda.....	83.94	86.98	83.49	71.33	72.01	73.47	66.88	64.51	79.12	38.80	65.23	64.32	75.60	74.50	80.40	87.40	84.36	82.89	84.05	76.13			
Muriate of lime.....	4.85	2.14	4.45	8.24	6.38	8.05	7.19	9.54	12.87	5.00	4.40	2.12	1.45	1.35	6.50	2.11	2.07	3.78	2.60	15.80			
Muriate of magnesia.....	6.48	3.08	5.75	8.72	7.55	5.30	11.42	0.94	1.64	6.77	17.60	9.83	5.84	6.10	7.05	5.84	7.40	12.13	10.20	3.12			
Carbonate of lime.....	.80	1.75	.41	.85	6.00	3.00	1.65	4.20	1.05	9.67	3.32	6.08	8.38	9.30	4.21	2.22	3.70	.50	2.60	3.25			
Sulphate of lime.....	3.92	6.05	5.90	10.79	8.06	9.49	12.86	11.81	5.32	19.65	8.15	13.40	8.63	7.85	1.05	2.34	2.27	.20	.45	.50			
Carbonate of iron.....				.05						.05	.05	.05	.10	.05	.13	.09	.20	.40	.10	.10			
Vegetable matter ¹⁵										1.25	4.00			.60				.10		1.10			
Silicious and aluminous matter.....														.25									
Total.....	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100			

¹⁴For the location of the several springs, see corresponding numbers in Table No. 1.¹⁵Foreign.

TABLE NO. 3

Showing the solid contents of one hundred cubic inches¹⁶ of different foreign saline waters.¹⁷

Location	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
	Galen brine spring, New York.	Montezuma, New York.	Montezuma, N. Y., Deep well.	Onondaga, New York.	Muskingum, Ohio, Lower Salt wells.	Sea water ¹⁸ , middle of N. Atlantic.
Specific gravity.....	1.0544	1.0161		1.0958		
Muriate of soda.....	Grains 2246.05	Grains 551.52	Grains 2016.33	Grains 3780.34	Grains 3419.78	Grains 671.70
Muriate of lime.....	13.15	21.07	40.75	23.12	197.10	50.24
Muriate of magnesia.....	7.90	11.70	9.30	5.78	263.06	250.24
Carbonate of lime.....	2.63	2.24	.60	5.78		
Sulphate of lime.....	55.26	36.30	118.20	106.93		
Sulphate of soda.....						117.71
Silicic acid.....	1.30				Carb. of iron und.	
Solid matter.....	2326.29	622.93	2185.18	3921.85	3879.94	1089.89

¹⁶Three and a half wine pints nearly.¹⁷The analysis of the waters from the state of New York, is given upon the authority of the late Dr. Chilton. See Stillman's Journal, Vol. 2.¹⁸Upon the authority of Dr. Marcet.

TABLE NO. 4

Showing the constituents of one hundred grains of the solid contents given in Table No. 3.

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
Muriate of soda.....	96.56	88.53	92.23	96.39	88.14	61.63
Muriate of lime.....	.56	3.38	1.92	.59	5.08	4.61
Muriate of magnesia.....	.34	1.88	.43	.15	6.78	22.06
Carbonate of lime.....	.11	.38	.02	.15		
Sulphate of lime.....	2.38	5.83	5.40	2.72		
Sulphate of soda.....						10.80
Silicic acid.....	.05					
Total.....	100	100	100	100	100	100

Numbers correspond with those in Table No. 3.

CLAY

Marly clay, of rather a coarse character, is distributed quite universally through the different counties of the state. These deposits of clay are frequently associated with pebbles of lime, which render them unfit for the manufacture of bricks; but since these pebbles in many instances assume a stratified and alternating position, the clay may, with a little care, be obtained nearly or quite free from them.

In Washtenaw county, near Ann Arbor, a bed has been opened, and the clay used in the manufacture of earthen ware, with very good success.

Near the middle branch of the Clinton river, in Macomb county, a bed of clay occurs, of superior quality, both in fineness and texture and freedom from calcareous matter, and is better fitted for the manufacture of pottery, than any I have seen in our state.¹⁹

SAND

Nearly the whole western coast of the peninsula, immediately upon Lake Michigan, is bordered by a succession of sand dunes or hills of loose sand, not unfrequently attaining a considerable altitude. These hills are in many places free from all vegetation, while in others they are covered by a growth of dwarf pines and cedar; and more rarely by other timber. When free from vegetation, the hills are constantly undergoing change by the action of the winds, and sand gradually encroaching upon the land. These movable sands, which are now unnoticed, may hereafter become matters of serious inconvenience, more particularly in those portions where the timber may be heedlessly removed. These dunes are not unfrequently composed of sand tolerably well adapted to the manufacture of glass, though its value is frequently much impaired by the presence of particles of dark colored minerals.

¹⁰My attention was called to this by Isaac W. Averill, Esq. who exposed the bed while conducting operations with a view of improving the salt springs of Macomb county.

Five to six miles northwest of Monroe, the disintegration of a siliceous limerock has given rise to a bed of sand of a very superior quality, and of considerable extent. The sand is of a snowy whiteness, formed of exceedingly small and angular grains, and is nearly pure quartz. These qualities render it better adapted to the manufacture of glass, than any other that has been seen in the state.

MARL

Our state abounds in deposits of marl, composed of recent shells, and in some few instances it has been used in the manufacture of lime. Inexhaustible beds exist in the northern part of St. Joseph and the adjoining counties, and as a manure will prove invaluable to the agricultural interests of those portions of our state. Several extensive beds were seen in Jackson county, as also in Monroe county, near the city of Monroe.

The great value of these beds of marl to the agricultural interests of our state is by no means appreciated, and its value as a manure appears to be but little understood by those to whom the information is of the utmost practical importance. My mind was called more emphatically to this subject from having seen, in the early part of the season, one of our farmers making use of plaster (transported from a distance and at great expense,) upon the sandy portions of his lands, while the marl, in his immediate neighborhood, and which would have answered his purpose nearly equally well, he wholly neglected.

BOG IRON ORE

Deposites of bog iron ore were seen at numerous points on the peninsula, but it exists in so small quantities at most of the places examined as to be of little value.

Near the village of Kalamazoo, a somewhat extensive bed of this ore was seen, which it is conceived may prove of some practical importance. It was cursorily examined over an extent of perhaps forty to fifty acres, and was found to vary from a few inches to three to four feet in thickness. Three specimens of the ore subjected to analysis, gave the following mean result for one hundred grains.

Peroxide of iron,	78.45 grains.
Silica and alumina,	7.95 "
Carbonate of lime,	1.10 "
Water,	12.50 "
	100.00 "

At a distance of six or seven miles northwest from Detroit, and in the county of Wayne, bog ore occurs at intervals, over an extent of several hundred acres, but I have not been able to examine it with sufficient care to determine its extent; I think, however, there can be little

doubt but it exists in sufficient quantities to be turned to practical account.

Near the mouth of Grand river, in Ottawa county, is a somewhat limited bed of bog ore, but the specimens subjected to examination, were found to contain too many impurities to be of much if any value.

MINERAL SPRINGS

Several springs charged with sulphuretted hydrogen, occur near Monroe, in Monroe county, and the waters being also charged with carbonate of lime, give rise to considerably elevated mounds of calcareous tufa, and from which the water is usually discharged in a constant stream. A spring of much larger size occurs in the marsh, near the town of Havre, in that county. This latter spring, which has a circumference of a hundred and fifty feet, and a depth of thirty-five feet, discharges a sufficient quantity of water, were it favorably situated, to turn a mill. The quantity of sulphuretted hydrogen contained by the spring, as also those near the city of Monroe, though not great, is sufficient to characterize them, and to render them of considerable value in the treatment, more particularly of cutaneous diseases.

The departments of Botany and Zoology, under the more immediate direction of Dr. Abraham Sager, principal assistant, have received due attention.

Extensive collections of plants have been made, and the preparatory steps taken towards arranging a Flora of the state.

The season was considerably advanced before we were enabled to turn our attention to the zoology of the state, yet several hundred specimens, mostly in the departments of Ornithology and Herpetology have been collected, and will furnish much aid in studying these departments of natural history.

Topographical maps of the several counties of the state, reduced from the original United States surveys, are in as rapid progress as circumstances will permit, and we hope during the progress of the geological survey to be enabled to render them minutely accurate.

In order to place our state university in such a condition that it may hold a high rank among the institutions of our country, it is very important that the parent institution, as well as its branches, be amply supplied with a collection of all that appertains to the natural history of our own state, at least. This may be accomplished during the continuance of the geological survey which is in progress, but not without much labor and expense. Since the making these collections would so far cripple our operations in the other departments, in consequence of the inadequacy of the appropriation, it remains to be decided whether these departments, which are being carried forward with so much zeal by the states around us, shall be continued as commenced, or shall be abandoned to a bare catalogue.

In conclusion, it may not be misplaced to allude to the numerous difficulties to which we are subjected, in

carrying forward the investigations before us. Our state is in its infancy, and although it is rapidly populating with an intelligent and industrious people, they are at present (with the exception of those in a very few of the counties,) thinly spread over a large district of country. The numerous difficulties and privations by which they are surrounded, have prevented much attention even to the general character of the country around them. For this reason, the amount of local information, which can be obtained, is small and exceedingly liable to error. We have on the peninsula no mountain chains, no lofty mural walls, or deep valleys, where the actual superposition of the rocks can be seen at a glance; our quarries of stone have scarcely been opened, all which, subject us to many difficulties. In addition to all this, those portions to which the immediate interests of the state call our attention, have no avenues by which they can be reached, excepting by the streams or the trails of the Indians. The ascent of a rapid stream by canoe, the only feasible mode of travelling, and the only manner by which examinations can be satisfactorily conducted, is attended by fatigue, labor and hardships of the most severe kind. Wading the streams by day, and annoyed by mosquitoes at night, separated for weeks together from all society, were it not that the mind is constantly occupied in the contemplation of objects which, from their symmetry and beauty, furnish a constant mental feast, there would be nothing which could possibly compensate for the hardships endured.

These difficulties in carrying forward the survey of our state, may be conceived, but can hardly be appreciated by those who have never had them to encounter; and when it is taken into consideration that the appropriation for the past year has not been sufficient to cover even the *traveling expenses* of those engaged in these arduous duties, it will be seen that the obstacles which we have been called upon to encounter, have been of the most perplexing kind: and I trust that however little may have been accomplished or expected from the examinations of a single season, conducted under so unfavorable circumstances, I can safely say, that no one connected with the survey has failed to use his utmost endeavors to forward the objects in view.

I have the honor to be, sir,
Your obedient servant,

DOUGLASS HOUGHTON.

*Geological Department of State,
Detroit, Jan. 22, 1838.*

GEOLOGICAL CORPS

DOUGLASS HOUGHTON, Geologist.

ABRAHAM SAGER, Princip. Ass't. in charge of Bot'l. arid Zoo'l. Dep's.

S. W. HIGGINS, Topographer and Drafts'n.

COLUMBUS C. DOUGLASS, Sub. Ass't.

BELA HUBBARD, Sub. Ass't.

WILLIAM P. SMITH, Sub. Ass't. in charge of Mechan'l Zoo'l.

APPENDIX TO THE REPORT OF THE STATE GEOLOGIST

In compliance with an act of the legislature of this state, authorizing a geological survey, a general reconnoissance was commenced and continued during the past season. Those engaged in carrying it forward, will, with the opening of the spring, commence a more detailed examination.

In consequence of the great area of the territory, it is impossible for them to examine it as much in detail, in the time specified, as is desirable in order to develop fully the mineral resources of the state. With a view to facilitate the progress to the survey, the following queries are proposed to the people of the state, with a hope that every one who is interested, either in having the mineral wealth of his estate known, or in advancing geology and its kindred sciences, will contribute such aid as may be in his power. The local knowledge of individuals may be of great importance in expediting the survey.

It is suggested to the proprietors of lands, that they forward to Detroit specimens of minerals, rocks, marls, peats, petrifications, and soils, to illustrate the nature of the materials of their lands.—The mineral wealth, as well as the agricultural value of an estate, should be known before a proper estimate of its worth can be formed. Our land owners and farmers are more immediately interested in the geological survey than any other class of the community, and they will appreciate the importance of having the mineral products of their estates represented in the state cabinet, as also in that of the university.

ROCKS

1. Have *ledges* of rocks been observed in your vicinity?
2. Are the ledges on the sides, or on the summits of hills; on the shore or in the valleys?
3. Is the direction of the ledges parallel to the hills, or what is the direction of each by the compass?
4. Are the rocks divided into regular layers?
5. Towards what point of the compass do these layers pitch with the greatest declivity?
6. Are there veins of other rocks traversing those before mentioned?
7. In what direction do these veins cut through the rock, and are they perpendicular or inclined?
8. Have any ores been found, either diffused through the mass of rock, or in separate beds or veins?
9. Have any useful, or curious, or rare minerals been found in the rocks or veins?

10. What names are commonly used to designate the rocks, ores, minerals, &c. referred to?
11. Have they been applied to any useful purposes?
12. Where ledges of rocks have been recently uncovered by excavations, are the surfaces smooth, as if by the action of running water, or with pot-holes, such as are seen at many waterfalls ?
13. Do any of these surfaces show grooves and scratches, as if hard masses had been dragged over them?
14. Are shells or petrifications of any kind, or the remains of plants, found in any of the rocks, and in what kinds of rocks do they occur?
15. Are slate, limestone, sandstone, &c. found in your vicinity?
16. When rocks of different kinds come in contact, is there any change in their characters near their junction?
17. Do the rocks show distinct lines of demarkation, or do they gradually blend into each other?

SANDS

1. Are there any beds of fine white sand, which contains no black, or red, or yellow grains?
2. Are there any beds of red or black sand washed upon the beach?
3. Are these sands abundant enough for the purposes of commerce?
4. Is the general surface of the country, sand, clay, or loam?
5. Do these substances form alternating regular layers?
6. Does the sand on the surface of the country drift by the wind?
7. Is the sand in any locality hardened into a sandstone?
8. Is sand washed along shore by currents, and deposited in new situations?
9. Where cliffs have been undermined, and have tumbled down, what kinds of earth, or rock, were exposed?
10. Were they arranged in layers?
11. Were bones, shells, bits of wood, or lignite imbedded in them?

CLAYS

1. Are any beds of clay known in the vicinity?
2. Are the beds extensive, or of small magnitude?
3. At what depth do they lie below the surface?
4. What is the thickness of the bed or beds?
5. What materials were observed in digging down to them?

6. Are the clays in thin layers which easily separate?
7. Do the beds of clay alternate with beds of sand and gravel?
8. Are the layers of the beds of the clay, gravel, or sand, inclined, or are they level or undulating?
9. What is the color of the clay?
10. Is it mixed with sand or is it free of grit?
11. When mixed with water, does it form a tough and plastic mass, or does it crumble to a pap?
12. When heated red hot, does it become red, brown, or white?
13. To what useful purposes has it been applied?
14. Has it been tried as a manure on sandy soils?
15. Do balls, or flat rounded masses of a hard earthly mineral occur in the clay?
16. Are they arranged, in layers parallel to the layers of clay?
17. Are they of the same material as the clay?

WATER, SPRINGS, &C.

1. At what depth is the water obtained?
2. What strata are passed through before reaching it?
3. Does clay, loam, or rock occur at the level of the springs?
4. Is the water "hard," or "soft," as these terms are usually employed when speaking of water?
5. Did the water percolate gradually into the well when first dug, or did it come in a strong stream?
6. Have shell, bone, coal, pieces of blackened or common wood, beds of marl or of clay, been observed in digging wells or cellars, or by the caving down of cliffs and banks on the shore or by the side of streams?
7. Have mineral springs been discovered?
8. What is their taste,—sulphurous, inky, pungent or saline?
9. Is there any sensible odor to the water? What is it like?
10. Is the water sparkling like bottled beer, and does air bubble up from the fountain?
11. Is there a redish or yellowish deposit where the waters flow off, or in the adjacent meadows or ponds, or is there a similar oily scum on the water?
12. Do sticks, mosses, leaves, &c. become incrustated with a hard stony coat, or is there a grey or yellowish rock forming near the spring, by deposit from its waters?
13. Has the water been used in the cure of any diseases?

14. Is the spring copious?
15. Do large springs burst from the earth?
16. What is the temperature of the springs?
17. Are there brine springs in your neighborhood?
18. Are there extensive "deer licks" in the vicinity?

SUBTERRANEAN FORESTS

1. In digging wells or other excavations, or by caving down of banks or cliffs of earth, have any traces of trees, wood, bark, leaves, nuts, or seeds, been discovered buried deep in the earth, or at a greater depth than we would expect to find them from the effect of present causes?
2. Were these remains in their natural state, or were they converted to stone, or to a black substance like charcoal?
3. If the latter, has the substance been used for fuel?
4. At what depth does it lie? and in what earth, [sand or clay]?
5. What strata were observed above and below?
6. Do the trees stand erect?
7. Do they lie all in one direction?
8. Do you suppose drifting sands, washed by water, or other causes, have buried them?
9. What is the direction of this lignite with regard to the water courses, and its relative height or depth above or below them?
10. Have shells or bones been found in the layer containing the lignite, or in the adjacent strata?
11. What is the color of the adjacent clay, sand, or gravel?
12. Have masses of a yellow metallic stone [pyrites] been found in the adjacent clay?

PEAT BOGS AND SHELL MARL

1. Are there inland meadows or swamps in your vicinity that tremble when one walks over them?
2. Are they covered by moss and cranberry vines?
3. To what depth can a pole be thrust down?
4. How many are there, and of what extent, in your vicinity?
5. Does the peat, or black tremulous mud, rest on sand, gravel, rock, or a white clayey marl, containing small shells?
6. Has the peat been used for fuel, or for burning lime or bricks?
7. Has the peat or shell marl been used as a manure?

BOG IRON ORE

1. Are there any ponds or marshes in the vicinity, in the bottom of which is a soft, spongy, yellowish brown stone or gravel?
2. Does it originate from mineral springs or from stagnant waters?

DRAINAGE OF LAKES

1. Are there any evidences of the lakes in your vicinity having once occupied a higher level than they do at present?
2. Does this evidence consist in elevated beaches, or the cutting down of their outlets, or both these combined?
3. Are there valleys which seem to have been once lakes, and what evidence is there on this point?
4. Are there regular stratified deposits of clay, sand, gravel, &c. in the valleys?
5. Are organized remains of plants, or animals found in them?
6. In the gorges at the outlets of lakes, or along the courses of the streams which flow from them, are there marks to show the wearing action of water much above its present level?
7. Are there deep defiles through the country, through which water flows, or seems to have once flowed?
8. What is the nature of the strata of these defiles, and generally, of the country at any of the particular localities to which you may have referred?

RIVERS

1. Are the rivers and streams in your vicinity, deepening their channels, or raising their beds, by the deposits of alluvial matter?
2. Do you know of instances of lateral streams bringing in such quantities of alluvial matter, and of so coarse texture, that the larger stream is unable to sweep it away, and causes the formation of lakes in the valleys above?
3. Are rivers or smaller streams lost by sinking in the ground?

ROLLED MASSES, PEBBLES, AND ERRATIC BLOCKS

1. Are there any large rounded, or irregular masses of rock found in your neighborhood?
2. Do they occur mingled with gravel and pebbles, or are they isolated on the surface, or imbedded in the earth?
3. Do they crumble away by the effect of the weather?
4. Are they smooth, or nearly so, like pebbles?
5. Are there scratches on them in one or more directions?

6. Are there ridges on them in one direction only from the harder points of the stone, and parallel to the scratches?
7. Are there rounded masses all of one kind of rock?
8. What rock or rocks constitute these masses or pebbles?
9. Are they similar to ledges of rock known to you, either in the vicinity, or elsewhere?

AGRICULTURE, MANURES, &C.

1. What manures are employed on the soil?
2. Has a rotation of manures been tried?
3. What rotation of crops is employed on the light, and what on the heavy soils?
4. Have changes of rotations of crops been tried, and with what success?
5. How are your manures prepared?
6. Does lime, or ashes, or marl, or gypsum, enter into the composition of the compost heaps?
7. Has salt, or nitre, or copperas, been tried in small quantity on the land as a manure?
8. Has limestone, or any other rock been ground and used as a manure?
9. Has peat been rotted and tried as a manure?
10. Have clay soils been dressed with sand, sand soils with clay, and marshes with gravel or sand?
11. Are there caves, land-slips, sink-holes, (formed by the sinking down of small tracts,) rocking-stones, natural icehouses, or curious, or interesting natural phenomena of any kind that have come under your observation, not embraced in the foregoing queries?

SUGGESTIONS FOR COLLECTING GEOLOGICAL SPECIMENS, AND OBSERVING GEOLOGICAL PHENOMENA

1. Collect specimens of all those rocks, earths, sands, clays, peats, marls and lignites observed, and note their relative quantities, whether abundant or rare.
2. If any of these materials be applied to useful purposes, note their particular applications, the places where used, the amount of industry and capital employed, and the articles produced.
3. If they be not used, note whether, in your opinion, any or all may be usefully employed, and for what; and what facilities the adjacent country may present for manufacture or transport, or from its contiguity to a market.
4. Note the order of superposition of the different beds of rock, earth, sand, clay, &c. with regard to each other; the amount and direction of the dip; whether dislocations or faults, dykes, veins, &c. traverse the strata, and the direction and inclination of these dislocations, veins,

dykes, &c. Sketches should generally be made to illustrate the thickness and relative position of strata, particularly if the strata be contorted.

5. Note if any traces of organic existence be observable in any of the materials mentioned, whether animal or vegetable, either as impressions, casts, or petrifications: whether imbedded or loose in these materials.
6. The excavations in mining, quarrying, cutting canals, railroads, &c. offer particular facilities for observing the phenomena of stratification, of the superposition of rocks, &c.
7. In boring for coal, salt springs, &c. it is hoped that specimens of the rock, clay and sand, of every foot in depth passed through will be preserved, and accurate minutes made in writing on the spot.
8. In deep wells, mines, and salt springs, the temperature of the water should be measured, as it issues from the strata.
9. The temperature of copious springs should be measured, noting if it be different at different seasons of the year.
10. Specimens to illustrate the various kinds of minerals, rocks, clays, marls, peats, &c. should generally be about two by threes or three by four inches, and one to two inches thick, of a rectangular form and free from hammer marks and weathering.
11. Fossils, or rock specimens containing fossils, must be taken of such a size as may be necessary to illustrate to the best advantage; still, where fossils are imbedded in stone much taste may be displayed in getting them out in a good shape, and free from hammer marks.
12. The occurrence of bones, tusks, teeth, shells, &c. where wells, cellars, canals, roads, &c. have caused excavations, should be particularly noted.
13. Every specimen from the same *stratum* at any *one locality* should be marked with a similar mark, and each specimen to correspond in its mark with that of the stratum from which it was taken, or the sketch or section.
14. Each specimen should be wrapped securely in a separate paper, and packed tightly in a box, so that it may not be rubbed and injured by transportation from one part of the country to another.
15. It is important that rock specimens and fossil remains should be taken from ledges of rock in their natural position and not from loose masses.
16. Soils should be taken from a depth of about eight inches below the surface.
17. The name of the county, township, section, and part of section should be distinctly marked on a small label, which should be enclosed in the wrapper of the specimen, and all information regarding the rocks, sand, clay, brine springs, &c. should designate the precise section on which they occur.

18. Specimens of quadrupeds, birds, fishes, reptiles, &c. are also solicited.

19. All communications, specimens, &c. touching the above subject, may be directed to the undersigned at Detroit.

DOUGLASS HOUGHTON.

Geological Department of State,
Detroit, Jan. 22, 1838.

Facsimile of Handwriting.

*Geological Dept of State
Detroit Jan 22. 1838*

*John R. Hunt Esq
Asst Comm. House Del. Sup.*

Sir,

In compliance with the requisitions of your communication of March 29th I beg leave to transmit to you, paying answer to the questions therein propounded.

I made a very general examination of the geology of the country immediately bordering upon the Detroit River, through nearly the whole course of that stream, during the past summer.

1. Delineation of coal in this, in the sand, would be a day at numerous points upon the bank of the river, but more particularly in the immediate vicinity of Cornua. At this latter place coal, embedded in a light clay, was seen, but under such circumstances as had led to conclude that what I saw was not a false. Its depth can be ascertained but the rock which appears in the immediate vicinity of Cornua belongs to the one formation, & a considerable layer may be understood of the existence of coal, in bed in that rock, but at what precise point the fact is difficult, I have not been able to ascertain, but I believe, I have not seen any deposits of iron in the immediate vicinity of the shoreline at any point.

2. It is extremely difficult to determine with any certainty upon the glacial of stone before the present have been found, for which reason I would be unwilling to give any very decided opinion as to the relation of the strata at the point mentioned in your communication. I took occasion at several points upon the River to examine the strata below Cornua, through a not very good quality. Above Cornua the bed is a kind of the yellow sandstone quality, also, at which is found to be in the immediate vicinity of the Cornua river. It seems at this place upon the bank, but a short distance in character of rock, well adapted to building purposes, a short time above. I wish however to give you to understand distinctly, that this only refers to that which appears upon the surface, & it is quite possible upon a slight excavation, the stone may be improved in quality, & the immediate vicinity of Cornua the rock has been quarried from the bed of the river & is well adapted to the construction of walls &c.

3. As far as examined the stone would be more easily quarried at Cornua, than at other points, but those portions which are exposed to the air. I think of an examination of a quality, rather superior at the latter place.

4. Numerous large boulders, (in some pieces of iron) are now scattered over the country but I did not find a place except at this point, where I think, however, there can be no doubt that it will be found in place at some point in the course of the geological survey of the country would lead me to conclude that this may also be the case at some points, but a few miles of distance from Cornua.

5. The answer to your question as to will be found in the accompanying list.

*All which is respectfully submitted
Yours with great respect
D. Houghton.*

Facsimile of Handwriting.

COMMUNICATION FROM THE STATE GEOLOGIST

(House Documents, 1838, No. 46)

To the Honorable House of Representatives for the
State of Michigan:

In compliance with the resolution of your honorable body, calling for information as to the direct benefits which may be anticipated to the agricultural interests of the state from the completion of the Geological Survey

now in progress, I beg leave to offer the following brief remarks.

It can hardly be supposed that the numerous incidental advantages which may be expected to result, could be set forth within the brief time in which an answer is desired. The direct benefit may be considered in five somewhat distinct points of view.

1st. In serving to give a knowledge of the character and composition of soils.

2d. In showing the best methods of correcting the deficiencies of barren soils, the diameter of manures required, etc.

3d. In bringing to light the hitherto unknown or unapplied manures which abound in our state.

4th. In illustrating the habits and best methods of destroying those insects which are so frequently destructive to the grain fields, the grass lands, the fruit trees, &c.

5th. In illustrating the habits, manner of growth, &c. of those plants which are, or may be advantageously used, as also in showing the best methods of destroying those noxious plants which are worse than useless.

In order to appreciate fully the importance of the first of these subjects, it is necessary to take into consideration that the fertility of a soil depends upon its mechanical and chemical composition; and since the excess or deficiency of any of the constituents of a good soil may, and does prove highly detrimental to its agricultural value, it becomes a matter of great importance to be able to apply the remedy without the necessity of repeated experiments and the partial loss of crops attendant thereon. Satisfactory conclusions may, in most instances, be drawn equally as well before as after these experiments upon the productiveness of the soil, for a simple examination will serve to show what may be deficient, and to suggest a remedy. This is more easily done, even by a random examination, than could at first be supposed. To illustrate this point more directly, let us turn our attention to some of the central portions of the state, where we will frequently see a soil of sand and gravel, bearing a luxuriant growth of vegetation, and, at but a short distance, a soil very similar in appearance, of a meagre and sterile character. The former, upon examination, will be found destitute of that important ingredient. The means of supplying this deficiency is then at once suggested, and the barren soil may be easily rendered fertile.

In the use of manures, it is well known to the farmer, that an equal benefit is not derived from the application of similar manures upon all soils, and the fact is also known that certain manures are at times absolutely detrimental; but how few of those most interested, even pretend to understand the true cause of this, and how few are prepared without the loss of a total or occasional crop, to determine what is really required. If the real cause of the loss of crops were known, it would no doubt frequently

be found to depend upon causes scarcely suspected, and which might have been easily remedied.

The important benefits arising from the use of plaster, lime, ashes, peat, marl, &c. upon certain soils, are well known to the great mass of our agriculturists, and more particularly the use of the former. Large quantities of plaster are annually used in our state, brought from abroad, while the same article exists in abundance at home, and only requires to be prepared for market.

The benefits derived from the use of marl upon land, do not appear to be as well understood as that of plaster, yet, there are many soils upon which it may be used with equally great, if not greater benefits. The article of plaster is not unfrequently transported at great expense, over bad roads, while the marl, which is perhaps lying at the very door, is wholly neglected, simply because its value is unknown or not appreciated. But some marls, in consequence of their chemical composition, are wholly unfitted for use as a manure, and are sometimes even hurtful.

The great amount of loss sustained by the agricultural interest, in consequence of the ravages of predatory insects, almost exceeds belief; but when we take into consideration how often the farmer in our neighboring states is compelled to mourn over his blighted fields of wheat, or the destruction of his clover and grass, or the disease and death of his finest fruit and ornamental trees, in consequence of the depredations of insects (whose operations, though of the most insidious character, are not the less ruinous and destructive,) we may form a slight conception of the loss sustained.

Now the geological survey in progress in our own, as well as in all the state's where similar surveys have been ordered, necessarily involves as one of its primary objects, the minute investigation of all these subjects, with the direct view to practical results.

The final report is contemplated to embrace a minute description of the rocks, soils, insects, plants, &c. of the state, considered in the most practical point of view possible. The general faults which may exist in the soils, the manner in which these may be best remedied, the character of the manure required and where it may be found; the habits, history and best methods for destroying predatory insects; the habits history and medical properties of our plants, together with the soils in which they flourish most advantageously, as also all the uses to which they have been, or may be applied. In fine, the subject involves all the operations of the agriculturist; yet, while he would be most benefited indirectly by the geological survey, in progress, as many of the benefits must necessarily be incidental, it would probably be uncalled for to enter at length upon all its bearings.

The older of the fourteen states now engaged in those surveys commenced with more direct view towards rendering aid to the farming interests, and in some of them, as for instance, New Jersey, where the work has been nearly completed, this has been almost the only

object considered, and the result have already been productive of great benefits. It is not to be concealed that agriculture is pursued in our country, for the most part, in a very unscientific and wasteful manner, and we have only to look abroad to be satisfied that our soil might be made, with less labor than is now devoted to it to yield a much more abundant harvest. In consideration of which, it may fairly be conceived, that any object which shall have in view the elevation of the character of this pursuit. or which may add to its ultimate profit, cannot, fail to be productive of good.

I have the honor to be, &c.
DOUGLASS HOUGHTON,
State Geologist.

*Geological Department of State,
March 2, 1838.*

1839

REPORT OF THE STATE GEOLOGIST IN RELATION TO THE IMPROVEMENT OF STATE SALT SPRINGS

(Senate Documents, 1839, No. 1)

*Office of State Geologist,
Detroit, January 1st, 1839.*

To the Honorable Legislature of Michigan:

In compliance with your instructions contained in the act approved March 24, 1838, entitled "An act for the improvement of the state salt springs," the undersigned respectfully submits the following report.

Immediately after the passage of the act, in order to avail myself of the most recent improvements upon the method of conducting this important work, as well as with the view to adopt such a course as would lead, in the most economical manner, to the results desired, I visited the principal salt wells of Ohio, Pennsylvania and Virginia, and although I had carefully examined many of them before, the numerous improvements which have been made, more particularly at Kanawha, in Virginia, rendered the examination, in a high degree, interesting and profitable. Another object which influenced me in these examinations was the desire of comparing carefully, while the subject was still fresh in my mind, the precise conditions of our own springs, with those similarly situated in the neighboring states.

The close analogy in situation, existing between the springs in the states enumerated and those in our own state, as set forth in a former report, will be borne in mind, together with the necessity for adopting a similar method of improvement. The salt springs of New York, it was there stated, are so very differently situated, that a satisfactory comparison with them can scarcely be instituted at this time, and any attempt to improve the water of our own springs upon the plan there pursued, would, most assuredly, prove valueless; but when water of sufficient strength and purity, and in sufficient quantity, has been obtained, the policy of management adopted

by the state of New York may readily be applied to our own state, and will undoubtedly be preferable to any other which could be devised.

The brine springs of our state, like those of Ohio, Pennsylvania and Virginia, emanate from the rock which lies deep, being covered with a mass of rock and earthy matter, which (in order to procure salt water that can be economically used,) it is necessary to penetrate. In this respect they differ most essentially from those of New York, for in that state a simple earth excavation has proved amply sufficient to insure an abundant supply of water of a superior quality. In the other states to which reference has been made, I am not aware that any spring has furnished water in quality or strength sufficient for economical purposes, by a simple earth excavation, nor has the water been very materially improved by any work of that kind.

In those portions of the states last mentioned, where the geological arrangement of the rocks is such as to admit of obtaining salt water, the salt rock lies at a considerable depth, and is overlayed by a strata of sandstone, limestone, slate, &c, and through fissures in these overlaying rocks I lie salt water, much diluted by the influx of fresh water, originally rose to the surface. In order to procure water of sufficient strength and purity, it has been found indispensable to penetrate the overlaying rocks, as well as a portion of the rock from which the salt water flows. The depth to which it has been found necessary to sink, varies from three hundred and fifty to one thousand feet, the deep borings for the most part, furnishing water of a strength superior to the more superficial ones. This variation in the depth to which it is necessary to carry the borings, depends, chiefly, upon the inclination of the salt rock, and by keeping in view the general inclination of that rock, together with the elevation of the country, can be determined with nearly as much certainty before operations have been commenced, as after they have been completed.

The appearance of a salt spring at the surface, is, of itself, very far from being evidence of the existence of water of value in the rock below; it is only a single link in the chain of facts, for in very many instances water of considerable strength appears at the surface where no permanent supply of sufficient strength and purity to be of any practical value could be obtained by the most complete borings, and some of the most valuable springs have been brought to light by improvements, where, originally, no salt water appeared upon the surface. A complete elucidation of this subject does not properly come within the scope of the present report, and illusion is made to the facts as they exist, simply with a view to rendering the character of the improvements proposed more intelligible than they would otherwise be.

Having called your attention to the close similarity which exists between the salines of our own and the states last mentioned, you will be prepared to appreciate the necessity of adopting a similar method of improvement. Your attention is more particularly called to this subject

from the fact that many of our citizens having been familiar with the condition of the salt springs of New York, and erroneously looking upon our own as similarly situated, are unprepared to realize the different, character of improvements required. At the Onondaga, springs a simple shaft has been found sufficient to furnish an ample supply of water highly charged with saline matter; but improvements of this character, simply, would be of no value at any of the springs I have examined in Michigan, and I can safely say that no point will, ever be found in this state, where improvements of that kind will, alone, lead to any practical results.

In commencing the improvements directed, it was deemed desirable to select two points for operations, where, all circumstances combined, rendered it most certain they would lead to a successful termination. Two places were, selected rather than one, from the slightly different circumstances under which the salt springs occur; a difference which would still leave the subject in doubt should the experiment result unfavorably at a single point. As a matter of economy, it was considered desirable to pursue both these works at the same time, from the fact that the two improvements can be proportionally much more economically conducted in concert than with either of them alone. Feeling the importance of settling the question fairly, these points were selected with much care, and it is believed they are quite equal, if not superior, to any which have been chosen in the state. The principal facts connected with this subject were laid before you in a former report, from which you will be enabled to draw conclusions as to the probability of eventual success; but since the date of that report, many facts have been elicited which would serve to increase our confidence on that subject. The water of these springs is quite equal in strength and purity to that of any of the springs of the western states before noticed, as they originally existed; the geological situation of the country is such as to lead to favorable conclusions, and should there be a failure of eventual success, it may safely be said it will depend upon causes which could not possibly have been calculated.

The state salt lands on the Tittabawassa river, in Midland county, are peculiarly eligibly situated, being a few miles below the head of navigation of that stream, and embracing the mouth of Salt river. A reexamination of this saline district, showed it to be more extensive than had been supposed, and it was in consequence of this, in connexion with the strength and purity of its numerous springs, deemed a strong point for commencing operations.

The time occupied in making these preliminary examinations prevented the commencement of active operations at the point selected until near the middle of June; and separated as it is from settlements, it became necessary, first, to make arrangements for rendering those comfortable who should be engaged in the work. A house was first erected and sufficient ground cleared from timber to prevent annoyance from mosquitoes, since which a shaft has been commenced at a point

about half a mile below the mouth of Salt river on the direct bank of the Tittabawassee river. Much difficulty was first encountered in sinking the shaft, from the presence of quicksand, but this was at length surmounted, since which the work has progressed with as much rapidity as could have been anticipated.

As this shaft is commenced directly upon the bank of the river, it was deemed advisable, in order to secure the works more perfectly, as well as for other purposes, to erect a wharf, which was accordingly done. It is proposed to sink this shaft, already commenced, to the rock, which may be estimated to lie at a depth of something over one hundred feet, and to secure it carefully from the influx of fresh water. Having accomplished this, the salt rock, which will probably be found, at this point, to lie at a depth of between five and seven hundred feet, will be reached in the usual manner, and until this be fully accomplished, we cannot hope to arrive at any satisfactory conclusion upon the subject.

During a portion of the months of August, September, and October, this work was partially suspended, in consequence of the sickness of those employed in carrying it forward.

Circumstances connected with my other state duties prevented a re-examination of the state salines on Grand river until about the middle of July, soon after which operations were commenced at the point selected, three miles below the village of Grand Rapids and upon the direct bank of the river: — But in consequence of the excessive heat of the season and the exposed condition of the men employed, nearly all those engaged upon the work became unfit for duty by sickness, and more than two months elapsed before I was enabled to renew the work successfully, although other hands had been employed and sent on in the mean time. They also became unfit for duty from similar cause.

A neat and commodious house has been erected at this place, a portion of the timber for the dock, to secure the works, prepared, and I have men now busily engaged in clearing grounds and taking all the necessary preliminary steps for commencing a shaft. A steam engine has been procured and some of the machinery prepared for commencing work upon the shaft, and this work would have been already commenced had the condition of the appropriation warranted such a step. The distance to the rock being, at this point, comparatively short, the expense of sinking the shaft will not be great, but the amount of rock boring required will not vary very much from that at the Tittabawassa salines. I should also add that a conditional contract has been made with a man of great practical experience in rock boring, at the Kanawha salines, in Virginia, to take charge of that portion of the work in this state, and had the appropriation been sufficient he would have commenced work before this time.

In regard to the importance of this point for the commencement of these improvements, it will probably be sufficient to refer you to my report of last year, on this

subject, barely adding that the examinations of this year have added confidence to my hopes of success, if the operations be continued to a final result.

Other points might have been selected where little doubt can be entertained but salt water could be procured, and where operations could be conducted at a less expense, but at this stage it was deemed of the utmost importance to select such springs only as bid most fair, and such as would, in the event of a failure to realize our expectations, render it forever unnecessary to make further attempts. Should the works already commenced prove of value, it will, no doubt, be found for the interest of the state to make similar improvements at other points, but, for the present, those commenced are amply sufficient.

It would hardly have been expected, from the small amount appropriated for improvement of our springs, that very much, except to take the preparatory steps, could have been accomplished, yet under ordinary circumstances no more than this amount would have been required. The sickness of the past season has been such as to embarrass our operations very much, and this embarrassment was increased in consequence of the difficulty of supplying with fresh hands, the places of those who became unfit for duty in consequence of sickness. Compelled to live, for a time, until buildings could be erected, more exposed than usual, much annoyed by mosquitoes, in connexion with the extremely hot weather, the men employed sickened and were nearly all, for a length of time, unfitted for labor. Their places were supplied with fresh hands as soon as circumstances would permit, and the work pressed forward with all possible dispatch.

There* has been expended at the works on Grand river, in-chiding the expense of erecting a house and the purchase of a steam engine, the sum of one thousand seven hundred and sixty seven dollars, fifty-two cents; and at the works on the Tittabawassa river the sum of two thousand one hundred and eighteen dollars, sixty-seven cents, amounting in total to three thousand, eight hundred and eighty-six dollars, nine teen cents, a schedule of which disbursements, with the proper vouchers, will be duly laid before you.

It will be seen by this statement that the expenditures have exceeded the appropriation in the sum of \$886.19. I had proceeded with the utmost precaution in order to avoid a result of this kind, but the increased expenses incident upon supplying the places of those workmen rendered unfit for duty in consequence of sickness, as well as unlooked for difficulties and expenses connected with the transportation of provisions, &c. rendered it impossible to make accurate estimates, for which reason, after the principal expenses had been incurred, I was under the painful necessity, either of leaving the work, at a season of the year most favorable to conduct the operations, or to exceed the amount appropriated for that purpose. Had a different course been pursued, the state would have been subjected to great loss and delay in the progress of the works, which has thus far been

avoided, and notwithstanding the condition of the funds, I am still continuing the work though in a manner which will render the expenses inconsiderable.

The commencement of a work of the character of that under consideration, necessarily involves the expenditure of an amount, for the erection of houses and work shops, for clearing grounds, for machinery, for implements, &c. which must render the first expenses much greater than those which will follow. In consequence of the limited amount appropriated for that purpose, only a portion of this has been accomplished, and the sum which will be required for successful continuance of the work will, therefore, be considerably larger than would otherwise be necessary.

With a sufficient appropriation for the current year, we may hope to be able to make such additional improvements in the grounds as will be required, to erect work shops, &c, to complete the shafts to the rock, and secure them from the influx of fresh water, and unless some unlooked for accident should occur, to sink with the auger through four hundred feet of rock at each place, making the sum total as estimated, inclusive of earth excavation, nine hundred and seventy feet. There will be required for this purpose, under a system of rigid economy, the sum of \$12,350, which estimate will in elude the amount of \$886.19 before stated to have been advanced upon the work in progress.

In closing this subject, I cannot refrain from alluding to the present state of the salt spring lands. The fact that we have a grant of seventy-two sections of land, located in different portions of the state, much of which might be made available, yet producing no revenue, is one which deserves attention. Situated as these lands now are, they are subject to constant waste from the loss of timber by intruders, — a source of loss which is daily increasing. Some portions of these lands, which will never under any contingency be required for salt purposes, may be made available by lease, at once, the only course which can be pursued in conformity with the act conferring the grant, while the measures now in progress will fully test the condition of the most marked springs, and either lead to a result which will add much to the prosperity of our state, or teach us that some other method will be required to render the large amount of salt lands held by the state of any real value.

It is desirable, therefore, in order that the whole subject may be placed in that situation which will prove most beneficial to the state, that the works now in progress be pursued to a final result as speedily as possible, for until it be done, no decisive steps can be taken with any other than a portion of the lands, and the interest upon the amount which is thus lying idle would soon make a return of the amount expended by the state in making the improvements. With this view of the subject, laborious as is the task of conducting these operations, in connexion with the other severe duties I am called upon to perform, the task is made light by the hope that in the end it may not fail to lead to results of the most

vital importance to the prosperity of our young state. All of which is respectfully submitted.

DOUGLAS HOUGHTON.

REPORT OF THE COMMITTEE ON THE STATE
GEOLOGIST'S REPORT IN RELATION TO THE
IMPROVEMENT OF THE STATE SALT SPRINGS

(House Documents, 1839, No. 4)

The select committee to whom was referred the report of the State Geologist, in relation to the improvement of the State Salt Springs, beg leave to report:

That they have had the subject under consideration, and in view of the great interests involved, would recommend the immediate appropriation of a sum sufficient to carry forward the works already commenced.

Our salt springs, we have good reason to believe, may become one of the most fruitful of our internal resources. We trust they will soon provide our citizens with one of the first necessities of life, at a very moderate expense, and prove to be a perpetual source of revenue to our state.

After a thorough investigation of the facts connected with the whole subject, your committee are not only satisfied that it is for the interest of the state to pursue the improvements already commenced to a final result, but also that any delay in doing so must be attended with loss.

The large amount of salt lands which are now unproductive to the state, taken in connexion with the great amount of money which is annually sent abroad for the article of salt, furnishes arguments of the strongest character.

It should be one of our first objects to render state binds productive, and until improvements of the character of those already commenced have been carried forward to completion, it will be imprudent to take any steps to render them permanently available.

We have every reason to believe, that the improvements proposed, will prove successful, but should this fail to be the case, we are satisfied that the lands may be so disposed of as to furnish a permanent revenue, which will, in a very short time, reimburse the state for all she may expend, in the improvements now going on.

The amount of money sent abroad for the article of salt, acts as a drain upon our state, which your committee regard as of no small moment.

From data in the hands of your committee, they are led to believe, that the amount annually sent abroad for the article of salt, cannot be less than three hundred thousand dollars, and probably has considerably exceeded that sum during the past year.

Should the improvements now in progress be successfully carried forward, little doubt can be

entertained but that amount of money sent abroad may soon be retained at home, and our salt springs like those of New York, furnish a handsome revenue to the state.

The revenue derived from duties on salt in the state of New York for the space of ten years, after deducting all expenses, has varied from one hundred and fifty to two hundred and fifty thousand dollars per annum, an amount which serves materially to lessen the burthen of taxation in that state.

The work of improvement in our state, is now going forward and the amount which will be required fully to test the subject should, compared with its great importance to the citizens of this state, be looked upon as of minor importance; for in whatever light the subject may be turned, your committee look upon the prompt improvement of our state salines as of the utmost importance.

The embarrassment which the works are now suffering in consequence of the fact, that more than the whole amount of the appropriation of the last year has already been expended, calls loudly for the immediate action of the legislature upon this subject.

The Geologist feels unwilling to involve the expenditure of money in this work without direct instructions upon the subject, while the abandonment of proceedings, even for a short time, would involve an expense in replacing hands in consequence of the isolated position of the springs, which he is very justly anxious to avoid. He has procured a steam engine and other implements for the promotion of the design, and provisions for the winter's support of men now employed, all of which expenditure will mostly be lost, if obliged to suspend operations.

Your committee are also informed by the Geologist, that the work can now be prosecuted to better advantage than at any other season of the year, and that an immediate expenditure is required for pumps, &c. to secure one of the works from an influx of water, which has but recently taken place, and of which, information has been forwarded by express.

The situation of the Geologist under these circumstances is embarrassing in the extreme: not feeling authorized to advance funds for that purpose, and in constant fear lest a failure to supply what is required, may lead to unfortunate circumstances, he cannot fail to feel much anxiety that the most prompt action be had upon the subject.

In fulfilling the duties assigned your committee, they cannot refrain from alluding to the laborious and responsible duties of the State Geologist, and the deep interest manifested by him in the success of his operations, and trust that every facility will be afforded, which is necessary for the development of the resources of our young and rising state.

Your committee would therefore recommend that the amount embraced in the accompanying bill, be appropriated for the works now in progress, to be expended in the manner there directed.

NORMAL LITTLE
NOBLE H. FINNEY
J. GOODWIN.

REPORT OF THE STATE GEOLOGIST, IN RELATION
TO THE IRON ORE, &C., ON THE SCHOOL
SECTION IN TOWN FIVE SOUTH, RANGE SEVEN
WEST, IN BRANCH COUNTY

(House Documents, 1839, No. 21)

*To the Honorable the House of Representatives of
Michigan:*

In compliance with a resolution from your honorable body, "directing the State Geologist to furnish such information as he may possess in relation to the iron ore and clay on the School section in township five south, range seven west, in the county of Branch,"

I would respectfully lay the following facts before you, simply premising that all the examinations which were made in Branch county, are of a general or exploratory character, preparatory to the more minute examinations, which are intended to follow.

The school section to which my attention is called, by your resolution is characterized by the appearance of the clay iron stone formation; a formation which has not, as yet, been seen to occur in any other place in our state.

The clay iron stone, or kidney ore, appears in the usual form, being composed of thin concentric layers of the carbonate and hydrate of iron, deposited upon nodular masses, mostly composed of lime.

These masses of iron ore are imbedded, (in somewhat regular strata,) in a tough semi-indurated and stratified clay, which at first might easily be mistaken for rock. Neither the clay or iron has, as yet, been submitted to a minute chemical examination, nor in fact, is it considered, in this instance, of sufficient importance, to prevent our arriving at conclusions sufficiently accurate for general purposes.

It is well known that the presence of lime renders clay unfit for the manufacture of stone ware, fire bricks, &c., for the reason that the clay, by this admixture, is rendered fusible at a low temperature. The clay in question, is nearly, and in some instances, quite destitute of lime, and only differs from that which is denominated pipe clay, in its color and geological position. It is admirably adapted to the manufacture of stone ware, fire bricks, &c, and no further exploration is required, to render it certain that this article exists, in sufficient quantity, to furnish all that will ever be required for those purposes.

The iron ore is of the same kind as that which is almost exclusively used in some of the great furnaces of Ohio; and most of the English iron imported into this country, is manufactured from a similar one. The kidney ore from the readiness and cheapness with which it may be

reduced, may be said to be one of the most valuable ores which is ever found in a secondary country; and occurring under the circumstances it does in Ohio, it constitutes one of her great sources of wealth; in a large way it has been found to furnish, upon reduction, from thirty to thirty-seven per cent of cast iron.

The ore occurring in Branch county may safely be said to be fully equal in purity to that of Ohio.

As before stated, the examinations which I have made, of the extent of this ore, are only of a general character, in consequence of which it is wholly impossible for me to define either its boundaries, the extent of the formation, or the amount of ore a complete exploration would bring to light. In regard to its extent, sufficient is already known, to satisfy me that it is sufficiently extensive to be made available for practical purposes, (provided the expense of raising it shall not be too great,) for I have already traced it over an area of from eight hundred to one thousand acres. In order to determine the expense of raising the ore, it will be imperatively necessary that sufficient excavation be made to determine the amount of ore which can be obtained from a given area; a character of examination which would involve an expenditure that I do not conceive myself authorized to make, nor would it be for the interest of the state to direct it to be made in this manner.

The Superintendent of Public Instruction, very properly, after the examination had been made, withheld the school section from sale, and were he the individual owner, I have no doubt he would refuse to sell the tract until further examinations should be made; and since the school interest in this instance must be looked upon in the same light as that of an individual, I can conceive of no reason why he should not be authorized to expend from the school fund an amount sufficient to enable him to arrive at some satisfactory estimate of the value of the land in question.

DOUGLASS HOUGHTON.

*Office of State Geologist,
January 28, 1839.*

SECOND ANNUAL REPORT OF THE STATE GEOLOGIST

(House Documents, 1839, No. 23)

*Office of State Geologist
Detroit, Feb. 4, 1839.*

To the Hon. Speaker of the House of Representatives:

Sir: I have the honor to transmit to the legislature the accompanying reports and documents, setting forth the progress which has been made in the geological survey for the current year ending February 3, 1839.

I am, very respectfully,
Your ob't serv't,
DOUGLASS HOUGHTON
State Geologist.

REPORT, &C.

*Office of State Geologist,
Detroit, Feb. 4, 1839.*

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

In conformity with the requisitions of your honorable body, I herewith transmit such information, touching the progress and general results of the works placed under my charge, as would appear to be called for in an annual report; reserving the great mass of matter which has been accumulated, with the view to an elucidation of the condition and resources of our state, for a *final* report.

Immediately upon the reception of an act "relative to the geological survey," approved March 22, 1838, I proceeded, in conformity with the instructions contained in said act, to organize a geological board, and to divide the complete work in such a manner as to constitute a geological and mineralogical, a zoological, a botanical, and a topographical department.

At as early a day as circumstances would permit, the heads of each of these departments took the field, and continued their arduous duties until the inclemency of the season compelled a suspension of labor; since which time they have been busily engaged in arranging the great amount of information which has been obtained in such a manner that it may eventually be made available.

My individual labor has been chiefly devoted to an examination of the coast of those portions of our state bordering on lakes Huron and Michigan, together with so much of the interior of the peninsula as circumstances would permit. I have also devoted a portion of the past season to a general examination of some of the southern and central counties of the state, preparatory to the more minute examination which has been commenced and which it is proposed to renew with the first opening of spring.

The geographical information respecting the northern portion of this peninsula is so imperfectly understood that, were it at this time desirable, it would be impossible to lay before you the minute results of the examinations in that portion of the state, in such a manner as to be intelligible, unless accompanied with complete new maps, which could not be expected to be forwarded in a report, that at most, can only be looked upon as setting forth, in a general manner, the progress of the work placed under my charge.

NORTHERN PART OF THE PENINSULA

Topography and General Character

The country under consideration, lying west of Saginaw bay, and extending north from townships 10 and 11 north, to the straits of Mackinac, has been so imperfectly known to the citizens of our state that no estimate of its value could be made. No circumstances have occurred to aid in developing its resources, and from the forbidding character of most of the coast, it has very naturally been considered as a flat country, worthless, except for the immense tracts of pine timber which were supposed to exist in it; both of which suppositions are, to a great extent, without foundation. It is true however, that the northern portions of the peninsula are characterized by a larger proportion of irreclaimable marsh than is to be found in the southern counties, yet notwithstanding this, many portions are not inferior to the other parts of the state.

Several streams of considerable size occur on the northern part of the peninsula; among the most important of which are the Maskego²⁰, White, Pere Marquette, Manistee and Platte on the west; Cheboygan on the north, and Thunder Bay, Au Sable, Pere and Tittabawassa rivers on the east.

The Maskego river, which is the largest of the streams enumerated, has its principal source in a group of large inland lakes situated west of the meridian, in about ranges three and four west, and towns twenty-two and twenty-three north. These lakes are almost completely surrounded by nearly impenetrable swamps, covering a large portion of the area from seven to eight townships, the chief portions of which may safely be said to be utterly irreclaimable. From one of the principal lakes of the group mentioned, the Maskego river runs southwesterly in a line partially parallel with the coast of Lake Michigan, receiving numerous tributaries, until it finally discharges its waters into the last

²⁰Muskegon—Editor.

mentioned lake, in town ten north, range seventeen west. The stream through its whole course is extremely crooked, and its total length, including its windings, may be estimated at about two hundred miles. The waters descend with an extremely rapid, though for the most part uniform current, and their depth is very regular. The stream is capable of being easily made navigable for steamboats, nearly, if not quite to the lake which forms its source. Large portions of the land situated upon this

stream are well adapted to the purposes of agriculture, and although the great majority are timbered lands, there is, nevertheless, a sufficient amount of prairie to greatly facilitate the settlement of the surrounding country.

The Maskego, like almost all the streams on the western side of Michigan, first discharges its waters into a small lake that is separated only by a very slight distance from the main lake. The Maskego river may be said to furnish one of the best natural "stream" harbors which is found upon Lake Michigan.

The Tittabawassa on the east, which is one of the brandies of the Saginaw river, has its source not very far distant from that of the Maskego, and the upper portion of its course is nearly parallel to the latter stream, the Maskego being upon the west side of the summit, while the Tittabawassa is upon the eastern side. The latter stream, gradually curving to the east, discharges its waters through the Saginaw river into Saginaw bay of Lake Huron.

The Tittabawassa is navigable for boats of light draught for a distance of from forty to fifty miles, above which it is obstructed by numerous rapids, that will furnish, if properly applied, an abundance of hydraulic power. The surrounding country is considerably elevated, and the banks of the stream sometimes rise quite abruptly from a height of from twenty to forty or even fifty feet. Portions of the lands in the vicinity of the river are of good quality and well adapted to agriculture; but other portions occur where the soil is of a light sandy character and will require much labor to render it productive. Some valuable tracts of white pine exist in the vicinity of the Tittabawassa, but in consequence of the ravages of fire, which have been communicated from Indian camps, pine in quantities is rarely seen upon the immediate banks of the river.

The Au Sable and Thunder bay rivers are both capable of being made excellent harbors for lake shipping, and they are streams of considerable magnitude. The former may be rendered, navigable, but to what distance I am unable to say. The navigation of the latter stream is obstructed near its mouth by a series of rapids, the bed of the stream being composed of limestone in place.

The water of most of the other streams enumerated, like I have already mentioned, flows with a brisk current and sometimes with great rapidity. The beds of the streams are chiefly composed of a yellow sand, and the depth is remarkably uniform. An abundance of hydraulic power will be furnished, but the sandy character of the soil, more particularly upon the eastern slope, will sometimes render it difficult, to secure from accident the dams which may be erected.

The country north of the southern boundary of Arenac county and east of the meridian, so far as examined, is on the whole but ill adapted to the purposes of agriculture, being chiefly composed of sandy ridges with intervening swales, and rising so gradually towards the central portions of the state as to leave the country extremely flat. There are, however, many valuable tracts

of white pine, which will serve to render this portion of the state of some importance. Yellow pine, well adapted to light spars, also abounds.

A large portion of the immediate shores of the lake is composed of marsh.

An exception to the flatness of the country exists in an elevated district commencing in high hills a little south of Thunder Bay river and stretching in a southwesterly direction inwards the head of Lake Michigan. This range, at its commencement, is usually known as the highlands of the An Sable. These hills follow the line of bearing of the rock formation, and no doubt extend diagonally completely across the state, forming a portion of the summit of the more northern part of the peninsula.

The greater portion of the country, after passing the summit west of the meridian, is of a character totally different from that just described. From the site of old Mackinac, at the very extremity of the peninsula, south to the Manistee river, a direct distance of about 140 miles, the immediate shores of the lake are almost invariably considerably elevated, sometimes rising abruptly to a height of from 300 to 400 feet. The country, (more particularly the northern portions,) as we proceed into the interior, continues to rise, until it attains an altitude probably quite equal, if not superior, to any other portion of the peninsula. This is more particularly the case in the vicinity of, and southeast from Little and Grand Traverse bays. Here the surface is considerably broken by elevated ridges of limerock, which are, without doubt, a continuation of the line of bearing of the great limestone formation of Wisconsin.

In proceeding south from Grand Traverse bay, the interior of the country would appear to become less elevated, or gradually to fall away to the southeast, while the elevation of the coast is increased; a circumstance which will serve to account for the general direction of the two principal streams, the Maskego and Tittabawassa rivers. The elevated shores of Lake Michigan, which when viewed from a distance have the appearance of sand, are found in reality to be composed, except in the recent sand dunes, of alternating layers of highly marly clay and sand.

The hilly limestone region to which allusion has been made, is mostly heavily timbered with beach and maple, and although portions of it are rather broken, it is as a whole admirably adapted to the purposes of agriculture.

After leaving the limestone district, in passing south the country becomes more variable, the soil sometimes assuming a sandy character. The face of the country is also generally more level, although some districts are considerably rough.

This northern portion of the peninsula is usually regarded by the inhabitants of our state as possessing too rigorous a climate to admit of agriculture, but this is an error which deserves to be corrected. The Ottawa Indians, residing on Little Traverse bay, and who have somewhat extensive cultivated fields in the elevated

limestone district of the interior, more particularly in the vicinity of one of the southwestern forks of the Cheboygan river, inform me that their crops of corn have not failed within their recollection to yield largely; and certainly I never saw finer corn than in some of their fields.

The soil of these lands is strictly a "warm" one, and exposed as it is to the vivifying influences of the southern winds during the summer, it cannot fail to be productive. In this respect the country on the western slope is precisely the opposite of that on the northerly and easterly slopes, for this latter district is constantly subject to the chilling influence of the northerly winds from Lake Superior, an influence which even the most cursory observer could hardly fail to notice. This difference of circumstances, even were the character of the soil similar upon the opposite sides of the peninsula, could not fail materially to affect the value of the lands for the purposes of agriculture, adding to the value of those of one district while it would detract from those of the other.

Rocks

The examinations of the past year, in the northern and unsettled portions of the peninsula, have been wholly of a general character, and were made with a view of determining, as far as possible, the precise points to which the minute examinations can, hereafter, be directed with the greatest profit. These examinations cannot be completed in such a manner as to enable us to delineate the geology of that country upon our maps, until the United States' *linear* surveys be completed. These latter surveys, which during the past year have been extended as far north as town twenty-six, have nearly reached a portion of the peninsula, which, in a geological point of view, is possessed of the highest interest. Several parties of surveyors are now nearly in readiness to commence the work north of the town mentioned, and we confidently hope, that during the ensuing year the chief part of the subdivisions which remain to be done, may be completed.

It is not my intention, at this time, to enter into a minute description of the order of superposition of the rocks, over the large area of country under consideration, nor would it be possible, were it desirable, to present the subject to you in such a shape as to render it intelligible without the aid of diagrams. The accompanying description will, therefore, be almost exclusively confined to those points at which the *outcrop* of rock occurs under such circumstances that it may be made available for practical purposes, together with such suggestions as the circumstances may appear to warrant.

The rocks of this northern portion of the peninsula may be regarded as referable to the great carboniferous group of the state, a position to which their fossil contents is amply sufficient to substantiate their claim. In this respect they coincide with the rocks heretofore described as occupying the southern counties; nevertheless, it must be borne in mind, as there stated,

that these rocks occupy a very different position in the series.

The rocks of the district under consideration consist of a succession of limestones, with intervening shales, sandstones and clays; and as we approach the very extremity of the peninsula, the limestone is shattered, in a manner similar to that exhibited by the sandstone of the southern counties of the state.

The line of bearing of the members constituting this group of rocks, not only in the northern but likewise in the southern portion of the peninsula, is regularly northeasterly and southwesterly, a direction which it is believed the rocks upon the opposite side of Lake Michigan will also, at least to a certain extent, be found to pursue. The general character of the separate portions of the group are preserved, in a remarkably distinct manner, at great distance, and the mineral contents are but little varied.

My examinations would lead me to infer that the coal of the central portions of our state, and that upon the Illinois river, is embraced in a rock which belongs to the same portion of the great basin; a conclusion which, if borne out, will aid much in determining some important points, respecting the relation which the neighboring rocks bear to each other.

I am also led to conclude that that portion of the rock series which, in Illinois and Wisconsin, embraces the ores of lead, is identical with a portion of the rock formation which occurs in the northern part of our own state; a circumstance which might fairly have been inferred from the general line of bearing of the rock. Whether this extension of the rock also contains that mineral, in sufficient quantities to be of any practical value, remains yet to be determined.

A slight glance at the map of our state will sufficiently explain the relation which Saginaw bay, of Lake Huron, holds to the *line of bearing* already mentioned. This great arm of that lake, stretches in a southwesterly direction, making a deep indentation in the peninsula, and occupying a denuded space in the sandstone just at that point where the latter comes in contact with the limestone of the north. Thus, while the southerly portions of the bay are characterized by the appearance of abrupt, but low cliffs of sandstone, which rock may be traced in a southwesterly direction completely across the peninsula, the opposite, or northerly shore, is not less marked by the occurrence of limerock, which stretches in a like manner, southwesterly to Lake Michigan. This limestone forms several of the headlands and small islands of Saginaw bay and Lake Huron, and also occasionally appears in the beds of the streams, giving rise to rapids near their places of embouchure.

In proceeding northerly from the mouth of Saginaw river, limestone is first noticed, forming the very extremity of Point au Grais. Quarries have been opened here, and a rough building stone obtained. It is of compact structure, tolerably adapted to resist the action of the elements, and being situated, as it is, in such a manner that the

stone may be readily quarried and transported, it is a point from which the country in the vicinity of Saginaw river may be more economically supplied with this character of stone, than from any other. By judicious selection, portions of it may be made use of for the manufacture of lime, but the great mass is of too silicious a character to admit of use for that purpose.

Limestone still more silicious in its composition, occurs on the Charity islands, where it may be quarried to a limited extent, and will answer a good purpose for rough walls. The rock of these islands, for the reason already stated, will scarcely admit of being applied to use for the manufacture of lime. That at Great Charity Island contains large quantities of embedded chert.

Between Charity islands and the southerly cape of Thunder bay, limestone appears at short intervals, but at such low levels (usually forming the bed of the lake) as to be of no practical value. At this latter point the rock occurs in an abrupt cliff, which rises directly from the water, to a height of from ten to twenty feet, and is continued for the distance of half a mile.

The limerock alternates with layers of a fissile clay slate, the latter of which composes about two thirds of the whole *out cropping* rock forming the face of the cliff. The limestone may be easily quarried, and portions of it would answer tolerably well for architectural purposes, but as a whole, in consequence of the irregular shapes into which the rock is liable to separate, it is of inferior quality.

At a distance of something less than two miles, southeast from the cliff just mentioned, a dark colored and highly bituminous shale occurs, forming a small island. This island, which, during the past season, in consequence of the high water, has been nearly submerged, is usually denominated Sulphur island.

This bituminous shale, which is seen to extend a considerable distance around, forming the bed of the lake, dips below the limestone just described, and may be regarded as of no great thickness. Small specks and nodules of iron pyrites are embedded in it, and so completely is the whole mass saturated with bitumen, that when thrown upon "the fire", it blazes freely. From this circumstance it has been mistaken for coal, and considerable quantities of it were actually shipped to Detroit, under this delusive supposition.

Limestone is again seen in the bed of Thunder Bay river, at a distance of about one mile from its mouth. Over the *out-cropping* edge of the rock the waters descend in a series of very brisk rapids; and the stream is capable of furnishing a greater amount of hydraulic power, at this point, than has been noticed at any single place on the peninsula. Were it not that the sandy nature of the banks would render much care necessary in order to make the works secure, it might be very cheaply applied; and occurring as it does, near the mouth of a large stream, which will furnish a safe harbor for hulk vessels, the great value of this immense power, for application to

mechanical purposes, cannot fail to be eventually appreciated.

Limestone was not observed at any point upon Thunder Bay river, sufficiently elevated, to admit of its being quarried.

Lime rock also occurs at the northerly cape of Thunder Kay, the Thunder Bay islands and the Middle island, as also at several intermediate places upon the coast; but it chiefly occurs either below the water of the lake, or so little elevated above it as scarcely to be capable of being turned to any considerable practical account.

Outer Thunder Bay island is composed of limestone, covered, in part, by a very thin deposit, chiefly of vegetable matter. An inferior coarse building stone may be obtained, in considerable quantities, upon this island, but it is extremely irregular in shape and not of the most durable character.

The southerly portion of outer Thunder Bay island is composed of a shelly or sub-slaty, silicious limestone, considerably charged with bitumen, and almost wholly composed of a congeries of fossils, the animal matter of which has undoubtedly given rise to the bituminous character of the rock. It possesses much interest in a scientific point of view, but is of no value for any practical purposes.

Much of the surface of Middle island is composed of loose masses of a limestone, which is admirably adapted to the manufacture of lime. Occurring, as these masses do, of a convenient size, the labor of quarrying is saved, while the manufactured lime may be safely and conveniently shipped. The manufacture of lime, for the counties bordering on the lower rivers, may be safely and economically carried on at this point. Several kilns have already been burned upon the island.

Between Middle island and Forty mile point, limerock appears, at intervals, forming the bed of the lake. The rock was not noticed, at any place, to rise above the surface of the water, and although it is of a compact and regular structure, and well adapted for practical use, its submerged situation will effectually prevent its application to any useful purpose.

Limerock again occurs at the straits of Mackinac and in the vicinity. It appears upon the island of Mackinac, together with Bois Blanc, Round and St. Martin's islands, as also upon the Northern Peninsula, north from Mackinac.

The island of Mackinac, which has a circumference of about nine miles, rises in rocky cliffs, upon its easterly and southeasterly portions, very abruptly, to a height varying from 120 to 150 feet.

The site of the present Fort Mackinac is elevated 150 feet above the water of the lake. Beyond the first elevation, upon which the fort is situated, there is a somewhat level plateau, which, however, rises gradually, until by a final and quite abrupt ascent, the island attains its greatest elevation, being 219 feet. This final

elevation, which is somewhat conical, has a flat area of limited extent on its very summit, upon which, during the late war, Fort George, afterwards called Fort Holmes, was erected. This beautifully situated spot furnishes one of the finest views of the surrounding coast and islands that could be conceived.

The island of Mackinac is based upon limestone, with a very superficial covering of soil. This soil, in consequence of the large amount of calcareous matter which enters into its composition, possesses a fertility that a superficial observer would scarcely ascribe to it.

The limestone chiefly consists of an irregular assemblage of angular fragments, united by a tufaceous cement. These fragments usually appear, at first, sight, to possess a compact structure; but a more minute examination shows them to contain numerous minute cellules, sufficiently large to admit water, which, by the action of frosts, subjects the rock to rapid disintegration. Portions of the rock may, nevertheless be selected partially free from this difficulty, and which are possessed of sufficient compactness to render them of value as a coarse building stone.

Hornstone, striped jasper, imperfect hog-tooth spar, calcareous spar and fluor spar occur imbedded in the rock, although the latter is of very rare occurrence.

Limestone, of a similar character, constitutes the chief portion of Round island; but here the rock is more compact, and will prove less subject to disintegration than that before mentioned. It will answer a good purpose as a coarse building stone.

A range of somewhat elevated hills, of limerock, occurs upon the main land, northwesterly from Mackinac, commencing a short distance inland. One of these hills, known as the "Sitting Rabbit," presents an abrupt cliff, destitute of vegetation upon its southerly side. This rock is, without doubt identical, in geological position, with that upon the islands last mentioned.

The low group known as the St. Martin's islands are also composed of a similar limestone.

The shattered and deranged condition of the rock upon the island of Mackinac, and its vicinity, gives the whole mass a peculiarly complicated structure, and has led to what is conceived to be an error respecting it. Thus the rock has been described as a conglomerate, destitute of stratification, a conclusion which would appear to have been drawn without a proper consideration of the facts connected with the subject. That the fragmentary masses, composing the main portions of the rock, have not been transported, is conclusively shown by the fact that the most delicate angles are preserved, a circumstance which could not have taken place had they been subjected to the action of water, before being cemented. A careful examination has shown that portions of the rock still remain, in which the relative position of the original lines of stratification are preserved for an extent of several rods; and on Round

island the line of stratification was traced for a distance of nearly half a mile.

The rock in question, no doubt occupies very nearly its original relative situation, and its present condition may be ascribed to an uplift of the strata, subsequent to the complete induration of the rock; a cause which is amply sufficient to account for the present appearances. The fragments thus separated have been imperfectly cemented by the gradual infiltration of calcareous matter, thus re-uniting the complete mass.

It is well known that portions of the sandstone, in the southern counties of the state, are shattered in a similar manner; but in this instance the fragments have not been re-united.

The *old red sandstone*, over a large area, in the vicinity of the Porcupine mountains of Lake Superior, has been similarly disturbed, and the protruded trap rocks, which occur in the immediate vicinity, afford a sufficient explanation of the causes which have been most active in producing it; facts which should not be lost sight of in explaining the causes of the present condition of the rocks in the vicinity of Mackinac.

From the island of Mackinac to Little Traverse bay, rock does not appear upon the immediate shore of the lake, though hills based upon limestones stretch at a distance, through the interior. These hills approach very near the head of the bay mentioned, where they attain an elevation of several hundred feet; and as a whole they probably constitute the most elevated and regular chain of hills on the peninsula.

On the easterly side, and near the head of Little Traverse bay, the lime rock *crops out*. It continues for a distance of nearly a mile, forming an abrupt cliff, elevated from 10 to 20 feet.

This rock varies from a dark blue and compact limestone to that of a grayish color and sub-crystalline structure. The rock may be easily quarried, and portions of it will answer a tolerable purpose as a building stone. But much of it is of an inferior quality; for the dark blue limestone is subject to break into irregular fragments, while much of the grey rock is either too flaggy, or contains so large a proportion of argillaceous matter in its composition as to render it unfit for use.

At a distance of from two to three miles westerly from the place of *out-crop* just mentioned, the rock again appears, in a continuous cliff, elevated from 15 to 20 feet.

The inclination of the rock is here northwesterly. It continues for a distance of about three-fourths of a mile, when it dips beneath the water of the lake. This series of rocks no doubt overlies that last described.

The separate strata of this cliff, at its highest point, are represented, in a descending series, as follows: the rock being overlaid by about one foot of soil:

1. Siliceous limestone almost partaking of the character of sandstone—9 feet.

2. A confused mass of broken fossils, chiefly encrinites and cyathophyllae, imbedded in clay—2 inches.

3. Vesiculated chert, colored with iron—4 to 8 inches.

4. Flaggy limestone, mostly separable into layers varying from one-fourth of an inch to one inch in thickness; the laminae usually forming a small segment of a large circle—8 feet.

5. Bluish clay [having the odor and appearance of silt,] divided by septae into irregular masses. It contains imbedded semi-crystalline grains of iron pyrites, which has the appearance of coarse golden yellow colored sand. About four feet of this stratum appears above the surface of the lake, and it was estimated to extend 4 feet below, making its total thickness 8 feet.

This clay is underlaid by limestone.

The rock appearing in the cliff is, as a whole, of an inferior quality for economical purposes, yet portions may be selected which would answer a very tolerable purpose as a building stone.

Limestone was noticed, at intervals, forming the bed of the lake, as far south as the northerly cape of Grand Traverse bay. At this latter place it was last seen to rise above the surface of the water, attaining an altitude of from 4 to 8 feet.

This rock contains large quantities of imbedded hornstone in irregular layers, varying from 2 to 12 inches in thickness. The siliceous matter having been deposited in thin successive layers gives the whole mass of hornstone a beautifully zoned appearance.

Portions of the limestone rock will furnish a tolerably good material for use as a coarse building stone, but as a whole it is of inferior quality.

About four miles southeasterly from the lime rock last described, and just within Grand Traverse bay, a dark colored bituminous slate, containing nodules of iron pyrites *crops out*, and continues at intervals for a distance of a mile. It closely resembles that before described as occurring at Sulphur island, near Thunder bay, except that it is not so highly charged with bituminous matter. The rock is of no practical importance.

South from Grand Traverse bay to the southerly boundary of the state, rock was not seen, *in place*, upon the immediate shores of the lake, but it occurs at many points a little in the interior, one of which may be noticed as being immediately connected with the rock strata under consideration.

This limerock comes to the surface in a hilly region, lying between Pere Marquette and White rivers, [town 15 north,] at a distance of from 10 to 12 miles from the shore of Lake Michigan. The surrounding country, embracing between one and two townships, is composed of broken, conical hills, rising abruptly to a height varying from one to two hundred feet. From the

bases and sides of these hills numerous beautiful springs of water are discharged.

The rock is mostly covered with soil, and its character is not well determined, but situated as it is, at a distance from the coast, and not near any navigable stream, it is at the present time of no practical value.

.In connection with the subject under consideration, I would call your attention to the immense quantities of rolled pebbles of limestone which occur on the shores of Lake Huron, more particularly between Thunder bay and Forty Mile point. The shores are lined at short intervals, with these masses, consisting of the harder portions of the rock, which have resisted the action of the elements. These masses, possessing, as they do, great uniformity of size, are admirably adapted for use in the construction of roads.

The coast is not unfrequently lined, many feet in thickness, with these fragments, and so situated that vessels may be readily laden with them. Occurring in the form they do, the expense of pounding will be saved, and no preparation will be required to fit them for immediate use in macadamizing roads.

It is well known that great numbers of vessels annually pass down the lake "in ballast," and it is deserving of serious consideration whether sufficient inducement could not be given, for the transportation of this material for use upon the roads in the vicinity of Detroit river.

The finer gravels have already been considerably used for graveling walks, but I am not aware that any use has, as yet, been made of the larger stones which occur in such abundance upon the, upper lake coast.

Tertiary Clays

A large proportion of the rocks of the peninsula are overlaid by a series of beds of clay, sand and gravel, that sometimes attain a thickness of several hundred feet. These beds compose a group of deposits, the lower portions of which, so far as I am able to determine are destitute of fossil remains. Some of the members of the group, would appear to be of a local character, occupying but a limited extent; while others are spread over a large area of county. Of these deposits perhaps no one occupies a greater extent than the lower clay which is nearly universal upon the border portions of the peninsula.

The members of this group are most largely developed, upon those parts of the peninsula bordering on the coast, and they gradually become thinner as we proceed inland, until they finally wholly disappear; their place being supplied either by rock in place or by diluvial deposits.

The great thickness of the exposed portions of these *tertiary* beds, upon the northwest part of the peninsula, afford ample opportunities for examining this interesting series of deposits. But since the consideration of the subject, as a *whole*, will be left to the future, a few

allusions only will be made to some of the clays embraced in the series.

The lower clay, which is usually of a blue or bluish gray color, is almost universally more or less filled with imbedded pebbles, chiefly of *primary* rocks, which sometimes, though rarely attain to several hundred pounds weight. These water-worn masses usually completely ruin the clay for all practical purposes, but in a few instances the clay has been found sufficiently free from them to admit of use, for the manufacture of bricks. The thickness of this clay is known only at a few points; and as the deposit was made unconformably upon an unequal surface, its thickness must be subject to very great variation. In the vicinity of Detroit it has been sunk completely through and found to have a thickness of 118 feet.

This lower deposits of clay, in the southeastern part of the state, is usually overlayed by a stratum, varying from 1 to 5 feet in thickness, of an exceedingly fine marly clay. This clay, when sufficiently free from lime, is well adapted to the manufacture of bricks and earthen ware.

On the northwestern side, bordering on Lake Michigan, the upper clays are much more largely developed than upon the more southeasterly portions of the peninsula. These deposits of clay alternate with beds of sand and gravel, the whole some-times attaining a thickness of from 100 to 400 feet. The separate beds vary considerably in character; the upper usually containing a much larger proportion of lime than the lower ones, yet they usually agree in possessing an extreme fineness of texture. Many portions of these clays, appearing in the abrupt shores of Lake Michigan, are well adapted to the manufacture of bricks and earthen ware, but they usually contain so large a proportion of lime as to render them unfit for use for those purposes. Some portions of these clays, in which lime enters largely as an ingredient, rather deserve the name of marls, and they are admirably adapted for use upon the sandy lands of the northern part of the peninsula.

Shell Marl

Several beds of shell marl were noticed upon the northwesterly side of the peninsula; and upon the eventual settlement of the country they will prove of great value to the agriculturist, as well as for the manufacture of lime. In consequence of the unsurveyed condition of the country, it is impossible, at this time, to designate the localities.

White river of Lake Michigan takes its name from the occurrence of a bed of shell marl, of a very white color, directly at its mouth. The marl composing this bed would appear to have been deposited in an old channel of the river, which had been shut up by the action of the winds and waves upon the sand at its mouth, and afterwards to have been buried many feet in depth by drifting sands. In process of time the river returned to its former place of embouchure, thus laying bare the marl in question. It will prove a valuable material for the manufacture of

lime, as well as for application to the light sandy lands in the immediate vicinity. The bed is not extensive.

Gypsum

Gypsum occurs, associated with the northern limestone, but for the most part under circumstances that will effectually prevent its being obtained in any considerable quantities.

Gypsum of a beautiful white color occurs in the bed of the lake a little north from Point au Gris river, but to what extent it is impossible to determine, for it is covered by several feet of water, which will effectually prevent the working of the bed.

On the St. Martin's group of islands, near Mackinac, gypsum also occurs, chiefly in loose pieces, scattered over the islands. A bed of gypsum is said to be associated with the limerock in the immediate vicinity of these islands, and in such a situation that during the low stages of water, it appears above the surface; but at the time of my examination it was covered by several feet of water. I am informed that some years ago several shiploads of gypsum, collected in loose masses upon the St. Martin's islands, were transported to the lower lakes. Nearly all which appeared upon the surface has been removed, and the low level of the islands will effectually prevent any considerable explorations for more.

Gypsum also occurs on the *northern peninsula*, between Green Bay and Mackinac, but to what extent has not yet been determined. Small quantities have also been collected and shipped from this part of the coast.

Change of Elevation in the Waters of the Great Lakes

Intimately connected with the geological changes which are taking place, from the deposits of detrital matter at the mouths of streams, and in the deeper portions of the lakes, together with the degradation of the lake and river coasts, are the changes in the relative level of the waters of the lakes; a subject to which the attention of our citizens has been more particularly called within the past two years.

The great interest, which this subject possesses in connection with our lake harbors, as well as with those agricultural interests situated upon the flat lands bordering the lakes and rivers, may be a sufficient apology for the introduction, in this report, of the accompanying facts and reflections upon the subject. An accurate and satisfactory determination of the total rise and fall of the waters of the lakes, is a subject, the importance of which, in connection with some of our works of internal improvement and harbors, can, at this time, scarcely be appreciated.

Much confusion is conceived to have arisen, in the minds of a portion of our citizens, in consequence of a confounding of the regular *annual* rise and fall to which the waters of the lakes are subject, with that apparently irregular elevation and subsidence, which only appears to be completed in a series of years; changes that are

conceived to depend upon causes so widely different that while the one can be calculated with almost the same certainty as the return of the seasons, the other can by no means be calculated with any degree of certainty.

It is well known to those who have been accustomed to notice the relative height of the water of the lakes, that during the winter season, while the flow of water from the small streams is either partially or wholly checked by ice, and while the springs fail to discharge their accustomed quantity, the water of the lakes is invariably low.

As the spring season advances, the snow that had fallen during the winter is changed to water, the springs receive their accustomed supply, and the small streams are again opened, their banks being full in proportion to the amount of snow which may have fallen during the winter, added to the rapidity with which it has been melted.

The water of the lakes, in consequence of this suddenly increased quantity received from the immense number of tributaries, commences rising with the first opening of spring, and usually attains its greatest elevation, (at least in the upper lakes,) some time in the month of June or July. As the seasons advance, or during the summer and a large portion of the autumnal months, evaporation is increased, and the amount, of water discharged by the streams lessened, in consequence of which the water of the lakes falls very gradually until winter again sets in, when a still greater depression takes place from the renewed operation of the causes already mentioned.

The *extreme variation* in the height of water from winter to summer is subject to considerable change, according as the winters may vary from cold and dry to warm and wet; but during the past eight years, it may be estimated at two feet.

This annual rise and fall of the water of the lakes, dependent as it manifestly is, upon causes which are somewhat uniform in their operation, must not be confounded with that elevation and depression to which the waters are subject, independent of causes connected with seasons of the year. These latter changes which take place more gradually, sometimes undergoing but little variation for a series of years, are least liable to be noticed, unless they be very considerable: but with respect to consequences they are of vastly more importance, since they are subject to a larger and more permanent range.

That the waters of the lakes, from the earliest settlement of the country, have been subject to considerable variation in relative height, is well known. At one time the belief was very general that these changes take place at regular intervals, rising for a space of seven years, and subsiding for a similar length of time; a belief which would appear to be in consonance with that of the Indians upon the peninsula, and with whom it no doubt originated. It is not wonderful that a subject, the causes of which are so little comprehended by our natives,

should be invested with an air of mystery, or that an error once propagated (in consequence of the long series of years required to bring about any considerable change,) could scarcely be eradicated.

While the idea of the septennial rise and fall must be regarded as founded in error, it is nevertheless true that from the earliest records, the height of the lakes has been subject to a, considerable variation, usually rising very gradually and irregularly for a series of years, and after this falling in a like manner.

Our old inhabitants agree in stating that the waters were high from 1800 to 1802; in proof of which it is stated that the roads which had before been in use upon the banks of the Detroit river, were so completely inundated as to be rendered impassable. A similar circumstance is related to have occurred in the vicinity of Chicago, a broad sandy beach forming the immediate shore of the lake near that place, having been wholly overflowed.

I have been unable to obtain authentic information respecting the changes which took place between the years just mentioned and 1814, but from the latter year to the present time we have a more connected series of facts relating to the subject”.

“It is now the matter of record, that in 1814 and 1815 the Detroit and St. Clair rivers were unusually high; that the foundations of the houses, and much land that had long been under dry cultivation, were submerged. These buildings had been erected many years before, and of course under the belief that they were aloof from all but extraordinary and temporary inundations. No observations appear to have been made upon the progress of the elevation, whether it were gradual or abrupt, or whether there were any preceding seasons of a character to produce it.

“In 1820, or about; that time, the rivers had resumed their usual level. Several wharves were built at Detroit, between that year and 1828, at a height, as was supposed, sufficiently above the general level for all purposes of convenience and safety. At the latter date the rivers had again attained the elevation of 1815, and remained so until 1850, with only such occasional depressions as might be caused by strong winds, being nearly upon a level with the wharves.”²¹

From 1830, when my attention was first drawn to this subject, to the present year, I have been enabled to make a somewhat connected series of observations, under circumstances peculiarly favorable, having, during that time, followed the complete line of coast, from the foot of Lake Huron to the head of Lake Superior by canoe, and having traversed portions of the coast several times, thus being enabled to renew observations at points where they had been previously made. During the time of these examinations, I have been enabled to fix, with a considerable degree of certainty, upon the height at which the waters of the lakes stood in 1819 and '20, when they were at their lowest level; a step which was conceived to be one of the first necessity in

determining the complete range between high and low water.

²¹The above extracts arc from the pen of Col. Henry Whiting, U. S. Army, and their value is much enhanced from the fact that they embrace only such portions of the subject as were the result of his personal observation.

For the last two years my attention has been more particularly called to the coasts of Lakes Huron and Michigan, and I feel confident in asserting that the water of these lakes has, during the last year (1838), attained a greater elevation than has before occurred in a very great number of years; a fact which is conclusively shown by the renewed degradation of banks covered, with debris, that had long remained undisturbed, as well as by the great number of forest trees, sometimes covering many acres of ground, that have been, destroyed in consequence of inundation. Many of these forest trees may be estimated to have attained an age of from one to two centuries.

In order to arrive as nearly as possible at correct conclusions as to the variation in the height of the water of the lakes from 1820 to 1838, I have carefully compared my own observations with those contained in an invaluable register, kept in this city by Col. Henry Whiting, U. S. Army, as also with the valuable data contained in the report of the State Topographer, hereto appended. It should be noted that the height of the water in the Detroit river is much more subject to fluctuation from slight causes, such as the effects of the winds and ice, than that in the open lakes; causes for the operation of which, it is sometimes difficult, if not impossible, to make the proper allowance. In fact, slight causes are productive of such changes as to render it absolutely impossible to arrive at accurate conclusions, except by simultaneous observations, made at points widely separated.

Assuming June, 1819 and '20 as zero, or the point of low water, the following table will not vary very far from an accurate statement of the relative height for several of the subsequent years.

	Ft. in.
June 1819 and '20	0.00
" 1828, rise,	2.10
" 1830, same level,	2.10
" 1836, rise,	10-3.08
" 1837, "	5-4.01
" 1838, "	7-4.08 Total.

In examining this table of relative heights, it should be borne in mind that this estimate does not include the regular yearly variation to which the waters of the lakes are subject. The estimates, it will be seen, are made from June of each year, or that month in which the waters are invariably high; but it is conceived the result would not be varied were the calculations made from any other month in the year, provided the same month were selected for the observations of the succeeding years. Were the difference in height computed from February, 1820, to June, 1838, the total amount would

be found to be increased to about six feet eight inches, a method of estimating which would lead to conclusions wholly unwarranted; nevertheless the assumption of these defective premises may serve to account for the exaggerated statements which have so often been made, of the increased height of these waters.

This rise of waters has by no means been confined to the great lakes, for the waters of the small lakes through the whole interior portions of the state have, unless their waters are discharged through broad and shallow outlets, been increased in a like manner. Small streams, the width of which, at their points of intersecting the section lines, were recorded by the United States' surveyors, in those surveys made from 1820 to 26, have been found, in many instances, during the past year, to have nearly double the width assigned them; and mills have actually been erected upon streams which, according to the field notes taken in the years mentioned, must at that time have been nearly dry. It is also well known that within the last few years, (preceding 1838,) portions of the elevated country which were previously dry, have been inundated with water; springs have burst out where they had been previously unknown, and that marshes, which before contained but little water, have been transformed into small ponds or lakes.

These changes have not been peculiar to Michigan, for they have been noticed, more or less, over the whole western part of the United States, and perhaps it may not be too much to add, over most of the northern part of the continent; and they are changes which, from the immense extent affected, must, depend upon causes which have operated in a very general manner.

It is well known that the water of all streams, during the occurrence of a wet and cold season, when the fall of rain is increased and evaporation diminished, is augmented, and that; the augmentation or diminution will be in proportion as these causes are in more or less active operation. Our great chain of inland lakes, so far as these causes may be supposed to operate, may be regarded as a stream of great width, and must necessarily be liable to be affected by similar causes; although when the great extent occupied by these bodies of water is taken into consideration, it can be readily understood why these causes when once brought into operation would produce their results more slowly, as well as why the results once produced would be of a more permanent character.

That the changes in the relative height of the waters of the lakes may be dependent upon the operation of a similar series of general causes, operating for a succession of years, I have many reasons for inferring. The succession of cold and wet seasons immediately preceding 1838, have been proverbial over the whole western country; and the unfavorable influence which these wet seasons have produced, more particularly upon those farming interests situated on low and flat lands, has been severely felt by that portion of our agricultural community. While these facts may be

apparent to all, it is nevertheless desirable to refer to the subject in a more definite manner; a task which is rendered somewhat difficult, for the reason that, until the last few years, continuous tables, indicating the amount of rain which has fallen, have only been kept in a very limited number of places in the United States.

The total amount of rain which fell at Philadelphia (as shown by a register, chiefly kept at the Pennsylvania hospital) from 1810 to 1814 inclusive, or during the five years immediately preceding the high water of 1814 and '15, was 185.68 inches; and the amount which fell at the same place from 1815 to 1819, the five years immediately preceding the low water of 1819 and '20, was 151.14 inches; showing an excess of 34.53 inches, or a fraction over 2 feet and 10½ inches for the years immediately preceding the stage of high water.

The amount of rain which fell at Philadelphia, as deduced from the same table, from 1816 to 1826 inclusive,²² was 364.43 inches, and from 1827 to 1837 inclusive,²³ 451.05 inches, being an increase, in the last eleven years, of 86.62 inches, or a fraction over 7 feet 2½ inches.

The amount of rain which fell at Marietta, Ohio, (as deduced from the tables of Dr. Hildreth,) from 1819 to 1823 inclusive,²⁴ was 202.83 inches, and from 1828 to 1832 inclusive,²⁵ was 228.17, showing an increase during the last five years estimated, of 25.34 inches, or a fraction over 2 feet 1 1/3 inches.

That there has been a corresponding increase in the amount of rain that has fallen within the area of the great lake basin, I am not able to show by actual data, but the known increased size of the numerous tributaries, together with, the other facts mentioned, will go far to substantiate the opinion that the fall of rain over that area has been greatly increased during that time.

²²Eleven years, embracing the complete time from which the waters had perceptibly commenced falling, until they had again nearly attained the same altitude.

²³Eleven years, during most of which time the waters have been steadily increasing in height.

²⁴Five years, embracing the time of low water.

²⁵Five years, during most of which time the water was increasing in height.

According to the estimate of the State Topographer, it appears that the basin of the great northwestern lakes has a superficial area, nearly four times larger than that of the lakes themselves. Now if we may be allowed to assume that the increase of the amount of rain which has fallen into this basin, during the last eleven, of the fourteen years estimated, be equal to the increase at Philadelphia, during that time, it would follow that, had all sources of discharge been cut off, this cause alone would have been sufficient to elevate the waters of the lakes about 29 feet;²⁶ an elevation more than six times greater than that which is estimated to have taken place.

When we take into consideration, in connexion with the causes already enumerated, the fact that during the wet

years, evaporation must have been less than during the dry ones, it may fairly be presumed that sufficient *apparent* causes have existed, to produce all the results which have been noticed; and we may add, should a succession of dry and warm seasons follow, we may look with certainty for a return of the water of the lakes to its former low level.

SOUTHERN PART OF THE PENINSULA

A small portion of the season was devoted to general examinations, chiefly in the counties of Calhoun, Branch, Hillsdale and Jackson, but as it is proposed to commence the minute examination of these counties with the first opening of spring, it will not be desirable to lay the mass of facts collected before you at this time.

The county of Calhoun, which in an agricultural point of view cannot be looked upon as second to any county in our state, is abundantly supplied with many of those materials which, if properly appreciated, may be made to add much to the eventual prosperity and wealth of the people. But while

²⁶It is not, of course, supposed, that had the sources of discharge been cut off, this would have been the actual result, for the estimate is made without any reference to the increased evaporation and other causes, which would have been brought into action in consequence of the extended area.

the agriculturist reaps a rich reward for his labor, in abundant crops, he should not fail to bear in mind, that the soil which is now yielding so abundantly, will, unless the most watchful care be used, sooner or later be rendered comparatively sterile. With a lavish distribution of all that will be required to retain the original fertility of the soils of this county, it is to be hoped that those most deeply interested will not neglect to turn the materials around them to the best account.

The whole northern part, *at least*, of *Calhoun county*, is based upon the sandstone series of the great carboniferous group of rocks. The outcropping edge of this rock furnishes an abundance of a material well adapted to the purposes of building. Quarries have been opened, at short intervals, through nearly the whole of that portion of the county traversed by the Kalamazoo river, as well as upon several of the tributaries of that stream, and with a little care in selection, it is admirably adapted to the purposes to which that rock is usually applied.

Shell marl occurs at numerous points in the county, occasionally in beds of considerable extent, and it may be profitably applied to use, either as a manure or for the manufacture of lime, an article, of which, under other circumstances, the county would be nearly destitute.

Fibrous peat also occurs in considerable quantities, and when properly prepared, in the compost heap, will prove of great value to the farmer in enriching his lands.

The articles of marl and peat, occurring as they do, at very short intervals through most of the county, will eventually be of a value, in sustaining the agricultural interests, that at the present time can scarcely be

appreciated. It is true that most of the gravelly soils, which predominate through Calhoun county, contain at this time, sufficient calcareous matter to favor the growth of the small grains, more particularly wheat and rye, which are well known to require a comparatively large proportion of that ingredient in the soil to insure productive crops; but the time will come when this will cease to be the case, and when the marl beds must be called upon to supply the deficiency.

The county of Calhoun, together with the adjoining portions of Jackson and Hillsdale, abounds in large springs, which having their sources deep in the sandstone, are little liable to be affected by the droughts of summer. The waters of these springs are, for the most part, "hard," in consequence of the contained salts of lime, but they are usually of great transparency and coldness. Several springs were noticed, the waters of which were so highly charged with carbonate of lime, as to have given rise to somewhat extensive beds of tufaceous marl.

No rock, *in place*, was noticed in the southwestern part of Calhoun, but a little *South*, and just within the line of Branch county, a deposit occurs, which may probably be referred to one portion of the carboniferous group, though this conundrum has not absolutely been shown to exist.

The deposit consists of a tough semi-indurated and stratified clay, having at first sight much the appearance of a very fine sandstone. It contains imbedded clay iron stone, composed as usual, of thin concentric layers of the carbonate and hydrate of iron, surrounding nodular masses of septaria.

The iron ore in question is of the same character as that from which much of the iron of our neighboring state, Ohio, is manufactured, and should future examinations show the deposit to contain the ore in sufficient quantity to admit of working, it cannot fail to prove of immense importance to the surrounding country. Occurring as the ore in Branch county does, upon the borders of a township, nearly the whole of which is heavily timbered, very great facilities exist for procuring the materials necessary for its reduction.

The "kidney ore" is usually reduced with great facility, and in the large way, in the furnaces of Ohio, yields from 30 to 37 per cent of cast iron.

Portions of the clay embraced in the deposits under consideration, if care be used to select such only as is free from iron, will prove of great value for the manufacture of stone ware, fire bricks &c. The presence of lime, it is well known, renders clay unfit for the manufacture of the articles mentioned; for the reason that the clay, by this admixture, is rendered fusible at a comparatively low temperature. The great mass of the clay alluded to, contains only a minute portion of lime; and being so situated that it may be obtained with facility, it may be very advantageously applied to the purposes mentioned.

The deposit under consideration was first noticed on the Coldwater river, a short distance above the junction of that stream with the St. Joseph, where it appears in the bed of the stream, and also forms the banks, attaining an elevation of from 10 to 12 feet. The outcropping edge was traced for a distance of from one to two miles, and it was also found, but slightly covered with soil, extending over an area of from 800 to 1000 acres. It is not supposed, however, that the complete extent of its near approach to the surface has been examined, for there can be little doubt that the range will be found to be quite extensive.

Allusion has already been made to the numerous springs which occur in Calhoun county; but in no portion of the state has such an abundance of large springs been noticed as in the southwestern parts of Jackson county. Springs were here observed, frequently at very short intervals, discharging almost incredible quantities of water, and in some instances giving rise to streams of considerable size, at once. The waters of the larger of these springs are invariably found to proceed from the sandrock. They are little liable to be affected by drought, and, as I am informed, never freeze. The waters of those springs examined had, during the month of October, a temperature ranging from 47° to 49° Fahrenheit.

The counties of Branch, Hillsdale and Jackson, like that of Calhoun, abound in beds of shale and tufaceous marl, which is usually well fitted for the manufacture of lime, or for use for agricultural purposes. Ligneous peat also frequently occurs, and it may, with proper preparation, be rendered of much value as a manure.

Coal

We have been enabled, during the past year, considerably to extend the small amount of information before transmitted to you, respecting the coal beds of our state; and although, from the limited extent of the minute examinations in the coal district, I am still unable to place the subject before you in such a manner as could be wished; its great importance would, nevertheless, seem to call for an allusion, at least, to such additional information as has been obtained.

By reference to the report of C. C. Douglass, Assistant Geologist, hereto appended, on the subject of the minute surveys of Ingham and Eaton counties, it will be seen that the main bed of coal, which traverses the central counties of the state, has been traced northerly to within a few miles of the south line of Shiawassee county; and that the bed has been found of sufficient thickness to admit of being profitably worked.

Much labor will be required in order to determine the northeasterly limit of the coal range; but so many facts respecting the line of its *out-crop*, have been collected, that the labor will be considerably lessened during the continuance of the examinations. The unbroken character of the country, together with the readiness with which the rock embracing the coal, disintegrates, thus covering the out-cropping edges with debris, throw

obstacles in the way of a connected series of examinations, which are severely felt; but thus far, we have been enabled to combat these difficulties with greater success than could have been anticipated.

The line of coal has also been traced southwesterly into Jackson county, where the bed is of sufficient thickness to admit of being worked, and the coal is of a quality well fitted for all purposes to which that substance is usually applied.

Two miles, in a southeasterly direction, from the village of Barry, (Jackson county,) some explorations have been made, and an amount, estimated at about 1500 bushels of coal, raised. This coal has been applied to use in the blacksmiths' shops of the vicinity, and is mostly of good quality, although it is occasionally somewhat injured by the presence of iron pyrites. For the reason that the out-crop of this bed is nearly on a level with the water of Sandstone creek, the persons engaged in the work were unable to sink completely through the coal; it was, however, penetrated at one point, to a depth of about three feet. The immediate banks of the stream rise, by a gentle acclivity, to a height of from ten to fifteen feet, and by renewing the examinations upon that side of the stream opposite to the dip of the strata, they may be conducted free from the difficulties before mentioned. This bed of coal is associated with a series of shales and sandstones, in a manner similar to that of the other beds in the state. The coal is highly bituminous, a character in common with all that has been seen in the state, and it may safely be said that none other need be looked for on the peninsula.

From facts now before me, I am led to hope, that coal will be found in the elevated hills of the northern part of the peninsula, easterly from Little Traverse bay; a circumstance which, should it prove to be the case, will add much to the value of that portion of the state.

Salt Springs and State Salt Lands

The subject of salt springs, which was laid before you, somewhat at length, in the first annual report from this department, has been partially re-examined during the past year, and the observations considerably extended. These renewed examinations have served to add confidence to the hope then expressed, that a portion of these springs will eventually prove of value to the state. Many springs, before unknown, have been observed, and would be more particularly noticed, had not the facts, involving the *main question*, been before submitted.

The progress which had been made in the improvements directed to be commenced "at one or more of the state salt springs," has been duly submitted to you in a separate report. Since the reception of your instructions to continue the improvements, which had previously been partially suspended, the work has been renewed with a vigor commensurate with its importance. Should, the examinations in progress lead to favorable results, as we trust they will, this important addition to

the products of the state, cannot fail to add to its prosperity; while, should we fail in our anticipations, the income which may be derived from the lands, will create a sinking fund, that may soon be made to reimburse to the state, the amount which may be expended for that purpose.

Of the salt springs granted to our state by the general government, five yet remain to be located; which, with their contiguous lands, will amount to thirty sections. The location of these lands has been thus far delayed, in consequence of the unfinished condition of the United States' surveys, they not having been sufficiently completed to allow those selections to be made which were most desirable. Nor have we, as yet, been enabled to obtain from the general land office "plats" of the sections of country, in which it is proposed to complete those locations. Since, according to the terms of the grant, the returns of these lands are required to be made during the current year, it becomes a matter of no small moment to complete the selections at the earliest day possible; in view of which, so soon as the necessary information can be obtained from the general land office, steps will be taken to complete the locations.

Zoological and Botanical Departments

These departments of the geological survey, which, during the year 1837, were united under the direct charge of Dr. Abraham Sager, have, in conformity to the provisions of the revised act, been separated into two distinct departments, that of zoology having been left in charge of Dr. Sager, while that of botany was placed under charge of Dr. John Wright.

The success which has attended the labors of the heads of these departments, is of the most flattering kind, and affords ample proof that the high character which those gentlemen have sustained as men of science and industry, has not been misplaced, and that we may anticipate from their labors the most interesting and useful results.

The subjects falling within the scope of these departments, being of a more abstruse character, do not so readily admit of being treated in a disjointed manner, as the other subjects of the geological survey; for which reason the heads of these departments, in most of the states where these surveys are in progress, have not been called upon for annual reports, it being intended to embody the whole at once, in a final and connected report. As our own state is somewhat differently circumstanced, having been less explored, it was deemed advisable to throw together such catalogues as would furnish those persons who have devoted attention to the subjects in our state, a skeleton of the progress that has been made, hoping thereby to elicit such additional information as may be at hand. The reports of the zoologist and botanist, numbered 1 and 2, are hereto appended.

The fact that there is, in reality, but one science in nature, and, that all the subdivisions of that science are to a great extent, arbitrary, is frequently lost sight of in

our utilitarian age: a circumstance to which, no doubt, may in part be ascribed the general disposition to scan results closely, while the steps necessary to bring about those results are scarcely considered. We are thus too often disposed to consider as of little value or importance, those very subjects, the laborious investigation of which are daily adding to our comfort and enjoyment.

The man who should richly endow an institution would be looked upon as a benefactor; while the man of science who should engage in a patient investigation of the habits of the Hessian fly, and thereby be able to suggest some successful expedient for avoiding the ravages committed upon our wheat fields, would, no doubt, be looked upon as one engaged in a work of no value to his fellowmen; yet, if we look at results, the latter would be much more eminently entitled to the name of benefactor.

One of the fathers of natural history, after carefully studying the habits of a small worm that had proved destructive to the timber in the navy yards of his country, suggested a simple yet perfect remedy, thereby saving annually more than a million of dollars to his government; yet during these investigations, he was stigmatized as one engaged in a work which was wholly unworthy his attention, and which could not possibly prove of any practical value.

The subjects of geology may be regarded as so intimately connected with the other departments of natural history, as to be absolutely inseparable. "All the branches of natural history, and most of the other sciences, cluster around geology, and lend to it and each other a mutual support. No man can make great advances in all the branches of geology; the proper course to be pursued, is for each individual to become acquainted with the outlines of the subject, and then devote his attention to some particular branch of inquiry. It is by such a division of labor, that geology has advanced so rapidly within a few years. The geologist must have the results of such labors before he can draw definite conclusions on some points of geology."²⁷

When the work in the departments under consideration shall have been completed, it is proposed to embody in a final report, in a condensed yet intelligible manner, all that has been elicited during the progress of the examinations, as

²⁷ Governor Marcy's report to the legislature of the state of New York, on the subject, of the geological survey of that state.

well as what is now embodied in abstract works upon those subjects. While an attempt will be made to render this of value to the man of science, the subjects of general utility will, nevertheless, be kept constantly in view.

The medical properties and various uses to which the indigenous plants of our state may be applied, are at this time scarcely known, and less appreciated, by our citizens; and while we are looking abroad for many

articles necessary to our health and comfort, the very same articles, or those which will answer the purpose equally well, are growing in abundance around us.

Collections for the State University

That portion of the duties assigned the geological board, involving the collection of specimens of natural history for the university, has received as large a share of attention as a faithful performance of the other duties assigned would permit. The present time, no doubt, offers a more favorable opportunity to supply the parent university and its branches with specimens of natural history, than any that will again soon occur, in view of the limited facilities which are afforded for the study of these subjects in the colleges of our country, as also of the character which the addition of such facilities would give to our state institution, the board of regents have manifested a deep anxiety to furnish every facility in their power to aid in making these collections as perfect as possible.

The collections already made in the several departments of mineralogy, geology, zoology and botany, are in such condition that they may be readily transferred to the university, at Ann Arbor, whenever the proper arrangements shall have been made by the regents for that purpose.

The board of regents have already furnished ample rooms, in this city, as a temporary place of deposit for the collections now being made.

Topographical Department, Maps, &c.

This department of the geological survey, which was duly organized under the provisions of the act of 1838, has been placed under the immediate charge of S. W. Higgins, Esq., whose report, No. 3, is hereto appended.

The arduous duties connected with this department have been performed with a degree of energy and devotion which deserve the highest encomiums; and we trust it may result in furnishing for our state an amount of accurately delineated geographical and topographical information, which will not be exceeded by any state in our union.

The present time is an exceedingly favorable one for carrying forward this portion of the work; for at this time, while the state engineers are engaged upon our works of internal improvement, and while the United States' surveyors are engaged in subdividing the northern part of the peninsula, we are enabled, with a comparatively small amount of labor and expense, to collect a vast amount of the most accurate geographical and topographical information, which unless recorded at once would soon be lost.

The necessity for the construction of accurate geographical maps, for the delineation of the geology and topography of the state, can be easily understood: and without the former, the projection of the latter would be a dead letter. The inaccuracy of our present maps, together with, their reduced scale, is well known; and the

necessity for the construction of those of a larger and more perfect character, has been deeply felt by every person whose attention has been called minutely to the subject. In order to avoid the embarrassment which this defective character of geographical information is daily producing, it is very desirable that the remedy should be provided, with as little delay as may be compatible with the magnitude of the work.

Maps of the separate counties of the state have been commenced, upon a scale of two miles to the inch,²⁸ a size which

²⁸This scale is a fraction larger than that adopted by the surveyor general of the state of New York, for the maps of that state, which were constructed under his direction.

will enable us to place upon them most of that information which will be required for the use of town and county officers: such as the length of fractional section lines, variations in the surveys, width of streams at the crossings of the section lines, principal roads, &c. &c. Upon these maps, when completed, will also be introduced the complete geology and topography of the country.

In order that the materials upon which to base these maps may always be at hand, the complete original United States' surveys, so far as returns have been made to the land offices of the state, have been copied; and steps have been taken to procure from the general land office those new surveys in progress, immediately upon the transmission of the returns by the deputy surveyors. These "plats," however, only designate the small streams and marshes at the crossings of the section lines, leaving the whole interior of the sections to be filled up. In order to accomplish the immense work of filling up the deficiencies in the township maps, each of the assistants engaged in the survey, is instructed to take into the field perfect copies of the original surveys of the district in which he may be engaged, and to return the same with the streams carried out, across the interior of the sections, together with an accurate delineation of the marshes, small lakes, ranges of hills, the area of different kinds of soils, timbered lands, openings, prairies, the courses of the township roads, &c. &c, as also with the geology, and so much of the topography, as the work may warrant.

The difficulties connected with the construction of accurate maps, of the older counties of the state, are much increased in consequence of the inaccuracy of the original United States' surveys. In fact, so great is the discrepancy, in many instances, as to lead to the inference that some of the subdivisions were made, or platted, without going upon the ground. And where the lines, in many parts of these counties, were "run," the variation between the actual and proposed course is so great, as to render it nearly impossible to make the "work close." Many streams of considerable magnitude, are wholly omitted upon these "plats;" lakes and swamps are placed where none exist; and small lakes, in a few instances, have been found to be upon sections widely separated from those upon which they are represented,

facts which are known to have given rise to mistakes of a most serious character. Instances can be cited where lands have been purchased at the land office, by reference to the "plats" on file, and those lands afterwards found to be completely covered by the waters of a lake: others, where, in consequence of erroneous marks at the corners of sections, lands have been "entered" several miles distant from those intended; circumstances which have given rise to much individual distress.

In connection with this subject, I would respectfully call your attention to the importance of dividing the northern portion of the peninsula into counties, and assigning to each a definite limit, with as little delay as the progress of the United States' surveys will permit. The most natural divisions may as readily be determined from information which will be elicited during the continuance of the work in progress, as at any future time. By adopting this course before private interest comes to clash upon the subject, much legislation may be avoided; at the same time that it will throw those portions of our state into such a form that they may be more satisfactorily projected upon the maps now in progress. No possible objection, it is conceived, can be urged against this course, while it may fairly be supposed it will result in great good.

Reports of Geological Assistants

The reports of Messrs. C. C. Douglass and Bela Hubbard, assistants in the geological department proper, of the survey, numbered 4 and 5, are hereto appended. The great mass of geographical and topographical information which they have been industriously engaged in collecting, could not be laid before you, except in connection with complete maps of the counties in which they have been engaged. The duties which were assigned these assistants, notwithstanding the numerous difficulties by which they have been surrounded, have been accomplished in a manner highly creditable; and we have now on file nearly all the matter requisite for the complete elucidation of the condition and resources, as well as for the construction of maps of the counties, in the survey of which they have been engaged.

The consideration of that portion of the work which relates more particularly to agriculture, it has been deemed advisable, thus far, to defer, for the very good reason that sufficient time has not yet elapsed for the complete analysis of the soils, a labor which must be performed before minute practical conclusions can be drawn. The extent of certain characters of soils, in the counties examined, together with their adaptation to the purposes of agriculture, and the remedies necessary to supply any defects in their composition, are subjects, to the consideration of which much time has already been, and will hereafter be devoted.

Upon the first opening of spring, it is proposed to renew the minute surveys in the southern counties of the state, and to complete the work, in each of those counties, as rapidly as circumstances will permit.

The difficulties by which we were surrounded, in perfecting the survey, under the original act, have been removed by the present plan of organization, and moving on as a whole, the assistance and support given each, other, by the separate departments, is such, that a much larger amount of labor is accomplished than, under other circumstances, could possibly be done, while the work is, at the same time, rendered uniform and complete.

In conclusion, I would respectfully tender through you my grateful acknowledgments as well for the uniform kindness with which I have been received, as for the valuable information and assistance which has been rendered to the work in progress, by the citizens of our state.

DOUGLASS HOUGHTON,
State Geologist.

DOCUMENTS

[No. 1.]

Report of Doct. Abm. Sager, Zoologist of Geological Survey. Detroit, January 12, 1839

To Douglass Houghton, State Geologist:

Sir—In conformity to the provisions of an act approved March 22, 1838, providing for a geological survey of the state, the undersigned respectfully submits the following report of the progress made in the zoological department.

Previous to submitting the result of the investigation in this department during the past year permit me, for the satisfaction of those whose liberality and zeal for the interest of our state authorized the survey, to present a condensed view of the objects and anticipated results of the investigation in this department.

To investigate as far as practicable the mode of existence, the relative position, office and influence in the sentient organic world of every animal native to our state, from the insect, of ephemeral existence, the worm that wends its way darkling through a brief and simple life, to the quadruped of most varied and complicated structure and functions, more especially their relation to and influence, either direct and obvious, or indirect, upon the interest and happiness of man: operating by the development of our intellectual and moral natures, and ministering to our physical necessities,—to ascertain if possible the means of rendering them directly subservient to our interests and avert the evils arising from an excessive development of the species,—to collect, preserve and systematically arrange, in order to display affinities of structure, specimens of every species, and materials illustrative of their habits and instincts, the whole with a view to excite and disseminate a taste for the interesting and important study of zoology:—These appear to have been the objects contemplated by the legislature that framed and enacted the bill authorizing the investigation.

It must be obvious to every reflecting mind, that no well directed or availing efforts can be made, either to improve the advantages or avert the evils growing out of our connection with the animal world, without an intimate acquaintance with their structure, capabilities and habits. Destitute of this knowledge, we but strike in the dark, and are more likely to impair than promote our interests.

It will be seen at a glance that the subject is of vast extent; and surely if the study of the phenomena of the inorganic world, with a view to determine its general laws of which to avail ourselves to advance our interests, is worthy of encouragement as of last importance, not less so are those manifold and varied manifestations of the Infinite that constitute the phenomena of the organic world, and the proper study of the Botanist and Zoologist. Nor should we anticipate less important results when those studies have been prosecuted to the educating those general principles that rub the organic creation, than we already derive from an acquaintance with those by which the inorganic world is directed and governed. As intellectual pursuits, in moral interest and sublimity, they do not concede the palm of superiority to any other subjects whatever. Surely the mind that can view from the pinnacle of the temple of science, at a glance, the whole organic world outspread beneath him, can comprehend its vast and intricate machinery, and behold it moving by a few simple, uniform and unvarying principles, is favored with a prospect not less sublime than that to whose intellectual vision the whole Inorganic world is revealed.

As early in the season as the necessary arrangements and preparations would permit, we commenced our labor, the results of which will, in part, be found in the subjoined catalogue. Of many of the species contained in the catalogue, the requisite number of species have been preserved; of some other species, a much larger number than was required have been collected, with a view to foreign exchanges, and in consequence of the rarity of others, not a sufficient number have been secured. Besides the species enumerated in the catalogue, a very considerable number belonging to the inferior classes have been obtained, but do not yet admit of arrangement in a catalogue. Although a considerable amount of materials have been collected towards forming a history of the subjects of our investigation, yet much remains to be accomplished before the subject can be said to approach completeness.

ARM. SAGER, *State Zoologist.*

CATALOGUE

Class Mammalia

Order Quadrumana

- Fam. Vespertilionidae. Gray. Bats
- Sub-fam. Vespertilioninae. Gray.
- Vespertilio arcuatus. Say.

Order Ferae. Linn.

- Fam. Felidae
- Lupus occidentalis. Rich. Wolf
- Vulpes fulvus. L. Red fox
- Fam. Mustelidae. Sw.
- Sub-fam. Ursinae. Sw.
- Procyon lotor. L. Raccoon
- Sub-fam. Mustelinae. Sw.
- Putorius lutreola. Cuv. Mink
- Fam. Soricidae. S.
- Sorex parvus. Say. Shrew
- Scalops canadensis. Cuv. Canada mole
- Condylura macroura. Harl. Star nosed mole

Order Glires. Linn.

- Div. 1st. Claviculata
- Fiber zibeticus. L. Musk rat
- Arvicola
- Meriones canadensis. Ill. Jumping mouse
- Spermophilus Hoodii. F. Cuv.

- Sciurus vulpinus? Gm. Fox squirrel
- carolinensis. L. Gray squirrel
- Sciurus hudsonius. L. Chickaree
- niger. L. Black squirrel
- Tamia striata. Kl. Ground squirrel

Div. Inclaviculata

- Lepus americanus. Gm. American hare

Class Aves

Order Raptores

- Fam. Falconidae
- Sub-fam. Aquilinae. Eagles
- Pandion americanus. Sw. Fish eagle
- Aquila leucocephalus. Bald eagle
- Sub-fam. Buteoninae. Buzzards
- Buteo Sancti Johannis. Gm. Black hawk.
- lagopus.? Roughed legged hawk
- lineatus, Aud. Red breasted hawk
- Circus cyaneus. L. Marsh hawk
- Sub-fam. Falconinae. Falcons
- Falco peregrinus. Gm. Wandering falcon
- sparverius. L. Amer. sparrow hawk
- columbarius. L. Pigeon hawk

Sub-fam. Accipitrinae. Hawks

- Accipiter pennsylvanicus. Sw.
- Cooperi. Nutt. Cooper's hawk
- Astur borealis. Sw. Red tailed hawk

Fam. Strigidae Owls

- Scotophilus acadica. Sw. Little owl
- Otus, brachyotus. Sw. Short eared owl
- vulgaris. Sw. Long eared owl
- Asio virginiana. Sw. Great horned owl
- Ulula nebulosa. Cuv. Barred owl
- Nyctea candida. Sw. Snowy owl
- Surnia funerea. Dum. Hawk owl

Order Insectores—Perchers

Tribe Dentiostres

Fam. Laniidae

Sub-fam. Laniinae

Lanius septentrionalis. Gm. Shrike

Sub-fam. Tyranninae

Tyrannus intrepidus. Sw. Great crested king bird

crinita. Sw. King bird

inornata. Nutt.

Tyrannula fusca. Sw. Phebe

virens. Sw. Wood pewee

acadica. Sw. Little pewee

Traillii. Sw. Trail's pewee

Fam. Merulidae

Sub-fam. Merulinae

Orpheus polyglottis. Sw. Mocking bird

rufus. Brown thrush

felivox. Sw. Cat bird

migratorius. Sw. American robin

mustelinus. Sw. Wood thrush

aurocapillus. Golden crowned thrush

aquaticus. Water thrush

Fam. Sylviidae

Sub-fam. Saxicolinae

Sialia Wilsonii. Sw. Blue bird

Sub-fam. Sylvianae

Culicivora coerulea. Sw.

Sub-fam. Parianae

Setophaga ruticilla. Sw. Amer. redstart

canadensis. Sw. Canada flycatcher

Setophaga cucullata. Sw. Hooded flycatcher

Dumecola [?] *Wilsonii*. Sw. Wilson's flycatcher

Sylvicola americana. Sw. Blue yellowbacked flycatcher

discolor. Sw. Prairie warbler

coronata. Sw. yellow crowned warbler

castanea. Sw. Baybreasted warbler

icterocephala. Sw. Chestnutsided warbler

Blackburnae. Sw. Blackburnian warbler

virens. Sw. Summer yellowbird

Canadensis. Blackthroated blue warbler

Vermivora pinus. Sw. Pine warbler

chrysotera. Sw. Goldenwinged warbler

rubricapilla. Sw. Nashville warbler

Mniotilta varia. Veill. Black and white creeper

Parus palustris. L. Black cap tit

Trichas personatus. Sw. Maryland yellow throat

Fam. Ampelidae

Sub-fam. Vireoninae

Vireo olivaceus. Wils. Redeyed greenlet

Vireo flavifrons. Veill. Yellowthroated greenlet

noveboracensis. Bon. White eyed greenlet

Sub-fam. Bombycillinae

Bombycilla carolinensis. Briss. Cedar bird

Sub-fam. Garrulinae

Cyanurus cristatus. Sw. Bluejay

Fam. Sturnidae

Sub-fam. Scaphidurinae

Quiscalis versicolor. Veill. Crow blackbird

Scolecophagus ferrugineus. Sw. Rustle grackle

Sub-fam. Icterinae

Icterus Baltimore. Daud. Golden oriole

spurius. Bon. Orchard oriole

Sub-fam. Aglainae

Dolichonyx orizivora. Sw. Rice bunting

Agelaius phoeniceus. Bill. Swamp blackbird

Molothrus pecoris. Sw. Cowpen

Sturnella collaris. Bill. Meadow lark

Fam. Fringillidae

Sub-fam. Coccythraustinae

Coccyborus ludovicianus. Sw. Redbreasted grosbeak

Carduelis americana. Sw. Yellow bird.

Sub-fam. Tanagrinae

Phoenisoma rubra. Sw. Summer red bird

Pipilo erythrophthalmus. Veill. Towee bunting

Sub-fam. Fringillinae

Fringilla graminea. Wils. Ground sparrow

juncorum. Lath. Field sparrow

Zonotrichia savannarum. Sw. Savanna finch

leucophrys. Sw. White crowned sparrow

pennsylvanica. Sw. Whitethroated sparrow

melodia. Sw. Song sparrow

Ammodramus palustris. Sw. Swamp sparrow

Chondestes strigata. Sw. Lark finch

Emberiza canadensis. Sw. Tree sparrow

americana. Wils. Black throated bunting

cyanea. Sw. Indigo bird

Plectrophanes nivalis. Selb.

Sub-fam. Alaudinae

Alauda cornuta. Wils. Lark

Sub-fam. Motacillinae

Anthus aquaticus. Bech.

Tribe 3d—Scansores

Fam. Picidae

Picus villosus. L. Hairy woodpecker

pubescens. L. Downy woodpecker

Dendrocopus varius. Sw. Yellow bellied woodpecker

Dryotomus pileatus. Sw. Log cock

Colaptes auratus. Sw. Flicker

Melanerpes erythrocephalus. Sw. Redheaded woodpecker

Centurus carolinus. Sw. Carolina woodpecker

Fam. Certhiidae

Sub-fam. Certhianae

Certhia familiaris. L. Creeper

Sub-fam. Sittinae

Sitta carolinensis. L. White bellied nuthatch

Sub-fam. Trogloditinae

Thryophorus palustris. Veill. Marsh wren

Troglodytes europaeus. Winter wren

Fam. Cuculidae

Sub-fam. Cuculinae

Erythrophrys domenicus. Sw. Blackbilled cuckoo

Coccyzus americanus. Sw. Yellowbilled cuckoo

Tribe 4th—Tenuirostres

Fam. Trochilidae

Trochilus colubris. L. Humming bird

Fam. Halcyonidae

Ispida alcyon. Sw.

Fam. Caprimulgidae

Caprimulgus vociferous. L. Whippoorwill

Chordeiles americana. Sw. Night jar

Fam. Hirundinae

Cypselus pelagius. Temm. Chimney swallow

Hirundo purpureus. L. Purple martin

Hirundo rufa. Gm. Barn swallow

Hirundinae

Hirundo bicolor. Veill.

Order Rasores

Fam. Tetraonidae

Bonasia umbellus. Bon. Ruffed grouse

Tetrao cupido. L. Prairie hen

canadensis. L. Canada grouse

Ortyx virginiana. Steph. American quail

Fam. Columbidae

Ectopistes carolinensis. Sw. Turtle dove

migratorius. Sw. Passenger pigeon

Order Grallatores. Waders

Fam. Ardeidae

Ardea herodias. L. Blue heron

Egretta americana. Sw. Egret heron

Butor americana. Sw. American bittern

exilis. Sw. Least bittern

Class Reptilia

Fam. Rallidae
Fulica chloropus. Gm. Common gallinule
 atra. Wils. Common coot
Rallus virginianus. L. Virginian rail
 noveboracensis. Bon.
Fam. Scolopacidae
Scolopax minor. Gm. Woodcock
 griseus. Gm. Red breasted snipe
 Wilsonii. Bm. Wilson's Snipe
Limosa fedoa. Veill. Marbled godwit
Tringa pectoralis. Bon. Pectoral sand-piper
 minuta. Leisl. Small sand-piper
 Wilsonii. Nutt. Wilson's sand-piper
 cinerea. Knot
Totanus melanoleucus. Veill. Tell-tale
 flavipes. Veill. Lesser yellow shanks
 Bartramius. Temm. Bartram's tatler
 macularius. Temm. Spotted sand-piper
 chloropygius. Veill. Green rump sand piper

Strepsilas interpres. Ill. Turnstone
Charadriidae
Charadrius vociferus. L. Killdeer plover
 pluvialis. L. Golden plover
Squatarola melanogaster. Bech.
Order Natatores
Fam. Anatidae
Sub-fam. Anserinae
 Cygnus musicus. Bech. Swan
 Anser Canadensis. Veill. Canada goose
 Anser hyperboreus. Pall. Snow goose
Sub-fam. Anatinae. River ducks
 Mareca americana. Leach. American widgeon
 Dendronessa sponsa. Sw. Tree duck
 Chauliodus strepera. Sw. Gadwall
 Anas clypeata. Sw. Shoveller

 Boschas domestica. Sw. Mallard
 crecca. Sw. Greenwinged teal
 discors. Sw. Bluewinged teal
 obscura. Sw. Dusky duck
 Dafila caudacuta. Leach. Pintail duck
Sub-fam. Fuligulinae
Fuligula ferina. Steph. Pochard
 valisneri. Steph. Canvasback
 marilla. Steph. Scaup duck
 rufitorques. Bon. Ringneck
 Clangulla albeola. Rich. Buffelhead
 Haralda glacialis. Sw. Longtailed duck
Sub-fam. Merganidae
Mergus merganser. L. Gooseander
 serrator. L.
 cucullatus. L. Crested merganser

Fam. Colymbidae
Podiceps rubricollis. Lath. Rednecked grebe
 cornutus. Lath. Horned grebe
Dasyptilus carolinensis. Sw. Pied dobchick
Fam. Alcadae
Sub-fam. Laridae
 Sterna Hirundo. L. Swallowtailed tern
Sub-fam. Larus Bonapartii. Sw. Bonaparte's gull
 zonorhynchus. Rich.
 glaucus. Brunn.
 atricilla. Sw.

Order Chelonia

Cistudo clausa. Say. Box tortoise
Emys picta. Schw.
 geographica. Say.
 guttata. Schw.
 pennsylvanica. Harl.
Chelydra serpentina. Schw. Snapping turtle

Order Ophidia

Coluber obsoletus. Say.
 constrictor. L. Black snake
 sipedon. L. Brown water snake
 saurita. L. Ribbon snake
Coluber sirtalis. L. Garter snake
 proximus. [?] Say.
 punctatus. L.
 septemvittatus. Say.
 heterodon. Daud. Hognosed snake
 eximius. DeKay. Chicken snake
 vernalis. DeKay. Green snake
Crotalus tergeminus. Say. Rattle snake

Class Amphibia

Order Batrachia

Bufo musicus. Cuv. Toad
Hyla versicolor. LeConte. Tree toad
Rana clamitans. Daud.
 halecina. Daud. Shad frog
 palustris. LeConte. Tiger frog
 sylvatica. LeConte. Wood frog
 gryllus. LeConte. Savannah cricket
Salamandra symmetrica. Harl.
Salamandra cinerea. [?] Gr.
 undetermined
Menobranthes lateralis. Harl.

Class Pisces

Order Acanthopterygii

Fam. Percoides
 Perca flavescens? Cuv. and Val. perch
 Labrax—undetermined
 Lucioperca Americana. Cuv. Pickerel
 Pomotis auritus? Cuv.
 Centrarchus aeneus. Cuv.

Order Malacopterygii Abdominales

Fam. Cyprinidae
 Labeo Cyprinus. Cuv.
 Catostomus macrolepidotus. Les. Sucker
 nigricans. Les.
 3 species undetermined
Fam. Esoces
 Esox reticulatus. Les. Pike
 estor. Les. Muskegon
Fam. Siluridae
 Pimelodus catus. Lac. Catfish
Fam. Salmonidae
 Salmo amethystes. Mitch. Trout

Corregonus albus. Les. Whitefish
 Artedi. Les.
 Fam. Clupeae
 Hyodon tergisus. Les. Herring
 Fam. Lepisosteus. Lac.
 Order Malacopterygii Subbrachiata
 Fam. Gadceides
 Lota maculata. Cuv. Dogfish
 Order Chondropterygii
 Fam. Sturiones
 Sturio maculosus? Cuv. Sturgeon
 Fam. Cyclostomes
 Petromyzon nigricans? Les. Lamprey

DIV. MOLUSCA

Class Chonchifera

Sect. Lamellipoda
 cyclas similis. Say.
 dubiosa. Say.
 Naiadae. Fresh water bivalves
 Unio plicatus. Say.
 alatus. Say.

 purpureus. Say.
 fasciolaris. Raf.
 undulatus. Barnes.
 multiradiatus. Lea.
 circulus. Lea.
 penitus. Con.
 lapillus. Say.
 compressus. Lea.
 triangularis. Barnes.
 cariosus. Say.
 fragilis. Raf.
 subrotundus. Lea.
 coelatus. Con.
 iris. Lea.
 hildrethianus. Lea.
 siliquodideus. Barnes.

 nasutus. Say.
 rectus. Lam.
 dilatatus. Raf.
 tuberculatus. Raf.
 bullatus. Raf.
 olivarius. Raf.
 rubiginosus. Lea.
 gibbosus. Raf.
 ventricosus. Bar.
 Anodonta Ferrussaciana. Lea.
 cataracta. Say.
 Alasmodonta marginata. Say.
 undulata. Say.
 Alasmodonta edentula. Say.

Class Molusca

Order Gasteropoda
 Phyllidiana
 Patella
 Order Trachelipoda
 Colimacea
 Helix solitaria. Say.
 albolabris. Say.
 zaleta. Say.
 multilineata. Say.
 clausa. Say.
 materna. Say.
 fallax. Say.
 hirsuta. Say.
 perspectiva. Say.
 palliata. Say.
 inflecta. Say.
 thyroideus. Say.
 fraterna. Say.
 ligera. Say.
 fuliginosa. Say.
 concava. Say.
 profunda. Say.
 alternata. Say.

 tridentata. Say.
 inornata. Say.
 elevata. Say.
 arboreus. Say.
 Pupa ovata. Say.
 Succinea ovalis. Say.
 campestris. Say.
 Lymneana
 Planorbis trivolvis. Say.
 exacuus. Say.
 campanulatus. Say.
 bicarinatus. Say.
 Physa heterostrophia. Say.
 elongata. Say.
 Lymneus columellus. Say.
 elodes. Say.
 desidiosus. Say.
 stagnalis.

 Melaniana
 Melania virginica. Say.
 depygis. Say.
 Peristomiana
 Valvata tricarinata. Say.
 sincera. Say.
 Paludina decisa. Say.
 ponderosa. Say.

[No. 2.]

*Report of Doct. John Wright, Botanist of the Geological
 Survey*

Detroit, January 1st, 1839

To Douglass Houghton, State Geologist.

Sir—In compliance with the act passed by the state legislature, March, 1838, providing for the geological survey of the state, the undersigned respectfully submits the following report:

The examinations in the botanical department of the survey, during the past season, have been made in the two most southern ranges of counties of the state, from the Detroit river to Lake Michigan, excepting in the county of Monroe, and in St. Clair county.

The extensive requisitions of the bill, making it obligatory on those engaged in investigating the natural history of the state, to collect and preserve, as far as practicable, seventeen specimens of each kind of its products, has been the principal inducement for confining the sphere of action to the above mentioned portions of the state. The bulky apparatus necessary to be conveyed from place to place, during the excursion, for the preservation of the plants in such extensive collections, and the requisite conveniences for drying and protecting them, render it impracticable to examine a very great extent of country, and particularly such portions of it as are unsettled, during a single season, or until the principal mass is collected.

The plan adopted during the past season, was to make the collections in the more inhabited portions, or in such situations of the country as are the most favorable for the preservation of the plants, and get together, as far as possible, the required number of those species which are found in them.

The parts which we have examined, undoubtedly contain the majority of the whole number of species which grow in the state; and as they are sufficiently settled to possess the requisite facilities for acquiring such extensive collections, we have been enabled to accumulate a large number of specimens, which could not have been collected under any other circumstances; and, at the same time, to include in them the majority of the individual plants of the state; thereby preventing the embarrassing necessity of securing this extensive mass while investigating larger and less inhabited tracts, where these facilities are not offered.

With the able assistance of Mr. George H. Bull, assistant botanist, I have been enabled to examine between eight and nine hundred native or naturalized species of phenogamous or flowering plants; and to collect specimens of each, illustrative of their character, amounting, in all, to about nine thousand, which are now in an excellent state of preservation. More than this number of species were observed growing in the counties examined, but they were not in a proper condition for the selection of specimens for preservation at the time of observation.

A considerable number of cryptogamous or flowerless plants were also noticed and secured.

It has been our object, while making these collections, to select those specimens which will exhibit all the characters of the individuals; and for this purpose, all parts of the plant have been taken, as far as time and opportunity would admit of.

The herbaceous plants, when not too large, have been kept entire, including their roots, stems, leaves, and flowers; and when too large, suitable portions of each have been taken to illustrate them: of the wood ones, small branches with their leaves, and when practicable, flowers and fruit, have been selected for the purpose: and it is intended to make the suit more perfect by procuring sections of their trunks, which want of time

prevented us from doing, during the botanizing season. The size of the paper sheet used for holding them is 12 by 17 inches; thus allowing of the preservation of ample sized ones, which have accordingly been chosen. It has also been considered necessary to a complete herbarium, that the ripe seeds should be added, and those of a considerable number of species have been obtained for this object.

Observations relating to the individual plants have been made, with reference to their economical and medicinal uses; and to their correct analysis and individual characters. It is not my intention in this report, to give a detailed account of such observations; for this would obviously be improper, as the investigations are not finished, and, in consequence, not sufficiently complete to allow of their being made at the present time; or, if made, would cause unnecessary repetition in the final report.

For these reasons, I have thought it advisable to confine the notice of the plants, at present, to a catalogue of their names, reserving a detailed account of them for a final report; and endeavor, in the mean time, to collect such facts in regard to them, as opportunity shall offer, as will be of use both in a practical and scientific point of view.

It is my intention to examine, hereafter, those portions of the state which have not been explored, and render the collections as complete as possible.

The accompanying catalogue embraces the phenogamous and filicoid plants which have been collected.

JOHN WRIGHT, *Botanist.*

CATALOGUE

A

Acalypha virginica, Linn.²⁹ Three-seed mercury
Acer oriocarpum, Mx. Silver maple
 nigrum, Mx. Black maple
 saccharinum, Linn. Hard maple. Sugar maple
Achillea millefolium, Linn. Yarrow. Milfoil
Acnida cannabina, Linn. Water hemp. Indian hemp
Acorus calamus, Linn. Sweet flag
Actaea alba, Bw. White cohosh
 racemosa, Linn. Cohosh. Black snake root
 rubra, Bw. Baneberry
Actinomeris squarrosa, Nutt
Adiantum pedatum, Linn. Maiden hair
Aesculus glabra, Ww. Small buck eye
Agrimonia Eupatoria, Linn. Agrimony
Agropyron caninum, R. and S.
Agrostemma Githago, Linn. Cockle

Agrostis alba, Linn. White top
 clandestina? Sprengel
 lateriflora, Mx.
 tenuiflora, Ww.
 vulgaris, Smith. Red top
Aira cespitosa, Linn.
Aletris farinosa, Linn. False aloe
Alisma Plantago, Linn. Water plantain
Allium canadense, Linn. Meadow garlic
 cernuum, Roth.
 triccoccum, Aiton. Three seed leek
Alnus serrulata, Ww. Alder
Alopecurus geniculatus, Linn. Fox tail
Amaranthus hybridus, Linn.
Ambrosia elatior, Linn. Hog weed
 trifida, Linn.

²⁹For abbreviations of authors' names, see the end of the catalogue.

Amelanchier Botryapium, Lind. Shad bush. June berry
Amelanchier ovalis, Lind. Medlar bush
 sanguinea, D. C.
Amorpha canescens, Nutt. Lead plant
Amphicarpa monoica, Elliott.
Andromeda calyculata, Linn. Leather leaf
 polifolia, Linn. Wild rosemary
Anemone aconitifolia, Mx.
 nemorosa, Linn. Wood anemone
 virginiana Linn. Wind flower
Andropogon furcatus, Muhl. Fork spike
Andropogon nutans, Linn. Beard grass
 scoparius, Mx. Broom grass
 virginicus, Linn.
Angelica atropurpurea, Linn. High angelica
 triquinata, Mx.

Anethum foeniculum, Fennel
Anthemis cotula, Linn. May weed
Apios tuberosa, Moenchhausen. Ground nut
Apocynum androsaemifolium, Linn. Dog bane
 hypericifolium, Aiton. Indian hemp
Arabis canadensis, Linn. Sickie pod
 laevigata, D. C.
 lyrata, Linn.
 sagittata, Torrey
Aralia nudicaulis, Linn. Wild sarsaparilla
 racemosa, Linn. Spikenard
Arbutus Uva-ursi, Linn. Bearberry
Archemora ambigua, D. C.
Aretium lappa, Linn. Burdock
Arethusa bulbosa, Linn. Arethusa
Arenaria stricta, Mx.
 lateriflora, Linn.
Aristida stricta, Mx.
Arum triphyllum, Linn. Wild turnip. Wake robin
Artemisia canadensis, Mx. Wild worm wood

Arundo canadensis, Mx. Reed grass
 coarctata, Torrey
Asarum canadense, Linn. Wild ginger
Asclepias incarnata, Linn.
Asclepias lanceolata, Ives.
 phytolaccoides, Lyon.
 purpurascens, Linn.
 syriaca, Linn. Milk weed
 tuberosa, Linn. Pleurisy root. White root
 verticillata, Linn.
Aspidium acrostichoides, Ww.
 asplenoides, Linn.
 bulbiferum, Ww.
 filix-femina, Ww.
 intermedium, Muhl.
 noveboracensis, Ww.
 thelypteris, Ww.

Asplenium angustifolium, Mx.
 thelypteroides, Mx. Silvery spleenwort
Aster acuminatus (?) Mx.
 corymbosus, Aiton.
 diversifolius, Mx. [?]
 laxus, Ww.
 paniculatus, Aiton.
 salicifolius, (?) Pursh.
 sericeus, Nutt.
 tradescanti, Ww.
Astragalus canadensis, Linn. Milk vetch
Atheropogon apludoides, Muhl. Beard grass

B

Baptisia alba, Ww.
 tinctoria, Brown. Wild indigo
Batschia canescens, Mx. Puccoon. False bugloss
Betula excelsa, Aiton. Yellow birch
 glandulosa, Mx. Scrub birch
 papyracea, Ww. Paper birch. Canoe birch

Bidens Beckii, Torrey. Water marygold
Bidens cerneua, Linn.
 frondosa, Linn. Burr marygold. Cuckold
 petiolata, Nutt.
Blephilia ciliata, Rafinesque.
 hirsuta, Rafinesque.
Blitum virgatum, Linn. Slender blite
Botrychium fumaroides, Ww. Grape fern
 virginicum, Swartz. Rattlesnake fern
Brachelytrum aristatum, P. de B. False drop grass
Bromus ciliatus, Linn.
 pubescens, Linn.
 purgans, Linn.
 secalinus, Linn. Chess
Buchenera americana, Linn. Blue hearts

C

Cacalia atriplicifolia, Linn.
 tuberosa, Nutt.
Cakile americana, Nutt. Sea rocket
Calla palustris, Linn. Water arum
Calopogon pulchellus, Brown. Grass pink
Caltha palustris, Linn. American cowslip
Campanula americana, Linn.
 Erinoides, Muhl. Prickly bell flower
Campanula rotundifolia, Linn. Flax bell flower
Cannabis sativa, Linn. Hemp
Capsella bursa-pastoris, Moenchhausen. Shepherd's purse
Cardamine hirsuta, Linn.
 pratensis, Linn.
 rhomboidea, D. C.
Carex acuta, Linn.
 alba v. *setifolia*, Dewey
 ampullacea, Gmelin.
 anceps, Schkuhr.
 aquatilis, Wahlenberg.

 aurea, Nutt.
 bromoides, Schkuhr.
 bullata, Schkuhr.
 cephalophora, Ww.
 cespitosa, Linn.
 collecta? Dewey.
 conoidea, Schkuhr.
 crinita, La Marck.
 cristata, Schwinitz.
 curta, Gmelin.
 Deweyana, Schwinitz.
 disperma, Dewey.
 festucacea, Schkuhr.
 filiformis, Gmelin.
 flava, Linn.
 folliculata, Linn.
 formosa, Dewey.

 gracillima, Schwinitz.
 granularis, Muhl.
 hystericina, Ww.
 lagopodioides, Schkuhr.
 lacustris, Ww.
 laxiflora, LaMarck.
 limosa, Linn.
 lupulina, Muhl.
 marginata, Muhl.
 miliacea, Muhl.
 nigro-marginata? Schwinitz.
 œderi, Ehrhart.
 paniculata, Linn.
 polytrichoides, Muhl.
 psuedo-cyperus, Linn.
 pubescens, Muhl.
 retrorsa, Schwinitz.
 scabrata, Schwinitz.
 setacea, Dewey.

squarrosa, Linn.
stellulata, Schreber.
stipata, Muhl.
straminea, Ww.
sylvatica.
tenera? Dewey.
tentaculata, Muhl.
teretiuscula, Gmelin.
trichocarpa, Muhl.
trisperma, Muhl.
varia?
virescens, Muhl.
xanthophysa, Wahlenburg.

All of the marsh hay made in the state is composed of more or less of the species of the preceding genus.

Carpinus americana, Mx. Horn-beam
Carya amara, Nutt. Bitter-nut
 porcina, Nutt. Pig-nut
Cassia marylandica, Linn. American senna
Ceanothus americanus, Linn. New Jersey tea
Celastrus scandens, Linn. Climbing staff-tree
Celtis crassifolia, LaMarck. Hoop ash
Cenchrus echinatus v. *tribuloides*, Torrey. Burr-grass
Centaurella paniculata, Mx. Screw-stem
Cephalanthus occidentalis, Linn. Button-bush
Cerastium vulgatum, Linn. Chick-weed
Chelone glabra, Linn. Snake-head
Chenopodium album, Linn. Pig-weed
 ambrosioides, Linn. Sweet pig-weed
 Botrys, Linn. Oak of Jerusalem
 hybridum, Linn.
 rubrum, Linn.
Chrysosplenium americanum, Swartz.
Cicuta bulbifera, Linn.
 maculata, Linn. Water hemlock
Cinna arundinacea, Ww.

Circaea alpina, Linn.
 Leutetiana, Persoon. Enchanter's nightshade
Claytonia virginica, Linn. Spring beauty
Clematis virginica, Linn. Virgin's bower
Clintonia borealis, Rafinesque. Wild lily of the valley
Cnicus discolor, Ww. Thistle
 glutinosus, Bw.
 lanceolatus, Ww.
 odoratus, Muhl.
 Pitcheri, Torrey.
Collinsia verna, Nutt.
Collinsonia canadensis, Linn. Horse balm
Commelina angustifolia, Mx.
Comptonia asplenifolia, Aiton. Sweet-fern
Convallaria multiflora, Ww. Giant Solomon's seal
Convolvulus Sepium, Linn. Wild morning glory
 spithameus, Linn. Dwarf morning glory

Coptis trifolia, Salisbury. Gold thread
Corollorhiza multiflora, Nutt.
 verna, Nutt. Coral-root
Coreopsis palmata, Nutt.
 trichosperma, Mx.
 tripteris, Ww. Tick-seed sunflower
Coriandrum sativum, Linn. Coriander
Cornus canadensis, Linn.
Cornus circinata, Schwinitz.
 florida, Linn. Dogwood
 paniculata, L'Heritier.
 sericea, L'Heritier.
Corylus americana, Walter. Hazel-nut
Crataegus coccinea, Linn. Thorn-bush
 punctata, Jacquin. Thorn-tree
Cryptotaenia canadensis, D. C.
Cuscuta americana, Linn. Dodder.
Cynoglossum amplexicaule, Mx. Wild comfrey
 officinale, Linn. Hound-tongue

Cyperus alterniflorus, Schwinitz.
 flavescens, Linn.
 mariscoides, Elliott.
 phymatodes? Muhl.
 strigosus, Linn.
Cypripedium acaule, Aiton. Ladies' slipper
 pubescens, Swartz. Mocassin-flower
 spectabile, Swartz.

D

Dalibarda fragaroides, Mx. Dry strawberry
Danthonia spicata, P. de B. Wild oats
Datura tatula, Linn. Purple thorn-apple
Decodon verticillatum, Elliott. Swamp willow-herb
Dentaria diphylla, Mx. Tooth-root. Pepper-root
 laciniata, Muhl.
Desmodium acuminatum, D. C.
 bracteosum, D. C.
 canadense, D. C. Bush trefoil
 canescens, D. C.?
 ciliare, D. C.
 laevigatum, D. C.
 marylandicum, D. C.
 nudiflorum, D. C.
 obtusum, D. C.
 paniculatum, D. C.
 rotundifolium, D. C.
 strictum, D. C.
Diarrhena americana, P. de B.
Diervilla canadensis, Ww. Bush honeysuckle
Digitaria filiformis, Elliott.
 sanguinalis, Scopoli. Finger-grass
Dioscorea villosa, Linn. Yam-root
Dracocephalum virginianum, Ww. Dragon-head
Drosera longifolia, Linn.
 rotundifolia, Linn. Sundew
Dulichium spathaceum, Persoon. Galingale

E

Eleusine indica, LaMarck.
Elymus canadensis, v. *glaucifolius*, Torrey.
 Hystrix, Linn. Hedgehog-grass
 villosus, Muhl. Lime-grass
 virginicus, Linn. Wild rye
Epigaea repens, Linn. Trailing arbutus
Epilobium coloratum, Muhl.
 lineare, Muhl.
 molle, Torrey.
Epiphegus virginianus, Barton. Beech-drops
Erigeron bellidifolus, Ww.
 canadense, Linn. Flea-bane
 heterophyllus, Muhl.
 philadelphicus, Linn.
 strigosus, Muhl.
Eriocaulon pellucidum, Mx.

Eriophorum angustifolium? Bw.
 polystachyon, Linn. Cotton grass
Eryngium aquaticum, Linn. Button snake root
Erythronium americanum, Smith. Dog tooth violet
Euchroma coccinea, Nutt. Painted cup
Euonymus americanus, Linn.
 obovatus, Nutt.
Eupatorium ageratoides, Linn.
 amoenum, Pursh.
 perfoliatum, Linn. Boneset, Thorough wort
 sessilifolium, Linn.
Euphorbia corolata, Linn.
 maculata, Linn.
 polygonifolia, Linn.
Equisetum arvense, Linn. Horse tail
 hyemale Linn. Scouring rush
 limosum, Torrey.

F

Fagus sylvatica, Linn. Beech
Festuca duriuscula? Linn.
 nutans, Ww.
 tenella, Ww.
Fragaria virginiana, Linn. Strawberry
Frasera caroliniensis, Walter. Columbo
Fraxinus acuminata, La Marck. White ash
 pubescens, Walter. Red ash
 sambucifolia, Ww. Black ash
Fuirena squarrosa, Mx.

G

Galeopsis Tetrahit, Linn. Flowering nettle
Galium asprellum? Mx.
 boreale, Pursh.
 circaeazans, Mx.
 lanceolatum, Torrey
 obtusum? Bw.
 pilosum, Aiton.
 tinctorium, Linn. Wild madder
 trifidum, Linn.
Gaultheria hispidula, Muhl.
 procumbens, Linn. Wintergreen
Gaura biennis, Linn. Virginian loosestrife
Gentiana crinita, Froelich. Fringed gentian
 quinqueflora, Ww.
 saponaria, Linn. Soap gentian
Geranium maculatum, Linn. Crane's bill
 robertianum, Linn.
Gerardia auriculata, Mx.
 flava, Linn. False foxglove
 glauca, Eddy.
 pedicularia, Linn.
 purpurea, Linn.

Geum rivale, Linn. Purple avens
 strictum, Aiton. Upright avens
 virginianum, Linn. Avens
Gleditschia triacanthos, Linn. Honey locust
Glyceria fluitans, Brown. Water fescue grass
Gnaphalium plantagineum, Linn.
 polycephalum, Mx. Life everlasting
 uliginosum, Linn. Cud weed
Goodyera pubescens, Brown. Rattle snake plantain
Gyromia virginica, Nutt. Indian cucumber

H

Habenaria bracteata, Brown. Vegetable satyr
 ciliaris, Brown. Orchis
 dilatata, Pursh. Giant orchis
 fimbriata, Brown.
 grandiflora, Torrey.
 herbiola, Brown.
 huronensis, Sprengel.
 orbiculata, Pursh.
 psycodes, Sprengel.
 tridentata, Hooker.
Hamamelis virginica, Linn. Witch hazel
Hedeoma pulegioides, Persoon. Pennyroyal

Helenium autumnale, Linn.
Helianthemum canadense, Mx. Rock rose
Helianthus altissimus, Linn.
 divaricatus? Linn.
 frondosus, Ww.
 giganteus, Linn.
 gracilis
 strumosus, Linn.
 trachelifolius, Ww.
Heliopsis laevis, Persoon.
Hepatica acutiloba, D. C.
 americana, D. C. Liverwort

Heracleum lanatum, Mx. Masterwort. Cow parsnip
Heuchera americana, Linn. Alum root
Hibiscus trionum, Linn.
Hieracium Gronovii, Linn.
 kalmii, Linn.
 marianum, Ww.
Paniculatum, Linn.
 scouleri, Hedwig.
 venosum, Linn. Blood wort
Hippophae canadensis, Ww. Sea buckthorn
Hippuris vulgaris, Linn.
Houstonia cillolata, Torrey.

Hydrastis canadensis, Linn. Golden seal. Yellow root
Hydrocotyle umbellata, Linn.
Hydropeltis purpurea, Mx. Water shield
Hydrophyllum canadense, Linn. Rough burr flower
 virginicum, Linn. Burr flower
Hypericum ascyroides, Ww.
 canadense, Linn.
 parviflorum, Ww.
 prolificum, Linn.
 punctatum, La Marek.
 virginicum, Linn.
Hypoxis, erecta, Linn. Star grass
Hyssopus nepetoides, Ww. Giant hyssop
 scrophularifolius, Ww.

I

Ictodes foetidus. Bw. Skunk cabbage
Impatiens fulva, Nutt. Speckled jewels
 palida, Nutt. Jewel weed
Inula Helenium, Linn. Elecampane
Iris versicolor, Linn. Wild flag
Isnardia palustris, Linn. Water purslane

J

Juncus acuminatus, Mx.
 bufonius, Linn.
 effusus, Linn. Bulrush
 nodosus, Linn.
 polycephalus, Mx.
 cetaceus, Rostk.
 tenuis, Ww.
Juniperus communis, Linn. Juniper
 virginianus, Linn. Red cedar

K

Kalmia glauca, Aiton. Swamp laurel
Krigia amplexicaulis, Mx.
Koeleria nitida, Nutt.
 pennsylvanica, D. C.
 truncata, Torrey.
Kuhnia critonia, Ww.

L

Lactuca elongata, Muhl. Wild lettuce
sanguinea, Bw. Wood lettuce
Lathyrus ochroleucus, Hooker.
myrtifolius, Muhl.
palustris, Linn. Marsh pea
venosus, Muhl.
Laurus Benzoin, Linn. Spice bush. Fever bush
sassafrass, Linn. Sassafrass tree
Lechea major, Mx. Pinn weed
Leersia oryzoides, Swartz. Cut grass
virginica, Ww. White grass. Rice grass
Lemna minor, Linn. Green duck meat
polyrrhiza, Linn. Water flax seed
triscula, Linn. Duckmeat
Leontice thalictroides, Linn. Poppoose-root. False cohosh
Leontodon Taraxacum, Linn. Dandelion

Leonurus cardiaca, Linn. Motherwort
Lepidium virginicum, Linn. Wild peppergrass
Leptandra virginica, Linn. Culver's physic
Lespedeza angustifolia, Elliott.
capitata, Mx.
polystachia, Mx.
prostrata? Pursh.
reticulata, Persoon.
violacea, Persoon.

Liatris cylindrica, Mx.
scariosa, Ww.
spicata, Ww. Gay feather
squarrosa? Ww.

Lilium canadense, Linn. Nodding lily
philadelphicum, Linn. Red lily

Lindernia attenuata, Muhl. False hedge hyssop
dilatata, Muhl. Pimpernel
Linnaea borealis, Gronovius. Twin flower
Linum usitatissimum, Linn. Flax
virginianum, Linn. Wild flax
Liriodendron tulipifera, Linn. Whitewood. tulip tree
Lithospermum officinale, Linn. Gromwell
Lobelia cardinalis, Linn. Cardinal flower

Claytoniana, Mx.
Kalmii, Linn.
siphilitica, Linn.

Lolium temulentum, Linn.

Lonicera parviflora, LaMarck.

Ludwigia alternifolia, Ww. Seed box

Lupinus perennis, Linn. Wild lupine

Luzula campestris, D. C.
pilosa, Ww.

Lycopus europeus, Linn. Water horehound
virginicus, Linn. Bugle-weed

Lysimachia capitata, Pursh.
ciliata, Linn. Money wort
hybrida, Mx.
quadrifolia, Linn.
revoluta, Nutt.
stricta, Aiton. Loosestrife

Lythrum Salicaria, Pursh. Milk willow herb
Lycopodium complanatum, Linn. Ground pine
lucidulum, Mx. Moon-fruit pine

M

Malaxis lillifolia, Ww. Twayblade
Malva rotundifolia, Linn. Low Mallows
Marrubium vulgare, Linn. Horehound
Melanthium glaucum, Nutt.
Menispermum Canadense, Linn. Moonseed
Mentha borealis, Mx. Horsemint
piperita, Smith. Peppermint
Menyanthes trifoliata, Linn. Buckbean
Microstylis ophioglossoides, Nutt.
Milium effusum, Linn. Millett
pungens, Torrey. Dwarf milletgrass
Mimulus alatus, Linn.
ringens, Linn. Monkey flower

Mitchella repens, Linn. Checkerberry. Partridgeberry
Mitella cordifolia, LaMarck.
diphylla, Linn. Currant leaf
Momordica echinata, Muhl.
Monarda allophylla, Mx.
punctata, Linn.
Mollugo verticillata, Linn. Carpet weed
Monotropa uniflora, Linn. Indian pipe-bird's nest
Muhlenbergia diffusa, Schreber. Dropseed grass
Myriophyllum verticillatum, Linn. Water milfoil

N

Nasturtium amphibium, Brown. Water radish
natans, D. C.
palustre, D. C.
Nemopanthes canadensis, D. C. Wild holly. Mountain holly
Nemophila paniculata, Sprengel.
Nepeta cataria, Linn. Catnip
Nicandra physaloides, Persoon
Nuphar advena, Aiton.
Kalmiana, Aiton.
Nymphaea odorata, Aiton. White pond lily
Nyssa multiflora, Walter. Pepperidge.

O

Oenothera biennis, Linn. Scabish
fruticosa, Linn. Sundrops
muricata, Linn.
pumila, Linn.
Onoclea sensibilis, Linn. Sensitive fern
Onosmodium hispidum, Mx. False gromwell
Orobancha americana, Linn.
uniflora, Linn. Squaw root. Cancer root
Oryzopsis asperifolia, Mx. Mountain rice
Osmorhiza brevistylis, D. C.
longistylis, D. C. Sweet cicely
Osmunda cinnamomea, Linn. Flowering fern
interrupta, Mx.
regalis, Mx.
Ostrya virginica, Ww. Hop hornbeam. Iron wood
Oxalis stricta, Linn. Yellowwood sorrel. Sheep sorrel
Oxycoccus macrocarpus, Pursh. Cranberry

P

Panax quinquefolia, Linn. Ginseng
trifolia, Linn. Dwarf groundnut

Panicum capillare, Linn.
crus-galli, Linn. Barn grass
dichotomum? Linn.
nervosum, Muhl.
nitidum, LaMarck, and varieties. Panic grass
pubescens, LaMarck.
virgatum, Linn.
Parnassia americana, Muhl. Flowering plantain
Pastinaca sativa, Linn. Parsnip
Pedicularis canadensis, Linn. Lousewort
pallida, Pursh.
Penthorum seaboides, Linn. Virginian orpine
Pentstemon pubescens, Aiton. Beard tongue
Phalaris americana, Elliott. Wild canary grass
Phaseolus diversifolius, Persoon.
Phleum pratense, Linn. Timothy grass
Phlox aristata, Mx.
Phragmites communis, Trinius. Common reed
Phryma leptostachya, Linn. Lopseed
Physalis obscura, Mx. Ground cherry
Phytolacca decandra, Linn. Pokeberry
Pinus pendula, Aiton. Tamarack. Hackmatack
resinosa, Aiton. Yellow pine. Red pine
strobus, Linn. White pine
Piptatherum nigrum, Torrey. Clustered millet grass
Pisum maritimum, Linn.
Plantago cordata, LaMarck.
lanceolata, Linn. Snake plantain
major, Linn. Plantain
Platanus occidentalis, Linn. Buttonwood. Sycamore
Poa annua, Linn.
aquatica v. *americana*, Torrey.
capillaris, Linn.
compressa, Linn. Bluegrass
eragrostis, Linn.
hirsuta, Mx.
memoralis, Linn.
nervata, Ww.
pratensis, Linn. English grass. Meadow grass
reptans, Mx.
serotina, Ehrhart.
trivialis, Linn. Pasture grass
Podophyllum peltatum, Linn. Mandrake. May apple
Pogonia ophioglossoides, Brown. Snake-mouth arethusa
Polanisia graveolens, Rafinesque
Polygala cruciata, Nutt.
paucifolia, Ww. Flowering wintergreen
paucifolia v. *alba*, Eights.
purpurea, Nutt.
Senega, Linn. Seneca snake-root
verticillata, Linn. Dwarf snake root
Polygonum amphibium, Linn. Mud knot-weed
arifolium, Linn.
aviculare, Linn. Knot-grass
Convolvulus, Linn. Blind knot-weed
Fagopyrum, Linn. Buckwheat
lappathifolium, Linn.
mite, Persoon. Tasteless knot-weed
pennsylvanicum, Linn.
persicaria, Linn. Heart's ease, Lady's thumb
punctatum, Elliott. Water pepper
sagittatum, Linn.
scandens, Linn.
tenue, Mx.
virginianum, Linn.
Polymnia canadensis, Linn. White leaf-cup
Uvedalia, Linn. Yellow leaf-cup
Polypogon racemosus, Nutt.
Pontederia cordata, Linn. Pickerel-weed
Populus canadensis, Mx.
candicans, Aiton. Balsam poplar
grandidentata, Mx. Tree poplar
tremuloides, Mx. White poplar. American aspen
Porcelia triloba, Persoon. Pawpaw. Custard apple
Portulacca oleracea, Linn. Purslane
Potamogeton heterophyllum, Schreber.
natans, Linn. Pond-weed
lucens, Linn.
pectinatum, Linn.
perfoliatum, Linn.
zosterifolium. Trinius.
Potentilla Anserina, Linn. Tansey cinquefoil, Silver-leaf
arguta, Pursh.
canadensis, Linn. Five-finger
Comarum, D. C. Marsh five-finger
fruticosa, Linn. Shrubby cinquefoil
norvegica, Linn. Cinequefoil
Prenanthes racemosa, Mx.
Serpentaria, Pursh.
Prinos verticillatus, Linn. Winterberry. False alder
Prunella vulgaris, Linn. Heal all. Self heal
Prunus americana, Marshall. Meadow plum
depressa, Pursh. Sand cherry
obovata, Beck.
pennsylvanica, Aiton.
Ptelea trifoliata, Linn.
Pteris aquilina, Linn. Common brake
Pycnanthemum virginicum, Persoon. Virginian thyme
Pyrola elliptica, Nutt. White wintergreen
rotundifolia, Linn. Shin-leaf
secunda, Linn. One-sided shin-leaf
umbellata, Linn. Prince's pine
Pyrus coronaria, Linn. Crab apple
melanocarpa, Ww.

Q

Quercus alba, Linn. White oak
bicolor, Ww. Swamp white oak
imbricaria, Mx. Shingle oak. Laurel oak
macrocarpa, Linn. Over-cup oak. Burr oak
rubra, Linn. Red oak
Queria canadensis, Linn. Forked chickweed

R

Ranunculus abortivus, Linn.
acris, Linn. Crowfoot. Butter-cup
aquatilis, Linn. Water crowfoot
fascicularis, Muhl
lacustris, Beck and Tracy. Lake crowfoot
pennsylvanicus, Linn.
recurvatus, Poiret
repens, Linn.
Ranunculus sceleratus, Linn. Celery crowfoot
Rensselaeria virginica, Beck. Water arum
Rhamnus franguloides, Mx. Dwarf alder
Rhus copallina, Linn. Mountain sumach
glabra, Linn. Sleek sumach
radicans, Linn. Poison ivy
toxicodendron, Linn. Poison ash
typhina, Linn. Sumach
venenata, D. C. Poison elder. Poison sumach

Rhynchospora alba, Vahl.
glomerata, Vahl. False bog rush
Ribes floridum, L'Heritier. Wild black currant
gracile, Mx.
triflorum, Ww. Wild gooseberry
Rochelia lappula, R. and S.
virginiana, R. and S.
Rosa carolina, Linn. Swamp rose
parviflora, Ehrhart. Wild rose
Rubus frondosus, Bw. Leafy raspberry
occidentalis, Linn. Thimbleberry. Black raspberry
sexatilis, Mx.
trivialis, Mx. Creeping Blackberry. Dewberry
villosus, Aiton. High blackberry

Rudbeckia hirta, Linn.
laciniata, Linn. Cone-flower
pinnata, Mx.
purpurea, Linn.
Ruellia strepens, Linn. Ruel
Rumex acetosellus, Linn. Field sorrel
acutus, Linn.
britannicus, Linn.
crispus, Linn. Yellow dock

S

Sabbatia angularis, Pursh. American centaury
Sagittaria sagittifolia, Linn. Arrow-head
Salix Muhlenbergia, Ww. Speckled willow
recurvata, Pursh. Shrub willow
rosmarinifolia, Linn. Rosemary willow
Sanguinaria canadensis, Linn. Blood-root
Sambucus canadensis, Linn. Black-berried elder
pubescens, Persoon. Red-berried elder
Sanguisorba canadensis, Linn. Burnet saxifrage
Sanicula marylandica, Linn. Sanicle
Saponaria officinalis, Linn. Soap-wort. Bouncing Bet
vaccaria, Linn. Field soap-wort

Sarracenia purpurea, Linn. Side-saddle
Saururus cernuus, Linn. Lizard's tail
Saxifraga pennsylvanica, Linn. Water saxifrage
Scheuchzeria palustris, Linn. Less flowering rush
Schoenus mariscoides, Muhl. Water bog rush
Schollera graminea, Barton. Yellow-eyed water-grass
Scirpus acicularis, Linn.
acutus, Muhl.
americanus, Persoon.
autumnalis, Linn.
brunneus, Muhl.
capillaris, Linn.
capitatus, Linn.

Erisphorum, Mx.
equisetoides, Elliott.
lacustris, Linn.
lineatus, Mx.
macrostachyos, Muhl.
palustris, Linn. Marsh club rush
spadiceus, Linn.
sub-squarrosus, Muhl.
sub-terminalis, Torrey.
tenuis, Ww. Club rush
Scleria triglomerata, Mx. Whip-grass
Scrophularia lanceolata, Pursh.
marylandica, Linn. Fig-wort
Scutellaria ambigua, Nutt.
cordifolia, Muhl.
galericulata, Linn. Scull-cap
lateriflora, Linn. Mad-dog scull-cap

Senecio Balsamitae, Muhl. Balsam groundsel
hieracifolius, Linn. Fire-weed
Senecio vulgaris, Linn. Groundsel
Setaria glauca, P. de B. Fox tail. Panic grass
Sida Abutilon, Linn. Indian mallows
Silene antirrhina, Linn. Sleepy catch fly
stellata, Aiton.
Silphium gummiferum, Elliott. Rosin plant
perfoliatum, Linn. Ragged cup
terebinthinaceum, Linn. Prairie dock
Sinapis nigra, Linn. Black mustard
Sisymbrium officinale, Scopoli. Hedge mustard
Sisyrinchium anceps, Cavanilles. Blue eyed grass
Sium latifolium, Linn. Water parsnip
Smilacina bifolia, Des Fontaines. Dwarf Solomon's seal
racemosa, Des Fontaines. Spiked Solomon's seal
stellata, Des Fontaines

Smilax herbacea, Linn. Bohea tea
peduncularis, Muhl. Jacob's ladder
rotundifolia, Linn. Horse brier. Green brier
Solanum nigrum, Linn. Deadly nightshade
Solidago axillaris, Pursh.
canadensis, Linn. Canadian golden rod
juncea, Aiton.
flexicaulis, Linn.
lanceolata, Aiton.
memoralis, Aiton.
rigida, Linn.
serotina, Aiton. Smooth golden rod
Sonchus oleraceus v. *aspera*, Linn. Sow thistle
Sparganium americanum, Nutt. Lake burr reed
ramosum, Smith. Burr reed
Spartina cynosuroides, Ww. Spiked salt grass

Spergula arvensis, Linn.
Spiraea lobata, Jacquin.
opulifolia, Linn. Nine bark, hard hack. Snow ball
salicifolia, Linn. Willow hard hack
tomentosa, Linn. Steeple bush
Spiranthes cernua, Richard. Nodding ladies' tresses
gracilis, Beck.
tortilis, Richard.
Stachys aspera, Mx. Hedge nettle
hyssopifolia, Mx.
Staphylea trifolia, Linn.
Stellari longifolia, Muhl.
media, Smith. Chick weed
Stipa avenacea, Linn.
juncea, Pursh.
Streptopus roseus, Mx. Rose bell-wort

T

Teprosia virginica, Persoon. Goat's rue
Teucrium canadense, Linn. Wood sage

Thalictrum cornuti, Hooker.
dioicum, Linn. Meadow rue
Thaspium barbinode, Nutt.
Thesium umbellatum, Muhl. False toad flax
Thuja occidentalis, Linn. White cedar. Arbor vitae
Tiarella cordifolia, Linn. Mitre wort
Tilia glabra, Ventenat. Basswood. Limetree
Toffieldia glutinosa, Mx.
Tradescantia virginica, Linn. Spider wort
Trichodium laxiflorum, Mx.
scabrum, Muhl.
Tricuspis sesleroides, Torrey. Red top

Trientalis americana, Pursh. Chick wintergreen
Trifolium pratense, Linn. Red clover
 repens, Linn. White clover
Triglochin maritima, Linn. Arrow grass
 palustre, Linn. Marsh arrow grass
Trillium erectum, Linn. False wake robin
 erythrocarpum, Mx. Smiling wake robin
 grandiflorum, Salisbury.
Triosteum perfoliatum, Linn. Fever root. Wild coffee
Triphora pendula, Nutt. Three bird orchis
Trisetum purpurascens, Torrey.
Typha latifolia, Linn. Cat tail. Reed mace

U

Ulmus fulva, Mx. Slippery elm. Red elm
Urtica canadensis, Linn. Canada nettle. Albany hemp
 capitata, Linn.
 dioica, Linn. Common nettle
 pumila, Linn. Stingless nettle
Utricularia fornicata? LeConte.
 gibba, Gronovius.
 macrorhiza, LeConte. Bladder wort
 purpurea, Walter.
Uvularia grandiflora, Smith.
 sessilifolia, Linn.

V

Vaccinium pennsylvanicum, LaMarck. Whortleberry
 resinosum, Aiton. Black whortleberry
Verbascum Blattaria, Linn. Moth mullein
 thapsus, Linn. Mullein
Verbena caroliniana? Pigmy vervain
 hastata, Linn. Vervain
 urticifolia, Linn. Nettle leaf vervain
Vernonia nove boracensis, Ww. Flat top
Veronica Anagallis, Linn. Brook pimpernel
 arvensis, Linn. Wall speedwell
 beccabunga, Linn.
 scutellata, Linn. Scull-cap speedwell
Viburnum acerifolium, Linn. Arrow wood
 oxycoccus, Pursh. High cranberry
 pubescens, Pursh.
Vicia americana, Muhl.
 caroliniana, Walter.
 cracca, Linn. Tufted vetch
Vitis aestivalis, Mx. Summer grape
 riparia, Mx. Odoriferous grape
Viola blanda, Ww. Smooth violet
 canadensis, Linn.
 cucullata, Aiton. Blue violet
 muhlenbergiana, Genging. Slender violet
 ovata, Nutt.
 pedata, Linn.
 pubescens, Aiton. Yellow violet
 rostrata, Muhl. Beaked violet

X

Xanthium strumarium, Linn. Clot burr
Xanthoxylum fraxineum, Ww. Prickly ash
Xylosteum ciliatum, Pursh. Twin berry
Xyris caroliniana, Walter. Yellow eyed grass

Z

Zizania aquatica, Lambert. Wild rice, Wild oats
Zizia aurea, Koch. Meadow parsnip
 cordata, Koch. Alexanders
 integerima, D. C.

Bw. Bigelow.
 D. C. DeCandole.
 Lind. Lindley.
 Linn. Linneaus.
 Mx. Michaux.
 Nutt. Nuttall.
 Muhl. Muhlenberg.
 P. de B. Palisot de Beauvois.
 R. & S. Roemer & Schultes.
 Ww. Willdenow.

[No. 3.]

Report of S. W. Higgins, Topographer

To Douglass Houghton, State Geologist, Michigan:

Sir—I herewith present a summary of the proceedings of the department which you did me the honor to place under my charge, with such facts in relation thereto as have been deemed of importance.

It is fortunate for the success of our undertaking, that in the new states the surveys of the general government have superceded the necessity of a large expenditure of time and funds in developing the surface of the country, by means of trigonometrical surveys. In order, therefore, to determine what strictly belongs to this branch, it was presumed that the information which might be obtained by referring to the several land offices, would prove sufficient.

It was thus my first object to make copies of all the records in the state, and collect from every source all the information in my power. For that purpose, after commencing with the Detroit land office, I proceeded to Flint; from thence to Ionia and Kalamazoo, and lastly to Monroe, where this part of my labors terminated, having obtained copies of 763 townships. These I set about compiling immediately into counties, connecting the sectional lines and streams. Copies of the counties, on a lineal scale of two miles to the inch as well as separate townships on an enlarged scale, have been used by the geographical corps successfully in their explorations, for the purpose, not only of noting the geology in detail, but of delineating the true course of the smaller streams, the extent of swamps and marshes, public roads and improvements. Incorrectness will not be owing to the want of labor or attention bestowed, and from the materials in progress of collection, a certainty arises of a more correct execution of the maps to be made hereafter, than of any heretofore constructed.

It is to be regretted that there are so few statistics of the lakes. Many of the particulars which I have inserted appear indefinite for the want of more certain data; particularly their depth. In general, too much is left to conjecture, and until the necessity is urged upon the general government for a thorough hydrographical survey, and accurate descriptions of every part of them, losses and disappointment will check the ardor of enterprise. Much of the destruction of property may be

charged to the want of charts, and the losses of a single year will amount to far more than the cost of an entire survey. A commencement of such a survey was made when Gov. Cass occupied the war department, but ceased at the end of two years having extended from the foot of Lake Huron to Middle Island.³⁰

For a description of our topographical location, data were readily obtained from the records of the public works in the

³⁰This survey simply included meanderings.

adjoining states. Their various public improvements have led to the exploration of every point of importance, and from a comparison of these points, with the records of our own public works, the true position of every required place on the southern portion of the peninsula may be relatively known.

Topographical location of Michigan

The topography of the state of Michigan, when viewed in relation to its exterior position, being separated by a natural boundary of rivers and lakes on the east and north-east from Upper Canada, from Illinois and Wisconsin on the west and south west, and from Ohio and Indiana on the south, or only in reference to the space included within its own political and isolated boundaries, presents many peculiar features.

Lake Michigan on the west and north-west, Lake Huron. the river and lake St. Clair, the straits of Detroit, with the west end of Lake Erie on the east and north-east, enclose a peninsula forming a cone, of which the straits of Mackinaw is the apex, the south line or base being one hundred and seventy-four miles east and west, and the length north and south three hundred miles. With this extent of coast, the number of large rivers, and the infinity of small interior lakes, gives the utmost facilities to internal navigators, add to this the superior quality of the soil, its easy tillage, the heavy and abundant crops, and perhaps the whole is not surpassed by any section of equal extent on the surface of the globe.

The northern or upper peninsula belongs to a higher level. Beginning at the eastern end of Lake Superior, and running southerly along the Sault de Ste. Marie's river, it lies nearly at right angles with the southern or peninsula proper, and separated from it by a part of Lake Michigan and Green Bay, as far as Menomonee river. It thence takes a northwest course to Montreal river, from the mouth of which, it follows the southern shore of Lake Superior to the place of beginning; presenting an irregular and nearly isolated form, varying from twenty to one hundred and twenty-five miles in width.

Michigan, with the states west and southwest, are designated by geographers, as laying [sic] west of the great dividing ridge which determines the course of the rivers falling into the Atlantic on one side, and the Mississippi on the other. This Appalachian ridge, rising in Alabama, runs north-east, varying in altitude, to the gulf of the St. Lawrence, in many places spreading out into broad mountainous districts of thousands of square

miles in extent. These districts being occupied by subordinate ridges, are often cut through by rivers, causing depressions, or valleys of corresponding depth. If, however, in, tracing the continuation of the great ridge, across the St. Lawrence to Labrador, it should be found that the same system continued, then the important fact would be elicited, that it had been cut through by that river, the only occurrence of the kind, from its source on the south, to its termination in the north. The Potomac, the Susquehanna and the Mohawk rivers have their sources on its eastern declivity. The lowest pass across the slate of New York on the line of the Erie canal, is 565 feet, above tide water; the medium height, however, a few miles south, commencing at Catskill, on the Hudson, and terminating at Portland harbor on Lake Erie, is thirteen hundred feet, presenting no height less than nine hundred and eighty five feet, and the greatest twenty-one hundred and forty-four feet. With these and other surveys, it has been ascertained, that a water communication could not be made across the country south of the state of New York."

Further south the elevation is no where less than twenty-four hundred and seventy-eight feet above the ocean. The Round Top at Catskill mountains, is thirty-eight hundred and four feet, and the High Peak, thirty-seven hundred and eighteen feet above tide water. The western part of the state bordering on Lake Erie, embracing Chautauque and Cattaraugus counties, Warren and McKeen counties of Pennsylvania, and the country southward, are occupied by a mountainous ridge: "Chautauque lake, the largest sheet of water on this table, is twelve hundred and ninety-one feet above the level of the ocean, and seven hundred and twenty-three feet above Lake Erie, though only nine miles distant: its discharged waters descend to the ocean, along the western declivity of the Appalachian range, through the Ohio and Mississippi rivers. The lowest pass to the east over a swell of land near Cassadaga outlet, in Chautauque county, is seventeen hundred and twenty feet high, and another pass on the same swell, nineteen hundred and seventy-two feet. The lowest niche in the height of land, between Kim and Little Valley creeks, in Cattaraugus county is seven, teen hundred and twenty-five feet, and between Little Valley and Big Valley, the lowest pass is twenty-one hundred and eighty feet above the level of the ocean. Franklinville has an elevation of fifteen hundred and eighty feet, and Angelica fourteen hundred and twenty-eight feet, although both are situated in valleys. This height of land extends close to the shores of Lake Erie, as it may be seen that the Allegany, a tributary to the Ohio, rises within four or five miles of the lake."

To the north this ridge gradually declines, until near the southern shore of Lake Ontario. Seven miles north of the cataract of the Niagara, it takes its last step to the margin of the lake. The ridge of rocks which forms this step continues eastward, and passes round the border of the lake, being of a uniform elevation of three hundred and nineteen feet; causing not only the cataract of Niagara, but also those of Genesee, Oswego, and the

Black rivers. It thence unites with the more elevated spurs of Chateaugay, south of Montreal, forming the eastern boundary of the great basins of Lake Erie and Ontario, and giving the direction to the course of the St. Lawrence river through its whole length.

From the foregoing remarks, it is observable that the great basins or depressions of these lakes, are the abrupt terminations of the mountain range, and that we fall immediately into an extensive district, different in its topographical features, the peculiarities of which belong only to the region of the great lakes which bound the principal part of the northern frontier of the Union.

Leaving Chautauque county and passing around the south shore of Lake Erie, this ridge falls off to the southwest, curving towards Iroquois county, in Illinois. It gives rise to the Muskingum, Sciota, and Miami rivers, in Ohio, and to the Wabash, in Indiana, on its southern declivity, and to Maumee, emptying into Lake Erie on its northern declivity, while a small swell approaches the south bend of Lake Michigan, giving rise to the Illinois and its tributaries. The height of this ridge at the Portage summit, in Akron, thirty-eight miles south of Cleveland, on the line of the Ohio canal, is three hundred and ninety-five feet above Lake Erie, and nine hundred and sixty-three feet above tide water, and the deep cut twenty-eight miles east of Columbus, is but seventy-two feet less; at Portsmouth on the Ohio river, where the canal terminates, the elevation is four hundred and seventy-four feet above tide water, and ninety-four feet below Lake Erie. At the summit of the Maumee canal, at Port Defiance, it is ninety-eight feet above the lake. It then falls to seventeen feet west of Chicago on the line of the ship canal, thence it pursues an uninterrupted course northward to the Portage at Fort Winnebago, between the Wisconsin and Fox rivers, an elevation of one hundred and twenty-one feet above Green Bay, and one hundred and thirty-four above Lake Erie.

At this point the Wisconsin river, after flowing one hundred and seventy miles from its source in the north, suddenly turns to the west, and falls into the Mississippi near Prairie Du Chien, one hundred and sixty miles; the Fox river, rising to the east, runs westwardly, approaching it within eighty-two hundred feet, and turning, takes its course again eastwardly, and falls into Green bay. The surface of the water in the Fox is usually three feet lower than that in the Wisconsin, but in time of floods, passages are made from one to the other in boats. The following table will show the elevation of this summit above Lake Michigan and Green bay, the distance by the military road being one hundred and twenty-four miles.

	Feet.	Descent.
From Portage to Lake Winnebago.....		30
Winnebago Rapids ³¹	10.5	40.5
From Winnebago Rapids to Grand Chute.....	3	43
Rapids Grand Chute ³¹	25	68
Fram Grand Chute to Little Chute.....	6	74
Rapids at Little Chute ³¹	1.5	75.5
From Little Chute to Grand Caecalin.....	5	80
Rapids at Grand Caecalin ³¹	31	111
From Grand Caecalin to De Perre.....	3	114
At De Perre dam and level Green Bay ³¹	6	120
		121 ft.

The same swell continues to rise with about the same uniform degree of elevation, approaching the northern peninsula of Michigan, until it can be seen from. Lake Superior, bounding the southern horizon. It divides the waters that ran north into that lake, and those of the south into the Mississippi. Green bay and Lake Michigan, one of the most elevated ridges receiving the appellation of Porcupine Hills. Swells branching off to the eastward, and having their bases washed by the waters of the lake present mural precipices, and assumes different names. Those of the Pictured Rocks are said to be the most imposing. Some of these cliffs are three and four hundred feet high. From the Porcupine Hills, the country slopes eastward to the Sault de Ste. Marie, the outlet of Lake Superior; this river is obstructed by a rapid 1,500 feet long, with a descent of eighteen feet.

³¹ Ascertained by instrumental survey.

Table of the height of Lake Superior, with the intermediate lakes above, and their distances from tide water.

Route.	Miles.	Feet.
St. Lawrence river up to tide water.....	450	
Level Lake Ontario.....	200	650
Level Lake Erie.....	175	825
Level Lake Huron.....	340	1165
Level Lake Michigan.....		13
Level Lake Superior.....	240	1405
West End Lake Superior.....	490	189

From the above data we infer the following curious fact: that if a barrier eighteen feet high existed across the foot of Lake Huron, near Fort Gratiot, Lakes Huron and Michigan would rise to a level with Lake Superior; or if a similar barrier was placed of thirty-one feet, across the foot of Lake Erie, at Buffalo, the singular result would follow that four of the great lakes would become one uniform level and merged in one immense inland, sea.

By an examination of the foregoing table, we see a striking peculiarity of this region of "broad rivers and streams"—its vast extent—commencing at the gulf of St. Lawrence and extending in a southwest direction up that river; thence into the basin of Lake Ontario, at an elevation of 232 feet above the ocean, thence again rising by the Niagara river and cataract, 333 feet to the level of Lake Erie; the first in the central subdivision, including Lakes Huron and Michigan, of the great basin,) forming an angle at the western end of that lake in the estuary at the mouth of the Maumee river, it thence runs nearly north through the straits of Detroit, the lake and river St. Clair, into Lake Huron, rising 13 feet; thence by

a northwesterly course, through the straits of the Sault de St. Marie, rising 18 feet, to the west end of Lake Superior, a distance of 1,895 miles. The whole depression contains an area of 100,900 square miles, 91,000 of which is occupied by water, still leaving an extent sufficient to sustain a population of more than seventy millions of inhabitants.

The following will show, in a condensed form, estimates of the mean length, breadth, depth, area, and elevation of the several collections of water:

	Mean Length. Miles.	Mean Breadth. Miles.	Mean Depth. Feet.	Elevation Feet.	Area in square miles.
Lake Superior.....	400	80	900	596	32,000
Green Bay.....	100	20	500	578	2,000
Lake Michigan.....	320	70	1000	578	22,400
Lake Huron.....	240	80	1000	578	20,400
Lake St. Clair.....	20	18	20	570	360
Lake Erie.....	240	40	84	565	9,600
Lake Ontario.....	180	35	500	232	6,300
River St. Lawrence.....			20		930
					94,000

Michigan occupies a central position, between the extremes, and uniting with the upper division of the St. Lawrence basin, having an area of forty-three thousand five hundred square miles on the lower, or peninsula proper, and twenty-seven thousand square miles on the upper peninsula: making an aggregate of seventy thousand five hundred square miles.

The Lakes and Lake Coast

These constitute a prominent feature, and must be of great and increasing interest connecting the agricultural with the commercial enterprise of Michigan. As no state with a location so distant from the seaports, has done more in the same short period to develop the advantages to be derived from its internal resources, none can be in a situation better to reap the advantages arising from an extended inland coast.

If the distance by meanders of the shore of the lakes, and indentations of the bays, were to be made the standard for the length of the coast, it would amount to more than twice that of another, run without regard to the sinuosities of the shore.

The exact distance from the foot of Lake Huron, (near Fort Gratiot,) at a point where the north line of township number six north, and range number 17 west, intersects the water, to Middle Island by meanders, is 345 miles, including Saginaw bay. The same distance on a direct line is only 143 miles. Thence to Mackinaw, 97 miles; but by meanders, including the False and True Presque Isles, the distance would be increased to 150 miles; making a total by meanders of 495 miles; and by a direct line, 240 miles.

If the eastern shore of the peninsula appears so irregular and deeply indented with bays and harbors, the western is not less so, particularly in the northern part. The difference will be proportionally greater, as the Little and Grand Traverse bays are larger, excepting Saginaw bay,

than the largest bays on the eastern side; but as a small part only of the western shore has been surveyed, the subject will not admit of a more extended notice at this time.

Many doubts have heretofore existed in relation to the number and convenience of harbors. A minute examination of the shores, has, however, removed much of the prejudices against the navigation of the lakes, and there is probably no line of coast of equal extent, (being 700 miles,) that will, with inconsiderable improvements, furnish a greater number of good harbors. Much of the apprehended danger has arisen, therefore, from ignorance of these facts, and the localities of the numerous sheltered bays which would afford protection at all seasons; and as but few if any attempts have been made by actual navigators to explore for themselves, and being without charts, it is no wonder that representations of danger should have obtained, and the dread of shipwreck on an apparently desolate coast, magnify in a great degree, the fears attendant on crossing these inland seas.

Depth of the Lakes

The depth of the lakes has been a subject of speculation, from the earliest period of their discovery by Europeans. Tables have been constructed, and the areas and contents of each, endeavored to be ascertained. Errors have been made in these as well as in their elevation above the ocean; in the latter case, however, little is left to conjecture.

Lake St. Clair, an expansion of the straits between Lakes Huron and Erie, 18 by 20 miles, is much the shallowest, the average depth being only 20 feet. Lake Erie does not exceed 84 feet. An ordinary storm disturbs its bottom, and its waters appear turbid. These lakes may be considered as receiving the detritus brought down by the rivers flowing into them, and deposited there. This in particular is apparent, around the head of Lake St. Clair, where alluvion islands are constantly forming, and in spring choke up the numerous channels at the mouth of the St. Clair river, extending in the form of a delta far into the lake. The same remark may be made in respect to the west end of Lake Erie, where detritus extends some miles from the mouth of Maumee river; the channel is often devious, and a prevailing westerly wind reduces the lake to less than one fathom.

Lakes Michigan and Huron have undoubtedly the deepest chasms. Receding from the shore, their waters deepen uniformly, and there exist no central shoals or islands, showing in any manner a broken or alpine formation at their bottoms. It is only in the straits of Mackinaw, and above and around the Georgian or Manitou bay of lake Huron, that islands and shoals make their appearance. The channels among these islands, however, are only chasms through rocks, caused by abrasion from the waters of the lakes. Soundings have been made to the incredible depth of eighteen hundred feet, without reaching the bottom, and the most

experienced ship masters do not hesitate to assert the average depth to be more than one thousand feet. Lake Superior, though larger, cannot be considered deeper than the others, for reasons already assigned. It abounds with islands, many of which are large; Isle Royal is one hundred miles long. Primitive masses of rock lie disrupted above and below its surface, in every direction, and a permanent impression is left that a chasm, shapeless in its exterior, as well as its interior dimensions, fed by springs and tributary rivers, are the great features of this lake, at a depth of nine hundred feet.

Mountain districts, as has been heretofore observed, may be cut through by rivers, causing deep vallies [sic] and depressions, but no where on the continental surface of the globe can be found so deep chasms as the basins of these lakes. Though elevated 596 feet above, their bottoms are more than 400 feet below the level of the ocean. Their superficial area is 94,000 square miles, and they contain 11,300 cubic miles of water; a quantity more than half of all the fresh water on the earth.

Interior Peninsula Lakes

Neither is the subject of the lesser interior lakes on the peninsula, so far as their number and magnitude are ascertained, to be overlooked, forming as they do by their frequency a great contrast in the topography of this, to that of the other states.

From the Ohio and Indiana line on the south, up to range line number seven north, including all south of the northern railroad, an extent of 9,688,320 square acres, there are 1,425 of these lakes, occupying areas of from one to thirty-live hundred square acres each. Their waters are remarkably cool and transparent, and give to the landscape a highly picturesque appearance. To apply the principles of hydrography in ascertaining their aggregate extent, becomes the more difficult, since, in addition to their great number, no two are of the same dimensions. The following, however, will be found to approximate the truth: allowing each lake an area of 160 rods square, we shall give to the whole 228,000 acres, an extent equal to nearly ten townships, and somewhat larger than Lake St. Clair; and a proportion of about one acre of water to every thirty-nine of dry land.

All the rivers in the state have their sources in groups of these lakes, and they are the fountains of the unremitting volumes that flow through the thousand channels of our streams. While the rivers of neighboring states have measurably disappeared during the drought of the last summer, and caused derangement in their commerce, ours have suffered comparatively little diminution.

Periodical Rise and Fall of Water in the Lakes

This interesting question has given rise to a variety of curious speculations. The inference drawn from the following data, it is presumed, will not be altogether inconclusive.

Calculations may be made sufficiently accurate to determine nearly the amount of surface drained, "and if our climate shows a successive series of cold and moist years, and a series of warm dry ones, mutually following each other," variations in the volume of water, cannot but necessarily be great.

Taking into our account only the central and upper divisions of the St. Lawrence valley, from Niagara, to the northwest angle of Lake Superior, embracing all the country whose streams are tributary to the lakes, we have, by the following table of sections, 248,755 square miles of surface, besides that of the lakes.

The floods in Lake Ontario are generally the highest by about two feet, and for the obvious reason, that it receives the successive accumulation of all the other lakes, from the Niagara to the head of the St. Louis river.

From the year 1814, we can speak with some degree of confidence of the rise and fall of these waters. During that year, the upper lakes were full. This was the case in 1815, with the central and lower lakes. In 1819 and 1820, the water is said to have been at an unusually low ebb in the same lakes.

Superficies Drained by the Central and Upper Divisions of the St. Lawrence Basin

	Medial length.	Medial breadth.	Area in square miles.
Peninsula E. and S. E. of Lake Huron, and N. of Lake Erie, from Iroquois bay to Niagara.....	123	88	10,455
N. and N. E. from Iroquois bay to the Ottawa river.....	300	200	60,000
N. E. of Lake Superior, from Mackinaw to Nipigon river.....	320	60	19,200
N. W. of Lake Superior, from Nipigon to St. Louis river.....	310	55	17,050
S. W. and S. of Lake Superior, from St. Louis river to Desert lake and Portage... ..	300	200	60,000
W. Side Lake Michigan from Portage to head Des Plaines river.....	150	100	15,000
Peninsula between Lakes Michigan and Huron, and west end Lake Erie.....	325	174	56,550
South of Lake Erie to Niagara.....	300	35	10,500
Add area of Lake Superior.....	32,000		
“ “ Green Bay.....	2,000		
“ “ Lake Michigan.....	22,400		
“ “ Lake Huron.....	20,400		
“ “ Lake St. Clair.....	360		
“ “ Lake Erie.....	9,600		86,760
Total square miles.....			335,515

The difference in the time of the apparent rise between the upper and lower division may be accounted for on the principle that the largest bodies of water are on the upper level, and as these are discharged, the lower division would be comparatively high, while the upper would be reduced to low water mark.

From 1820, the water again began to rise, and continued to increase, until 1828; since which time, A. E. Hathon, Esq., civil engineer of Detroit, has given the subject particular attention. His first observations were taken at the old hydraulic works, at the time when the pipes were being laid for furnishing the city with water from the Detroit river; he has since transferred it to the top of the water table of the tower, at the new hydraulic works. The surface of the river at the time of the transfer,

August 21, 1838, was 3.21 feet below that base: this will serve as a reference for the future.

It appears from his journal, that the water was low in the spring of 1830, having fallen about two feet since 1828. In June following, it had again risen two feet, or to the level of 1828. From that time, its rise was gradual, until June, 1830, at which time it was found to have attained the height of one foot eight inches. In June, 1837, it rose seven inches. In June, 1838, nine inches, and on the 21st August following, three inches; making the rise 3 feet 3 inches since June 1830, and 5 feet 3 inches since March in the same year.

Table Showing the Rise of Water from March, 1830 to Aug. 1838

	Feet.	Inches.	Rise.
June, 1830.....			2.0
June, 1836.....	1	8	3.8
June, 1837.....		7	4.3
June, 1838.....		9	5.00
Aug. 21, 1838.....		3	5.5

Some allowance ought to be made for the sudden rise of two feet from March to June, as from observation, it is believed that winter has the effect of producing a partial decrease.

On the 21st November, 1838, the water had fallen 12¼ inches and on the 2d February, 1839, 3 feet 8 inches.

Many conclude that the present high flood is greater than has been known for at least a century, from the fact that orchards have been killed along the St. Clair and Detroit rivers, in consequence of the lands being overflowed. In some instances, forest trees have been destroyed by the overflowing water, and upon counting the concentric circles in sections obtained from their trunks, they were found to exceed a hundred.

In order to estimate the enormous accumulations of water during the time of the highest flood, and which is discharged through the river, it will only be necessary to refer to the table where 5¼ feet appears to be the maximum of the rise. A transverse section of the river taken opposite Detroit, where it is contracted to 52.80 of a mile of this depth contains 18,018 cubic feet; and allowing the current a velocity of one mile an hour, which is known to be less than its ordinary current, there would be discharged 95,135,040 cubic feet per hour, or 1,585,558 cubic feet per minute, an amount sufficient to supply fifty-eight canals of the dimensions of the Clinton and Kalamazoo,³² or thirty-five of the grand Erie canal, and more than sixteen times the amount contained in the Cedar river, and Sycamore creek, Ingham county, Deer creek and Grand river, Eaton county, Shiawassee river, Livingston county, and Rabbit river, Allegan county.³³

We are not prepared to say that there are sixteen times as many rivers, (as those above enumerated,) at the north, which have changed their course, and discharge in directions contrary to their former ones, thus filling the basin of Lake Superior, and causing the periodical rise of the lakes; nor is it reasonable to suppose that rivers,

discharging so great a quantity can be found in that region. We must, therefore, look for the cause to the quantity of rain which has fallen, and to the melting of the snow in spring, upon the immense surface drained by these lakes.

Rivers

Streams receiving the appellation of rivers in the state are numerous. This name, however, is applied to none unless of

³²27,313 cubic feet is required per minute, for this canal. See rep. of J. Hurd, engineer,

³³These rivers discharge in the aggregate, 98,846 cubic feet per minute, at the places designated. J. Hurd's report.

sufficient magnitude to be considered worthy of meandering on both sides; accordingly, instructions to that effect have been given by the Surveyor General to his deputies, in the prosecution of the government surveys. The Grand, Muskego and St. Joseph, will bear a comparison in length with many of the western, and no small number of the eastern rivers, of the first and second class. Their width and depth are not in proportion to their length, arising from the fact of their uniform descent. This characteristic will apply to all the other streams on the peninsula. They are unbroken by cataracts, and but little obstructed by rapids. The number in the surveyed part, and discharging into the lakes, is twenty;—of these the Grand river is the largest.

This river rises in Hillsdale and the south part of Jackson counties, in a cluster of more than fifty lakes, that interlock with the Kalamazoo and St. Joseph, each emptying into Lake Michigan on the west, and with the Raisin, which empties into Lake Erie, on the east. These, with the Little St. Joseph, St. Joseph of Maumee, and Tiffins, or Bean creek, running south, have their sources on the highest table land in the southern half of the peninsula, being an elevation of six hundred and forty-six feet above Lake Erie. From its source in a northerly direction to Jacksonburgh, is twenty-five miles; its level here being three hundred and twenty-five feet above Lake Michigan. From Jacksonburgh, it is fifty-three miles to Red Cedar river, thirty to Looking-glass river, and eighteen to the Maple river. At this point its elevation is fifty-six feet above the lake, where it takes a westerly course of fifty miles to Grand rapids, and forty more to its mouth, making its entire length two hundred and sixteen miles. It conveys the surplus water of 2,949,120 square acres. There are many other large tributaries besides those above mentioned, which it receives from the north—among these are the Flat, and Rogue rivers, no inconsiderable streams. Its width the first forty miles from its mouth is 800 feet, and for fifty miles further, to Lyons, on the Maple, it is 500 feet. In spring, floods raise the river about ten feet, overflowing and enriching its valley, which is densely covered with a heavy and beautiful growth of forest trees.

The St. Joseph has for its source more than twenty-five lakes, and as before mentioned, has its origin in Hillsdale and Branch counties; it runs a northerly course,

afterwards passing to the southwest, and crossing the south boundary of the state, enters Indiana; again curving northwardly, it reenters this state and falls into Lake Michigan, receiving many large tributaries, among which are the Paw Paw, the Dowagiac, Elkhart, Prairie, Pigeon and Fawn rivers.

From its mouth to the line of Indiana, the distance is forty-eight and a half miles, at a level of sixty-eight and a half feet; after running forty-three miles in Indiana, and at an elevation of ninety feet, it re-crosses the state line; the distance to Three Rivers is twenty-three and three-fourths miles, rising thirty-five feet, thence twenty-six and one-fourth miles to Sturgeon lake, and twenty and a half to Union city, making the whole distance one hundred and sixty miles from its mouth to this place, and its height above Lake Michigan two hundred and eighty-five feet; the entire length of the river is two hundred and eight miles, its width is nine hundred feet at its mouth, and carries the surplus waters of 2,827,040 square acres.

The Kalamazoo river drains nearly all the remainder of the surface on the western declivity, (situated between the Grand and St. Joseph rivers above described,) or about 1,382,400 square acres. Its tributaries are not many or large; its average width is about two hundred feet; its source is in a group of 20 lakes. Farwell's lake is six feet above the source of Grand river, though hardly forty rods distant, and so near-do the rivers rising on this plateau approach each other, that the waters flowing east, west and south, might easily be made to mingle at this point. Its course is more direct than either of the others mentioned.

The distance from its mouth to Allegan is thirty-eight miles, with a current of three miles an hour; thence twenty-five miles to Kalamazoo, where it is one hundred and forty-eight feet above the lake; thence to Albion, at the Forks, thirteen miles rising nine feet making a distance of one hundred and sixteen miles, and at an elevation of three hundred and forty-five feet. From the Forks to its source is thirty-four miles; its entire length is therefore one hundred and fifty miles.

The rivers discharging on the eastern coast of the state, within the surveyed district, have a less volume, and may be described together as having similar features, or if there be an exception, it is in the length. The length of all is abridged, however, by having a space to traverse only of about forty to sixty miles; the dividing ridge being so much nearer the eastern than the western side of the peninsula.

The river Raisin heads in a series of fifty lakes, the nearest of which is but a few rods from the head of Grand river. Its whole length may be computed at 85 miles.

The head waters of the western branches of the Huron also rise near those of Grand river, while its eastern sources inosculate with the Clinton. This river and the Clinton have their sources in by far the greatest number of lakes; they are no less than 200, and some of them

large, embraced in the area of Oakland, Livingston and Washtenaw counties.

The Saginaw river receives the discharged waters of the Cass, Flint, Shiawassee and Tittabawassa rivers, twenty-five miles from its mouth. These rivers with their tributaries descend from every point of the compass—the Tittabawassa from an unsurveyed district in the north; the Shiawassee from the western declivity of the summit in Oakland county in the south; the Flint and the Cass from the summit of the same swell, in Lapeer and Sanilac counties, on the east and southeast. Their average length is ninety miles.

United States' Surveys

These are progressing with rapidity, and if continued during the next two years, the whole peninsula will have been surveyed. The highest point to which they have been carried is town 26 north, embracing 180 townships. The facilities are reported by the surveyors, to be as favorable as those of any other new country, and equal to those of earlier surveys for carrying forward their work: maps of these surveys have been collected, in part, for the future use of the geological department. An inspection of them exhibits in the general outlines, a similarity to the southern portion of the state; the variety and number of small lakes, the great length of the principal streams, with an undulating surface, are the principal features.

It is understood that contracts will be made for commencing on the upper peninsula, at the opening of next season and it is probable that the standard lines will be run, and the completion of the eastern half, from Chocolate river on Lake Superior to the head of Green bay, during the same time.

The lands heretofore held in reserve, and which are by treaty to be sold, have been subdivided. These reserves are among the best locations in the state. The avails, after deducting the surveys and other expenses, go to the Indians.

Little will be left after the survey of the state shall have been completed, requiring adjustment. The simple rectangular method adopted by the general government, first, in subdividing the country into townships of six miles square, and these again into sections of one mile, give a character of mathematical accuracy which is excelled by no other system; the width and course of all streams crossing the lines, and their distance from the nearest corner, are noted, as well as the entrance into and distance across marshes and swamps; it will therefore require but little attention to draft the streams not meandered, as well as the marshes, in the interior of the sections, by personal examination, with sufficient accuracy for correct topographical maps.

Levels

Information of the most valuable kind has been obtained from the Board of Commissioners of internal improvement; copies of the surveys of the central and northern railroads have been furnished, and by a

resolution which passed that board in 1837, they will continue to furnish copies of all the surveys connected with the public works; these, with the surveys of the different railroad and canal companies, will leave but few points, the elevation or depression of which may not be known, either in reference to the lakes or the ocean. Vertical sections connected with correct lineal drawings, are appreciated by the geologist, and have an interest with him as great as with the engineer.

Accompanying this report you will receive a map of the state made by your direction for general reference. Upon the same sheet, projections of all the levels which have been made across the state, are constructed. A slight inspection will show at once the vertical relation of almost every important point throughout the territory included in the survey. The surface of Lakes Huron and Michigan is made the plane of reference; these are 578 feet above tide water

By a reference to the heights, it appears that there is a swell of land, which may be called the true *water-shed*, running from Point aux Barques south forty-five degrees west, and passing out of the state into the northeast 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 plane of reference. 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 on the summit level of the Clinton and Kalamazoo canal, it is 336 feet. It then again rises, and at the head waters of Belle river, in Lapeer county, is 414 feet. From this point it gradually falls off, and with a few rills descending on its north and eastern slope, sinks to the level of the beach of the lake. This swell will present but few elevations above the actual surveyed levels, exceeding fifty feet, and these knobs, where present, are located without design, and without uniformity of range.

On the line between Oakland and Livingston counties, a branch diverges to the northwest, giving rise to the Red Cedar, Looking-glass and the Maple rivers, on its western declivity, while the Shiawassee rises at the point of divergence, and runs northwardly parallel to its eastern side. The lowest pass across this swell is 95 feet above Lake Huron. Leaving this point and ascending to township 10 north, of range 5 west, its course is changed to the north, and it rises to its greatest elevation at the sources of the Maskego river in Lake Otisco, in town 22 north. From an inspection of the map an apparent design appears to have marked the future communication between Lakes Huron and Michigan, from the broad and deep indentation of Saginaw bay over this narrow and low pass.

From the dividing swell, the country lies in one plane on each side, inclining gently and uniformly to the margin of the lakes, with the exception of a slight corresponding elevation on the western side of the state. This may be traced from the great bend of Grand river to where it

crosses the Kalamazoo west of that village; thence curving with the shore of the lake, terminates at the South Bend, where it diverts the St. Joseph river through a part of Indiana. Its average height at Grand river is 80 feet, 200 at Kalamazoo, and 75 at South Bend, above the level of the surrounding country. It need not be stated that the interior peninsula lakes partake of the highest elevation, when reference is had to their being situated at the sources of all the rivers, and that the summit in Oakland and Livingston counties abounds with the greatest number.

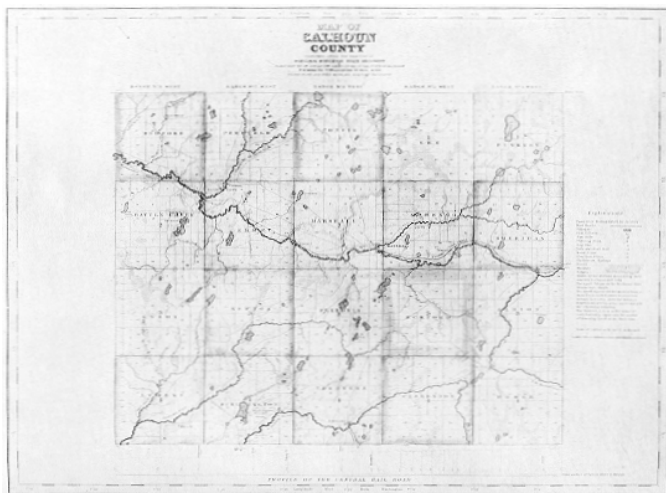
From tables in which I have collected the elevation of places, I have selected a few remote from each other, which may serve to show the uniformity of the surface generally. Contusions from this table cannot be drawn, however, in detriment to the healthy and rapid, and not infrequently precipitous flow of all our streams.

Outlet of Grass lake, Jackson county,	377 feet
Village of Barry, " "	362
Head of Spectacle lake, Calhoun county,	373
Head of Mill creek, St. Clair county,	368
Kalamazoo river at Albion, Kalamazoo county,	351
Sandstone creek, Jackson county,	347
Outlet Gillet's lake, "	354
Village of Newberry, St. Clair county,	284
West end Prairie Ronde, Kalamazoo county,	278
Rice creek, near Marshall, Calhoun county,	280
Honey creek, Washtenaw county,	266
North Branch Raisin river, Lenawee county,	276
Hasler's creek, Lapeer county,	265
Geddes, Washtenaw county,	220
Flint river, at Lapeer, Lapeer county,	238
Huron river, Dexter, Washtenaw county,	232
Old Fort Holmes, Mackinaw,	219
Kalamazoo river, near Augusta, in section 35, town 2 south, range 8 west, Kalamazoo county,	187
Branch St. Joseph, 30 miles south section 35 town 6 south, same range, St. Joseph county,	187
Kalamazoo river, Kalamazoo village,	154
Thirty miles south southern railroad crossing, St. Joseph river, St. Joseph county,	138
Shiawassee river at Owasso, Shiawassee county,	145
Fort Mackinaw, Mackinaw,	150
Cliff. Robinson's Folly, Island Mackinaw,	128
Ypsilanti, Washtenaw county,	130
Bank of Lake Michigan, New Buffalo, Berrien county,	100
Huron river, at Ypsilanti, Washtenaw county,	100
Paw Paw river, Lafayette village, Van Buren county,	106
Brush creek, near Mason, Van Buren county,	76
Bank of Galien river, ten miles east of New Buffalo, Berrien county,	74
Stoney creek, crossing northern railroad, Ionia county,	82
Mouth Maple river, Ionia county,	56
Bass river, crossing northern railroad, Ottawa county,	56
St. Joseph river, at Bertrand, Berrien county,	53
Half way house, Wayne county,	54
Crossing southern railroad four miles west Monroe, Monroe county,	49

A fact may also be inferred from the collated levels, that the average height of the peninsula is 160 feet above the surface of the lakes.

Maps, &c.

Much of my time has been occupied, as will be observed, in making collections preparatory to the final publication. They are intended to embrace the geology as well as the topography and geography of every section of the state. Twenty counties are in a state of great forwardness, five of which may be said to be finished in detail, viz: Wayne, Monroe, Jackson, Eaton and Ingham. It was thought unimportant to enter into a description of these in this report, as during the next year a large number will be added, and a report including the whole will then be made. Drawings will also be given of such remains of ancient works and tumuli as are scattered through St. Joseph, Kalamazoo and some other counties. These are more rare in this, than in some of the states south and west; sufficient evidences remain, however, of a former population, remote to the oldest traditions of the inhabitants. The time is not distant when the curious will be gratified with the system they pursued, and the facts it unfolds relative to the uses for which so much labor has been expended by an ancient people, upon the different structures found in the west. Public attention is being directed to their development, and when the position and dimensions of those that remain shall have been determined, elements for a history will remain, as perfect ns may be collected in the absence in part of tradition or written documents.



[Map of Calhoun County]

Here let me publicly acknowledge the hospitable intercourse of the citizens of the state, and the polite regards of gentlemen in the different public offices, in affording every facility, and giving access to the records in their charge.

S. W. HIGGINS,

Topographer of the Geological Survey.

Detroit, 2d February, 1839.

[No. 4.]

Report of C. C. Douglass, Assistant Geologist

To Douglass Houghton, State Geologist:

Sir: I have completed the detailed survey of so much of the district which you assigned me, as is embraced in Ingham county, together with a portion of Eaton and Jackson counties. Much time having been occupied in tracing and examining the coal formation, in order to arrive at satisfactory conclusions as to the probable extent of this valuable deposit in the district, it is thought advisable to defer the report of a part of Eaton and the whole of Jackson county, until the work shall have been more nearly completed. The examinations of the coal district resulted in the collection of many important facts, some of which cannot be properly made use of until more extended examinations have been made. But it may be observed, that these have been sufficiently satisfactory to place beyond doubt the existence of this valuable substance in sufficient quantity to be of much prospective value to the state.

The maps of the counties under consideration, have been found to be exceedingly incorrect, and in accordance with your instructions, I have been able to accomplish much towards correcting the numerous geographical errors upon the maps, now being constructed. These, according to your instructions, having been transferred to the topographical department, can only be generally noticed in this report.

One of the most prominent characters of the county under consideration. When compared with the more southern counties, is, its remarkable uniformity of surface. Although the whole country may be considered as gently undulating, it has no great irregularity of surface, except in those sections traversed by streams, where gorges, frequently of considerable depth, are sometimes found.

Occasionally some few isolated hills and ridges are seen, but they, with a few exceptions, are hardly worthy of notice. In township three north, range one east, a series of isolated ridges commences on section thirty-four, and extends in a northeast direction, across sections thirteen, twenty-three, twenty-four, twenty-six and twenty-seven, having an altitude of from twenty to eighty feet.

A second and nearly parallel elevation was noticed, commencing on section three, in the same township, and extending to section thirty-four, in the adjoining town, having an elevation varying from twenty to forty feet.

A third commences in the south part of Vevay, and extends in a northwest direction, nearly through the town, varying from ten to eighty feet in height. At the village of Mason, the Sycamore creek passes through a ridge of diluvion composed of stratified coarse sand and pebbles, slightly united by a calcareous and ferruginous cement.

About three-fifths of the county of Ingham consists of timbered land, while the remaining two-fifths are oak openings and plains. That portion of Eaton county embraced in this report consists of timbered lands.

Timber

The timber upon the less elevated bottom lands extending along Grand river consists of sycamore, black ash, elm, black walnut, &c. Upon the inclined uplands, connecting the bottom with the table lands, a general mixture of the usual hard wood timber is found.

The table lands are mostly timbered with the varieties of oak, beach, maple, lynn, hickory, cherry and whitewood; with sycamore, butternut, black walnut and elm on the margins of the streams.

Ingham county occupies a very central position in the slate, and possessing as it does a rich soil, valuable quarries of sandstone and extensive deposits of bituminous coal, it promises to become one of the most important counties in the state.

Soil

The prevailing soil of Ingham county and that part of Eaton county lying in township four north, ranges three, four, five and six west, is sandy loam and loamy sand, over an extent of more than seven-eighths of the surface. Limited tracts of a stiff loamy clay, with occasional hillocks and ridges of fine yellowish sand, occur, and were observed more especially near the small lakes and streams.

Beds of sand and gravel are sometimes seen to alternate with those of loam and marly clay in such a manner that a field of a few acres may exhibit almost every variety of soil, from a fine sand to a stiff marly clay.

The art of the farmer may be here put in requisition to modify the natural texture of the different soils, and fit them to receive nutritive and stimulant manures with the greatest advantage. The stiff heavy clays may be dressed with sand and the light soil with loam or clay, (marly where it can be obtained,) with a view to transform the whole into a loam of such a texture as to make a pulverulent soil, and yet leave it sufficiently argillaceous to retain a desirable quantity of water. Yard manure, composts mixed with lime, ashes, and muck of the marshes and swamps, if thrown into heaps with quick lime are allowed to undergo a more perfect decomposition, would make a valuable manure for the light soils. Lime is essential to the fertility of the light soils, and as shell marl is within the reach of nearly every farmer, it being found in many of the lakes and marshes, no reason can exist why these light soils may not be made and retained of the most fertile character. The marl may be taken from the pit in the fall and winter or at any leisure season, and spread over the land in the same manner as fine yard manure. Experience must determine the quantity best adapted to each particular soil.

The marly clays of Ingham and Eaton counties may be employed with advantage on the light soils, for they will not only add consistency to the soil, but will also furnish the necessary lime.

Marshes and Swamps

Many extensive marshes exist in both Ingham and Eaton counties, and probably may be said to extend over an area of about one-ninth of the surface. Many of these marshes have originated from the stoppage of water in the streams, having been dammed by the beaver, which formerly existed in the country in great numbers.

Two marshes of this character commence near the south line of township two north, range one east. That on the west of the township, extends in a northeast direction nearly to the corner of town three, having a length of twelve miles and an average width of eighty rods.

The one on the east extends north two or three miles into the adjoining township, having a length of seven miles and an average width of half a mile.

A vegetable deposit of from one to eight or nine feet thick, frequently tremulous when wet, occurs in many of these marshes. This deposit is mostly underlaid by marly clay, which is sometimes covered to a slight depth with sand and gravel, and in some instances with shell and tufaceous marls. This vegetable matter, being imperfectly decomposed, forms a light fibrous peat.

A large majority of these marshes can be readily drained, and will, by proper culture, become fertile meadows or even arable lands. Many of them when filled with water are tremulous. Most of the swamps and marshes are covered with a luxuriant growth of sedge, tamarack and cranberry vines.

Springs and Wells

Most of the springs and wells in these counties furnish water containing the salts of lime, and constitute what is termed hard water. The country is generally well watered, though during the past season, owing to the drought, some portions were nearly destitute. Along the valleys of the streams and through the whole extent of the sandstone formation, water is abundant, rising to the surface in springs, and collecting in the low grounds, forming numerous small streams.

In the township of Onondaga the sand rock, occurs at various depths, and water is generally obtained at the surface of the rock, or by penetrating it a few feet. Many of the springs contain large quantities of carbonate of lime in solution, which, as the water comes in contact with the air, is deposited in the form of tufa or a fine pulverulent marl. When the quantity is small, the porous vesicular deposit, called tufa, is found, but when the water is abundant, or the springs rise in a level tract or swamp, it is deposited in the shape of marl.

The most copious springs of this kind are along Grand and Cedar rivers. Nearly all the small streams, as well

as most of the bakes and marshes, (which do not originate from heaver dams,) have their origin in springs.

The water of most of the springs noticed, aside from the lime it contains, is remarkably pure and limpid, but occasionally chalybeate springs occur. The springs last mentioned not unfrequently give rise to very limited beds of bog iron ore.

Streams

Grand and Cedar rivers are the two principal streams in Ingham county; the first watering only a small portion of the western townships, while the Cedar, entering on the east, completely traverses the country.

There are, besides these, numerous small streams, varying from a few links to sixty links in width.

Among the largest of these are the Sycamore, Willow, Mud and Deer creeks, and the east branch of the Cedar river.

It will be noticed by reference to the map, that all the streams have a bearing to the north, excepting the few north of the Cedar river.

These streams furnish the country with a tolerable supply of hydraulic power.

Marl

An extensive deposit of shell marl was noticed on section fifteen, township one north, range one west; occurring near the source of a small stream. It is chiefly in the state of a compact and beautifully white powder, containing an abundance of recent shells. The stream before noticed passes through an extensive marsh, much of which is underlaid by the marl, covered with peat and vegetable muck, of from two to six or eight feet thickness.

Marl also occurs in a basin shaped hollow, on section thirty-three, in the town of Leslie.

I was informed by Mr. Woodworth, that an extensive bed of marl occurs on section thirty-five, township two north, range one west.

Calcareous tufa was noticed at several places in the counties, but not in sufficient quantity to be of any practical value.

Bog Iron

Several deposits of bog iron were noticed in Ingham county, which, however, are of not sufficient extent to be of any practical value. These were in most cases noticed along the streams, outlets of marshes, and in connection with chalybeate springs.

The most extensive deposit observed in Ingham county, was on section eighteen, township three north, range two east, in the bunk of a small stream. It consists of coarse and fine grains, forming masses in the soil, which is of a sandy loam.

A deposit of an argillaceous ochre, was noticed on section twenty-two, in the town of Leslie, covering an

area of four square rods, and from a few inches to three feet thick. It is very unctuous, containing but a small proportion of sand and gravel. Mr. Woodworth informed me that he had made use of it; as paint, and found it to answer a good purpose.

On section eleven, in the town of Stockbridge, was noticed a deposit several rods in extent, and from a few inches to one foot in thickness, varying from a deep to a light red color, unctuous, and containing sand and gravel in small quantity.

Another deposit was noticed at the outlet of a marsh, in the southwest corner of Onondaga.

Crag

On section three, township four north, range three west, in the bank of Grand river, sand, cemented with calcareous matter, occurs, and has been mistaken by the inhabitants for a ledge of sandstone. It has an elevation of fifteen feet, but is not extensive. It is covered with a light colored clay soil. The sand from which the crag is formed is considerably extensive, and will afford a good sand for mortar.

Boulders

Primary boulders were noticed at numerous points in these counties, particularly along the streams, where they occur in great numbers.

Boulders occur more frequently upon the surface of the plains than on the timbered lands. They are not unfrequently seen in great numbers upon the summits of the most elevated hillocks and ridges.

On section thirty-one, township four north, range two east, several small angular boulders of light-colored limestone, containing fossils, were seen.

Clay

Blue and variegated clays, inferior in quality, are not unfrequently met with in Ingham and Eaton counties. A variegated marly clay, of fine texture, was observed on the west side of Pine lake, and will afford an excellent manure for the light neighboring soils.

An analysis of two hundred grains of this clay gave the following results:

Carb. lime,	66.00 grs.
Alumine,	120.00
Silex,	14.00
	200.00

This bed of clay has been found to be twelve feet thick at a well on the west side of Pine lake, and to repose on fine sand.

Clay was again noticed on section thirteen, township four north, range two west and two east, in the banks of the Cedar river. This clay contains only a small portion of lime, is free from gravel, and will afford a tolerable material for brick.

Blue clay, containing gravel and pebbles, occurs at intervals along the banks of Grand and Cedar rivers.

Clay suitable for brick was observed in the town of Leslie, near the village of Leslie. In the town of Stockbridge, on section eleven, clay that will afford a good material for brick was also noticed.

Building and Flagging Stone

The great sand rock formation embraces the only rock found in place in Ingham, and the north and east parts of Eaton counties. It is exposed at many points along the Grand and Cedar rivers, forming in some cases, perpendicular cliffs. It is also seen at a distance from the river, in the beds and banks of the small streams. At many points in the county the rock is found covered by only a slight depth of soil, and it may reasonably be supposed that as the settlement of the county advances, the rock will be found to approach sufficiently near the surface for quarrying, at many points where it is now wholly unperceived.

Southwest from the mouth of the Cedar river, on section nineteen, a compact, grey, calcareous sandstone occurs in the bed, and banks of Grand river. An analysis of this sandstone showed it to be composed of

Siliceous sand with mica,	60.00 grs.
Calcareous matter,	40.00
	100.00

Embraced in this micaceous sandstone is a compact, white, quartzose sandstone, cemented with lime. Both these varieties of sandstone will afford a valuable material for building. The upper portion of the calcareous sandstone is composed of thin layers, which would answer a valuable purpose as a flagging stone.

In the southwest part of township three north, range two west, a sandstone well adapted for building purposes, was noticed in the bed and bank of Grand river. It is regularly stratified, the layers being from two inches to twelve inches in thickness, it may be quarried in blocks of several feet superficial extent. It contains numerous remains of extinct plants. This rock is analogous to the calcareous sandstone near the mouth of Cedar river.

In the town of Onondaga, Ingham county, on sections seven, twenty-eight and twenty-nine, a coarse, quartzose, micaceous sandstone was examined, some portions of which will afford a good building material.

On section thirty-six, township four north, range two east in the bed and banks of the Cedar river, a white, coarse grained micaceous sandstone occurs. It is friable, when first taken from the quarry, but hardens upon exposure to the atmosphere.

This out-cropping edge of sandstone embraces a bed of bituminous shale and coal.

An out-crop of the sandstone was examined in the bank of Deer creek, near the sun eyed line of the canal, on section fourteen, township three north, range one east,

Ingham county. This sandstone resembles, in appearance, the calcareous sandstone at the mouth of the Cedar river, is very much shattered, and some of the blocks have nearly a vertical position.

Sandstone was again noticed on section twenty-two, town of Leslie, and is apparently well adapted to economical uses. It resembles in texture the sandstone at Napoleon.

Sandstone of a friable nature was noticed on sections six teen, twenty and twenty-one, in the town of Vevay, from one to two miles south of Mason. The quality of the stone can not be well known until excavations are made.

Sandstone also occurs on Grand river, Grindstone and Coal creeks, in Eaton county, in mural walls of from ten to forty feet in height, and extends along each of these creeks for the distance of a mile, and along Grand river for a distance of from one and a half to two miles. These sandstones embrace a succession of coal, fissile shale and iron ore. They also contain many remains of plants.

Some portions of the sandstone will afford a good material for building, as also for grindstones.

On section twelve, in the same township, forming the bed of Grand river and occasioning a strong rapid, is a fine grained sandstone cemented with lime, and characterized by the appearance of numerous vegetable impressions.

A good material for building and grindstones, and embracing a, bed of bituminous shale, was noticed in the bed and banks of Grand river, on section twelve, town one north, range three west, Eaton county, and section seven, town one north, range two west, Ingham county. It extends north along the valley of the Grand river into the adjoining township. It is here overlayed by a thin bed of coarse red sandstone that has an irregular dip of about four inches to the foot.

Coal

The whole rock formation of Ingham and Eaton counties may be referred to the coal bearing series, and several beds of this material, which may be looked upon as valuable, have been examined. The level and unbroken character of the country which brings the rocks but rarely to the surface, together with the disintegrating nature of the rock, (the latter serving to cover those edges, which under other circumstances, would be exposed,) render it difficult to follow these beds in a continuous manner, but no doubt can be entertained but they exist over a large area of the counties.

The most extensive beds of coal were noticed in township four north, range one and two east, in Ingham county, and ranges three and four west, in Eaton county.

Coal also occurs in the valley of Coal and Grindstone creeks, and on section three, ten and eleven, on Coal creek. The coal is here comprised in four beds, having a thickness of four, ten, twelve and twenty inches, and neither bed exceeds two feet at any one point.

It was examined at several places along the table lands and in the bed of the stream, for a distance of one and a half miles, where in consequence of its dip, I was unable to trace it further.

The coal is embraced in a succession of fissile shales, and compact and friable sandstone, varying in thickness, from live to forty feet. I was enabled to remove several bushels from the different localities, that proved to be highly bituminous, and of very good quality, though occasional pieces were observed slightly contaminated with iron pyrites. It ignites easily, burns with a light flame, and leaves only a small quantity of earthy residuum.

The coal on Grindstone creek is a continuation of the coal on Coal Creek, and was traced in the immediate vicinity of Grindstone creek, across the eastern parts of section three ten and eleven, where a part of the coal had but a thin covering of soil, making a distance along the stream of one and a half or two miles. The coal here consists of a single bed, having an average thickness of eighteen inches, and at no one point, exceeding two feet. Other beds of small extent, were noticed along the same stream.

In the north bank of Grand river, in township before mentioned, a thin bed of coal occurs, having an average thickness of three inches and not exceeding six inches at any one point. This coal, which is also embraced in a succession of fissile, shale, compact and friable sandstone, varying from ten to thirty live feet in thickness, was traced across section two, three, ten, eleven and twelve, where in consequence of its being covered with debris, I was unable to trace it farther. A bed of bituminous coal more than two feet thick, of a superior quality, in town four north, range two east, occurs in the bed and bank of Cedar river, Ingham county. It was traced along the stream, for nearly half a mile, where, in consequence of its dipping below the stream, I was unable to trace it further. This coal is overlaid by a broken down sandstone and fissile shale, varying in thickness, from five to ten feet. In consequence of its appearance in the bed of the stream, and the friable condition of the sandstone, I was enabled to remove several bushels of coal, which proved to be bituminous and of an excellent quality, containing but Very slight traces of iron pyrites. It is compact, has a glossy lustre, ignites easily, burns with a light flame, and leaves only a small quantity of earthy residue.

I was informed by Mr. Haden, that in excavating to repair Mr. Ingersoll's mill, on the north bank of Grand river, in township four north, range three west, coal was penetrated upwards of a foot. The coal has a covering of coarse sand and pebbles, twelve feet thick. Some of the coal was examined, which proved not inferior to that on Grindstone creek, Eaton county.

I may here be allowed to express my obligations to many gentlemen, for the information which they have rendered, and hospitality which has been extended to me.

COLUMBUS C. DOUGLASS,
Assistant Geologist.

Detroit, January 28, 1889.

[No. 5.]

Report of Beta Hubbard, Assistant Geologist

To Douglass Houghton, State Geologist.

Sir—in compliance with your instructions, entrusting to me the geological supervision of the counties of Wayne and Monroe, I completed, late in the season, a detailed examination of those districts, the most prominent results of which are now submitted. It is hardly necessary to add, that as the annual reports are designed to embrace only subjects of immediate utility, considerations of a theoretical nature have been avoided.

Collections as extensive as was practicable, and which illustrate the subjects treated in the report, are deposited in the cabinets attached to this department.

In the furtherance of your plans, much attention has also been bestowed towards a correction of the minute topography of the country; a task rendered peculiarly difficult in the older counties, on account of the imperfections of the original surveys. It is however believed, that sufficient accuracy and completeness have been attained to furnish greatly improved maps of this section of our state.

WAYNE COUNTY

Topographical Features

Nearly the whole of Wayne county is included within that portion of the peninsula, constituting its eastern border, in which no considerable prominences occur, and the descent to the coast is gradual and uniform. In this county, consequently, if we except the township in its northwest corner, the general level is varied only by gentle undulations or isolated sand ridges, forming no continuous ranges, and seldom exceeding the relative height of 20 feet.

The greatest elevation of coast from Milk river point on the St. Clair, down to the Rouge, is about 20 feet; from the Rouge to the mouth of the straits, 10 feet.

Along the whole eastern border of the county, the altitude attained at distance of six miles from the coast, varies but little from 33 to 36 feet. At a single point only, in the vicinity of Detroit, it attains to 45 feet above the river; the general level of the table land at this place being about 26 feet.

A portion of this belt, three miles in width, extending through towns of Hamtramck, Greenfield and Springwells, falls from the general level and is

proportionately wet. Below the Rouge this belt becomes intersected by wet prairies, extending over the west half of Ecorce to the Huron river.

Throughout that portion of the county comprised in the belt above mentioned, the streams flow with but moderate current, have generally deep channels, and frequently spread into broad marshes near their embouchure, and even in high stages of the water, to the distance of several miles inland. These borders of marsh alluvion are frequently many acres in extent; as at Grand Marais of Lake St. Claire; on the Rouge, Ecorce, Brownstown and Huron rivers.

Beyond the belt above described the land rises more rapidly, attaining at the western line of the county to about 140 feet above the straits. The streams are rapid and furnish abundant water power.

Two-thirds of the county are flat, heavily timbered lands, producing a stout growth of oak, elm, white wood, maple, beech, lynn, (bass,) ash, hickory, butternut, black walnut, &c. Chestnut is found on sandy ridges in the towns of Dearborn and Van Buren. The remaining third is undulating oak openings, or plains interspersed with wet, grassy prairies; the latter obtaining a proportion of about one-fifth. The proportion of actual swamp is small, and probably little or none exists that may not be reclaimed by a course of drainage properly conducted.

Soil, and Agricultural Character

Clay and sand loams constitute the soils of the timbered land. These occupy nearly equal proportions of surface and often alternate within short distances. The former derives its character from a bed of yellow or brown friable clay, which reposes upon the extensive blue clay deposit immediately overlying the limerock.

Clay is reached throughout the portions characterized by sandy soil, at a depth of from 5 to 12 feet.

The upper clay has an average thickness of 5 feet. The lower clay is of a variegated blue color, gravelly, and intersected by layers of strata of quicksand and gravel. This clay sometimes approaches the surface, as in the vicinity of Detroit. Its average thickness must exceed 100 feet.

These soils are excellently adapted to agriculture. Silex enters largely into their composition. Both clays generally contain a large portion of lime,³⁴ which adds to their fertility. The contained gravel assists to conduct away the surface waters and prepare the ground for tillage, while the retentive powers of the clay render it little liable to suffer from drought. Thus, while the sand loams may be cultivated to wheat and other grains, the greater portion of the clay lands is natural meadow, adapted to grazing. Its value for this purpose is beginning- to be understood, and it is probable that were its merits fairly tested by a system of dairy farming, it would prove productive of a profit to the husbandman second to none in the state.

The sandy oak openings and plains are generally productive. They possess the advantage of being easily tilled, and are well adapted to grain and roof crops. Some portions produce good wheat. This soil contains only a minute proportion of lime.

No part of the county can be said strictly to have a limestone soil. The great limerock formation approaches the surface at several points in Brownstown and Monguagon, but is in general too deeply covered by the clays to allow it to characterize a large extent of soil.

In the town of Plymouth, a different character of country prevails from any yet described. This town and part of the two adjoining, may be considered as lying without the border portion of the peninsula, in which I have described Wayne county as included.

This township presents a surface more rolling, and broken into frequent ridges. They rise often from 60 to 80 feet from

³⁴An analysis of 100 grains of the clays, taken at random, showed--

	<i>Upper Brown Clay</i>	<i>Lower Blue Clay</i>
Sand and siliceous matter.....	51.50	27.50
Alumina	29.95	52.30
Carb. lime	18.55	18.98
Oxide iron	.00	1.22

the plain, with a steep declivity, and having no apparent uniform direction. They are composed of gravel associated at the surface with a clay loam. For the production of wheat, probably this soil is not excelled.

The boundary between the land of this character and the more level tract which constitutes the whole remainder of the county, is strongly marked by a low gravelly ridge, the supposed former shore of the lake. Its course is southwest through a corner of the town of Livonia, entering Plymouth between sections 12 and 10, passing a little to the east of Plymouth corners; thence through section 33 into the town of Canton, which it leaves on section 30. As but a small portion of this ridge is found in Wayne county, a particular description is deferred to future report.

Boulders

No part of the county can be denominated stony. Imbedded in the clays, and occasionally found grouped upon the surface, are water-worn boulders or fragments of the primary rocks. A species of reddish granite predominates, occurring frequently of more than a ton weight. Boulders are found in great numbers in the town of Plymouth, a large proportion being of fossiliferous limerock. Limestone boulders are also numerous in the bed of the Huron river, sometimes of large size. Occasional banks of *cobble stones* were found heaped along its sides, of a size suitable for paving.

An interesting locality of boulder rocks was met with at Rawson's mills, town of Van Buren. An excavation in the river bank had exposed a bed of limestone and clay-slate rocks, thickly deposited near the water's edge, to the depth of several feet. The slates were often of two or three feet in diameter, of dark color, fissile, and containing iron pyrites

Marshes or Wet Prairies

Comprise extensive tracts; they are of generally similar character, being low portions of the sandy openings that have been subjected to an overflow of water for a sufficient period to allow a deposition of muck or peat from vegetable decomposition. This peat supports a growth of wild grass, destined to add annually to its accumulation. Thus what were ponds, become by this process extensive beds of vegetable soil, varying in humidity with the seasons. These beds have a depth of from one to six feet, and upwards.

Indications are apparent which prove that very many, at least, of these peat marshes had their origin in the labors of the beaver, aided by the natural conformation of the surface. They occupy gently rolling tracts, in which ridges of sandy "openings" and detached prominences or islands of the same are intersected by long bands of marsh. Nearly all the streams of the border townships head in these tracts, and it is easy to conceive how the portions now converted into marsh might have been flooded by the obstruction of those natural channels.

If this view be correct, the practicability of drainage becomes at once established, and such conclusion is verified by actual results.

The following comprise the principal marshes of the county:

About fourteen sections, two-thirds of which are in the town of Hamtramck, and the remaining third in Oakland county, are of the character above described; but not more than one-half this extent is actual prairie. This yields an abundant growth of wild hay. The marsh is now in the progress of successful drainage. A thickness of fibrous peat is disclosed, averaging four feet, succeeded by a subsoil of gray sand, nearly free from aluminous and vegetable matter.

Prairie of similar character occurs in the towns of Greenfield, Bedford and Royal Oak. It covers 8 sections, one-half of which is in Oakland county. Comparatively a small portion consists of dry openings, and one-half bears a dense growth of small tamarack. Its soil varies in depth from three to six feet, and is in many places so charged with water as to be tremulous. It produces large quantities of cranberries.

Prairies of a different character occur in the lower part of the county, over a surface of 46 sections, of which 18 are in the town of Ecorse, 11 in Brownstown, 7 in Romulus and 30 in Huron.

Branches of the Ecorse and Brownstown creeks meander this tract. These, flowing with little descent through lines of level prairie, are ramified in every direction, and form a net work or connected chain of marshes over the whole surface. The dry portions consist of sandy plains, frequently but little elevated above the surrounding marshes, and producing a scattered growth of yellow and white oaks. They sometimes assume the form of ridges, which continue unbroken for many rods, and without any uniform

direction. The marshy portions, which generally predominate, have a soil of black muck, intermixed with sand washed from the adjoining plains, averaging 2 to 8 feet in depth. This is covered by a few inches of light, fibrous peat. Subsoil is sand. In a few instances clay was found approaching the surface, and it undoubtedly underlies at no great depth.

Wild hay is cut on these marshes in considerable quantities.

According to reports of Indians, beavers disappeared from this region thirty years ago. Their numbers previous are said to have been incredible.

Few trials have been made in drainage. A shallow ditch, or even a passage cut through a beaver dam, has in two or three instances effected great improvement. I observed vegetables growing upon a piece thus ditched, and it is said that wheat succeeds well.

This tract is owned mostly by "non-residents." Several untenanted houses gave evidence that a few families who had commenced a settlement have deserted to more favorite spots. Ditching had not been attempted. The expense of this kind of improvement is comparatively small, and I do not doubt that were less than half the ordinary labor in "clearings" bestowed upon a course of drainage, these lands, instead of their present little estimation, might soon be accounted amongst the most fertile in the state.³⁵

In the southeast quarter of range eight east, town of Huron, marshes occupy, it is supposed, two-thirds of the surface. They have a peat soil, averaging two feet, but occasionally much deeper and inclined to bog. Cranberries grow abundantly. Branches of Swan creek meander this tract in such manner as to facilitate drainage; and the comparatively dry character of a large portion will render the cost of ditching moderate.

Smaller marshes occur in the county, though not frequent, and of little general account.

Encroachments of the River and Lakes

Extensive damage has been occasioned by the unusual height of the lake waters during several past seasons. From the St. Clair to the Huron river, the coast, which is mostly gravelly blue clay, with alternations of sand, has been abraded to such an extent, since 1835, as to remove the entire line of coast, where unprotected, several yards to the westward. Along the coast of Hamtramck, above Detroit, scarcely a vestige of the old river road remains. Near Milk river point the waters are said to have advanced inland 150 feet within the past two years. Below Detroit the depredations upon the coast have been less severe, but sufficiently so to render a portion of the road below the Ecorse unserviceable, and deprive the already narrow turnpike above of several yards of its width. Along the Gibraltar front, at the mouth of the straits, where the bank is from 6 to 10 feet in height, the waters have advanced 10 feet inland

³⁵Ditches may usually be cut, of 3 feet wide by 2 feet deep, for from two to four shillings per rod: perhaps less. The main ditches of the extensive marshes in Hamtramck, owned by Judge Conant and others, are 6 feet by 4, and cost \$1 per rod.

This abrasion of the coast has been in progress not only for the past two or three seasons, but to some extent through the fluctuations of level in the lakes during a much greater term of years. While the configuration of the straits preserves the Canada shore in a great degree from erosion by the current, its whole force is felt upon the western coast; a much greater abrasion being prevented only by the low and shelving character of a large portion.

From the same cause the marshes bordering the shores have been greatly extended. Many acres of former arable land, both in Wayne and 'Monroe, are now embraced by the wafers. Numbers of orchards, the growth of a century, have become a prey to the flood, and families of the old French inhabitants are driven from homes till now occupied from childhood. The United States road from Detroit to Monroe has been rendered impassable at no less than three points, and the travel forced into other and circuitous routes.

Leaving to an abler pen the investigation of the causes of this unprecedented rise, it may not be amiss to notice, briefly, such remedies as have been tried, or may be proposed to check the devastations occasioned by it. Should those causes continue to operate in maintaining the present elevation of the waters, the subject will become of vast importance to the interests of this portion of our state. Every foot of coast now suffered to waste away, involves a loss much exceeding that already sustained. The inconvenience now felt from the diminished breadth of the river road below Detroit, calls for one of two remedies; either the roadside must be protected by a dock along nearly its whole extent, or a new and broader road must be opened in the rear and beyond such a probable future contingency. The former method, owing to its expense, will, it is presumed, never be resorted to by public authority, nor by individuals to much extent.

Although the erection of docks is undoubtedly the only permanent protection, more simple remedies may to some extent prove of avail. Quantities of brush, strewed thickly along the exposed bank, afford a considerable protection against the direct force of the waves, and also aid, by the retention of the sand and gravel brought up, to form a beach along its foot. A heavy log or fallen tree, placed at right angles to the shore, serves to accumulate a beach, and thus often affords protection.

These remedies are not invariably successful; but they are easily attainable, involve but small expense, and will be properly estimated if they tend to preserve even a small portion of the wealth of the landholder from the devouring wave.

Clay

Clay suitable for bricks and pottery, is found at numerous places in the county, though the value of

much of it is deteriorated by the presence of lime. The manufacture of bricks is conducted at several points.

At Springwells a brick yard has been established for several years. The clay used is from the blue clay deposit, and is tolerably free from grit. The sand is taken from a cap or hill lying above the clay, with strata of gravel interposed. The bricks find a market at Detroit. About 500,000 are manufactured annually, worth \$5.00 per thousand.

A superior clay for brick is found in the banks of the valley of the Rouge, and several kilns are established in the towns of Springwells and Ecorse. At a yard belonging to Mr. Abial Wood, on the south side of the river, (farm No. 661,) the clay employed is of a light blue color, free from grit. It improves with the excavation. At a depth of six feet, I observed it of a lighter color, sometimes veined with white. About 800,000 bricks were manufactured this season.

At the yard of Mr. Wood, on the opposite side, about the same number have been made. This yard has been established three years. The blue clay is used, and is said not to improve with depth. The overlying yellow clay is considered inferior. A cap of sand overlies, of 2 to 4 feet.

Two adjoining brick yards have manufactured about the - line number each;—an amount this season less than usual, on account of the prevailing sickness.

A fine blue clay appears near the river bank at Flat Rock, from which brick is made. Its quality is said to be impaired by lime. About 500,000 have been burned.

At Morris, three miles above Mt. Pleasant, a brick yard is commenced—clay said to be of good quality. The yard is on the summit land adjoining the river, at a height of 50 feet.

Two yards are established on the middle branch of the Rouge, in the town of Nankin. At Wilkinson's near Schwarzburg, clay appears in a stratum running along the bank, and is here two and a half feet thick. Portions contain too much lime to be used with advantage. Good bricks are manufactured of the clay taken from the river bottoms, at Swift's, section 11.

A bed of clay occurs in the town of Plymouth, section four, from which bricks and earthen ware are manufactured. It consists of strata of the blue and yellow varieties underlying probably 8 acres, with an average thickness of 4 feet. A cap of sand, of 2 feet thickness, overlying, is used in the manufacture. Sand and gravel underlie the bed of clay, which are unfit for use from the lime contained. The bricks are of good quality; 100,000 were made this season, worth 15.00 per thousand. The pottery ware receives a good glaze, and is durable.

A bed of clay exists west of Plymouth corners, section 27. It is supposed to cover 80 acres. Considerable lime is contained; 500,000 bricks are made from it each season.

A bed of fine blue clay exists on section 11. The above were the only deposits observed in this township.

Blue clay appears at the surface in the town of Canton, which is free from lime.

In the town of Huron a fine blue clay underlies the low lands bordering Swan creek, at small depth, and frequently comes to the surface.

The blue and yellow clays make their appearance at every bluff along the Huron. They are in general very marly and seldom free from grit. A kiln was erected in a ravine of Woods' creek, section 36, Van Buren, but the clay proved so calcareous that the works were abandoned.

Limerock

The great limerock formation, upon which the clay deposits of the county rest, makes an *out-crop*, or appearance at the surface, through the townships of Monguagon and Brownstown. It forms the bed of the strait near its mouth, as well as a foundation to the islands.

The most easterly point at which the rock appears above the level of the water, is at Stony island. This is wholly constituted of the rock, covered by only a few inches of soil. Limerock was formerly quarried upon this island, as is testified by numerous pits, but the fractured surface stone only appears to have been removed. These fragmentary rocks seldom exceed a foot diameter, are of a white color, compact, and afford good lime. The island is but little above high water level, and the pits are now flooded.

Quarries have been opened at the lower end of Grosse Isle. The rock makes its appearance in a slightly elevated ridge, at some distance from the shore. Trenches are opened for quarrying in no place more than 5 feet deep. The upper layers are of a few inches thickness, removable in irregular pieces of a size suitable for rough building. One of the trenches exposes a stratum of 8 feet thickness, for the distance of 300 feet. This stratum is compact and may be broken out in nearly square masses.

Sulphate of strontian, in large crystals, is abundant in the upper layers. No fossils were discovered.

In section seven, of Monguagon, is a protrusion of the rock in a ridge, occupying a surface of a dozen acres. Quarries have been extensively worked, chiefly for lime. The rock is in a strata of from 6 to 10 inches thickness, of gray color, crystalline and eminently fossiliferous. The quarries have extended to the depth of 6 feet. The color of the stone deepens into blue, and its hardness increases with the depth. Calcareous spar is contained in crystals, lining small *geodes* and fissures. Thin layers of indurated bituminous matter, approaching coal, are contained between some of the strata. The largest masses of stone observed to be quarried in good condition, were two feet in length by about eighteen inches wide. Whether larger slabs might not be obtained

by proper care, I was unable to learn. It is fully equal in beauty to the much admired building material brought from Ohio, but its superior hardness renders the dressing and polish much more expensive.

From 9,000 to 12,000 bushels of lime are manufactured annually at; this quarry.

Limerock makes its appearance in Brownstown creek, one and a half miles west from Gibraltar, and has been used to a very limited extent for domestic purposes.

Rock is said to appear at the water's edge on the lower end of Celeron island.

Limerock forms the rapids in the Huron at Flat Rock. It appears in a smooth almost unbroken bed, for the distance of forty rods, forming a foundation to the dam above, and disappearing in deep water below the mills. The rock is of a dark gray color, occasionally porous. A specimen contained hornstone.

Rock was also occasionally found forming the bed of the channel from Flat Rock till within two miles of Mt. Pleasant, and large tabular masses, but little worn, appeared even farther up, proving the existence of rock in place at no great distance.

A very slight general *dip* in the limerock of this county, northwesterly, is observable.

Marl

The only deposits of shell marl known to exist in the county in sufficient quantity for economical purposes, are in the town of Plymouth. The following deserve notice:

On section 22, (at Deacon Purdy's,) is a small deposits, which occupies two-thirds of an acre. As other beds occur in the township of similar origin, it may be advisable to notice the circumstances of its formation. Upon a gentle slope a protuberant bog has formed, which is wet and slightly tremulous. It consists of peat, or vegetable matter, having a depth of about 3 feet. Below this is found the marl, which has here a thickness of from one to three feet. It is a plastic substance of a milky gray color, perforated by roots and may be cut out in masses like clay. The presence of lime is indicated at the surface by a calcareous deposit upon moss.

Beds thus formed originate chiefly in deposition from water of springs highly charged with lime; circumstances under which *tufa*, or indurated deposits of lime, usually occur. Lime is favorable to the formation of shells, which are generally associated in abundance, but do not constitute the bed as when it occupies the former bottom of a lake. Several species of the genus *Helix* (snails) are most numerous, with *Lymnea*, *Planorbis*, &c.

As the producing causes are still in operation, marl existing under these circumstances may be supposed still in progress of formation.

Eight hundred bushels of lime have been manufactured at this bed. Much of it beautifully white and of good quality.

The marl furnishing this number of bushels was taken from an area of three square rods. Should the deposit cover but half an acre, with the depth of a foot, (a low estimate,) the amount of lime it is capable of furnishing would be 21,333 bushels. Five hundred bushels of this lime cost in the digging and manufacture 57 days' labor. Beckoning these as so many dollars, and the lime at two shillings per bushel, (average price,) there will appear a profit of more than one-half the price brought by the article.

On the farm of Caleb Herrington, Esq. sections 5 and 8, a very extensive deposit was exposed in digging a drain to remove the water from a tamarac swamp. At several places a pole was thrust into the bed, without passing through, to the depth of six feet. From the indications apparent, I am led to believe that the entire area of the swamp (30 acres) is underlaid by the marl. It is compact, heavy and plastic. This marl is well adapted to the manufacture of lime, but has not yet been applied to that purpose.

On the land of Sylvanus Taft, section 4, is a bed of an acre or more in extent, with an average thickness of two feet. It is compact and of good quality. No lime has been manufactured, but much of it used in its natural state, by the neighbors, for plastering and whitewashing, is said to have fully answered the purposes of kilnburnt lime.

Numerous other indications of marl occur through the township. A bed is said to exist on section 27. Also on farms of Mt. Holmes and others, probably to small extent.

A small bed was found on land of Wm. Yerkus, section 2.

Upon the surface of a knoll at Waterford a considerable quantity of a dry pulverized marl was observed.

On the farm of Pitz Taft, on the base line, within the boundary of Oakland county, is a deposit which may be noticed in this connection. It covers two acres, with an average depth of six feet. It is a tufaceous shell marl, in coarse particles, with a stratum of tufa underlying, and occurs under circumstances similar to those of the deposit on section 22, first noticed.

Ten square rods have been excavated, out of which were manufactured, 3,000 bushels of lime of good quality. It sells at three shillings per bushel.

Assuming the above proportion, the quantity of marl may be estimated at 31,680 cubic feet. The amount of lime which the bed is capable of furnishing, at 96,000 bushels.

Marl in small quantity, has also been found in town of Canton, section 9.

No experiments have been made in the employment of marl as a *manure*, in this county, nor, so far as I am informed, elsewhere in the state. This is somewhat a matter of surprise, since trials of plaster (gypsum) and quicklime are acknowledged to have produced

extraordinary results. It is, however, scarcely known to our farmers that marl, or *bog lime*, may be used with equal profit, while it has the advantage of being obtained at a much cheaper rate. It deserves to be made the subject of immediate and ample experiment, particularly upon sandy soils, and those which are found to contain but small proportion of that essential ingredient, *lime*. This is often the case with the lands in the immediate vicinity of the marl beds.

Peat

Peat, or vegetable alluvion, is found in considerable bodies in town of Plymouth, overlying the mail, and in the marshes or wet prairies of Greenfield, Hamtramck, Ecorse, Brownstown and Huron. These latter deposited have, been already noticed under the head of Marshes.

The greater proportion of peat found in this county belongs to the variety called *fibrous*, being a mere mass of spongy fibres of grass roots, partially decomposed and elastic to the tread. A small proportion is of the *sphagnous*, or peat moss variety. Comparatively little is *compact*, or in a state which would render it of much value for fuel.

A bed in the tamarac swamp on sections 5 and 8, Plymouth, to the depth of live feet, was found to consist chiefly of the kind denominated *ligneous*. It disclosed a half decomposed mass of tamarac logs, with moss, roots, &c. At depth of several feet, I found entire stumps, trunks and limbs of a former growth of timber, retaining their form, but so soft as to yield readily to the spade.

The body of fibrous peat which composes the marshes in Hamtramck, includes about 1,900 acres, with an average depth of four feet.

The adjoining marsh, in Greenfield and Royal Oak, comprises about 3,000 acres of this deposit, with the same average depth. Probably a portion of this peat, is of ligneous origin.

From 3,000 to 4,000 acres of fibrous peat, with average depth of two feet, are contained in the marshes of West Huron.

Of the other smaller deposits of peat noticed under marshes, no estimate could be made.

None of these beds of peat have yet been esteemed of importance as an article either of fuel or manure. The wants of our population do not demand any present consideration of its value for the former purpose. But in the latter capacity, it will be found serviceable and cheap, and it is desirable that fair trials of it be made. It may not prove sufficiently decomposed for the purpose until mixed in the compost heaps and consolidated by the application of quick lime. This disposition of it might be made with peculiar facility where it occurs, as in Plymouth, imposed upon beds of marl.

Bog Iron

Deposites of bog ore occur in limited quantities at numerous places; their origin being apparent in the presence of highly ferruginous soils.

In the township of Greenfield, deposits of ore occupy considerable extent, chiefly on sections four and nine, when I traced it at intervals over an area of one-half a square mile. It follows mainly the course of two brooks discharging into a large tamarac marsh, on section ten, and embraces the intervening ash swales. It is distributed over this area, in beds of a few yards wide and irregular patches. The deposit consists of an exceedingly compact bed of a foot thickness, which is broken out in large masses, and is mostly of inferior quality, being what is technically known as an *old ore*. This is succeeded by from two to six inches of the variety called shot ore, which is apparently rich. The covering of soil is from a few inches to two feet in thickness. This is by far the largest deposit in the county. Time would not permit a very accurate analysis of the ores of this county, but a more detailed account of their composition may be expected, at a future period, in treating of the other ores of the state. One hundred grains, however, subjected to a rough analysis, gave,

Siliceous and aluminous matter	26.50
Per-oxid of iron,	73.50
	—————
	100.00

In township of Livonia, section twenty-eight, bog iron occurs in a low, wet swale, which serves as the outlet to a series of small marshes. The bed follows the lowest portion of the swale for about half a mile, with a width varying from two to four rods, and a thickness of six to eighteen inches. It consists mainly of a bright colored shot ore. Peaty muck overlies, of two feet average depth.

Estimating the average thickness of the deposit at one foot, and its width at three rods, will show a proximate result; of 130,000 square feet of the ore. From the position of the low grounds following the course of the outlet, it is not improbable that other deposits of this mineral may be found below. The ore is a very rich one, and is well deserving a more extended investigation by the proprietor.

In township of West Huron, section twenty, is a small deposit, occupying an area of thirty rods long, by one wide. It forms a compact body six to ten inches in thickness, mostly "dead ore."

On section twenty-one, a narrow deposit of bog ore occupies the bed of a small run connecting the marshes, it is similar to the above, and of small extent.

Other indications of ore occur in this township; probably of but little account.

Much of the soil of the township of Plymouth is found charged with iron.

Strong indications also exist in the towns of Canton and Nankin, Minong the wet prairies of Ecorse and along the bottoms of the Huron, in the township of Van Buren.

Chalybeate Springs

occur in several of the above townships.

One in Canton, section 5, has formed a considerable mound by deposit of calcareous matter from the water.

A spring, much impregnated with iron, issues from the river bank, near Rawson's mills, town of Van Buren.

Sulphur Springs

of considerable strength, occur, but are not numerous.

A very large one rises in the bottom of the Huron, in the Wyandot reserve. It occupies a hollow of an oblong shape, 300 feet by 150. The water deposits thin films of sulphur.

In the town of Ecorse, section 22, is a spring very strongly impregnated. It occupies a basin of 100 feet diameter. This spring, with the one above mentioned, probably exceeds in strength any others in the state. They are favorite resorts for domestic cattle, as well as for deer and pigeons.

On section 20, town of Dearborn, several sulphur springs issue; copiously from the bank of the Rouge. Their waters also contain iron, which imparts an inky color to surrounding surfaces, by combination with the characteristic acid of their vegetable portions.

A spring of considerable strength issues from the bank of the Huron a mile below Flat Rock.

On section 29, Brownstown, a spring, strongly impregnated, rises in the edge of a tamarac marsh, forming a large basin. The stream issuing is sufficiently large to overspread a considerable tract. Indications of salt and lime were present.

Strong sulphur springs abound in the neighborhood of the marshes around Gibraltar. Their vicinity is strongly colored by a milkwhite precipitate.

The source of these springs is noticed under the geology of Monroe county.

Brine Springs

Springs of brackish water are found occasionally through the northern and western townships; but their position in regard to the true saline district, of the state, would probably not warrant the expedition of profit resulting from them in the manufacture of salt.

Several "licks" were, visited in the towns of Springwells, Bedford, Canton and Nankin; but they contain, mostly, the salts of lime.

A spring, impregnated with saline matter, rises on the bank of the Rouge, in town of Redford, section 27. The discharge from it is about 60 gallons per hour.

In an early state of the country, salt was manufactured here by the Indian and French settlers. A hollow gum was sunk, which has long since rotted away. Furnaces were constructed of brick. An attempt was made a few years ago, at considerable expense, to revive the manufacture. The result was the manufacture of a small amount, half a bushel of which was sold in Detroit as table salt. Sickness occasioned discontinuance of operations, which the diminished price of salt has since rendered unprofitable.

In the town of Nankin, section 11, springs occur, at one of which a well is now sinking preparatory to an attempt at salt manufacture. The excavation has proceeded eight feet, being protected by a strong curb of wood. I was informed by the proprietor that an ordinary pail full of the brine produced a gill of saline residuum.

An analysis of 100 cubic inches of water from this spring, furnished in the first annual report of the State Geologist, showed 38.47 grains of muriate of soda, (common salt,) combined with muriate of lime and other matters. This result exhibits a strength equal to only one-fourth that of the brine springs at Grand Rapids, and less than one-tenth that of the springs of the Tittabawassa, the points at which operations are commenced for the state salt manufacture.

In regard to the conduction of operations by individual enterprise, we would refer to the whole subject of brine springs as presented in that report. It may thus be seen under what conditions only certain reliance can be had of ultimate success; nor should it appear surprising that expectations, not the result of a thorough understanding of the subject, may end in disappointment.

Water, Wells and Springs

The county may be considered as in general, well watered, by streams discharging into the straits at intervals of a few miles. Their waters, like that of the lakes, are soft. The River Huron alone forms an exception, which passing over limerock and through marly clays, becomes hard, or charged with lime.

The early French settlers dug no wells. They clustered about the streams, and partook from those natural fountains. The surface waters thus in most cases obtained, and from streams often winding sluggishly along low and marshy banks, afforded but an indifferent beverage.

Numerous wells have since been sunk, and with various success. The thick bed of blue clay which underlies the county at small average depth. Though charged with grained, is not sufficiently pervious to admit the percolation of large underground streams. For this reason springs do not abound, and a large portion of the water of wells is a mere drainage from the surface. Some springs, however, exist in the clay district, as on the Bloody run. They are more frequent and copious beneath the caps of sand and through the openings, as at Springwells, (La Belle Fontaine of the French.) Mt. Pleasant, &c. on the Huron.

But, though the obtaining of water from living spring throughout the clay district, is thus in a degree rendered uncertain, excavations for water have been generally successful. Occasionally copious streams are opened, discharged through *seams* of gravel and sand. Usually water percolates slowly through a gravelly stratum of the clay, and is sweet and pure, and in sufficient quantity for ordinary purposes. Well-diggers assert that such a seam of gravel, at depth of twenty feet, in very general.

These experiments determine: first, that a reasonable prospect exists of obtaining good water by digging; secondly, that a very deep excavation cannot be recommended.

Wells of from five to twenty feet, frequently afford an abundant supply, rising from below: while excavations in the same neighborhood of from fifty to one hundred feet, through a hard, dry, reddish blue clay, yield no water or are filled from the surface. The boring at Detroit, which extended in the depth of two hundred and sixty feet, one hundred and thirty-three feet of which was in rock below the clay, failed to furnish the desired supply. Instances have occurred, however, from diggings in the vicinity of the limerock, of a very copious discharge from, an unusual depth.

Much of the bad effects of stagnant water might be avoided by occasional cleansing of wells. A fresh supply should be obtained by thoroughly draining the well of its contents, when ever an approach to putrefaction is perceived.

Might not a quantity of lime or charcoal, whose antiseptic qualities are well known, thrown in, be a useful auxiliary in preserving purity?

No purer water perhaps exists than that of our immense upper lakes, the whole body of which passes through the straits of Detroit. It is exceedingly soft, and in its under current of almost uniform coldness throughout the seasons.

Detroit denied herself the enjoyment of this luxury, when, by an unfortunate policy, the supply that should have been sought in that volume which flows pure and icy cold in the depths of its channel, is transferred to the reservoir from the warm, contaminated surface, at the docks.

A remedy is obtained by removal of the works above the city and the substitution of iron pipes for wood: but it is suggested whether another improvement might not be effected by extending the supply pipe from its present mouth, at five feet below the surface, into the deep recess of the channel.

Plymouth, which borders on the flat clay district, is the only township that abounds in numerous and copious springs of the purest water. Through this tract of broken, gravelly hills, single springs occur sufficient to give rise to considerable streams.

Roads

The importance of good roads to Wayne county, particularly in the flat district bordering on Detroit, has been long felt, and much labor and expense have been bestowed towards their improvement. Nor can the value of a universal highway, passable with safety and expedition at all seasons, scarcely be overestimated. The soil of this heavily timbered region, it, is true, is but ill adapted to such roads as are required, but great improvements might be effected in their present management.

The importance of the subject will excuse, in these pages, an allusion, though necessarily brief and imperfect, to improvements of this nature; more especially as such only will be referred to as impose no additional expense, but occasion an actual reduction of present outlays to a vast amount.

Heavy taxes are annually assessed for construction and repair of roads. These frequently fall into the hands of men who are ignorant or careless of essential facts, and are appropriated without the oversight of those who are most interested. Or, a requisition is made upon the districts once or twice a year for personal services, on which occasion the whole amount of tax is expended, and the road passes without attention the remainder of the year.

Instead of this inadequate method, we would advise the appointment of a road overseer of at least some practical science. It should be his constant occupation to smooth the ruts and repair every damage as often as they shall occur. A permanent, uniform service should be preserved. This may be effected by means of a broad road scraper and a few hands, only, employed as an occasion requires. The work will then be more effectually accomplished, and will require less than one-half the time labor and cost ordinarily expended.

In road construction it should be borne in mind, that a liberal breadth is favorable to the preservation of a uniform surface. It removes the necessity for a constant use of the same track; thus such portions of the road are avoided from choice as are otherwise cut into continually deepening ruts and hollows. No small advantage also results in the increased facilities for evaporation due to a wider exposure to the sun and a more free circulation of air, as well as in the convenience of ample sidewalks for foot passengers.

The necessity for free removal of water from the side ditches, by drains, conducting to lower levels, is also an urgent consideration. While these are essential to the perfect accommodation of the soil to agriculture, it is also evident that if the roads are left to dry solely by the slow and uncertain process of evaporation, no continuance of labor can be completely effectual.

It may be important to consider whether the elevated crowning given to some of our roads, be not useless as well as expensive, for the steep sides and uneven draught thus created, force all the travel into the only

sate path, at the lop of the grade. The Grand river road, which was thus constructed for a few miles, at great expense, is probably in worse condition at all seasons than if the travel were permitted to shift at will over the same extent of more level surface. A rise of one inch in three feet is thought by the most skilful road engineers more than sufficient for purposes of drainage, it is evident that as ruts are longitudinal to the direction of the road, an increase of elevation cannot assist to conduct off the water which inevitably settles into these convenient receptacles.

The primary expense of the excavation and embankment would provide all the moderate applications needed on a flat road for a great length of time.

The use of brush or logs as a foundation, can be of permanent service only while a constant solid covering of earth is maintained. This cannot be effected but by continual oversight and attention to the considerations above presented.

Possessing, as does the tract of country under consideration, such slender amount of good materials for road construction, it may be well to inquire whether the loads of gravel removed from the river coast and used to fill in the docks, together with the broken stone and pebbles brought as ballast in vessels, might not be employed to public profit, particularly in the streets of Detroit.

These hints touch but very partially the improvements susceptible in our roads. We aim only at directing attention to the subject. Road making has become a science, and to engineers, of whose profession it is more properly a study, we leave its full elucidation.

MONROE COUNTY

Topography

The county of Monroe partakes of the general uniformity of the surface of the eastern border district of the peninsula. This general level is here interrupted by no sudden prominences exceeding 20 feet in height. The rise from the lake is gradual and nearly uniform, attaining at the western line of the county to about 115 feet. The streams descend with a rapid flow, furnishing numerous mill sites.

Lake Coast

The very gradual ascent of the coast renders a border of many acres liable to be overflowed, and has occasioned broad marshes along nearly its whole extent.

From the same cause, the streams, after flowing with a lively current, on approaching the coast, subside to a level, and are affected by the fluctuations of the lake to the distance of two and three miles inland.

This joint action of the tide and current has given origin to several extensive deltas. Thus the approach to the city of Monroe, three miles inland, is through a circuitous channel, among islands of low alluvion, making a

passage of six miles. A cut effected by the ship canal, now in progress, will shorten this distance one-half. The unfavorable impression produced by the Raisin and other streams, at their entrance to the Juke, is, however, removed, on tracing their course through the rich and varied interior.

At least one-half of the whole line of coast presents a border of marsh, irreclaimable, except at the will of the lake.

The most elevated portion of the coast is at Point aux Peaux and Stony Point, near Brest. About one mile in extent has here an. altitude of 5 to 8 feet, occasioned by an out-cropping ledge of limerock.

The effect of the surf breaking upon the outer edge of the alluvial fields and islands, is to accumulate detritus, bronchi up by the lake, occasioning sand beaches. These by successive additions assume the form of ridges, generally elevated about 4 feet. Beaches thus formed skirt the outer edge of the delta of the Raisin. A narrow ridge of sand is frequently seen protecting low marshy tracts in their rear. In a similar manner a spit of sand, four miles in length, forms the barrier to Ottawa bay. This has probably a base of limerock, with clay superimposed, which has been protected from the erosive action of the lake by the cover of sand at the same time deposited from its waters.

Soils and Timber

The county is bordered on the east and west by heavily timbered clay lands, having a width varying from two to nine miles. This timbered tract, on the west, continues into the adjoining county.

The whole included portion, in width from 8 to 14 miles, and extending in northeast and southwest direction into the adjoining counties on the north, and Ohio on the south, consists of sandy "openings" and plains, with a large proportion of wet prairie or marsh.

The heavily timbered tracts produce a large growth of oak, white and black ash, elm, lynn, beech, maple, whitewood, black walnut and sycamore, evincing a rich and very durable soil. Cotton wood is found in swamps, on the western edge of the county.

The limber of the plains and openings is mostly a yellow and white oak, often a thin and scattered growth, upon a meagre soil. Some clayey and more fertile portions produce hickory, and through Frenchtown and Raisinville, burr oak and chestnut are abundant.

The entire county may be said to be characterized by the great limerock formation, which is found to lie no great depth throughout, and approaches the surface in at least twenty different places. Beds of clay and sand repose upon it. The former every where evince the proximity of the limerock by their extremely marly character, and the numerous, imbedded, angular fragments of the rock.

The *out-crops* of the limerock are found to lie in several distinct ranges, extending through the county in a northeast and southwest direction. The outer range,

commencing at the southeast corner of town of Whiteford, forms there a ridge or step, having a rise above the general surface of 15 feet in a breadth of 2 miles. It passes thence in a nearly northeast course to Brest, occasioning those intermediate hillocks or protrusions of rock which occupy areas of from one-half to two square miles. At Stony Point it comes out upon the lake in the ledge before mentioned, and still further on in the same direction makes its appearance on the islands at the mouth of the Detroit straits and the neighboring shores.

The second range, from the town of Whiteford, where it apparently approaches the range first mentioned, passes through the northern part of the town of Ida, in a nearly direct line, to Flat Rock.

West of this range, rock again appears on the Macon river, in the reservation, and in the Raisin at Dundee.

From all the data that could be obtained, the deposite of blue marly clay in the intervals between these ranges does not exceed in thickness 20 feet. Upon this rests a brown or yellow clay, similar to that, which overlies the blue in Wayne county.³⁶ It has a thickness of 3 to 10 feet. This clay constitutes the basis of more than three-fourths of the soil of the timbered binds. Sand loams occasionally alternate with it, and in the town of Milan a rich black sand loam constitutes three-fourths of the soil.

The sand of the openings and plains has a depth probably not exceeding 10 feet on the general level. Its surface is slightly undulating, and in a few instances considerable ridges rise abruptly. One of these was observed bounding the heavily timbered lands of the town of Erie, succeeded by others having no uniform direction, and varying in height from 6 to 15 feet; wet, grassy swales intervening. I traced one of them for a mile in a northerly direction. A sand ridge borders the prairies in the southwest corner of Ida. It continues for half a mile in a northeast course, attaining to 15 feet in altitude, with the breadth of 100, and terminates

³⁶An analysis of 100 grains of these clays showed—

	<i>Upper Clay</i>	<i>Lower Clay</i>
Siliceous matter	9.25	23.00
Alumine	67.25	44.00
Carb. lime	23.50	31.16
Iron	.00	1.84
	100.00	100.00

by sudden descent. Similar ridges may be observed on the plains near Sandy creek, town of Raisinville.

Marshes and Wet Prairie

characterize the plains, or whole central portion of the county, comprising nearly one-fourth their surface. They prevail under several modifications, and may be classed as the larger or wet prairie, occupying frequently an extent of several miles, and the smaller or swales, seldom exceeding an area of 20 acres. They differ also in character, according to the nature of their substratum. The latter class have generally a subsoil of clay, with a covering of peat or muck, deepening proportionately to its extent. Its average is one foot. They afford a coarse

grass, (a species of *Carex*,) much relished by cattle. Where the substratum is sand, a small wiry species generally prevails, considered of inferior quality. Beneath this sand stratum, however, clay will, without doubt, be found at no great depth.

Prairies of much greater extent occupy a large portion of the town of Ida, the southern part of Summerfield, and the eastern part of Whiteford. About five sections of the latter township are of this character; nine sections in Summerfield, and eighteen in Ida. The soil is a fibrous peat, of one or two feet, and occasionally much greater depth, generally reposing upon sand. It produces a rank growth of wild grass, but little valued.

These marshes are portions of a connected chain, and have outlets discharging into considerable streams. Facilities thus exist for rendering them available to agriculture by a proper system of drainage, and at comparatively inconsiderable expense. The experiment has been made to some extent in the town of Whiteford, and a tolerable soil for tillage produced. A crop of wheat is said to have grown upon the tract known as "White's marsh". But it should not be cause for discouragement if several years are required to test fully the value of such experiments. No such cause will exist when the nature of the soil to be dealt with is properly understood.

Similar marshes exist around the head branches of Swan creek, in Exeter, uniting with those described in town of Huron, Wayne county. They are supposed to occupy one half of the surface of the township north of Stony creek.

Small ponds of the lily and other aquatic plants are numerous upon these prairies. A large proportion of the prairies and swales are dry only at midsummer.

Peat

The upper soil of the marshes and swales above mentioned is of the kind denominated fibrous peat; an accumulation, simply, of the annually decaying vegetation. On drying, it will be found a light spongy substance, which may be reduced to an impalpable powder; a character but ill fitting it to become, singly, a fertile soil. When, therefore, it occurs unmixed with argillaceous or siliceous matter, it is to be doubted whether the most thorough drainage will render it permanently available unless care is taken to subject it to irrigation at proper seasons, by closing the drains, and it be united with a proportionable admixture of earths. This admixture may often be effected by bringing up the subsoil by deep ploughing. The washings from the sandy plains adjoining, when cultivated, will further assist the process.

A coat of lime sown upon the surface would prove a most useful auxiliary. This would exert the triple effect of absorbing moisture, hastening the decomposition, and bestowing one of the most important ingredients of a good soil.

The application of this peat to the soil of the plains, much of which is sterile, would be productive of very important

benefit. To effect this, it ought first to be carried to the manure heap and there become thoroughly decomposed by mixing with quick lime. When applied, this should be at once ploughed under. The fine fibre of peat would dry and dissipate, if left upon the surface.

When the comparative expense of cutting drains to that of clearing timbered lands, the immediate applicability of these tracts, and their utility in furnishing manure to the sterile soil adjacent, are considered, it will be apparent that the value of these portions of the country is not over-estimated.

Limerock

The ranges of this rock before described, have a direction through the county which corresponds to the *line of bearing*, or is at right angles to the inclination of the strata. The dip is, consequently, northwest, or northwest by north; very obvious in the outer range, and about 5° in amount.

The color varies from light shades of gray to dark blue. It is mostly compact, but exhibits all that variety of character for which the "mountain limerock" is distinguished. This will best appear in the following extended notice.

It occurs in the bank of Swan creek, at Newport, and in its bed for the distance of two miles above, where to a small extent it has been quarried for economical purposes. The stone is of dark gray color.

Stone of a similar character appears a mile northeast of Brest, (section 24,) and has been quarried to small amount.

At Point au Peaux it exhibits a vesicular or slightly oolitic structure in the lower layers. Superimposed are four feet of disrupted masses, of a more compact character.

Limerock appears in the bed and bank of Stony creek, at Brest, where it has been penetrated to depth of four feet. The thickest stratum opened was of three feet. It has a light, gray color, approaching white. It is compact, and some portions siliceous; considerable hornstone is contained. The stone is quarried in irregular, small blocks, suited to rough building.

The ledge appearing at Stony point, resembles in character the rock on Swan creek. It contains sulphate of strontian.

Limerock forms the bed of Sandy creek, at distance of two miles from the lake.

The city of Monroe is underlayed by limerock at depth of from two to five feet. The rock is quarried to small extent in the bank of the Raisin, near the city. Extensive quarries have been opened in the valley of Plumb creek, half a mile south of the city. The excavations reach to the depth of nine feet. The succession of strata passed through, presents a variety of characters. The vesicular limestone observed at Point au Peaux again appears associated with siliceous portions and compact strata, variegated with yellowish and blueish spots and veins,

having the appearance of veined marble. These bear a, tolerable polish, and might serve for ornamental purposes. At depth of nine feet a stratum occurs of dark blue color, and veined.

The stone is said to improve with depth, both for lime and building purposes. If this be the fact, it may be advisable to excavate lower down the creek, where, owing to the direction of the dip, these more valuable strata may be supposed to lie nearer the surface.

The stone is mostly quarried in angular pieces of small dimensions, but slabs are said to be obtainable of size sufficient for door and window sills, &c.

Limerock forms the bed of Otter creek, at Winchester, and for the distance of eight miles above. It is hard, of a bluish gray color.

Following the range southwest, we find a ridge or hillock composed of limerock, on sections thirty-one and thirty two, of Lasalle, and one and two of townships of Erie, it appears over an area, of more than a square mile, having an elevation of about ten feet above the level on the south. The stone, so far as penetrated, (five feet,) is of a light color, striped, and portions fissile.

Limerock is met with, in the same range, at not less than four places in the township of Bedford. In the bed of Hay creek a small quarry has been opened.

Near the centre of the township it appears twice over surfaces of two-thirds a square mile. These have been penetrated several feet, and are found to consist of a very siliceous rock, imposed of an aggregate of grains of quartz cemented by lime. The upper portions, which lie in loose masses, are calcareous and are alone suitable for burning.

At the southwest corner of section thirty, limerock appears at the surface and in the bed of Halfway creek. This continues at intervals for a mile west, and in a southwest direction, following Ottawa creek, to Whiteford, in Ohio. It underlies the intermediate spaces at a depth probably not exceeding five feet. A continuation of the ledge may also be traced north, along the whole eastern border of township of Whiteford. The upper portions only could be observed, which appeared to be a pure, compact limestone.

No fossils were found in this range, except *Terebratula*, at Newport and Stony point.

Another range or series of outcrops passes through the centre of the county, in a direction parallel to the former. It must be considered as the overlapping edge of a portion of the limerock formation, superimposed upon that whose outcrop forms the range first mentioned. This portion of the formation includes several strata of a very siliceous character, approaching in several instances, almost to pure sandrock.

Stone of this description makes its appearance six miles northwest from Monroe, and was traced over a surface of one-half a square mile. It disintegrates readily, where exposed, into a pure siliceous sand, which may be seen

to be composed of well formed quartz crystals. Where not discolored by oxides of iron, it is of a pure white.

Associated, with this stratum, is a gray siliceous limestone which is fossiliferous.

A similar sandrock appears in the bed of the Raisin, at low water mark, section twenty-nine, township of Raisinville, where it forms a ledge of a foot in thickness. Some portions are beautifully white and are nearly pure silex. It breaks easily and is inclined to disintegrate. It has not been used except as a scouring sand.

Near the west line of section 19, rock appears at the surface, and has been quarried superficially. It is a silica limerock, of dark color, and when quarried, moist and soft, and may be dressed with ease to any required form. Owing to its want of compactness, it may be doubted whether it would be permanent, exposed to the action of the atmosphere. It has been employed as a building material at Monroe.

Opposite Lawrence's mill a smooth ledge of limerock forms, the bed of the Raisin, and a quarry has been opened on the upland, several rods south from the river. The latter furnishes a siliceous limestone, varying in color from a light to a dark mixed gray.

In a southwest direction from the above, in town of Ida, rock is found at the surface over a small area, on section four. A superficial stratum only has been quarried, of a foot thick which is said to afford superior lime.

On section sixteen a siliceous limerock appears in the bank of a small pond and has been opened to the depth of four feet. It removes readily in slabs three feet in length will, thickness of four to six inches. Color, light yellowish gray.

A vesicular limerock forms the bank at the head of Ottawa lake, town of Whiteford. It affords excellent lime.

A compact limerock also appears in an inlet at the foot of Ottawa lake and has been quarried for lime. Portions are siliceous. Considerable calcareous spar is contained.

West of the range just described, limerock makes its appearance on the Macon river just above its mouth, and forms its bed for a mile. It has been quarried extensively, but the excavations have not penetrated below the first solid layer, a depth of eighteen inches. It is mostly of a dark gray color, sparry, approaching a crystalline texture, and abounds with fossils. Portions give out a very strongly bituminous odor. The stratum exposed is very continuous, and has been removed with wedges in pieces 10 feet in length; but the blocks are apt to sever under the chisel. From this locality are said to have been furnished, the caps and sills for the courthouse at Monroe. It will compare in appearance with the much admired Ohio stone. This locality is said to afford the best lime in the county.

Rock of a similar character forms the bed of the Raisin at Dundee.

Lime

More or less has been manufactured at most of the localities of limerock above mentioned.

Three kilns are maintained by the quarries at Plumb creek. Probably 900 or 1000 bushels are made annually.

At the quarry on section 19, Whiteford, five kilns have been burned, of 500 bushels each.

At the Macon quarry eight kilns have been burned, of 800 or 1000 bushels each, which sells at Tecumseh for four shillings per bushel.

Sand

The only locality, particularly worthy of mention, is that of the disintegrated siliceous rock found, as before noticed, in Raisinville, on the farm of Mr. Thos. Colwell. This bed was noticed by the State Geologist in his report of last year. It is mostly pure silex, and for the manufacture of glass, superior to any yet found in the state. A specimen of glass manufactured from it, in the possession of the proprietor, was unusually transparent and free from flaws.

Much of the sand of the plains in this vicinity, and even as far down as Monroe, is intermingled with white siliceous grains from this rock.

Clay

The clays are in general too calcareous to be used with advantage for bricks or pottery. The upper brown or yellow clay is least so, and may be found conveniently for brick at numerous places throughout the county.

The manufacture has been conducted extensively at Frenchtown, opposite Monroe. But few were made the past season. During the season previous so far as could be ascertained about 1,600,000 were burned at the several kilns. The clay is impure from the lime contained.

A single kiln of bricks has been burned at Brest.

At Mr. White's yard, Newport, 100,000 bricks have been burned. The first two feet of the clay only is sufficiently free from calcareous matter to render it fit for the purpose.

Attempts were made at two places in the town of Dundee to manufacture bricks, but were abandoned from the cause alluded to. Good bricks are said, nevertheless, to have been made from the clay on Saline river, in the town of London. All the clays in this region, that were tested, gave very strong indications of lime, so much so as to deserve the appellation of marly. As the clays, even in proximate situations often differ much in this respect, it is important to test them with a simple acid. Good vinegar will answer an ordinary purpose. Clay may, no doubt, be found considerably pure; besides that expense and disappointment may often be spared by a previous knowledge of the character of the material employed.

Marl

A bed of shell marl (bog lime,) underlies the marshy tract bordering the lake, near the city of Monroe. It has been penetrated to the depth of a foot by ditches, for a considerable distance. The deposit has probably a thickness of several feet, and apparently underlies the whole continuous tract; of March, to an extent of about a square mile.

A tufaceous marl is also deposited in considerable quantities by springs in the vicinity.

In the town of Exeter, section 7, a marl is said to have been ploughed up, dry, and crumbling on exposure.

A deposit of shell marl was observed in town of Ash, (town 6 south, range 9 east,) section 9. It occurs in a marshy swale, overlaid by two feet of muck or peat. The bed is about a foot in thickness and occupies an area of an acre. Similar swales are numerous throughout this section as well as in other parts of the county, and the proximity of the limerock warrants the conclusion that beds of marl may be found deposited on low spots, charged with springs.

The economical use of these marls has been noticed under the report of Wayne county. Probably many of the clays may be found approaching so nearly to *marl* as to be of great value is a stimulant manure to sandy soils.

Sulphur Springs

Two miles below Monroe, near the marshy border of the hike, several springs issue from an immense mound. They fire strongly impregnated with sulphur, and form thin white deposits of that substance. This mound occupies an area of 4 to 6 acres, rising about 10 feet above the general level. Its surface is wet and boggy. This mound is evidently a deposit from the water of the springs, which running through crevices in the great underlying rock formation, becomes highly charged with lime, and on approaching the surface, deposits that substance either in a soft plastic mass or as a, coating upon the moss and surrounding vegetation. Thus *marl* and *tufa* result. This process may be observed now going on. Large quantities of moss, still alive, are covered with a thin calcareous crust. A mile further south are numerous smaller mounds of similar origin. One of these discharges a considerable stream from a spring occupying a large cavity in the centre. Here a foot thickness of white marl is disclosed, overlaid by two feet of crumbling tufa. The spring boils up through a cauldron of calcareous and vegetable matter, into which a pole may be thrust many feet. This mound is circular, 100 feet diameter and 6 feet high. Most of the other mounds consist of a very indurated lime or *tufa*.

The famous sulphur spring in the Bay settlement, emerges from a low mound of similar formation, situated in the edge of the large marsh bordering the bay. It occupies a circular basin of 150 feet diameter by 45 deep. A stream flows from it which at its head is 10 feet wide and 3 feet deep, and has a considerable current. The odor of sulphur may be perceived at distance of half

a mile, though the water is not of extraordinary strength. A bathing-house was in contemplation at this place, but the unusual rise of the lake caused an abandonment of the project.

Springs occur in great numbers on Sulphur creek, town of Lasalle. They occasion mounds of the same character as those near Monroe, and discharge considerable streams. A few of these united, formerly supplied a mill.

In Raisinville, section 19, is a strongly impregnated spring, discharging water sufficient to form a brook.

Another, on section 25, forms the head of Plumb creek.

A spring of moderate strength issues from the margin of the Raisin, half a mile below Dundee.

A strong spring of sulphur and iron is said to be found on Stony creek, town of Exeter, section 21.

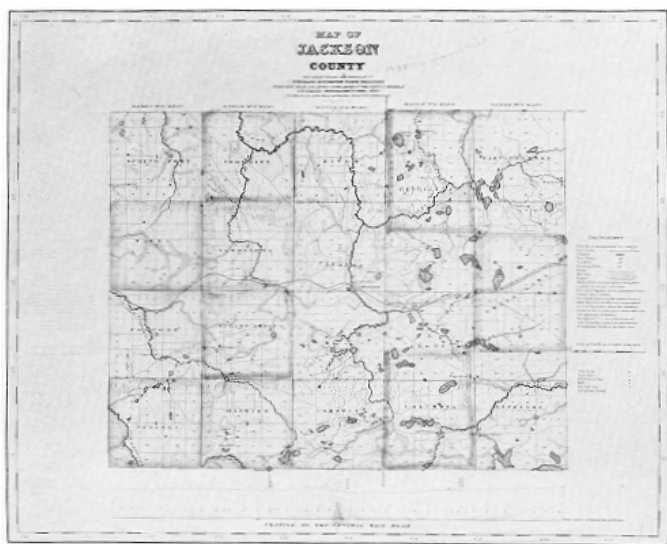
On Swan creek, town of Ash, are springs impregnated with sulphur and iron. One on section 36 ascends in a curb several feet above the level of the stream.

These springs all afford a copious supply, and are unaffected by a drought which renders dry the channels of neighboring streams. This fact, with that of their rise above the level of the surrounding waters, and their strong impregnation with the mineral sulphur, lime and iron, proves that they have distant sources and that they proceed from great depths below the surface.

Streams and Springs

This county is intersected by a number of considerable streams, following a parallel course to the lake: but small branches do not abound, as in a country of more broken surface. Most of the streams supply a *hard* water.

Water is obtained generally without difficulty from wells and springs affording a good supply, extremely hard. It is occasionally impregnated with sulphur and iron, owing to the proximity of the limerock.



[Map of Jackson County]

Several wells in the towns of Ash, Lasalle and Ida, sunk twenty feet, to rock, opened veins which tilled them suddenly, causing them to overflow.

Wells on the plains which do not descend to the clay, are generally soft; so that by proper precautions, water free from lime may be obtained in those situations.

Bog Ore

Several deposits of this mineral occur in the neighborhood of Petersburg and Dundee. The ore is much mixed with siliceous matter, and none of it can be considered of the best quality.

On section nineteen, township of Summerfield, ore is formed on the borders of a marsh of about ten acres. The marsh is fed by springs and is unaffected by droughts. The ore is deposited in loose, amorphous masses, mingled with shot ore. The sandy soil of the neighboring plains is much mingled with particles of shot ore resembling fine gravel. Several hundred loads might be obtained from this locality.

On section twenty-five, ore was discovered in digging a trench through a marshy swale. It is found over about an acre, principally disseminated in the state of shot through the sandy peat soil, in a stratum not exceeding six inches thickness. In the dry border some heavy mamillary ore is found, in loose pieces, some of which weigh several pounds.

On a neighboring farm ore of a, similar character was thrown out in ditching. A few loads might be obtained.

Swales similar to the above abound, and other localities of ore will no doubt be found whenever sufficient inducement shall be offered for its search.

Numerous indications of bog iron were seen in township of Bedford. No valuable deposit came under my observation. A locality is said to exist, supposed to be in quantity, on section three, (township nine south, range seven east.)

Indications also exist in township of London and elsewhere.

A bed of sandy red ochre is found on section twenty-one, Bedford, covering about three square rods, with a depth of from one to three feet. It is immediately underlayed by limerock. A small quantity has been applied as a paint, and tolerably answers the purpose.

Boulders

Numerous water-worn fragments of the primary rocks are found lodged on the limestone hillocks, and accompanying the ranges of limerock throughout the country, but seldom occur elsewhere upon the surface. Similar boulders are found imbedded in the blue clay deposit.

A large boulder from the limerock formation was noticed on section four, township of Milan.

Phenomena Accompanying the Limerock

Sink-holes.—In the township of Whiteford occur a number of these bowl-shaped depressions, known by the* name of “sinks.” The largest that came under by observation is near the northeast corner of the township. This immense basin occupies nearly one hundred acres, and at the centre is about fifteen feet below the general level. I found the bed to be composed of layers of blue clay and sand, covering at a slight depth limerock.

These sinks derive their name from the fact of their being collects for the waters of the surrounding region, which are here absorbed; no outlets being discovered. The waters no doubt disappear in a cavernous aperture of the limerock below. It is stated, on good authority, that when the large sink is filled, a whirlpool may be seen of sufficient force to draw in rails floating near the vortex.

Marks of Diluvial Action.—Upon the surface of the broad, flat ledges of limerock at Point au Peaux, was observed a beautiful exhibition of the *grooves and scratches* supposed to be occasioned by attrition of hard bodies moving in a strong current. These have a uniform direction, north 60° east. In some instances the surface has been worn to a fine polish, which imparts a beautiful light color to the stone, and exhibits the markings as fresh in appearance as if done yesterday.

A similar phenomenon is observable at Brest, and is a line illustration of the course and moving power of the current. The surface, about twenty square feet of which is exposed, is undulating and worn into curves. Two directions are here observed of the furrows, on contiguous portions of the same ledge; north 50° east and north 65° west.

Facts of this nature, which singly are of little importance, are noted, because they have a bearing upon the results of scientific inquiries; a consequence which, though for a time unheeded and “darkly hid,” tends to throw clearer light upon the ultimate plan of useful economy.

My acknowledgments are due to many persons in the above counties for hospitalities and assistance rendered in the prosecution of the survey.

BELA HUBBARD,
Assistant Geologist.

Detroit, January 26, 1839.

GLOSSARY

Including most of the Geological terms used in these reports front, Lyell's Geology, and other sources.

Alluvial. The adjective of alluvium.

Alluvion. A synonym of alluvium.

Alluvium. Recent deposits 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 deposits in which water is the principal agent.

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

Amorphous. Bodies devoid of regular form.

Amygdaloid. A trap rock which in 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 contrarywise, like the sides of the roof of a house.

Arenaceous. Sandy.

Argillaceous. Clayey.

Augite. A simple mineral of variable color, 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 also 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 Giant's 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. Sulphuret 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.

Botryoidal. Resembling a bunch of grapes in form.

Boulders. 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 lighted candle will not burn freely.

Carboniferous. Coal bearing rocks. This term has been applied to formations belonging to an ancient group of secondary rocks, which contains 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 horn stone. 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 to 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, 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 denned 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.* 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. Deposits 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. Sand raised into hills and drifts by the wind.

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

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.

Exuviae. 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.

Fluvialite. 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, other 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 geological 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 of 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.

In Situ. In their original position, where they were formed.

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.

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.

Mural Escarpment. A rocky cliff with a face nearly vertical, like a wall.

Mammillary. A surface studded with smooth small segments of spheres, like the swell of the breasts.

Mammoth. An extinct species of the elephant.

Marl. By this term an argillaceous carbonate of lime is usually implied. By custom, its signification is much more extended, and means mineral substances, which act as stimulating or fertilizing manures. There are clay marls, shell marls, and various others.

Marly clay. Clay containing carbonate of lime.

Mastodon. A genus of extinct fossil animals allied to the elephant. They are so called from the form of the grinders, which have their surfaces covered with conical mammillary crests.

Matrix. The mineral mass in which a simple mineral is imbedded, is called its *matrix* or *gangue*.

Megatherium. A fossil extinct quadruped resembling a gigantic sloth.

Mechanical origin, Rocks of. Rocks composed of sand, pebbles or fragments, are so called, to distinguish them from those of a uniform crystalline texture, which are of chemical origin.

Mica. A simple mineral having a shining silvery surface and capable of being split into very thin elastic leaves or scales. The brilliant scales in granite and gneiss are 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.

Miocene. One of the deposits of the tertiary epoch. It is more recent than the *eocene*, and older than the *pliocene*.

Mollusca. Molluscous animals. "Animals, such as shell fish, which, being devoid of bones, have soft bodies."

Mountain Limestone. "A series of limestone strata, of which the geological position is immediately below the coal measures, and with which they also sometimes alternate."

Muriate of soda. Common salt.

Naphtha. A fluid, volatile, inflammable mineral, which is common in volcanic districts, and in the vicinity of the salt springs of the United States.

New Red Sandstone. "A series of sandy and argillaceous, and often calcareous strata the prevailing color of which is brick red, but containing portions which are greenish grey. These occur often in spots and stripes, so that the series has sometimes been called the variegated sandstone. The European, so called, lies in a geological position immediately above the coal measures."

Nodule. A rounded, irregular shaped lump or mass.

Old Red Sandstone. "A stratified rock, belonging to the carboniferous group of Europe."

Oolite, oolitic. "A limestone, so named, because it is composed of rounded particles like the roe or eggs of fish. The name is also applied to a large group of strata characterized by peculiar fossils."

Organic Remains. See *Fossils*.

Orthoceratite. The remains of an extinct genus of molluscous animals, called Cephalopoda. The orthoceratites are long, straight, conical chambered shells.

Out-crop. See *Crop out*.

Out-liers. Hills or ranges of rock strata, occurring at some distance from the general mass of the formations to which they belong. Many of these have been caused by denudation, having removed parts of the strata which once connected the outliers with the main mass of the formation.

Oxide. A combination of oxygen with another body. The term is usually limited to such combinations as do not present active acid or alkaline properties.

Palaeontology. A science which treats of fossil remains.

Pisolite. A calcareous mineral, composed of rounded concretions like peas.

Pliocene. The upper, or more recent tertiary strata. This group of strata is divided into the older and newer pliocene rocks.

Petroleum. A liquid mineral pitch. It is common in the region of salt springs in the United States.

Porphyry. A term applied to every species of unstratified rock in which detached crystals of feldspar are diffused through a compact base of other mineral composition.

Productus. An extinct genus of fossil bivalve shells.

Plastic Clay. One of the beds of the Eocene period. The plastic clay formation is mostly composed of sands with associate beds of clay.

Pudding Stone. See *Conglomerate*.

Pyrites. A mineral, composed of sulphur and iron. It is usually of a brass yellow, brilliant, often crystalized, and frequently mistaken for gold.

Quartz. A simple mineral, composed of siliceous. Rock crystal is an example of this mineral.

Rock. All mineral beds, whether of sand, clay, or firmly aggregated masses, are called rocks.

Sandstone. A rock composed of aggregated grains of sand.

Saurians. Animals belonging to the lizard tribe.

Schist. Slate.

Seams. "Thin layers which separate strata of greater magnitude."

Secondary Strata. "An extensive series of the stratified rocks, which compose the crust of the globe, with certain characters in common, which distinguish them from another series below them, called primary, and another above them called tertiary."

Sedimentary Rocks—Are those which have been formed by their materials having been thrown down from a state of suspension or solution in water.

Selenite. Crystalized gypsum.

Septaria. Flattened balls of stone, which have been more or less cracked in different directions, and cemented together by mineral matter which fills the fissures.

Serpentine. A rock composed principally of hydrated silicate of magnesia. It is generally an unstratified rock.

Shale. An indurated slaty clay, which is very fissile.

Shell Marl—Fresh water, Shell Marl. A deposit of fresh water shells, which have disintegrated into a grey or white pulverulent mass.

Shingle. The loose water-worn gravel and pebbles on shores and coasts.

Silex. The name of one of the pure earths, which is the base of flint, quartz and most sands and sandstones.

Siliceous. Containing silex.

Silt. "The more comminuted sand, clay and earth, which is transported by running water."

Simple Minerals—Are composed of a single mineral substance. Rocks are generally aggregates of several simple minerals cemented together.

Slate. A rock dividing into thin layers.

Stalactite. Concreted carbonate of lime, hanging from the roofs of caves, and like icicles in form.

Stalagmites. Crusts and irregular shaped masses of concreted carbonate of lime, formed on the floors of caves, by deposits from the dripping of water.

Stratification. An arrangement of rocks in strata.

Strata. Layers of rock, parallel to each other.

Stratum. A layer of rocks; one of the strata.

Strike. The direction in which the edges of strata crop out. It is synonymous with line of hearing.

Syenite and *sienite.* A granitic rock in which hornblende replaces the mica.

Synclinal line and *synclinal axis.* When the strata dip downward in opposite directions, like the sides of a gutter.

Talus. In geology, a sloping heap of broken rocks and stones at the foot of many cliffs.

Tertiary Strata. "A series of sedimentary rocks, with characters which distinguish them from two other great series of strata—the secondary and primary—which lie beneath them."

Testacea. "Molluscos animals, having a shelly covering."

Tepid. Warm.

Thermal. Hot.

Thin out. Strata which diminish in thickness until they disappear, are said to *thin out*.

Trap—Trappean rocks. Ancient volcanic rocks, composed of feldspar, hornblende and augite. Basalt, greenstone, amygdaloid, and dolomite, are trap rocks.

Travertin. "A concretionary limestone, hard and semi-crystalline, deposited from the water of springs."

Tufa Calcareous. "A porous rock, deposited by calcareous waters on exposure to air and usually containing portions of plants and other organic substances incrustated with carbonate of lime."

Tufaceous. A texture of rock like that of tuff.

Tuff or *Tufa.* "An Italian name for a volcanic rock of an earthy texture."

Unconformable.—See conformable.

Veins. Cracks and fissures in rocks filled with stony or metallic matter. Most of the ores are obtained from metallic veins.

Zoophytes. Coral sponges and other aquatic animals allied to them.

REPORT OF THE COMMITTEE OF THE SENATE ON MANUFACTURERS, TO WHOM WAS REFERRED THE COMMUNICATION OF THE STATE GEOLOGIST. RELATIVE TO SALT SPRINGS AND THE SALINES OF THE STATE

(Senate Documents, 1839, No. 3)

Your committee beg leave to report, that having bestowed on the above subject, a portion of that attention which its magnitude requires, they have adopted the following conclusions:

1st. That an act ought to be passed by the legislature immediately, making an appropriation sufficient to enable the geological corps to progress with the improvements that have been already commenced at Grand and Tittabawassa rivers, and to pursue them to a final result, and also to enable said corps to continue such examinations of our salt springs in general, as the legislature shall direct.

2d. That some proper person ought to be authorized to take charge of the lands attached to said springs, and prevent, as far as may be, the loss of timber on them by intruders or trespassers.

3d. That as the lands attached to the salt springs, are at present wholly unproductive to the state, and from the waste of timber that is committed on some of them, there is danger of their value being reduced, and the examination of the State Geologist will soon enable him to determine what portion of those lands will be necessary for the manufacture of salt—that the state should memorialize Congress and ask the privilege of selling such of the salt springs lands as will not be required for supplying fuel or other conveniences in the manufacture of salt.

4th. That of the seventy-two sections belonging to the salt springs, there have been forty live sections located—twenty-six of which have been confirmed by the general government, and there is yet twenty-seven of said sections to be located, and less than one year to do it in; it is therefore very necessary that there should be vigilance used on the part of the state officers to make those locations in due time, otherwise the lands will be forfeited.

Your committee would further report, that as the reference of this subject. To them plainly indicates that the Senate fully anticipate the manufacture of salt and its transportation to its destined market—, they have been led to take into consideration the saline district of the state, and to some reflections upon the probable advances that will be wanted for the general accommodation of the inhabitants of the country, and upon the plan for obtaining the means of opening and improving those communications.

Your committee are of the opinion, that from recent examinations, the saline or salt bearing rock, is found in the northern part, of the slate, where the remainder of the salt springs will most probably be found, and as that part of the state, for about, two thirds of its whole length,

belongs to the United States, they are, therefore, fully impressed with the propriety of petitioning Congress for a grant of land of each alternate section of unlocated land, ten miles in width, commencing at the center of the south line of Michigan, running north to the straits of - Mackinaw, for the purpose of defraying the expenses of constructing a road on said line; for the same reasons, they recommend, that Congress be memorialized for a like grant of land of ten miles in width, commencing on the west side of Saginaw bay, taking each alternate section of unlocated land, and running west through the vicinity of the salt springs at Tittabawassa to Lake Michigan, for the like purpose of defraying the expenses of constructing a road on said line.

All of which the committee would respectfully submit, with the following preamble and resolution.

[See Proceedings of January 15, 1839]

COMMUNICATION FROM THE STATE GEOLOGIST RELATIVE TO THE GEOLOGICAL SURVEY

(Senate Documents, 1839, No. 25)

Office of State Geologist,
Detroit, March 7, 1839.

To the Hon, Senate of Michigan:

In compliance with the requisitions of a resolution from the Honorable Senate of Michigan, instructing the State Geologist to report "with all convenient dispatch,"

"1st. If there exist any outstanding contracts? and if any, what?

"2d. What loss, injury or detriment might result from a temporary suspension of said geological survey.

"3d. If in any respect such injury should be likely, in the opinion of said Geologist, to be incurred, then that he report what part of said survey, in particular, would be prejudiced by such suspension?" I would respectfully report:

That contracts have been entered into with that part of the appropriation arising from the general fund, or rather orders have been sent abroad for the fixtures of a lithographic press, paper, &c, for the use of the topographical department, as also for sundry items, such as instruments, &c, preparatory to a commencement of the work with the opening of spring. As no bills of these orders have as yet been received, I am unable to lay before you an accurate estimate of the amount of these orders.

As it is inferred that no portion of the resolutions are directed to that part of the work connected with the improvement of the salt springs, I will only briefly add with respect to this department, that contracts are considered as closed for some heavy portions of the work.

2d. "The loss, injury or detriment which might result from a temporary suspension of the geological survey," may be regarded as of such a character as would eventuate in an almost total loss of what has been already accomplished, and would, without doubt, prove fatal to the whole work.

In carrying forward a work of this character of that under consideration, it is indispensable that the heads of the several departments, or those who are eventually to be called upon for connected reports, remain unchanged, for the reason that many, and in fact a large proportion of the comparative data from which conclusions are drawn, being unfinished, are not in such a condition as to be either comprehended or understood by a third person, unless he pass through the very same steps of observation. In this respect the work may be compared to a long series of half solved mathematical problems, which a third person would be incapable of completing without passing over the same ground, a step which would be necessary, even for the very person first engaged in the work should he fail to pursue the subject to a close while fresh in his mind.

The chief assistants employed in the geological survey are men who have left lucrative professions with a simple desire of aiding the work in progress. They have engaged with an enthusiasm that is deserving of the highest respect, and they have labored to collect matter for the elucidation of their several departments, which will, no doubt, if carried to completion, be creditable to themselves while it will prove of practical utility to the people.

Had the several assistants taken charge of the separate departments from mercenary motives, and without any hope of originating a result that would be creditable to themselves while it would benefit the people, the circumstances would be very different; but as it is, having engaged with motive and inducements of a higher character, I can safely say that not a single one of the heads of the departments would desire to remain in the work a single hour, were he to entertain the idea that the fatigue, anxiety and labor which had been devoted to the subjects under his charge, were to be scattered to the winds. The reflection that this may be the result, has already acted as a blight upon their operations, for they have felt that there was no inducement whatever to carry forward the examinations which they had so fondly hoped to complete.

The temporary suspension of the survey will necessarily destroy the present organization; the assistants will return to their professions, and certainly without any desire of again undertaking a task which it might be feared would only end in disappointment and disgrace. The organization of a competent board of assistants for conducting operations of this character, is only made with the utmost difficulty, and were the one now acting dissolved, we could scarcely hope to affect a reorganization in such a manner that each would understand his duty in less than a year's time; and in fact it may be doubted whether, under those

circumstances, competent assistants could be induced to undertake the task; and should the work be again commenced, it would be necessary to pass a second time over a large portion of the road which has already been traveled.

In obedience to the instructions contained in the act of March 28, 1888, I nominated Dr. John Wright as botanist to the geological survey, and the same was duly continued. Dr. Wright was at the time engaged in a lucrative practice of his profession in Troy, New York, and it was only after the most urgent solicitations, and at much pecuniary sacrifice upon his part, that he was induced to accept the appointment; relying upon the faith of the state to complete the work which he had been induced to undertake. The duties assigned him have been performed with a devotion and success hardly to have been anticipated, and which, if continued, could not, it is conceived, fail to lead to important results. Even the most temporary suspension of the work would eventuate in the loss of the scientific and practical matter which has been collected in this department of the survey, while it certainly would be acting in no good faith to the head of that department.

The same in fact would prove to be the result in the several departments, were the work to be temporarily suspended. The assistants have performed their duties from a devotion to the subjects in which they are engaged, and certainly without any prospect of pecuniary advantage; they are men who would immediately find an active field of labor, were they separated from this work, and who, in all human probability, could never be induced again to undertake the task in which they are now engaged. To reorganize a corps of assistants would in fact be equivalent to commencing the work anew.

The present time is an exceedingly favorable one for conducting operations in the geological and topographical departments, for while the United States surveyors are engaged in subdividing the northern part of the peninsula, we are enabled, to procure, through them, a vast amount of information; and in fact through that source an amount of labor may be accomplished very far exceeding that, which under other circumstances, could be done. Those United States surveys will probably be completed during this and the ensuing year, and the time will then have passed for gaining the assistance of those persons who are engaged in this work.

There still remain of the salt lands granted our state by the general government, thirty sections to be located. The judicious location of these lands will involve a large amount of labor; yet that labor would be of such a kind that two objects would be gained, viz: the location of the land and the survey of the country. Should a special agent be appointed to make the selection of the lands, only one of those objects would be gained, at the same time that much difficulty might occur in making the proper selections.

Thirdly, "I am instructed to report what part of said survey, in particular, would be prejudiced by said suspension," to which I would answer unhesitatingly, *all parts of it*. The work is of a character which to be rendered really valuable, requires to be conducted as a whole; and to cut off any portion would not only leave a defect, but would cripple the operations of other departments, for those remaining could scarcely conduct the balance of the work in such a manner as to be creditable either to themselves or the state.

In answering that all the departments of the survey would be prejudiced by a suspension, I would call your attention to an *attached* duty, perfectly independent of the geological survey proper, the relation of which to our other duties, would appear to be but imperfectly understood: I allude to the collection of specimens of natural history.

It is well known that the regents of the university felt a deep anxiety to embrace the opportunity afforded by the work in progress, to supply the students of the state university with facilities for the study of natural history, unequaled by any institution in our country. The progress of the geological survey offered facilities for carrying this into effect, at a comparatively small expense. The geological board were directed to perform the duty, and the act directs the regents to refund to the state the sum of four thousand dollars, the estimated cost of these collections.

The duties incident upon the collection of specimens, in the manner directed, have much increased the labor of the work; yet they have been performed with pleasure, from the hope that these collections might prove of value to our state institutions. Yet the very industry which has been used for a faithful compliance with the requisitions of the act, would appear not only to have brought discredit upon the whole work, but also to have given rise to a variety of epithets, certainly of no very dignified character, which are in no wise calculated to extend the usefulness of those persons to which they are applied. It would be to those engaged in the geological survey, no small relief to be spared the labor of making these collections, and this portion of the work may be suspended without any detriment to the legitimate duties of those engaged in the survey; but since, if the amount required for making these collections be repaid from the university fund, nothing would be gained in economy to the state, no good reason can be conceived why the university should be denied the facilities offered for enriching her cabinet of natural history.

All which is respectfully submitted.

DOUGLASS HOUGHTON,
State Geologist.

REPORT OF THE STATE GEOLOGIST, RELATIVE TO
THE IMPROVEMENT OF SALT SPRINGS

(House Documents, 1840, No. 2)

Office of State Geologist,
Detroit, January 6, 1840.

To the Honorable Speaker of the House of
Representatives:

Sir—I have the honor to transmit to the house of
representatives the accompanying report from this
department in relation to the improvement of the state
salt springs.

I am, very respectfully,
Your obedient servant,
DOUGLASS HOUGHTON
State Geologist.

Office of State Geologist,
Detroit, January 6, 1840.

To the Honorable Senate and House of Representatives
of Michigan:

In compliance with the requisitions of an act approved
January 28, 1889, directing the State Geologist to
“continue the works already commenced at the state salt
springs”, I would respectfully beg leave to submit the
following report:

The details of the plan adopted for the improvement of
the state salt springs, (so far as such details were
deemed important,) we laid before you in a previous
report; and a repetition of such details being at this time
unnecessary, I would refer you, for information on that
subject, to a report from this department, dated January
7, 1889.

Immediately upon the receipt of instructions to continue
the work under consideration, (which had been partially
suspended,) it was recommenced, and steps taken
preparatory to the erection of such machinery as would
be required to carry into effect the design of the act.

A conditional contract was early made with a mechanic
residing at Kenawha, Va., competent to conduct the
practical part of the boring, who had stipulated to
complete to the extent of the estimates, at a certain rate
per foot; the state to furnish all such machinery as
should be required in carrying forward the operations.
Under this contract I had hoped to complete, with less
trouble and expense than otherwise could have been
done, a considerable portion of what had been directed
to be preformed. This contract, I regret to say, was not
complied with, upon the part of the contractor, in
consequence of assigned fears as to the health of the
country; a circumstance which operated unfavorably
upon the work since it had given rise to delay, and after

which the adoption of a course, totally different from that
originally intended, became necessary.

I had already made a journey through portions of Ohio,
Pennsylvania, and Virginia, for the express purpose of
examining the character of improvements adopted at the
salines in those states, as well as for the purpose of
contracting for the improvements contemplated in our
own. The failure of the contractor, as above stated, to
fulfill his contract, left me in a situation of great
embarrassment, which was much increased in
consequence of the difficulty of procuring competent
persons to take charge of the mechanical part of the
labor.

The duties which my office as state geologist, has
required me to preform, have been of so onerous a
character, that a *personal* direction of the improvements
in progress at the salt springs was impossible unless
accompanied with a complete relinquishment of the
legitimate duties of my office. Thus, during the past
season, the progress of the geological survey made it
necessary for me to devote nearly three months of my
time upon surveys in progress in the northern peninsula
several hundred miles distant from the salt springs, and
under such circumstances that it was impossible for me
to visit; them during that time. And even while engaged
in the survey of the southern portions of the state, the
duties were such as to prevent my taking that personal
supervision of the mechanical portion of the work, which
could have been desired. The work was necessarily left
in charge of superintendents; and the fact, that I was
almost constantly in the field, and at such points that it
was difficult, and at times impossible, to communicate
with these superintendents for weeks, and even months,
together, has rendered the trust a. subject of very great
embarrassment. It has also served to retard, in a
measure, the progress of the works, for the reason that
delays have occurred, in awaiting answers required to
communications requiring action where any considerable
expense would be involved.

These facts are presented at this time, to enable you
more fully to appreciate the manner in which the
attached duties connected with the improvement of the
salt springs, have conflicted with the legitimate duties of
my office. In fact, I may say, that the duties arising from
an attention to the mechanical part of the work at the salt
springs, are almost incomparable with a faithful
discharge of the other duties assigned me. These,
representations are not made in a spirit of complaint, but,
from a firm conviction of the impossibility of the
performance of both trusts in a manner which will not
subserve the interests of the state.

Since the date of my last report on the condition of the
state salt springs on Tittabawassee river, sufficient
additions have been made to the buildings to render the
situation of the workmen employed, comfortable; a
carpenters' shop, blacksmiths' shop, and engine house,
have been erected, a steam engine set up and put in
successful operation, and nearly the whole machinery
required for the operation of boring is upon the ground.

The work at these springs, in consequence of their distant; situation from settlements, has rendered a considerable expenditure for boats, &c, for the transportation of material and provisions necessary, as also the purchase of many articles which, under other circumstances would not have been required. The expense incident upon the transportation of the many bulky articles of provisions and forage for cattle, induced me to cause those articles to be raised upon the ground, and the result has shown the course to have been an economical one.

In continuing the shaft commenced at this place, much difficulty has been encountered from the influx of water; but the condition is such that this difficulty may now be easily overcome by properly sinking tubes. All is in readiness to progress with rapidity, and the whole outlay for materials having been involved, the remaining expense for completing the work will be comparatively small. A quantity of wood is also on hand, nearly if not quite sufficient to supply the engine for the completion of the work.

At a depth of little less than fifty feet, a considerable vein of salt water was opened, but so intermixed with veins of fresh water as to make it impossible to determine the absolute quantity of saline matter contained in it. This mixed water was nevertheless found to contain nearly double the amount of salt that is contained in the waters of those springs in the vicinity of the shaft. Although this water is not of sufficient strength to admit of its economical use for the manufacture of salt, it nevertheless serves to add confidence to the hope before expressed, of eventual success in obtaining the office sought, if the plan proposed be carried out.

At the salt springs on Grand river a steam engine has also been set up, and is nearly in readiness for operation; the necessary buildings have been erected, and the works secured by the erection of a dock, which is, however, only partially filled. The great mass of machinery and implements required for completing the boring, are already on hand.

The sinking of a gum (upon the same plan as that adopted at Kenawha, Va.,) has been commenced, and the gum is settled within about three feet eight inches of the rock. The great influx of water rendered the sinking of this gum exceedingly difficult, but this portion of the work is now so far completed that little difficulty can occur in fully commencing the operation of boring.

Much delay and considerable loss were sustained in consequence of the destruction by fire of a building erected for a blacksmith shop, in which tools and some machinery were stored; a loss which was felt the more severely for the reason that we were compelled to supply the place of the articles so destroyed with others procured in Detroit, thereby giving rise to much delay and expense. This fire is supposed to have originated from the hand of an incendiary.

In consequence of the embarrassments existing in the infernal improvement fund, it became necessary to

suspend operations in the month of September. This suspension of work would have taken place at an earlier day had not duties connected with the geological survey prevented my visiting the salines during the interval which elapsed from June to September; that space of time having been devoted to work upon the northern peninsula.

The necessity for this suspension, I trust, can be appreciated; but occurring at, the time and under the circumstances it did, it cannot be considered otherwise that, exceedingly prejudicial to the interests of the improvements under consideration. The main portion of the preparatory expense had been involved; persons had been brought from a distance to carry forward the work, and that, point was just reached where the expenses would have been comparatively trifling.

At each of the salines a man is left in charge, on very limited pay, to preserve the machinery from injury, as well as to prevent loss from other causes.

The chief portion of the machinery having been completed, and the materials for the continuance of the work being on hand, the amount required to bring it to a close will be comparatively small. An estimate of the amount required has been attempted, but the data before me are so unsatisfactory, that I have deemed it unnecessary to lay the estimate before you at this time.

In connection with this subject, I cannot withhold again referring to the embarrassments which a failure to receive the instalments of the appropriation has caused, for I have been compelled, so far as was in my power, to provide means from my private resources, to comply with the spirit of the contracts entered into. This difficulty, added to the onerous character of the other and *principal* duty assigned me, have rendered this portion of my *attached* duties a constant source of embarrassment.

I trust you will also appreciate the motives with which I repeat what was said on a former occasion, viz: that the charge of the mechanical portion of the duties connected with the improvement of the salt springs, is nearly incompatible with the other duties I am directed to perform; and however anxious I may be to perform faithfully the duties assigned, very nature of those duties is such as to preclude an absolute personal supervision. I am, in consequence, held responsible for the faithful performance of a trust, without the power to devote to it that constant and unwearied attention it requires.

This will be the more readily understood, when you reflect that to the office of state geologist certain duties are assigned, which if faithfully performed, should occupy his complete time and attention. After these duties had been defined, the charge of the improvement of the salt springs was also added, thus attaching a duty which of itself requires the complete energies and attention of a single individual.

In view of these difficulties and embarrassments, I would respectfully suggest to your honorable body, the policy

of so far modifying the present duties of the state geologist, as to rid ease him from the duties and responsibilities connected with the disbursements and superintendence of the improvements at the salt springs.

I would again, respectfully beg leave to call your attention to the condition of the salt spring lands. The "location" of the seventy-two sections of salt lands, granted our state by the general government, is now completed, and the sum expended in the improvement of the salt springs, may be regarded as an amount advanced, to be hereafter replaced from the liberal donation already made by the United States. With this view, no doubt can exist but the earliest, measures should be taken to render the lands available, and the conditions of the grant as such as only to admit of their lease. Numerous applications have been made for the lease of portions of those lands, which will, never be required for salt purposes; but no power exists to lease or place them in any condition by which profit may accrue to the state.

Nor am I aware that any power has been delegated, by which depredations upon the timber of those lands can be prevented. Extensive depredations have been committed upon the timber of some of the lands, and this in the most bold manner; for they have been committed without any apparent fear of consequences. It is unnecessary to represent to you the great injury thus done to the lands.

An exhibit of the condition of the fund placed under my control, will be laid before you at as early a day as a due regard to accuracy will permit.

All of which is respectfully submitted.

DOUGLASS HOUGHTON,
State Geologist.

STATE GEOLOGIST'S ACCOUNT CURRENT FOR
THE YEAR 1839, THE SAME BEING THE SUBJECT
MATTER OF THE THREE PRECEDING REPORTS

(*Senate Documents, 1840, No. 18*)

*Office of State Geologist,
Detroit, January 10, 1840.*

To the Honorable President of the Senate:

Sir—I have the honor to transmit to the honorable senate, the accompanying accounts from this department for 1839.

Full vouchers substantiating the same, have this day been transmitted to the honorable the house of representatives.

I am, sir, very respectfully,

Your obedient servant,

DOUGLASS HOUGHTON,
State Geologist.

*The State of Michigan, in account with Douglass
Houghton, State Geologist.*

DR.

1839.				
Jan.	1,	To cash paid Emerson, Moore, & Co., as per bill rendered		\$450.00
		do J. L. Wheeler	\$18.00	
	2,	do G. & J. G. Hill,	13.98	
	6,	do Detroit Iron Co.,	68.00	
				99.98
	12,	do Jas. Watson,		283.54
	21,	do H. Williams & Co.,	102.65	
	22,	do J. Roberts & Co.,	8.35	
	25,	do J. J. Riordan,	\$40.79	
	30,	do Sundry items of postage on letters	.59	
				\$152.38
Feb.	11,	do John Kenyon,	20.00	
	19,	do DeGraff & Townsend,	12.00	
	21,	do F. Chubb,	113.26	
	28,	do Postage on letters for Feb. 1839,	1.02	
				146.28
Mar.		do Jas. A. Kent,	4.44	
	6,	do DeGraff & Townsend,	4.50	
		do Randolph & Brother,	20.00	
		do McGraw & Knight,	1.56	
	12,	do J. B. Garland,	16.25	
	13,	do R. H. Renwick,	5.00	
	15,	do A. Bruno,	83.31	
	17,	do A. G. Pratt,	196.55	
		do Loren Parsons,	99.13	
				430.74
		do J. J. Riordan,	85.58	
	18,	do Wm. H. Nelson,	135.00	
	25,	do C. Wilse,	67.50	
		do S. Barnes,	10.00	
		do C. Cronkwright,	31.00	
				329.08
		do Thos. McCarty,	30.00	
		do A. F. Hayden,	100.00	
		do O. Crane,	6.50	
	26,	do H. Williams,	75.80	
		do Jas. Fraser,	20.50	
	30,	do for board of men, (no receipt,)	\$2.37	
	31,	do Postage, ac't for Mar.,	.82	
				\$235.99
April	2,	do A. Bruno,	83.31	
	9,	do Wm. Merrill,	21.45	
		do S. L. Rood,	2.88	
		do G. & J. G. Hill,	3.75	
	13,	do Wm. Darby,	45.37	
	19,	do DeGraff & Townsend,	153.50	
				310.26
		do J. L. Whiting & Co.,		1,167.98
	20,	do J. L. Whiting & Co.,	41.41	
	30,	do Postage and sundry other small items,	3.59	
				45.00

May 1,	do	Wm. H. Nelson,	135.00		do	H. Gardinier,	2.00	
	do	Wm. H. Nelson,	125.49		do	A. Ducher,	3.00	
	do	Geo. H. Powell,	79.35		do	Jas. W. McChesney,	200.00	
	do	Samuel Westbrook,	14.38		do	C. S. Hart,	134.09	
	do	James P. Allen,	63.87		do	B. B. Huntingdon,	98.00	
					do	Jacob Lawrence,	196.27	
				418.09				
	do	Geo. Myers, as per bill rendered,	41.77		do	N. Hathaway,	8.75	633.36
	do	John C. Allen,	68.23		27, do	J. W. McChesney,	126.53	
	do	Loren Parsons,	59.45		do	Z. Bemis,	16.50	
	do	J. J. Riordan,	43.03		do	R. Howlett,	28.00	
	do	A. G. Pratt,	34.36		do	Blake and Osgood,	22.19	
	do	W. D. Whitlock,	130.13		28, do	W. O. Lyon,	1.53	
				376.97	do	James Watson	370.70	
								574.20
3,	do	A. T. Nelson	\$48.88		do	Blake and Osgood,	6.68	
	do	Luke Wellington,	14.08		do	Loyd & Nelson,	36.25	
	do	Thos. Nelson,	199.66		do	A. Sturgess,	122.37	
4,	do	Wm. Renwick,	7.19		29, do	Cooke & Evans,	3.62	
	do	A. F. Hayden,	24.00					
	do	Geo. Davis,	1.13		30, do	Z. Bemis,	\$16.50	
	do	D. Lyon,	8.00		31, do	A. Ducher,	5.00	
				\$302.94	do	postage, cartage, &c., for May,	9.77	
	do	T. L. Howe & Co	5.19					\$200.19
	do	A. F. Hayden,	218.73		June 1, do	W. W. Peterson,	2.00	
	do	N. Little	76.19		do	James Watson,	1.75	
	do	John Bruno	49.31		do	R. Morris,	6.00	
	do	Gordon & Baker,	21.00		do	Cook & Evans,	9.75	
	do	Geo. Raby,	7.50		do	S. Harmon,	6.00	
	do	T. L. Howe & Co.	31.32					25.50
				409.24	do	S. Wright,	6.00	
	do	G. D. & E. Williams,	100.97		do	Wm. Peterson,	.50	
	do	A. Van Haun,	22.75		do	J. T. Holmes,	6.98	
5,	do	E. Jewett,	7.88		do	J. Watson,	.50	
6,	do	A. D. Nelson,	142.88		4, do	J. Watson,	1.75	
11,	do	Keeny & Mullett,	667.90		5, do	B. B. Huntingdon,	12.00	
	do	J. T. Holmes,	10.75		7, do	J. J. Baxter,	10.00	
				953.13				37.73
14,	do	J. J. Riordan,	7.61		7, do	L. Gray,	15.00	
	do	P. G. & Mather,	4.38		8, do	Norman Little,	38.00	
	do	W. N. Carpenter & Co.,	12.88		do	Cook & Evans,	3.00	
15,	do	John Owen,	24.06		9, do	H. Gardinier,	5.00	
	do	David Thompson,	30.00		11, do	A. C. Pierce	10.25	
16,	do	James Stewart,	42.05		13, do	W. D. Whitlock,	21.85	
	do	F. Moore,	8.70					93.10
				129.68	do	Cook & Evans,	1.69	
	do	S. Davis,	\$9.80		14, do	Detroit iron company,	6.00	
20,	do	John Wescott,	15.32		18, do	L. Parsons,	17.00	
21,	do	Myron Roy,	31.00		20, do	E. Green,	14.35	
	do	J. F. Chubb,	45.34		22, do	Blake & Osgood,	12.56	
	do	J. J. Malden,	1.13					
22,	do	Z. Bemis,	8.81					
	do	Robert Howlett,	24.56					
				\$135.96				
23,	do	Smith, A. & Evans,	39.97					
	do	Cooke & Evans,	26.66					
24,	do	Wezo Roys,	1.00					
25,	do	S. Hosmer,	3.00					
	do	S. Wright,	2.00					

24,	do	Lake Michigan lumber company,	\$8.34		27,	do	R. More,	\$2.00	
						do	J. Wheeler,	2.00	
				\$59.94					\$25.85
26,	do	H. Gardinier,	5.00		do	do	R. Sawyer,	3.00	
	do	Wm. H. Nelson,	243.17		do	do	R. Brooks,	1.00	
	do	A. A. Lull,	4.84		do	do	N. M. Sykes,	1.00	
	do	Geo. H. Powell,	26.73		do	do	H. West,	2.00	
	do	S. Westbrook,	46.11		do	do	L. H. Main,	1.00	
	do	N. M. Barker,	135.77		do	do	J. McDonour,	1.00	
	do	A. T. Nelson,	13.31		do	do	Wm. Brooks,	1.00	
				474.93	27,	do	R. Carle,	10.00	
	do	H. G. Williamson,	33.58		do	do	N. Bliss,	9.00	
	do	Thomas Smith,	122.82						58.58
	do	James P. Allen,	21.52			do	A. G. Pratt,	29.58	
	do	John C. Allen,	46.11		28,	do	John C. Allen,	29.44	
	do	George Myers,	46.80		29,	do	R. More,	4.00	
	do	A. G. Pratt,	36.69			do	D. McMahon,	13.50	
	do	W. Sibley,	29.19			do	Lyman Curtis,	.50	
				336.71	30,	do	A. McFarlin,	1.00	
28,	do	E. Jewett,	31.13		do	do	E. Ferrin,	12.00	
	do	T. L. Howe & Co.,	43.67		do	do	N. M. Sykes,	1.50	
30,	do	Postage, &c., for June	6.31						61.94
				81.11		do	D. Norton,	1.00	
July 1,	do	Jas. Watson,	.48		do	do	P. Guelot,	30.50	
2,	do	Chas. Wheeler,	1.00		31,	do	Wm. Allen,	1.50	
3,	do	F. Manyhan,	5.00			do	James May,	2.50	
	do	Wm. Roberts,	1.00			do	D. Govin,	1.50	
	do	R. Carroll,	3.00			do	T. Hansey,	3.00	
	do	Geo. Rice,	2.00			do	Postage and amount paid for draft,	9.29	
	do	James May,	1.25						49.29
				13.73					
	do	F. Hills,	\$1.25		Aug. 1,	do	M. Church, as per bill	\$3.00	
	do	H. Gardinier,	7.00		2,	do	R. Carroll,	15.00	
	do	N. Gilden,	1.00		5,	do	Higgenson & Wendell,	2.50	
	do	C. Sawyer,	2.00			do	J. W. Pierce,	2.88	
	do	E. Curtis,	1.00			do	E. Jewett,	6.00	
4,	do	S. A. Cook,	.75			do	Z. Marion,	1.00	
				\$13.00	7,	do	D. E. Fisher,	5.00	
	do	Jas. Watson,	5.71			do	L. French,	1.00	
5,	do	Wm. Brooks,	1.00			do	James Page,	.50	
8,	do	Jas. Fraser,	65.87			do	T. Hand,	2.00	
9,	do	R. Sawyer,	6.75			do	H. West,	1.00	
	do	J. W. Hopkins,	4.00			do	Ira Wheeler,	1.50	
14,	do	Jas. McCabe,	30.00						\$41.38
16,	do	D. Hubbard,	12.00			do	R. Brooks,	5.50	
	do	John Bloom,	22.00			do	Ira Curtis,	1.00	
19,	do	Wm. N. Carpenter,	36.68			do	Joseph B. Copeland,	5.50	
				184.01	8,	do	Cooke & Evans,	15.75	
22,	do	Jas. Watson,	31.79		9,	do	Jas. P. Allen,	24.80	
23,	do	N. Hathaway,	69.09		12,	do	Wm Miller,	1.25	
	do	C. Smith,	27.00			do	R. More,	1.00	
	do	Wm. Allen,	6.00		13,	do	C. Smith,	1.50	
	do	F. Manyhan,	7.00						56.30
	do	W. D. Foster,	1.50			do	C. Metty,	1.00	
24,	do	A. E. Sargeant,	21.00			do	R. Brooks,	1.50	
	do	R. Morris,	66.00		17,	do	C. Sawyer,	3.00	
	do	O. Wiltley,	70.00			do	R. Sawyer,	5.00	
				299.38		do	D. E. Fisher,	21.50	
25,	do	Jas. Fraser,	1.94		26,	do	J. W. Pierce,	.75	
	do	A. Middleton,	7.79			do	R. More,	2.00	
26,	do	Smith, Aldrich & Evans,	1.25			do	J. H. Ganies,	1.50	
	do	J. W. Robbins,	9.00		31,	do	Postage account for the month,	1.10	
	do	Wm. Renwick,	1.87						37.35

THIRD ANNUAL REPORT OF THE STATE
GEOLOGIST

(Senate Documents, 1840, Vol. II, No. 7)

Office of State Geologist,
Detroit, February 3, 1840.

To the Hon. Speaker of the House of Representatives:

Sir—I have the honor herewith to transmit to the hon. house of representatives, the third annual report and accompanying documents from this department.

I have the honor to be,
Sir, your obedient servant,
DOUGLASS HOUGHTON.
State Geologist.

To the Hon. the 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 held 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 section of the state.

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 the 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.³⁷

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 the Ste Marie 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 Mackinac,) 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

³⁷ In my labors to produce correct maps of this difficult section of country, invaluable assistance was rendered by Jas. L. Schoolcraft, 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.

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.

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 silicious 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 bitter 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 of 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 northeasterly from its mouth, and its sources interlock with the head waters of the Tonquoimenon 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 limerock *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. Intensive field 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 the Monominee river and Mackinac, have brisk currents and furnish abundance of hydraulic power, but with one exception this is, as you unapplied. A saw mill has been erected on the Esconnauby 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 portion of the coast. It is well known that while the waters of the whole line of coast alluded to furnish, whitefish 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 "[this ground]" appear to have been wholly neglected, or at least none of the usual evidence 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 of 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 SOUTHEASTERLY 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 river. As we proceed towards the northern declivity of the upper peninsula, the red sandstone of lake Superior, makes its appearance, underlaying the groups of limestones and shales before mentioned.

These sandstones together with the series of overlaying 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 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-westerly 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 these 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 river, (which contraction is formed by the near approach of the island of St. Joseph, to the mainland, 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 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 lichens, 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 sometimes composed of vegetable matter mixed with silicious 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 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 greenstone. Decisional minute chrystals 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-chrystalline rock, translucent at the edges and broking with a conchoidal fracture, to a granular or almost conglomerate quartz rock. Small quantities of hemetitic iron ore, and randy 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

This 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 the series of overlaying limestone 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 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 river are formed by the passage of the waters over the outcropping edge of the sand rock, 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 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 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 Genesee 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 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 upon a series of limestones and shales, resting upon and concealing the former rock. Those 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 river, at least in the two westerly channels, is in part over the very lower portion of these limestones, and by far the larger portion 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 in 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 portion 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 river, on the east they fl 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 river, it was 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 re-appears in close proximity to the primary, on the eastern side of that island, about five miles below Bears' encampment island, 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 sandstone 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 subjects 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 *Polypferus* 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 hike 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 the 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 struction, 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 the 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-chrystalline 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 the 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 eastern 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 mainland in the vicinity of Pte St. Ignace.

From the straits of Mackinac to Pte Detour of Green bay limestone may be very advantageously quarried at many points upon the immediate coast. A low cliff of granular, siliceous 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 Monistique 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 an 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 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 honorable body, I was instructed especially to examine, viz: the "iron ore on section sixteen, town five south, range seven west, in the county of Branch."

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

In that portion of Branch county, to which my attention was called by the instructions, and over many miles of the surrounding country, a stratum of what usually appears as a grayish brown clay, rises to the surface, or is reached by removing the superficial soil by which it is

covered. An examination of the ravines and banks of streams cutting through this indurated clay, shows it to be regularly stratified, and also, that the lower exposed portions approach in character very nearly to an argillaceous sandstone. It is in this stratum that the clay iron-stone under consideration, is imbedded, and upon it the sandstones lying north as well as easterly, rest. Although these clays of the ironstone formation are more largely developed in this portion of Branch county than in any other position where they have been observed, portions of the stratum have nevertheless been traced through other parts of Branch, as well as through a portion of Hillsdale and Calhoun counties.

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

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

The masses of ore, although distributed partially through the whole of the clay, are usually arranged in partial layers, separated from eighteen inches to two feet from each other, and by far the largest portion of it, as well as that of the greatest purity, occurs in the upper half of the bank. As we approach the harder and more siliceous portions of the clay formation, the character of the nodules of ore gradually changes, in consequence of the mixture of siliceous and aluminous matter with the iron, thereby rendering them nearly worthless.

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

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

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

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

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

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

The extensive bed of bog iron ore in the immediate vicinity of the village of Kalamazoo, alluded to in the first annual report from this department, and described in the accompanying report of Mr. Douglass, in consequence of the richness of the ore, together with its peculiarly favorable 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 when 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 reports I would refer you for more particular information on this important subject.

ZOOLOGICAL AND BOTANICAL DEPARTMENTS

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

department, and the appointment by the governor, of the several assistants contemplated by the act.

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

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

The resignation of the heads of these departments, and the suspension of work which necessarily followed during the complete season for labor in the field, has operated exceedingly unfavorable to the interests of these portions of the survey, and while I had hoped to see the zoology and botany of our state under the guidance of the able assistants in whose hands they had been placed, rapidly approaching to completion, comparatively little advance has been made, and the subjects 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 circumstances might admit, a single sub-assistant, Mr. Geo. H. Bull, retains his situation, and by his assistance I have been enabled to place the botanical portion of the work in such condition that it may be of use in the final and connected reports which are required to be made.

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

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

GEOLOGICAL AND TOPOGRAPHICAL DEPARTMENTS

The plan of organization adopted in these two departments of the survey is such, as to render them so

mutually dependent upon each other, that they can scarcely be considered separately; for the field duties in each are performed by the same assistants, and it is not until the field notes are returned to the office, that the geological and topographical portions are finally separated. The labor of the assistants in these departments, as well as a portion of my own time, has been devoted to a continuance of the surveys of the organized counties of the state, and the work, although still in many parts incomplete, has, nevertheless, made rapid advances towards completion.

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

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

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

Although a vast amount of labor yet remains to be done in the field in order to complete the work that has been commenced, will, nevertheless, with the present organization, be enabled, I trust, to complete the geological and topographical parts of it within the current year, being the time originally assigned by the act authorizing the survey. It will, however, be impossible, under any contingency, to complete the zoological and botanical portions of it within that time, and under the aspect which the subject has assumed since your last session, I have been led to believe a suspension of this portion of the work would be in consonance with your views. Should this be deemed desirable, no very great injury will now be sustained by the other portions of the survey, while the expense will be reduced nearly one-half.

In addition to the labors yet required to be performed, an abstract of which will be seen by reference to the report of the topographer, there yet remains to be surveyed the whole of the northern slope of the upper peninsula, extending from the rapids of the Ste Marie river, to the westerly boundary, at Montreal river, the complete line of coast from the foot of lake Superior to the most westerly boundary, will require to be triangulated for the use of the topographical department, as well as for the correct

delineation of the geography and geology. The uneven character of a portion of this country, will serve to render the topographical duties of those engaged in the geological survey, of the most arduous kind.

The geology of that district extending from 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 point to direct particular attention, it would be impossible to accomplish a work, involving such immense labor and hardship, within the time specified by the act of organization; but as it is, aided by the efficient and industrious assistants connected with the department, I can safely say, that the whole will be accomplished within that time.

DOUGLASS HOUGHTON,
State Geologist.

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

Detroit, January 12, 1840.

To Douglass Houghton, State Geologist:

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

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

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

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

Progress of Maps under construction

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

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

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

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

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

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

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

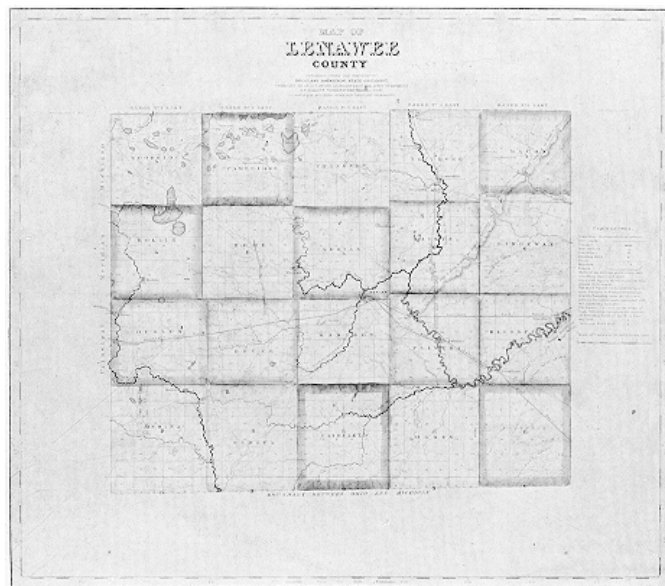
Barry,	Macomb,
Sanilac,	St. Clair,
Midland,	Gratiot,
Isabella,	Oceana.

The northern parts of Kent, Ottawa and Isabella, and the whole of Oceana, were unsurveyed at the time of establishing their boundaries, but since they have been sub-divided, along with much of the remaining portion of the peninsula, it would now be a proper time to determine any alterations to be made, and also to establish the boundaries of new counties over that portion of the state.

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

In progressing with the topographical maps, regard has been had, in connection with the geological survey, to a speedy publication of them, with as little delay as possible, in order to place in the hands of our citizens, as well as of the emigrant, who may require a more accurate knowledge of the country, the information which they contain. Much solicitude at the present time

is shown in many of the eastern states for similar maps, presenting such a delineation of their territories as will develop their own resources, and as may tend to the prevention of that tide of emigration which has set westward for the last few years.



[Map of Lenawee County]

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

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

To prevent Michigan from being a mere thoroughfare for emigrants, who, having embarked for states and territories in the west, are seeking the most direct passage into Illinois, Wisconsin and Iowa, while the best portions of our state are passed by, justice to the former reputation of our soil demands a description, the correctness of which would more than maintain its former and deserved estimation.

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

Maps of lands donated by the United States

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

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

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

While it is barely possible in any other of the surveys of the state that these conflicting claims can occur, on account of the regularity and method observed, almost endless litigation is likely to be the consequence of a re-survey and establishment of the boundaries of these donated tracts.

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

Extent of donated Lands

The number of acres comprised in these patents, as near as I can now state, is about 130,000 acres; 52,165 of which lie in the neighborhood of Monroe, viz: between the riviere aux Vase and riviere aux Loutre, or Otter creek, 3,980 acres; between the riviere aux Ho litre and Plaisance creek, 1,167; between Plaisance creek and Flenrisance 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 Cosine, 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.³⁸

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

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

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

Additional number of Peninsula Lakes

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

Lake Lemen, in Switzerland, undoubtedly merits all that has been bestowed upon it by the thousand travelers who take occasion to visit that region. It would require, however, but a very limited knowledge of almost any district in this state, to find it surpassed; and the praises so liberally published and sung from "*note books*" and "*scraps*," "*journals*," "*residences*," "*reminiscences*" and "*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 the country at every elevation, that for combination of all that is required in a finished picture, can never be excelled; hundreds of them present, what art has long endeavored to imitate in older countries, investing them with lawns, interspersed with orchards of a noble growth of oaks, and frequent prairies, flush as at the dawn of their creation. No eye, however sated, nor mind, however perverted, can contemplate a landscape so rich and varied, without yielding to the impression of its loveliness.

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

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

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

Roads and Highways

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

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

The only exception to the above remark is found in those roads which, commencing at the different frontier towns on the eastern coasts, lead across a low, timbered belt of country for the distance of six, ten and fifteen miles, and where the soil, as in some other districts, is clay. In these districts they require to be worked at no inconsiderable expense to keep them passable during the wet periods of the fall and spring.

The Chicago Turnpike or Trail

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

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

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

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

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

This trail is supposed to be as long as any other within the territory of the United States, being two hundred and forty miles from Detroit to the point where it received those diverging trails from the south and north-west, and the length of some of its branches cannot be less than three hundred miles further, while numerous smaller ones enter from different directions, by which means the early pioneers of the west easily threaded their way through these regions, and into the valley of the Mississippi beyond.

Natural Woods of Michigan

The arrangement which this subject calls for properly belongs to the department of botany. Nevertheless, without attending to the details which should accompany a catalogue of an entire flora, it will be sufficient to exhibit generally the geographical boundaries of such of the larger productions as unrequired 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 met, until reaching the central parts of Genesee, Lapeer and St. Clair. Here they are again found in the same range of northern townships, where they first occur, in the counties before mentioned.

North of this belt or zone, which is the natural boundary between the oak openings and plains of the south, the forest abounds promiscuously with the white, yellow and Norway pine, white cedar, tamarack, ash, oak, birch,

sugar maple, sycamore, beech, lynn, elm, white wood, black walnut, &c., &c.

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

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

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

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

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

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

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

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

Variation of the Magnetic Needle

The surveys of Michigan were intended to correspond with the true meridian, excepting those of Mr. Greely, before mentioned, which were made without an

observation to determine the true north. There appears, however, a variation between his first and last surveys of about 1°.

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

Mysterious as the movement of this instrument is accounted to be, were greater attention devoted to an examination of the causes that effect it, instead of diminishing confidence in many of its results, its habits, though governed no doubt by a subtle influence, would be intimately known and its uses appreciated accordingly. The rights of our citizens to their property is closely connected with this inquiry.

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

In 1835 the line of no variation was known to run longitudinally through about the middle of Lake Huron, the variation on the shore twelve miles above the foot of the lake was 6' east; on Pointe aux Barques, in lat. 43° 51' 85"; seventy miles from the foot of the lake it was 1° 38'; twenty miles west of Pointe aux Barques on the same parallel it was 2° 6'; farther west, at the mouth of the Saginaw River in lat. 48° 36' 30", 2° 19' east; at the same time it was 2° 10' at Detroit, lat. 42° 18'.

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

The rate of movement, from 1810 to 1822, was from 2 48' to 3° 13' 22", equal to 25' 22" increase of east variation. From 1812 to 1828 a decrease from 3° 13' 22" to 2° 50' (yearly difference, 4 4-10) and for the last twelve years, up to 1840, a decrease 2° 50' to 2°; (yearly difference, 4' 10") 2' 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° 30' east; thirty miles north, on the south side of Little Point aux Sable, it was 6° 15' east: and twelve miles further, on the north side of the same point, 6° 00'; at the mouth of Pierre Marquette River, seventy-eight miles above Grand River, 4° 34' east.

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

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

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

Diurnal Variation

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

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

Messrs. John Mullett and W. A. Burt are the only gentlemen who have communicated to me their observations. These were made without a thermometer to determine the degree of temperature, yet during several summers, the correspondence of their observations, with those made elsewhere, agree as to the amount of variation, the mean of August and September, being $14'$. Mr. Burt found the maximum for one day $40'$, but is probable that other causes were in combination.

Errors arising from incorrect observations

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

The fairest portion of the state was subdivided with this evident want of skill, and with a carelessness in the first surveyor³⁹ which has already resulted in a vast amount of trouble and absolute loss, to a portion of our citizens.

The area embraced by these surveys may be traced on the map, commencing at the south boundary of the state; thence northward forty-eight miles to the base line; thence fifty-four miles up to town number nine north; thus passing along the meridian of seventeen towns, of six miles square. Range lines intersecting these

meridians at right angles, were also begun at the southern boundary of the state, at the principal meridian, and closing on the eastern border of the State.

The lines throughout this whole tract were run at a variation differing but little from $4^{\circ} 39'$.

The error lies in a too great variation of about $1^{\circ} 30'$, as is proved:

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

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

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

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

³⁹Mr. Wampler.

In 1810, Col. Jared Mansfield record the variation at Detroit, at $2^{\circ} 48' 00''$ east.

In 1822 Messrs. Mullett and Lyon record the variation at Detroit at $3^{\circ} 13' 22''$ east.

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

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

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

Now, so far as the best information collected up to this time, in regard to the increase of magnetic variation, (which is stated by Prof. Loomis in the American Journal of Science, Vol. 34, to be about 1° in sixty English miles), these lines on the western boundary of the

survey should have been run at a variation of 1° 40" greater than on the eastern. Hence arises the cause of that series of fractional townships adjoining the principal meridian, throughout the extent of this survey.

Decrease of elevation in the waters of the Lakes

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

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

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

Their elevation in 1888 was given in my report of last year. The waters had then attained to five feet three inches. This proved to be a greater flood than had occurred within the last century.

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

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

Future prospects of the Peninsula

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

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

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

The necessity which compels the erection of manufacturing establishments propelled by steam elsewhere, is the want of hydraulic power; no such necessity exists throughout our whole peninsula; were it otherwise, and a resort be had to steam, the coal region

will furnish an abundant supply for all purposes which any other state can boast.

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

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

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

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

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

Report of C. C. Douglass, Assistant Geologist

Detroit, Jan. 12, 1849.

To Douglass Houghton, State Geologist:

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

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

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

In order to avoid, as far as may be, that repetition which would necessarily result from a consideration of the counties separately, I have grouped in a single district, the counties of *Jackson, Calhoun, Kalamazoo, Eaton,*

Ionia and Kent, and comprised in a second group, the lake counties, *Ottawa, Van Buren and Allegan*. The geological features of the first group of counties would be extremely interesting, containing as it does the principal coal series of the southern part of the state, were it not for that almost universal covering of 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 soil of these counties, as a whole, [does] not appear to have resulted from the disintegration of the rocks upon which they are based, but to have had their origin chiefly from the transition and primary rocks lying farther to the north. Intermixed with these, is not unfrequently a proportion of the debris of the coal bearing rocks, or the rocks of that series which forms by far the greatest portion of the district under consideration. Boulders of primary rocks, are not of unfrequent occurrence, and in some places occur in very great abundance.

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

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

MARL

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

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

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

Local details of Marl. Jackson County

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

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

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

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

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

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

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

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

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

Town of *Jackson*. Marl occurs in this town, in abundance, on sections twenty, twenty-one, twenty-six,

twenty-seven and thirty-one, (town three south, range one west,) and also on section thirty-one, (town two south, range one west.)

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

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

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

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

Eaton County

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

Kalamazoo County

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

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

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

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

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

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

Calhoun County

Marl occurs at intervals through this county in the alluvial lands of the Kalamazoo river, and pebbles and boulders are not unfrequently seen in the bed of the stream, incrusting 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. Tierce's mills. Also, in comparatively small quantity, in the low lands between the village of Marshall and the Kalamazoo river.

Kent County

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

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

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

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

Ionia County

Tufaceous marl occurs in inexhaustible quantities in the vicinity of Lyon, town of Maple. 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 live west; its extent unknown.

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

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

This abstract of the locations of this valuable mineral only includes some of the most extensive deposits. It is sufficient, however, to render it apparent that marl is distributed in sufficient abundance to afford a ready supply for use as a manure, as also for the manufacturing of quick lime. It is within the reach of every man to obtain this restorative for his soils or a lime for economical purposes; an article of which, otherwise this country would be nearly destitute.

Peat

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

Clays and Sands

Sands and clays forming portions of the diluvial and alluvial deposits are found in occasional somewhat extensive beds, in various parts of the counties under consideration, and may be found occupying positions, from the lowest sink to the summit of the highest

elevation, apparently having no regular order of place but appearing in the form of irregular deposits.

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

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

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

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

Boulders

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

Bog Iron Ore

Deposites of bog ore occur in limited quantities in many places, its presence being apparent in the highly

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

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

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

Bog Ore of Kalamazoo

This ore is chiefly of a light yellow color and occurs mostly in masses of several pounds weight, but also in the form of shot and ochre. It occurs in separate beds forming ridges, and these beds vary from a few rods to several acres in extent, over an area which may be estimated at from eighty to one hundred acres. It varies from a few inches to four feet in thickness. This ore is situated on and contiguous to the banks of the Kalamazoo river, and from half a mile to one and a half miles from the village of Kalamazoo. This is the most extensive and valuable deposit of bog ore I have examined in the state. It is well situated and will warrant the erection of an extensive foundry for its reduction. An analysis of one hundred grains of this ore gives the following mean results:

Peroxide of iron	Grains 78.45
Silica and alumine	7.05
Carbonate of lime	1.10
Water	12.50

Kidney Iron Ore

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

Gypsum

Gypsum or plaster, occurs in Kent county, forming the bed and banks of Plaster creek, near the junction of that

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

ROCKS

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

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

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

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

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

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

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

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

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

The result of my labors in tracing the extent of the coal basin during the past season, has been more

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

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

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

RANGE AND EXTENT OF THE COAL BEARING ROCKS

The following is the nearest approximation that our present knowledge of the subject can furnish towards the extent of the coal series of rocks in the counties under consideration. The rocks of the coal-bearing group, in their most southerly extension, occur at Napoleon, Spring Arbor and Concord, in Jackson county; and at Albion, Calhoun county. From thence the line of junction between these and the rock below passes through the town of Marengo, and the north part of the town of Marshall; thence it continues westerly through the town of Pennfield, into Barry county; through which county the line of junction has not been traced. Rocks of this group are again met with at the rapids of Grand river and its vicinity.

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

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

LOCAL DETAILS OF THE LOWER COAL GROUP

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

This is probably the lowest stratum of coal in the state. There can be little doubt that the bituminous shale discovered at Jackson, belongs to the lower coal stratum, and that coal might be procured at that place by sinking a shaft.

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

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

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

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

LIGHT GRAY SANDSTONE

The rock found next, superimposed upon the lower coal group just described, is a sandrock, mostly of a coarse quartzose character, and of grey or yellow color. It is 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*, *Stigmaria* and *Calamites*, together with thin masses of carbonaceous matter, were noticed at quarries both north and south of that village.

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

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

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

UPPER LIME ROCK

This rock usually appears at the surface, in detached beds, extending over an area varying from, a few acres to two or three sections in extent, and having a thickness, so far as could be ascertained, varying from one foot to sixteen feet. It is superimposed upon and usually appears near the 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 lithodorous molusca were observed in the less arenaceous portions of the rock, I was nimble to find any perfect specimens of fossils, except in the most sandy portions. The greater number of these were found at Bellevue, Eaton county, and the Grand rapids, Kent county. This limerock was noticed on the sections designated in the counties as follows:

Jackson County

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

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

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

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

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

Eaton County

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

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

Kent County

The lime rock is again seen on the west part of the state, at the rapids of Grand river, a point where, judging from the general inclination of the strata, its outcrop would be looked for. It is here identified with the rock of Bellevue, Eaton county, in its contained fossils and composition. Lime is manufactured from the rock at this place, for the supply of the surrounding country.

LOCAL DETAILS OF THE UPPER COAL GROUP

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

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

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

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

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

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

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

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

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

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

RED SANDSTONE IN IONIA COUNTY

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

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

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

VAN BUREN, ALLEGAN AND OTTAWA COUNTIES

General Remarks

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

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

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

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

SANDSTONE OF VAN BUREN COUNTY

Sandstone occurs on the line between Van Buren and Allegan counties, in town one south and one north, range four teen west. It exhibits a very compact texture, is of 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 anything further of importance respecting it than its composition and general character. I am unable, therefore, to refer to its place in the sandstone series.

CRAG OR CONGLOMERATE ROCK

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

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

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

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

CLAY

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

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

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

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

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

SANDS

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

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

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

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

LOCAL DETAILS OF MARL

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

On sections twenty and twenty-one, half a mile north-east from Mr. Newell's steam mill, on Maskego lake, is a very extensive deposit of shell marl that may be profitably used by, a manure on the sanely 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 deposit of shell and tufaceous marl occupying an area of more than seventy-five acres.

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

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

SALINE SPRINGS

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

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

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

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

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

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

BOULDERS

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

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

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

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

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

C. C. DOUGLASS,
Assistant Geologist.

Report of B. Hubbard, Assistant Geologist

Detroit, January 12, 1840.

To Dr. Douglass Houghton, State Geologist:

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

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

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

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

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

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

TOPOGRAPHICAL FEATURES

The leading characteristics of the surface of the peninsula were treated at large in the report of the state topographer of last year. By reference to that able document, it may be seen at once, what relation the counties mentioned, have to its distinguishing features. "It appears," says his report, "that there is a swell of land which may be called the true watershed running from

Pte aux Barques south, 45° west, and passing out of the state into the north-east corner of Indiana, about equidistant from lakes Erie and Michigan. It attains its greatest elevation in Hillsdale county, seven miles east from Jonesville, where it is 633 feet above the surface of Lake Michigan. Its summit, on the central railroad, at the division line between Jackson and Washtenaw counties, fourteen miles east of Jacksonburg, is 437 feet. In the village of Pontiac, in Oakland county, it is 336 feet. It then again rises, and at the head waters of Belle river, in Lapeer county, is 414 feet. From this point it gradually falls off, and with a few rills, descending on its north and eastern slope, sinks to the level of the beach of the lake."

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

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

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

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

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

Extent of Timber

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

Commencing on Shiawassee river, the line of timber passes through the southern part of Genesee county, the south-west part of Lapeer, and the western part of

Macomb; thence by south-west course through the southern part of Oakland, and eastern of Washtenaw; thence bending westerly, it continues in a very irregular course through Lenawee, Hillsdale and Branch, when it turns to the south and enters Indiana.

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

Soils

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

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

Scenery

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

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

The variety so essential in a landscape, of woodland, glade and sheets of water, are here combined in a manner which seems the result of art, but which is not less truly inimitable. It is difficult to resist the impression that we are surveying an old abode of civilization and of

tasteful husbandry. It resembles those exquisite pictures of park scenery, where the vision roams at will among the clumps of lofty oaks and over open glades, gemmed with flowers; while the distant woodland bounds the horizon, and the velvet-skirted lake gleams upon the eye as it reflects to light from the open prairie, or is faintly visible from the bosom of the glen, reposing in silent loneliness.

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

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

GEOLOGY

Before entering on a description of the geological structure of the southern counties of our state, it may be useful, for a more general comprehension of the subject, to premise a few leading facts relative to the geology of the western states generally.

It is well known to those acquainted with the geological character of the states west of the 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 overlaying rocks, (which embrace the carboniferous formation, or coal, measures,) have been removed from the ridges of these wave-like undulations, or at least are found occupying only the interior of the basins. In following, therefore, from these ridges of limerock in direction of the dip, we come successively upon the next overlaying rock, till we reach towards the centre, the highest rock of the series.

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

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

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

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

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 north-east and south-west, across the counties. Of Monroe and Wayne, and dipping north-westerly.

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

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

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

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

Economical considerations

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

Quick-lime is extensively made and supplies the wants of this section of country. The limestone which occupies the highest range, (and from which lime is made extensively in the Macon reservation,) has been described as strongly *bituminous*. This character of the stone, owing to a chemical action which takes place in the kiln, renders it very superior for the above purpose. When brought to a red heat, the carbonaceous matter begins to re-act on the carbonic acid, which is a constituent of limestone, and converts it into carbonic oxide, which having no attraction for lime is driven off, leaving the lime of a pure white, and perfectly caustic, with less 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 one hundred feet. These blue and yellow clays are presumed to be analogous to those which cover the limerock of the adjoining states, and which have been designated by Dr. Hildreth, of Ohio, as "semi-tertiary deposits." They are found almost universally to envelope the limerock in this state as far as to the commencement of the sandstone series. The great accumulation of all these several deposits may be conceived, when it is stated that a rise of two hundred feet is attained, after leaving the limerock in Monroe county, before rock in place is again discoverable.

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

The ore consists of nodular masses, formed of concentric coats or layers of iron, combined with lime and alumine, and surrounding a hard nucleus which frequently contains fossils. These masses are often of many pounds weight. They are imbedded in a gray, micaceous clay, of very fine grain, and frequently so hard as to have the appearance of compact sandrock. They are in general arranged in strata, alternating with the beds of clay, but are often found dispersed through the mass. This ore is analogous to that which is worked extensively and with profit in Ohio.

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

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

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

III. FOSSILIFEROUS, FERRUGINOUS SANDSTONES

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

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

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

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

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

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

By reference to the general topography of the state, it will be seen that the extreme southern termination of the sandstone series, has an elevation several hundred feet higher than any other part of the basin yet examined. This may account for the superior thickness and inclination of the rocks at this point, and for the circumstance of the clay and ironstone making its outcrop here. In consequence of the greater uplift at this point, several of the series are brought to the surface, which elsewhere are entirely concealed, owing to their more nearly horizontal position.

Most of the sandstones have been used for ordinary building purposes. The coarse grained rock [No. 1.] is

usually found eligibly situated for quarrying, and is well adapted both for building and grindstones. Ledges of this rock occur in the town of Somerset, section seven, and Moscow, section twenty-nine, and are numerous through the southern part of Jackson county.

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

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

IV. TERTIARY AND DILUVIAL DEPOSITES

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

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

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

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

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

Clays

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

The presence of carbonate of lime may be detected by dropping a small bit of the clay into an acid (strong vinegar will answer,) when, *if the clay be marly*, effervescence ensues, occasioned by the decomposition of the carbonate of lime and escape of the *carbonic acid*, which is always combined with the lime. In this way it

will often be easy to distinguish such portions of a bed as do not contain lime in sufficient quantity to impair their fitness for ordinary purposes.

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

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

Erratic, Fragmentary Rocks

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

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

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

Masses of native copper, some of several pounds weight, have been found in Berrien and Cass counties, as also in the valley of Grand river, and in several other portions of the state. These belong to the "*erratic group*," and are *no evidence of the existence of the ore* in their immediate vicinity.

The same remark will apply to the pieces of bituminous coal, found very generally, through certain districts, imbedded in the diluvium. Though they may be found at various depths and in considerable quantities, no

prospect can hence be inferred of finding coal beds in any of the counties embraced in this report.

Springs and Underground Water Courses

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

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

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

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

RECENT FORMATIONS

Conglomerate

In the county of Berrien some very extensive formations of this singular rock occur. They are of recent origin, compared with all the other rocks, and both in age and formation, may be classed with the marls and tufas. A stratum of gravel, cemented with lime, appears to be very universal throughout this country, at depth of a few feet, and extensive masses, strongly cemented, are frequently found exposed in the faces of ravines and banks of streams, appearing like ledges of rock in place.

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

About two miles north-east of Berrien, this rock was seen under similar circumstances, in the bank of a small creek, forming an outcropping ledge, exceeding eight feet in thickness. It is found also at several points higher up the stream, and in the sides of hills in the vicinity. Portions of this ledge are of finer grain than that at Millburg, having a stratified appearance, and are disposed to cleave horizontally. Blocks have been removed and used for fire-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 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 molusca animals, these circumstances are favorable to the collection of great numbers of shells, so that these not unfrequently constitute even the main portion of the bed itself, which may then receive the name of "*shell marl*."

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

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

Thus, according to circumstances, we find a variety of forms assumed by these deposits, from a "tufaceous marl," in which the particles have but partially cohered,

to a hard "tufa," or *travertin rock*, appearing as ledges in exposed hill sides.

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

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

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

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

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

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

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

But, although many of our soils are even found to improve under the first few years of cultivation, they must eventually wear out under a process which gives

no returns for the demands made upon them. This result is already becoming perceptible upon the older farms, and their cultivators are brought to the necessity of husbanding manures to renovate their exhausted soils. Considerable quantities of gypsum (plaster) are annually imported and used with most obvious success upon soils that have not been half a dozen years under cultivation.

Gypsum and marl are constituted of the same basis, *lime* under different states of combination: *sulphate of lime*, (sulphuric acid and lime), composing the former; *carbonic acid and lime* composing marl and the other carbonates. The sulphate, possessing greater stimulant properties, has a somewhat different and more speedy operation, but it is doubtful whether its effect be either so decided or so lasting as that of marl, if applied in the required proportion. I have to regret the inability to institute such a comparison of their several operations upon our soils as could be desired, having been unable to learn of a single instance of a fair trial of marl in the state. Notwithstanding, I do not hesitate to urge its use with full confidence, upon all who can be persuaded to make use of so simple a means to sustain their soils.

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

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

If even the enormous price paid for plaster is never regretted, most certainly I may be allowed to urge the simple experiment of giving a fair trial to so cheap an article as the marl. By such actual experiment, every

man, for himself, will best learn the proportions which his soils need, as well as the comparative results. Trial will, at least, furnish a satisfactory test of the truth, and we feel the more inclined to urge it from the fact, that if successful, nothing in the whole range of agricultural economy will exhibit more strongly the policy of availing ourselves of our native resources.

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

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

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

Peat

This *combustible* is found in very great abundance in most of the marshes. It is that which supports the luxuriant crop of grasses they afford, and is itself a mass of grass roots and half decomposed vegetation. This variety of peat is called *fibrous*. It is so universally distributed, and in such quantity, that my notice of it will be in general terms.

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

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

Peat being almost wholly a mass of vegetable matter, affords precisely that which is yielded by the most fertilizing manures. But as found, it is in a more or less

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

1. From the too excessive use of this manure, or its application to soils, the composition of which was not understood, and where lime may have already formed an abundant element.
2. From the use of mineral manures solely, under the mistaken supposition that *they* furnish the necessary nutriment to vegetation. Now, as has just been shown, these chiefly serve to *prepare* the food which has been furnished from other sources. So far from supplying the place of vegetable and animal manures, they only render necessary fresh supplies of the latter. By giving increased activity to vegetation, they of course cause a quicker consumption of the fertilizing principles. It will thus very easily be seen from what mistaken practice this "impoverishing of the soil," by the use of mineral manures, results, and also where may be found the proper corrective.

Bog Iron Ore, and Ochre

All our bog ores are a product of the diluvial or alluvial deposits, the mineral being originally contained in the ferruginous sands or clays. It is taken up in solution by rainwaters, and afterwards, like the marls, deposited in low grounds.

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

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

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

Along St. Joseph river, in St. Joseph county, small beds of ore and ferruginous sands were found, and also in town five north, range ten west, section nine. These are mentioned, as they may be of value from their vicinity to the beds of kidney iron in this part of the state. But should it be ascertained that the chief benefit of a mixture of the two ores results from the carbonate of lime supplied by the former, the *marl beds*, which abound throughout this district, will furnish a ready and cheap flux to facilitate the operations.

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

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

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

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

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

The ochres may serve a very good purpose as an ordinary red or yellow paint. This may be obtained in a

cheap manner, thus: stir the sand in water, then after allowing a few minutes for the siliceous grains to settle, pour off the liquid and obtain the colored sediment which is held in suspension.

ANCIENT LAKE RIDGE

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

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

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

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

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

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

The state topographer of Ohio, Col. 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 one hundred feet higher than at present; but there is not as yet, evidence enough to decide this interesting question. It would be difficult to find natural barriers for a sea which should have elevated itself to that height."

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

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

Let us then, for a moment, consider "this interesting question" solved, and proceed to inquire how far the results to which we are brought by the supposed elevation of the lake waters, one hundred and seven feet above the present level of lake Erie, accords with repeated observations made throughout the lake region. Supposing the characteristics of the land to have been relatively the same as now, the great lakes, which at present are but links of a connecting chain, would become merged in one immense irregular sea; their breadth being increased many miles on either side, while their connecting bands are lost in the wide expanse. The northern part of our peninsula becomes an island, or separated by only a narrow neck across a wide frith, following the valleys of the Saginaw and Grand rivers. The western and eastern tier of counties are flooded, and the Maumee country as far as Fort Wayne. West of lake Michigan, the spread of the waters is still wider; embracing, perhaps, with the exception of some islands, more than half of Wisconsin, and the whole of the immensely broad valleys of the Illinois, Ohio and Mississippi rivers. Upper Canada assumes the form of an island in the wide spread waste. The roar of Niagara is drowned beneath the rolling billows of a broad and deep inland ocean, having a breadth at this point of more than sixty miles. While stretching off to the east, the waters involve a great share of Lower Canada, the whole of the Genesee country of New York, with most of its chain of lakes, and a communication is made with the ocean, both by way of the St. Lawrence, and the valley of the Mohawk.

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

sea, in which whatever of the present land remains are as islands in the deep.

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

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

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 causes 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 sand, 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 a few local beds of clay are found, like those embraced 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 through 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 surface 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.

INFORMAL REPORT OF PROGRESS

(From manuscript collection, University of Michigan)

*Office of State Geologist
Detroit, Dec. 16, 1840.*

To his excellency Wm. Woodbridge.

Sir,

In fulfilling the duties that devolve upon me as Geologist of the State of Michigan, I have the honor to transmit the accompanying, somewhat informal, report of the general progress that has been made, during the past year, in the department over which I have been placed.

At as early a day as the season would permit, accompanied by the two assistants attached to the department and an additional force of nine men, I proceeded to the survey of the northern or upper peninsula of our State. The unexplored and unknown condition of the country rendered it necessary virtually to add a third assistant to the corps, and this third assistant was placed in charge of the instrumental observations, for the determination of geographical points, topography, etc., etc.

These assistants accompanied me only until the whole party, either separately or together, had completed so much of the work as was required to be done immediately upon, or only a few miles from, the coast of Lake Superior. So soon as this had been accomplished the condition of the surveys in progress upon the southern or lower peninsula rendered it imperiously necessary that they should return, in order to complete, during the working season, as nearly as the circumstances would permit, the surveys of this district.

After the departure of my assistants I carried forward the work in the interior of the upper peninsula, and continued assiduously engaged until the severe fatigue and hardships to which I had been exposed had so far impaired my health as to render me wholly unfit for duty. I accordingly suspended the surveys of this district after having spent nearly five months of the most excessive labor in it, and during which time I had been almost constantly exposed to all the vicissitudes of weather, and for nearly three months, in consequence of the impracticability of transporting them, mostly without either tent or blankets. The fall Storms had already set in, and the sufferings were much increased by constant exposure to wet and cold.

Much expense, trouble and delay had been looked for in transporting provisions, men, etc. from point to point upon Lake Superior, and particularly so in reaching Isle Royale and the north shore of the lake; but in this I was agreeably disappointed for the agents of the American Fur Company, with a kindness which appeared to know no bounds, not only made all arrangements in their power to facilitate my operations, but also in many things anticipated my wants. Through the instrumentality of the company I have been enabled to accomplish much that otherwise could not have been done, and the manner in

which the assistance was given, has not only placed me individually, but also the State, under the deepest obligations to them.

The surveys of that portion of the upper peninsula extending from pointe Du Tour of Lake Huron to Chocolate River of Lake Superior and south to Lake Michigan have been so far completed, that the geology and general topography may be satisfactorily defined and delineated. The geology of this district is simple, involves but few obscure points, and in an economical point of view, when compared with the country lying west of it, is of little importance. Nevertheless its valuable sand and lime stones are deserving of very great consideration. The general face of this district of country is level, though there are several ranges of regular and unbroken hills stretching through it. Its greatest absolute length as reduced from astronomical observations, is a fraction over 170 miles. This estimate is made from point du Tour to the mouth of Chocolate River, and does not include Drummond's island.

West from Chocolate river and extending to our boundary line at Montreal river the character of the country is completely changed. Instead of the level or gently undulating country, constituting the easterly portion of the peninsula, we have a series of ranges of rugged and broken hills with beautiful intervening valleys.

With this change in the general aspect of the country, the geology undergoes a corresponding change, and both topography and geology become exceedingly complex and difficult to unravel. This district which has a length of very nearly 147 miles, and an average breadth which is roughly estimated at 40 miles, embraces all the rocks that are rendered so highly interesting by their mineral riches. It should, however, be stated that only a small proportion of the rocks in this district belong to those which are truly metalliferous, for although the metalliferous rocks are believed to traverse very nearly, or quite the whole length of this district, they only make up a small fraction of the total width.

South of the country last alluded to, is a wide area that remains unsurveyed and of which but very little is now known.

The chief of my own labors during the past season has been devoted to surveys in the metalliferous district before alluded to, but with the utmost of my powers I have only been able to accomplish a portion of this arduous and difficult task. The imperfect knowledge which was possessed of the geographical features of the country, rendered it necessary first to settle with accuracy several important points to serve as a basis for the geological survey which was to follow. After this had been accomplished I proceeded to a survey of the several groups of rocks in order to define their area, thickness and relative position; a task more difficult than any I had ever been called upon to perform, and upon the accuracy and faithful performance of this portion of

the work depended nearly all the deductions which were to be drawn.

When the surveys of the geology of so much of the district as time and circumstances would permit me to traverse had been completed, and after having satisfactorily defined portions of the area occupied by the several groups of rocks, together with their character, thickness, etc. I directed my attention to a minute survey of those rocks embraced in a portion of what may be denominated the mineral district; a group of rocks which had been defined in the previous surveys I had made.

The precise extent of the mineral district I am unable at this time to state, since the surveys have not extended through its whole length. The district is long and narrow, at times approaching near to the shore of the lake and again stretching into the interior a distance of twenty-five to thirty miles. The width varies from one to four or five miles, and its length will probably exceed one hundred and twenty miles, though there may be considerable portions of this so situated as to be of no practical value. These observations are only intended to convey to you a very general idea of the extent of the region, and can only be considered as an approximation to the precise length and breadth of the district.

The minute examination of the mineral region has developed resources very much greater than had been supposed to exist, and those which are of such a character as it is conceived will not only add very much to the future settlement and prosperity of the upper peninsula, but also the state as a whole. The chief of the important minerals that occur in this district are the different ores of copper; which are found in veins traversing the rocks of the mineral region; and these veins are of a width which will not suffer by comparison with veins of a similar character in any known mining region. Upon the whole (while I would carefully avoid exciting any unfounded expectations among our citizens, and caution them to avoid engaging in wild schemes with a view to gain sudden wealth) the examinations and surveys which have been made would serve fully to justify the conclusion that this region of country will prove a continued source of wealth to our State.

But little, in fact almost nothing has, heretofore been known of what in reality constitutes the true mineral region of the upper peninsula. Loose pieces of native copper were occasionally picked up in the vicinity of Lake Superior and this led to the general belief that the metal existed in quantities in that region, but nothing definite was known upon the subject, for the reason that nearly the whole of the metalliferous rocks are situated in the interior, and in those rugged districts which heretofore have scarcely been visited by whites, and so little resemblance do most of the ores which occur, in the veins alluded to, bear to the native metals, that the Indians would scarcely detect them.

Very extensive collections of minerals from the mineral district have been made, but time has not as yet

permitted much progress in the analysis of them; and in fact the analysis of these minerals if faithfully performed would occupy several months of constant labor. I am now busily engaged upon this portion of the work.

In addition to the ores of copper, several other ores of metals occur, which may possibly prove to be of practical value, but of this I shall be unable to speak definitely until further progress has been made in the analysis.

Much yet remains to be done in order to develop fully the resources and capabilities of this interesting and important district of our state, and the surveys should by all means be made to cover that district to the south of that which has been already examined. If properly examined there can be no doubt but capital for permanent investment would flow into the country, while many of the wild and hazardous explorations for minerals, by visionary men, would be prevented.

The mineral district of the upper peninsula, so far as has been examined, is made up of a series of rugged hills, or low mountains, with intervening valleys sometimes of considerable width. The soil of these valleys is mostly of a superior quality and is well adapted for use for the purposes of agriculture and with a climate far less rigorous than is commonly supposed. In fact the opinion so prevalent that this portion of our state, in consequence of its cold climate, will not admit of advantageous cultivation is almost wholly founded in error.

The operations of the past season, not only in the northern but also in the southern peninsula have added much to our geographical and topographical knowledge and of a very considerable portion this has been carried to as great perfection as the character of the work will permit.

In accordance with instructions from the Hon. Legislature I have placed so many of the county maps as are sufficiently advanced to permit it under the hands of the engraver, and four of them will soon be ready for publication. Some little delay has occurred in preparing a small state map, as directed by the act above referred, to, which has been caused by the non-completion of a portion of the survey, but this difficulty is now in part remedied and the map will soon be ready to be placed in the hands of the engraver. No steps have as yet been taken for the disposal of the county and state maps for the reason that I was desirous to determine accurately the entire cost, before offering the maps for sale. There can be no doubt but they may be made to bring a handsome return of profit to the State.

The region of country which has been traversed during the past season, has been such as to bring me frequently upon the boundary line between our State and the Territory of Wisconsin, and after an examination of the subject, so far as circumstances would permit, my former impressions are fully realized, that the boundary as defined is absolutely impracticable.

By giving to the lakes and streams the same name as those contained in the act of Congress, and filling up some vacancies which exist, a boundary might be made very nearly in accordance with the original intent of the framers of that act. This subject is an important one to the interests of Michigan and most assuredly deserves early attention. [The facts connected with this subject I will lay before you, in a separate communication at as early a day as circumstances will permit.]

Of the condition of that portion of my duties relating to the Salt Springs of our State, you are already in general terms informed, and upon the completion of some of the details connected with the proposals for contracts at the Salt Springs I will transmit a separate communication to you upon this subject. Nothing has been drawn from the appropriation for these works for the year 1840. A small amount of expense has, however, been incurred in keeping the machinery and fixtures in repair, and for the purposes connected with the proposals issued for contracts which it will be necessary to provide for, and since I have no funds connected with this project at my disposal, some special action will be required upon the subject.

Since the fiscal year of the Geological department proper ends on the first of March 1841, it is impossible for me to lay before you at this time an account of the financial condition of the department.

The appropriation for the geological survey under the act by which the board is now organized ceases upon the 1st. of March next. The whole amount appropriated to the work by the act referred to has not been expended, but since the amt. appropriated was to be applied annually nothing can be drawn after that date.

The survey is so far advanced towards completion that a large proportion of the expense that has been heretofore necessarily incurred may now be dispensed with; but in order to secure to the State the benefit of what has already been done a sufficient appropriation will be required to enable the department to fill up some deficiencies that remain in the surveys of the lower peninsula, and at the same time to extend those of the upper peninsula.

The services of the Topographer will be absolutely required, for the work on hand in that department will not be closed and there is now on hand a very large amt. of matter which has not as yet been sufficiently digested to pass into the hands of that officer.

The duties of the topographer have been of the most arduous character and they have been performed with an ardor and fidelity which deserve the highest commendation. During the progress of the publication of the maps his services will be required, and it will be many months before he will be able to dispose of the mass of matter now on hand.

After the ensuing 1st. of March the services of the other assistants in the department may be dispensed with, as

may also a very considerable portion of the contingent expenses.

While referring to the pecuniary portion of the subject, it is with pride that I call your attention to the fact that in none of the thirteen states where these surveys are in progress has as much been accomplished for the same amt. of expenditure as in our own. My attention was called particularly to this while in attendance upon the convention of geologists of the several states, at Philadelphia in April last; and afterwards upon my visit to the legislature of the State of New York, at which time that body had under consideration a bill for extending the time of the survey of that state.

The original time specified for the completion of the survey of New York was four years, but by an act of the last legislature of that state, that time having been found insufficient for the completion of the work, was extended two years, thus milking the total term six years.

We have now nearly completed four years of labor in a country which is vastly more difficult to explore than that of New York and with a force less than one-fourth that of the inst state alluded to, yet in practical information we are nearly equally advanced.

The survey of New York is strictly a geological one, while that of Michigan includes also a topographical survey. In this respect the character of the works differ, but in consequence of it the practical value of that of our own State is much increased, at the same time that profits which will accrue from this portion of the work, if faithfully carried out, will replace a very considerable portion of the expense which has been incurred during the progress of the work.

The final and connected report which I am called upon to make at the close of my official labor must necessarily involve not only my individual reputation but also that of the State, and while I would be unwilling to involve my reputation in connexion with these surveys while portions of the work remain incomplete, the State most certainly can not desire the publication of imperfect surveys. In addition to this there are a portion of the maps of the several counties in such condition an absolutely to prevent publication until further surveys be made.

At as early a day as circumstances will permit I will lay before you a more detailed statement of the true condition of the Boundary line between Michigan and Wisconsin, so far as I have been able to determine the same, believing it to be of vital importance to the best interests of the State that the subject be adjusted at the earliest day practicable.

I have the honor to be,
Sinc. Your Obt. Servt.
DOUGLASS HOUGHTON,
State Geologist.

REPORT OF CONTRACTS

(From *Documents accompanying the Governor's special message, relative to the state salt spring lands. Joint Documents, 1841, No. 5*)

Office of State Geologist,
Detroit, December 26, 1840.

To his excellency William Woodbridge:

Sir—In compliance with the requisitions of an act entitled “An act for the improvement of the state salt springs,” approved March 31, 1840, I have the honor herewith to transmit for your examination, contracts which have been entered into, for the improvement of the salt springs at Tittabawassee and Grand river.

I also send you a copy of the advertisements for proposals, in order that you may have the whole subject before you. The contracts were closed with those whose bids were lowest. The sureties upon the bonds are all personally known to me, and are perfectly satisfactory. Some little delay has occurred in forwarding these contracts to you, for the reason that; it became necessary for me to await the return of the bond of Mr. Farrand from Saginaw, which has but just arrived.

The contracts are believed to contain all the information which you wished me to transmit to you, for which reason, further explanation will be rendered unnecessary.

I have the honor to be, sir,

Your obedient servant,

(Signed) DOUGLASS HOUGHTON,
State Geologist.

[Here follow contracts with Lucius Lyon and Ira T. Farrand]

1841

ANNUAL REPORT OF THE STATE GEOLOGIST

(*Joint Documents, 1841, Vol. 1, No. 11*)

Office of State Geologist,
Detroit, February 1, 1841.

To the Senate and House of Representatives:

In conformity with instructions contained in the act authorizing a geological survey of the state, I have the honor to lay before you, an outline of the operations of the department over which I have been placed, together with the general progress towards completion of the whole work.

It is a matter of regret to me, that the sufferings and hardships to which I have been exposed in conducting the field work over the wilderness portions of our state, have so far impaired my health, as to render it impossible for me to enter into so minute details as had been anticipated. I regret this the more, since it leaves many wide spaces in portions of the present report,

which are of much consequence to a proper understanding of the whole. But since the annual reports are intended to refer rather to the progress of the work than to its results, and since the whole will be embraced in a more perfect form hereafter, this defect is of less importance than it otherwise would be.

My individual labors, during the past season, have been chiefly devoted to surveys connected with the northern slope¹ of the upper peninsula, and to this district, the chief observations in this report, will be directed.

UPPER OR NORTHERN PENINSULA

General description and Topographical features

The published maps of that portion of the state of Michigan usually known as the upper peninsula, are so defective, not only in details, but also in general outline, that the task of giving a description, of any portion, in such a manner as to render it intelligible to any person who has not actually traveled over it, is exceedingly difficult. The extent of these geographical inaccuracies is much greater than would at first be supposed, for scarcely a single feature of the interior is given as it actually exists; mere brooks are magnified to rivers, and again those streams justly deserving the name of rivers, are either wholly omitted or scarcely noted, while the courses of the streams, as laid down, are almost invariably as far from the truth as could be conceived. Nor do the inaccuracies stop here, for even the coast maps of the great lakes, by which our upper peninsula is in part surrounded, are usually so defective as scarcely to be recognized, except in their most general outlines.⁴⁰

I have already, in a previous report, referred in general terms, to that portion of the upper peninsula bounded by lakes Huron and Michigan, for which reason my remarks at this time will be mostly confined to the northerly portions of the peninsula, or that portion bordering upon Lake Superior.

So little is known of the extent of country constituting the upper peninsula, that it may not be misplaced to make some reference to its dimensions, though at this time most of the estimates must be regarded as mere approximations. The most extreme length of the district is embraced between Point de Tour, of Lake Huron, on the east, and the mouth of Montreal

⁴⁰I am happy in being- able to except from this otherwise universal charge of inaccuracy, the coast map of Lake Superior published by the society for the diffusion of useful knowledge. This map was reduced from the surveys of Capt. Bayfield, R. N., as returned to the British admiralty office, and so far as the British coast is concerned, the map is minutely correct. The American coast upon this map is faithfully delineated in its general outline, but in minutiae it is frequently deficient.

River, of Lake Superior, on the west. From Point de Tour, the direction of the mouth of Montreal river is very nearly north, 80° 30' west, and the direct distance does not vary far from 316 miles. This estimate, it will be perceived, does not include Drummond's Island, which, if included, would add some twenty miles to the length as already given.

The easterly portion of the peninsula is narrow, and its width, for a distance of 130 miles west from Point de Tour, varies from 30 to 50 miles; west from this, the peninsula widens rapidly, though its width is exceedingly irregular. I am unable, at this time, to state with very much accuracy, the extreme width of the upper peninsula, but the area of the whole may be estimated at very nearly two-thirds that of the lower, or southern peninsula.

The topography and general features of the upper and lower peninsulas differ so widely from each other, that, with the simple exception of a part of the easterly extremity of the upper peninsula, they scarcely admit of a comparison. The wide contrast exhibited by the two districts, is wholly dependent upon geological differences, and these are so strongly marked, that they could not fail to attract the notice of the most superficial observer.

In the last report I had the honor to lay before you, some general references were made to the topography of the southern slope of the upper peninsula, which embraced simply those portions bordering on lakes Huron and Michigan, and extending from Point de Tour to Menominee river.

Although the rocks of the district extending from Point de Tour to Chocolate river, upon the northerly or Lake Superior slope, belong to an older series than those lying south, and are different in composition, the general features of the two districts, nevertheless, bear a close resemblance. Easterly from Point Iroquois, the country is for the most part flat, or but slightly elevated, and the near approach of the rock to the surface so far prevents the descent of the waters as to give rise to extensive districts of wet and swaly land. Westerly from point Iroquois to Chocolate river the country is more elevated and has a much smaller proportion of wet land. A range of hills, having an elevation varying from 300 to 600 feet above Lake Superior, commences a little easterly from Point Iroquois, and stretches very nearly west, or but a few degrees north of west, until the western escarpment again appears upon the coast, giving rise to the elevated hills of which the Pictured rocks and Grand island form a part. The outline of this range of hills has the most perfect regularity, being unbroken and uniformly covered with a dense growth of timber.

West from Chocolate river, to our boundary line at Montreal river, the physical character of the country is widely different from that of the district before referred to. This country is made up of a series of irregular, knobby ranges of hills, that have a general easterly and westerly direction, with intervening valleys of flat or gently rolling land. These hills not unfrequently rise to a height of from 600 to 900 feet, very near to the immediate coast of Lake Superior, and at a distance of 15 to 20 miles south from the coast, portions of south of the ranges rise to a height of 1,200 to 1,300 feet above the level of that lake. The ragged and broken outline which this district presents, when viewed in detail, from the lake, contrasts in a striking manner with that of the country lying east

from Chocolate river: for instead of the regular and unbroken range of hills uniformly covered with a dense forest that occur in the latter districts, we have a series of ranges of broken hills, with knobs not unfrequently nearly or quite destitute of timber. The escarpments of these hills are sometimes so abrupt as to render them difficult of ascent.

The only exception to the general easterly and westerly direction of these ranges of hills, occurs in that range constituting the Porcupine mountains. These mountains rise somewhat abruptly almost upon the immediate coast of Lake Superior, at a point 37 miles north-easterly from the mouth of Montreal river, and from this point then stretch inland, in a direction which, for the first thirty miles, is very nearly south-southwest, after which their course is more westerly, and in the direction of the sources of the Wisconsin river. The most elevated points of the Porcupine mountains, near to Lake Superior, attain an altitude of very nearly 950 feet, but several of the knobs, at a distance inland, rise from 1,000 to 1,300 feet above the level of the waters of that lake.

The valleys, before referred to as separating these ranges of hills, are uniformly heavily timbered, and by far the largest proportion of this timber is beech and maple.

The length of the hilly or mountainous district, estimating in a direct line west from Chocolate river to the boundary line on Montreal river, is very nearly one hundred and sixty miles, and it does not probably extend, at any point, more than 20 to 25 miles south from this line. Estimating this hilly district to extend regularly 20 miles south of a line drawn from the points before mentioned, the greatest width of the district would be opposite Keweenaw point, which extends 67 miles north from this line, making the total width at this point 87 geographical miles. The very great irregularities of the coast, with flu numerous deep bays and projecting points upon the north, together with the irregularities of the ranges of hills upon the south, cause so great variations in the width of the district, that it is impossible, with the present information upon this subject, to estimate the width of the district with any great degree of accuracy. Keweenaw bay, of Lake Superior stretches 60 miles, estimating from the extremity of Keweenaw Point, into this hilly or mountainous country.

South from the range of hilly country alluded to, and extending to Green bay, the country at first becomes more level and finally flat, though with several regular and unbroken ranges of hills. In topography and general character it more nearly resembles that district of country which lies east from Chocolate river.

Of the district of country lying between the hilly country and Green bay, less is known than of any other portion of the upper peninsula. The extent of my duties did not permit me to extend my examinations very far into it, nor was I enabled to obtain any information as to its general character

The streams which discharge their waters into Lake Superior upon its south shore, are invariably short, and with very few exceptions, the quantity of water they discharge is small. This remark, in fact, may apply to the whole of the region of country surrounding that lake, for this immense body of water is completely surrounded by hills that, at no great distance from the lake, fall away more or less rapidly. Thus, while many of the streams discharging their waters into Lake Michigan, Green bay and the Mississippi river, have their sources near to the south shore of Lake Superior, so also, many of those streams which discharge their waters northerly into Hudson's Bay, have their sources near to the north coast of the lake. The near approach of the summit of the ranges of hills surrounding the lake, to the immediate coast, leaves the area of country draining into Lake Superior, comparatively small.

The most important of the streams entering Lake Superior upon its south shore and within the limits of our State (commencing near the foot of the lake and enumerating westwardly), are the Tequoimenon, Train, Chocolate, Death, Yellow Dog, Huron, Portage, Fire Steel, Ontonagon, Iron, Presque isle, Black and Montreal rivers. Besides these, there are innumerable creeks, which are usually known to voyageurs as rivers, for this term is applied indiscriminately to all. The water of most of these streams are remarkably transparent and pure, with brisk currents and numerous cascades, and they almost invariably contain an abundance of the brook trout, a circumstance which I mention from the fact that this fish is scarcely known in the streams of the southern peninsula.

The Tequoimenon river, which is the only stream east, from Chocolate river that in reality breaks through the range of sandstone hills, before mentioned as extending westerly from Point Iroquois, has its embouchure about 18 miles south from Whitefish point, and near the foot of the lake. The discharge is through loose sands, and there is an average of 4 to 4½ feet water over the bar. Having passed the bar, the water for a distance of 7 to 8 miles varies from 10 to 15 feet.

Some of the sources of this stream approach very nearly to Lake Michigan, being directly at the base of the range of lime rock hills, referred to in my third annual report.

The Toquimenon river, with the exception of a distance of some four to five miles, while passing through the range of sandstone hills before alluded to, is, through its whole course, a sluggish stream, though at many points having a strong, deep current. The character of the river in its passage through the range of hills referred to, is totally changed, for it has there numerous chutes and falls, with almost continuous rapids. At one point the whole body of water contained in the stream is precipitated by a single leap from a height of forty-six feet, and the effect of this fall is much heightened by the elevated and overhanging rocks that bound the river upon either side.

Most of the small streams, discharging into Lake Superior between the foot of the lake and Chocolate river, have their sources to the north of the elevated range of hills mentioned, or minor branches only descend from those hills.

Chocolate river, which discharges its waters into Lake Superior at a point 146 miles very nearly due west from the Saut de Ste. Marie, is a stream of considerable magnitude, though in consequence of the loose sands at its mouth it is difficult of entrance at ordinary stages of water even with barges of moderate draught, but when once the bar is passed the stream is found to be deep, and for several miles has a width varying from 80 to 150 feet.

This stream will be made a point of reference in the strictly geological portions of this report, for it winds along near the line of junction of two widely distinct geological districts, the general features of one being characterized by its ragged and broken hills, while the other is not less marked by its general level, or regularly undulating surface.

Chocolate river takes its name from the dark color of its waters.

Those streams which occur between Chocolate river and Keweenaw bay, are, with the exception of Huron river, small-though were we to refer to the published maps of this district we would suppose that some of these streams were of very considerable length. But with the exception of Huron river and River Des Morts, I believe they all have their sources in small lakes lying along the bases of the elevated hills already described. These hills rarely recede farther than three to five miles from the coast, and the length of the streams, forming the outlets of the lakes referred to, is governed wholly by these features.

Ontonagon river, which is one of the most important of the rivers discharging its waters into Lake Superior, upon its south shore, has its embouchure wry nearly fifty-five miles east, or rather north-easterly, from the western boundary of the state, at, the mouth of Montreal river. Ontonagon river has its sources in a very great number of mountain lakes, situated in part upon the south-easterly spurs of the Porcupine mountains, and in part in the hilly district formed by the easterly and westerly ranges of hills before described, which ranges, upon this portion of the coast, curve very considerably to the south. Some of the sources of the Ontonagon river approach very near to the sources of the Chippewa river of the Mississippi. The great number of small tributaries of the Ontonagon, which are simply the outlets of the small lakes referred to, and concentrated into two principal branches that finally unite and form the principal river, at a distance of about eighteen miles from the coast of Lake Superior. The smaller tributaries are mostly mere torrents, with frequent perpendicular falls, and high banks, sometimes of precipitous rock. The main stream, from the junction of the two principal branches to within five or six miles of the lake is rapid

and shoal, but below this, the stream is comparatively still, and with a good depth of water. The mouth of the Ontonagon river is obstructed by a bar of sand, over which there is usually, at low stages, about six feet of water. The principal rivers west from Ontonagon river, and within the limits of our State, have already been stated to be Iron, Presque Isle, Black and Montreal rivers. These streams are all short, and the amount of water discharged by each separately, is comparatively small. Their waters descend from the elevated mountain region immediately south from the coast, and since the whole streams are concentrated before passing from these elevations, their waters are discharged in body and they descend with very great rapidity. A greater variety of grand and beautiful scenery than that presented by some of these streams in their descent to the lake, taken in connection with the rugged and wild character of the country, can scarcely be conceived. I was particularly struck with the great variety of picturesque views furnished by Black River, in its descent from the elevated country on the west side of the Porcupine mountains to Lake Superior. The stream was estimated to fall about live hundred feel in a fraction over four mile, and this descent is made up by a constant succession of falls, chutes and rapids, which continue with so little interruption that the waters for the whole distance may be said to be constantly white foam. The stream is bounded upon either side by banks elevated from one hundred to three hundred feet, sometimes sloping away from the stream, somewhat gently, and again rising in mural precipices of rock, separated from each other by so short distances as to appear scarcely sufficient to permit the passage of the waters of the river. The most considerable fall does not exceed fifty feet, and they are usually from ten to thirty feet in height, but their constant succession and variety add much to its interest.

Montreal river is a comparatively small stream, made up of numerous small tributaries that rise among the ranges of hills to the south-west and south-east of its mouth. The passage of the river through the range of hills near the lake, gives rise to several very considerable waterfalls, as also to much rugged and wild scenery. Almost directly at the place of embouchure into Lake Superior, there is a perpendicular fall of about forty feet. This stream, it will be recollected forms a portion of the boundary between Michigan and Wisconsin.

By the act admitting Michigan as a state into the confederacy, and in which her boundaries are defined, it does not appear to have been the intention to include within her limits any portion of territory lying upon the north shore of Lake Superior, but in consequence of the peculiar shape of the coast at that point where the *national* boundary line "last touches Lake Superior," at the mouth of Pigeon river, a direct line to the mouth of the Montreal river, if followed literally, would throw within the state of Michigan several small rocky islands, together with a few miles of the south cape of Pigeon bay, situate upon the north coast. This boundary leaves in Wisconsin the whole of the Apostles' group of islands,

near to the south coast, while it includes within Michigan, Isle Royale, situate near to the north coast of the lake.

Isle Royale is little less than an island of rock, rising abruptly from the lowest depth of the lake, in irregular hills, to a height varying from 100 to 450 feet above the level of the lake. The island has a length of a fraction over 45 miles from north-east to south-west, and a breadth varying from 3½ to 8 miles. The most northerly point of the island is very nearly in latitude 48° 12' 30" north, and the parallel of longitude 89° west from Greenwich, crosses the island a little east from its centre. Its nearest approach to the main land is near its north-westerly end, where it is separated from a point of the north coast, a few miles east from Pigeon river, by a distance of a fraction less than 18 miles. Isle Royale is separated from Keweenaw point, of the south coast, by a distance of 44 miles, and the elevated hills of this point may be distinctly seen from Isle Royale when the atmosphere is clear.

Nearly the whole of the north-westerly side of Isle Royale is a continuous, elevated, rocky cliff, which will scarcely admit of a landing, but the south-easterly side, together with the easterly and westerly ends, are deeply indented with bays, which form secure harbors. The north-easterly end is made up of a series of elevated, rocky spits, with intervening bays. These spits of rock continue for a length varying from 10 to 12 miles, with a width scarcely exceeding half a mile, and altogether they may not inaptly be compared to the hand with the fingers half spread. The bays have a sufficient depth of water to admit vessels of the largest class to enter nearly one-third the whole length of the island.

Much of Isle Royale is absolutely destitute of soil, and the island has a most desolate appearance, but notwithstanding this, it is of immense value for its fisheries, which are as yet scarcely appreciated.

Though not within the limits of our state, I will briefly refer to the general character of a portion of the country west from Pigeon river, on the north coast. That district of country upon the immediate coast, extending from our national boundary, at Pigeon river, to Fond du Lac, is more decidedly and abruptly mountainous than any portion of the south coast of the lake. The hills rise in broad and somewhat knobby steppes or plateaus, to heights varying from 400 to 1,200 feet above the lake, and the summits of these hills are usually not farther inland than from 10 to 20 miles. The rocks of the hills are very frequently bare over considerable areas, and the valleys containing arable soil, are few and very narrow.

The route of the fur trade to the northwest, via Rainy lakes, Lake of the Woods and Lake Winnepic, was formerly wholly carried on by passing over these hills, from a point a few miles west from the mouth of Pigeon river. The trail or portage path passes over a low portion of the range, and finally falls upon Pigeon river, which is ascended to its source, from which, by a series of portages, the sources of the streams flowing north-

westerly are reached. The hilly portion of the country, though of exceeding interest; in a ideological point of view, is the most desolate that could be conceived.

GENERAL GEOLOGY OF THE UPPER PENINSULA

The geology of the upper or northern peninsula of Michigan, when compared with that, of the southern or lower peninsula, bears a striking contrast, for while that of the district last referred to is uniformly regular, with rocks, which, though rarely exposed to view, are few and for the most part but little disturbed, over large areas of country, the upper peninsula, embraces a much greater number of rocks, distributed over a somewhat smaller district of country, and a portion of which are so much disturbed as to render their delineation exceedingly complex and difficult.

The widely different topographical features of the easterly and westerly portions of the northerly part of the upper peninsula would lead the most casual observer to infer that the geological features of the different districts would be equally distinct, and in this he would not be disappointed.

I have already referred to the rugged and broken character of the country extending westerly from Chocolate river to our boundary at Montreal river, and have also attempted to define its general length and breadth. This district, which is essentially made up of primary, trap and metamorphic rocks, with intervening sedimentary rocks, usually occupying the valleys and out boundaries, may be estimated to cover an area, equal to a little more than one-fourth of the whole of the upper peninsula. To the east and south of this district the rocks are wholly sedimentary, consisting of a series of sandstones, limestones and shales.

With a view of rendering the local details of the separate formations more intelligible, I will first describe in general terms the rocks occurring in so much of the peninsula as has been examined, together with their general extent. This will necessarily involve a repetition of a very small portion of the report last made, upon the subject of the limestones of the south and east portions of the peninsula, but since the examinations of the past year have enabled me to add another member to the limestone group, and to define with more certainty its outline, this may not be devoid of interest.

1. *Primary Rocks*.—The rocks constituting what may be considered as the true primary group of this region are chiefly granite, syenite and syenitic granites. The members of the group are first seen upon the south coast of Lake Superior, constituting a rocky point known as Little Presque Isle, a little south-east from Riviere Des Morts. These rocks frequently appear upon the coast north westerly, nearly as far as Huron river, and the Huron islands, off the mouth of Huron river, belong to the same group. West from Huron islands no rock appears upon the coast which, in a strict sense, I should regard as primary. The rocks of this group arise upon or near to the coast, in irregular and broken ranges of hills, to a height varying from 300 to 700 feet above the waters of

the lake, and these hills, or ranges of hills, are continued in a south-westerly direction. The precise limit of the primary rocks to the westward, has not yet been determined, but they are known to extend nearly or quite to the sources of the Wisconsin river.

A portion of the south-westerly prolongation of the Porcupine mountain range, is made up of rocks belonging to the primary group, but its precise limit here has not yet been determined.

2. *Trap Rocks*.—Flanking the primary rocks already described on the north and north-west, are a series of ranges of hills stretching in a direction generally south-westerly and north-easterly, which attain an altitude of from three to nine hundred feet above the lake. They are more regular, or rather less broken in outline than the primary hills; a change, however, which in the transition is noticed to take place gradually from one group to the other, or in other words the knobby character of the ranges becomes less and less apparent as we cross them in a north-westerly direction, or from the primary range. These hills are composed of rocks, differing at first but slightly from those of the primary group, but gradually the difference becomes more and more apparent, as we proceed northerly. The rocks of those hills nearest the primary range may possibly be regarded simply as rocks of that group, more or less altered, though the rocks of the outer ranges are plainly trap. The range of these rocks, which may be said to commence at the very extremity of Keweenaw point, extends, after a slight curve to the north, in a general south-westerly-direction, gradually receding from the coast, until at the crossing of the Ontonagon river, it is nearly 25 miles inland. Westerly from Ontonagon river the range becomes confounded with the northerly portions of the Porcupine mountains: while west from these mountains a portion of what may be considered the same range of rock has taken a more westerly course and approaches the coast, until, at the crossing of the Montreal river it is but a few miles distant from Lake Superior. West from the Porcupine mountains, a second range of trap is continued, at a distance of from fifteen to twenty miles inland. The trap range of Keweenaw point may be estimated to compose one-third the entire width of the point, and the south-easterly portions of the range are made up of compact greenstone, while those portions to the northwest are amygdaloid.

The range of hills constituting the north-westerly part of Isle Royale, and extending its whole length, are of similar rocks, and single knobs of well defined trap rock occasionally occur, in the very midst of the primary region before referred to, upon the south coast; the proofs of the character of which will be shown as we advance.

3. *Metamorphic Rocks*.—Flanking the primary rocks on the south, is a series of stratified rocks, consisting of talcose, mica and clay slates, slaty hornblende rock, and quartz rock; the latter rock constituting by far the largest proportion of the whole group. In traversing the country

south-easterly from little Presque Isle, the point referred to as the most southeasterly prolongation of the granite, this last rock passes almost insensibly into a serpentine rock, which has a regular jointed structure, sometimes approaching to stratification; continuing in the same direction, we find a series of hornblende slates, talcose mica and clay slates, resting against the serpentine rocks, and still farther to the south-east the rock becomes almost uniformly quartz. The rocks of this group dip irregularly to the south and south-east, while the cleavage of the slates is very uniformly to the north.

The rocks of the metamorphic group stretch into the interior, in a westerly or rather south-westerly direction, forming the south-easterly part of the hilly region.

Rocks referable to this group also occur upon the north coast of Lake Superior.

4. *Conglomerate*.—The rock to which I shall restrict this term, does not occur well characterized at any point east from the district referred to, as the commencement of the trap group, nor has it been noticed resting upon any of either the primary [or] metamorphic rocks, but is invariably seen resting upon the trap rocks. Commencing upon the north side of the trap, at the extremity of Keweenaw point, the conglomerate flanks the trap upon its northerly side, as far west as the boundary of our state; nor does it stop here, for the same rock is seen at intervals as far west as the head of Lake Superior. A similar rock also rests upon the trap of Isle Royale, facing the south-east.

In the course of the range of conglomerate upon the south shore, it forms a nearly continuous range of hills, with somewhat steep escarpments, but with a generally rounded outline. These hills sometimes rise to a height of from three to five hundred feet above the level of the lake.

The conglomerate attains a very great thickness, being greatest at its westerly prolongation, and it gradually thins out as we proceed north-easterly; but the irregularity in thickness is so very considerable that variations of several hundred feet are not uncommon within the space of a few miles.

The conglomerate rock of the south coast dips in mass irregularly to the north and north-west, while that of Isle Royale dips to the south-east.

5. *Mixed Conglomerate and Sandstone*.—The rock or rocks to which I have fixed the above name consists of an alternating series of coarse conglomerates and red sandstones, resting conformably upon the conglomerate rock before described. In strictness, these rocks should probably be considered as a member of the conglomerate itself; but for the sake of convenience in description, I have deemed it desirable to separate them.

This mixed rock was only noticed, as before stated, resting upon the conglomerate, and this only between Point Keweenaw and Montreal river. Its thickness immediately west from and upon the flanks of the Porcupine mountains, is very considerable, but it

wedges out rapidly both easterly and westerly, and on the east near the extremity of Keweenaw point, it wholly disappears.

The mixed rock dips regularly to the north and northwest.

6. *Lower, or Red Sandstone and Shales*.—The red sandstone, with its accompanying red and gray shales, occupies a much larger extent of the country bordering upon Lake Superior than any other single rock or group of rocks. It rests upon the primary, and metamorphic rocks, immediately west from Chocolate river; upon the conglomerate and mixed rocks from near Eagle river, of Keweenaw point, west to the head of Lake Superior; upon the primary trap, metamorphic and conglomerate rocks of the north shore of the lake, and upon the conglomerate rock of Isle Royale. It is this rock which forms the basis of the level plateaus or valleys occupying the spaces between the several ranges of hills south from Lake Superior, and west from Chocolate river. In these last situations this rock is frequently seen undisturbed to surround the bases of isolated knobs of granite, though when near to or in contact with knobs or trap there are invariable evidences of very great disturbance.

The rocks of this group attain their greatest thickness at their westerly prolongation, gradually thinning out as we proceed easterly.

With the exception of that portion of the coast extending from Point Iroquois, at the foot of the lake, to Grand Island, the predominating rock upon the immediate coast, both on the south and north shore, is this red sandstone; for even the primary trap and conglomerate rocks are almost invariably skirted with a band of it. It is also over this rock that the waters of Lake Superior are discharged at the Sault de Ste. Marie.

The sandrock forms the chief portion of the group, the shales occurring rather as beds than otherwise, as will be hereafter described.

The red sandstone both upon the north and south shores of Lake Superior invariably dips into the basin of that lake, which may therefore be regarded as a synclinal axis.

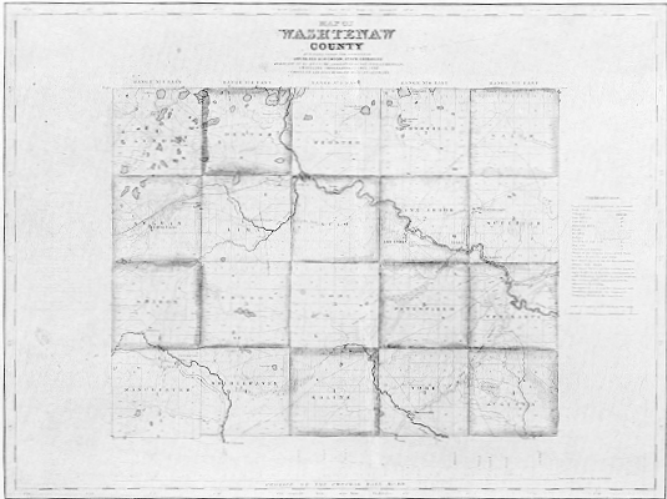
7. *Upper or Gray Sandstone*.—Upon the south shore of Lake Superior, and extending from Point Iroquois to Grand Island, a sandstone occurs, differing widely in its appearance from that before described. This sandstone rests *unconformably* upon the red sandstone, the former dipping gently to the south or south-east, while the latter dips very considerably to the north or north-west.

The elevated range of hills before described as commencing a little easterly from Point Iroquois and extending to the Pictured rocks, are composed of this rock. From the Pictured rocks, the range of hills curves more to the south, stretching-very far to the south-west, but its precise limit is not yet determined.

In its easterly prolongation the gray sandstone thins out rapidly. It is last seen at the Neebesh Rapids of the Riviera Ste. Marie, on the east, at which point, in consequence of not having been sufficiently examined farther westerly, it was confounded with the red sandrock in the last report which I had the honor to lay before you.

8. *Sandy Lime Rock*.—Resting immediately upon this upper or gray sandstone is a sandy limerock, which, although nearly wanting at the very easterly extremity of the peninsula, as we proceed westerly, occupies a more important place. This rock, which, as its name implies, is intermediate to between a sandstone and limerock, may be seen on Sailor’s encampment island of the Riviere Ste. Marie, as also at several points in the vicinity of Monusco bay, from whence it stretches westerly, occupying nearly the central portion of the peninsula, for a distance of at least sixty miles; from which its precise range and limit has not yet been determined. The outcropping edge of this rock appears at a level very considerably below that both of the sandstone to the north, and of the limestones to the south. Its width, for the distance mentioned varies from ten to fifteen miles, and it dips uniformly to the south-south-east.

The sandy limerock has not yet been examined with sufficient care to admit of accurate description. It contains but few fossils, but those few are sufficiently characteristic, were there no other considerations, to separate it from the lower limerocks and shales.



[Map of Washtenaw County]

Upon the sandy limerock to which reference is above made, rests the lower limerock and shales, and upon this last the upper limerock, both uniformly dipping to the south or southeast. These limerocks were described in general terms, in my third annual report, and although many additional facts have been gathered respecting their character, range and extent, it is, perhaps, unnecessary to lay them before you at this time. I will barely add, with respect to them, that the suggestion there mentioned, that a more careful examination of these limestones would render a farther division of the groups necessary, has been fully confirmed.

I had hoped to lay before you a profile section of the rocks of the upper peninsula, but the impossibility of having it engraved in time to accompany this report has led me to defer it. I regret this the more since many of the facts connected with a full understanding of the economical portion of this report are so intimately dependent upon the general geology of the country that, in the absence of correct maps, and without a profile section of the rocks, I fear it will be impossible for me to render the most important portion, so far as regards the prosperity of the state, intelligible.

As it is, I can only, in the place of this, lay before you a general section of the rocks of the upper peninsula, together with their thickness, so far as the same has been satisfactorily determined. This section is intended simply to represent the order in which the several rocks rest upon each other.

Having already described in general terms the range and extent of the rocks of the upper peninsula, so far as the same have been examined, the limits of the present report will admit of nothing more than a general description of the characters of these rocks, and I shall not attempt a minute description of any members of the series, except such as are more or less connected with subjects which are supposed to be of immediate practical importance.

Section illustrative of the order of super-position of the Rocks of the Upper Peninsula

	Thickness in Feet.
9. Tertiary Clays and Sands.	
8. Upper Limerock Group (embracing as members, the Drummond Island and Mackinaw limestones).	
7. Lower Limerock and Shales.	
6. Sandy or Intermediate Limestone.	
5. Upper or Grey Sandstone.	mean 700 feet
4. Lower or Red Sandrock and Shales.	extreme 6,500
3. Mixed Conglomerate and Sandrock.	extreme 4,200
2. Conglomerate Rock.	extreme 5,260
1. Metamorphic, Trap and Primary rocks.	

PRIMARY ROCKS

Although the usual ternary compound of quartz, feldspar and mica occurs but rarely in the primary, in the vicinity of the coast of Lake Superior, and in fact hut rarely in any portion of the range which I have visited, nevertheless, the great mass of rocks included within this range, may, in a broad sense, be called granite.

The compound above referred to is more common in the westerly than in the easterly portion of the range. The more common rock is made up of quartz, feldspar and hornblende, giving rise to a very dark colored syenite; occasionally mica enters sufficiently into the compound to form syenitic granite, and sometimes the place of the hornblende in the syenite is supplied by schorl or tourmaline, thus giving rise to a schorl rock.

The rocks of the southeasterly portion of the primary range¹ of hills are more clearly defined as granite rocks, than those situated more northerly, for they are more distinctly and largely crystalline in structure, and quartz enters much more largely as a constituent into their composition. As we proceed north-westerly, from the south-east boundary of the primary, over the several broken ranges of hills, we find the character of the rocks in mass almost imperceptibly changing. The quartz as a mineral gradually forms a less important part, and it finally almost wholly disappears, leaving a binary compound of feldspar and hornblende, which then assumes a granular structure, constituting greenstone. The intermediate rock, between the syenite and greenstone ranges, may not inappropriately be called a syenitic greenstone.

The primary rocks which appear in the vicinity of Lake Superior, in the several ranges of hills extending from a point opposite little Presque Isle, to Huron river, are essentially either syenite or syenitic granite. The rock, as a whole, is extremely compact, and the constituent minerals are mostly in small crystals, though occasionally the feldspar assumes a more largely crystalline form.

The granite rocks, so far as the range has been examined, in a southwesterly direction, are largely traversed by dykes, that are almost without exception made up of materials in all respects identical with the greenstone, before alluded to, as forming the more northwesterly range of hills. The courses of these dykes or veins are invariably marked by striking changes in the character of the rock traversed, and in the larger dykes, the evidences of the changes produced by the heat of the injected matter, extend to several hundred feet upon either side of the dyke itself. The connection between the rocky matter composing these dykes and the ranges of greenstone, lying northwest, is clearly identified, not only by the perfect similarity in mineral character, but also from the fact, that as we proceed in the direction of the ranges of greenstone, the dykes become much more frequent, until at length it becomes difficult to determine which of the rocks predominate in quantity.

These facts serve to throw much light upon the relative ages of the several ranges of hills, or in other words, serve to show the order in which they were severally uplifted; facts which will be more fully shown when we come to consider the present position of the overlying sedimentary rocks. These facts are not only important, to enable us to understand the many changes which have taken place, with regard to the relative position of the land and water, but they are rendered of practical

importance for the reason, which I think may be satisfactorily shown, that the mineral region of the upper peninsula, to be hereafter described, is strictly confined to only the outer portion of the rocks of a single epoch.

The veins and dykes of greenstone, referred to as traversing the granite rocks, do not in this portion of the group, appear to have any regular magnetic bearing, for they traverse the rock in all directions. Veins of any other matter are very rarely seen traversing the granite. In a single instance, what was regarded as a true vein of porphyry, having a width of nearly three feet, was noticed, which vein is crossed, at angles of 53° and 107°, by a vein of greenstone, having a width somewhat less than that of the porphyry. In this instance, the greenstone is clearly the most recent vein.

The veins of greenstone traversing the granite, vary from a mere line, to 50 or 60 feet in width. The intimate blending of the material composing these veins, together with the chemical differences, causes them to disintegrate or waste away more rapidly than the rock they traverse; the result of which is, that deep grooves are frequently left in the granite, the simple result of the wasting away of these dykes or veins. This is peculiarly the case upon the coast of the lake, where the rocks are subject to the action of the waves, which have, in some instances, so removed the debris as to leave long and narrow bays, with high perpendicular walls, occupying simply the space once occupied by the dyke. The Huron Islands, which are simple elevated granite knobs, appear, upon first examination, as a mass of rocks, completely rent in many places, with portions separated from each other by narrow clefts, having perpendicular walls of great height. While these rents are of sufficient width to admit of being traversed by small boats, the perpendicular walls are so little varied in their elevation as scarcely to leave a point, in these narrow passages, where a landing can be effected. A careful examination of these passages shows them to be simply the spaces once occupied by dykes or veins of greenstone, which having disintegrated, and the detrital matter having been removed by the action of the waves, has left the walls of the more enduring granite rock, unbroken and almost untouched.

Upon the north coast of Lake Superior, well defined granite and syenite, or syenitic granite, occasionally appear upon the immediate coast of the lake, but more frequently these rocks are flanked on the south by greenstone, with occasional narrow bands of sandstone; thus precisely reversing the magnetic order of those rocks upon the south coast.

TRAP ROCKS

Were we to consider the rocks of the district under consideration, strictly in their chronological order, those rocks which I propose to treat as trap rocks, would undoubtedly follow those slates and quartz rocks which are considered as metamorphic, and which may be regarded as identical in time of uplift with those rocks before alluded to, as being intermediate between the

granitic and trap rocks. The almost insensible gradations by which the granitic rocks pass into the greenstone of the trap formation, and the near analogy of the whole of the rocks of both formations, to each other, renders it more convenient, at the same time that it is more simple to follow the arrangement or order that I have adopted.

I have already stated that in passing from the granitic region on the south side of Lake Superior, in a direction northwesterly, we cross a series of ranges of hills, varying in height from three to nine hundred feet above the lake, and than pursuing this course, we observe that the character of the rocks gradually and almost insensibly change, until at length they become well defined greenstone.⁴¹

The rocks of the outer or northwestern range of hills, which were clearly the last of the series of uplifts, bears more unequivocally the evidences of igneous origin, than either of the outer ranges alluded to. The rock upon the south flank of these hills, is invariably very compact greenstone, while upon the north-westerly line it is almost equally invariably an amygdaloid, or at least, has an amygdaloidal structure. The causes of this difference of structure of the rock, upon the opposite sides of this range of hills, when carefully examined upon the ground, are very apparent, for it is evident, as will hereafter be shown, that the uplift of the rocks of this range of hills was wholly upon the south-easterly side, and while the rocks of this portion were in a solidified state, or, in other words, that a point in Lake Superior may be regarded as a

⁴¹In the present report, I used the term *greenstone* in its generic sense applying it to all the compact rocks, of a granulated structure, belonging to the trap range. By far the larger proportion of these rocks are greenstone, in its most restricted sense, or in other words, are composed of feldspar and hornblende: but the term is also used to include rocks which in a strict sense would be considered as altered syenite, syenitic, granite, hornblende and angitic rock.

The term *amygdaloid*, I apply, as it is usually applied to that portion of the rock having a difference of form simply, without any reference to the constituents of the rock. This generic use of terms is employed for the reason that the limits of the present report will not allow any thing more than a very general consideration of the subject. The term *trap* is used in such a sense as to include both the greenstone and amygdaloid, though it may sometimes prove that the amygdaloid has had its origin from the fusion of the lower portions of the sedimentary rocks.

fixed axis of the uplifted mass. That this was the case, is shown by the fact that the sedimentary rocks to the south or south-east are scarcely disturbed, so far as regards this range of hills, while the sedimentary rocks on the north or northwesterly side are invariably tilted to a high angle near the range of hills, which angle gradually decreases as we pass farther and farther from the hills themselves. These sedimentary rocks, which upon the north side always dip *from* the range of trap hills, are in their close proximity to the trap inclined at angles varying from 40° to 85°. Dykes of from fifty to four or five hundred feet are of frequent occurrence, traversing these sedimentary rocks, but the widest of these have invariably been protruded between the strata

of the sedimentary rocks, and consequently have the same general inclination. The result of these frequent dykes, which occur at comparatively short distances from the main body of trap, is, that the sedimentary rocks frequently so far lose their original character as scarcely to be recognized.

The rocks of the complete north-western escarpment of this range of hills were evidently in an intense state of ignition while in contact with the sedimentary rocks, as is clearly shown by the very great changes which have taken place in (the rocks last alluded to. In fact, I am disposed to refer the origin of much of the amygdaloid rock to the fusion of the lower portions of the sedimentary rocks referred to, for the reason that as we pass south from this junction, the amygdaloid rocks wholly disappear, their place being supplied by greenstone; and again so intimately are they blended that it is frequently impossible to determine where the amygdaloid ceases and the upper sedimentary rocks commence. Fragments of the sedimentary rocks, the characters of which can be clearly recognized, are not of rare occurrence, imbedded in the amygdaloid rock, a circumstance which although by no means conclusive, should not be overlooked in considering this subject.

I would not wish to convey the idea that the amygdaloid rocks have their origin exclusively from the altered sedimentary rocks, but simply that the change in the structure of the trap from greenstone to amygdaloid may and no doubt does depend upon the proximity of the sedimentary rocks to the trap, while the latter was in a state of ignition.

I have been compelled to tread upon grounds which may, perhaps, be considered theoretical, but it would appear to be necessary in order to convey a proper idea of the condition of the rocks composing the range of hills under consideration. These views, however, would not have been alluded to at this time had it not been for the fact that an understanding of all that relates to the mineral resources of this portion of our State is more or less intimately connected with this portion of the subject.

Although the general range of the trap hills has been already given, I will define as nearly as is in my power the line of junction between the trap and sedimentary rocks upon the north escarpment, premising that the elevation at which this junction takes place is usually at a height of from 100 to 500 feet above the lake, and only in a single instance does this line reach the coast of the lake. Commencing almost directly at the extremity of Keweenaw point, this line passes in a south-westerly direction, gradually receding from the coast; it crosses Sturgeon or Portage lake near its centre, after which it recedes still more rapidly from the coast, until finally it is seen to cross the upper fork of the Ontonagon river, and soon after the whole is apparently lost in the range of the Porcupine mountains; which last range has a course so much to the south-west as probably to completely intersect the first range mentioned. On the west side of the Porcupine mountains the range of hills and the line of junction appear again, but many miles farther north

than they would have been looked for; from thence the true line gradually approaches the coast, until, at its point of crossing the Montreal river, it is but about two miles above the mouth of that stream.

To the north and north-west, through the whole of the distance described, this trap is bounded by hills of conglomerate and sandstone, more or less elevated, but usually not exceeding four hundred feet. To the north-west of these hills of sedimentary rocks, a dyke of trap is seen to extend for many miles along the line of coast of Keweenaw point, and so threat it the width of the dyke, that unless carefully examined, its character might easily be misunderstood. It lies in a plane parallel to the stratification of the sedimentary rock by which it is embraced, and with that rock dips to the north-west. The dyke is chiefly made up of greenstone, but not unfrequently large portions of the mass consist of amygdaloid, in which the amygdules are filled or composed of quartz, chalcedony, agate, calc, spar, zeolite, &c.

The dykes just referred to, so far as their relation to the amygdaloidal portion of the trap is concerned, as also the many others similarly situated with respect to the superincumbent sedimentary rocks, will be regarded in the same light as contemporaneous veins, though they are only contemporaneous with the uplift of the strata, and not with their deposit. But there is still another class of veins which not only traverse a portion of the trap rocks, but also the upper sedimentary rocks, and which may be regarded as true veins. These last mentioned veins traverse the rock at a high angle with the line of bearing of the sedimentary rocks, as also with the line of junction of those last mentioned with the trap rocks. The composition of these veins is widely different from that of the contemporaneous veins or dykes before referred to. As this subject will be treated more at length in a succeeding portion of this report, I deem it unnecessary at this time to refer more particularly to the subject.

A single knob of trap appears under circumstances which add very much to its interest, at what is usually known as Presque Isle, an elevated rocky point immediately north-west from Riviere Des Morts, and almost directly within the granitic region. This point of land has its origin from the simple elevation of a mass of trap rock which rises on the north in abrupt cliffs varying from twenty to sixty feet in height. The trap is mostly greenstone, though portions of it are so largely impregnated with a dark colored, almost black serpentine, as to deserve the name of serpentine rock.

The knob of trap under consideration is possessed of additional interest, from the unequivocal evidence of uplift, as also from the manner in which these evidences are exhibited. The cliffs of trap occupy the very extremity of the point, while the neck and central portions are made up of conglomerate or trap tuff and sandrock resting upon the trap. These upper rocks also appear upon the immediate coast, in cliffs of from twenty to sixty feet in height, and in many places they are seen resting directly upon the trap. The stratification of these

sedimentary rocks has been very much disturbed, and they invariably dip at a high angle in all directions from the trap itself. The character of both rocks, at the immediate line of junction is almost completely lost, and the evidences of change most unequivocally marked. But the most curious feature of the whole is, that the sedimentary rocks for a distance of several hundred feet, have been completely shattered or broken into minute fragments, which, having retained their original position, were again cemented by the injection of calcareous matter. This injection has filled the most minute fissures, and so perfect is it, that, in looking upon the face of a mural cliff of these rocks, the veins may be easily seen at a distance of many rods, forming as it were, a complete net work over the cliff, and so minute is it, that a single hand specimen frequently contains many hundreds of these veins. This knob of trap, like the rock before described, is also traversed by veins of a date subsequent to the uplift of the rock.

The whole of the north-western portion of Isle Royale is made up of trap, and in truth that rock constitutes, by far, the largest proportion of the rocky mass of the island. The two northerly ranges of hills already alluded to as traversing the island, in its greatest length, are wholly trap. The most northerly range of hills is composed almost exclusively of greenstone, while the rock of the south or south-easterly range, becomes more decidedly amygdaloidal in its structure; thus reversing the order which these portions of the rock bear to each other upon the south shore of the lake.

The ranges of hills immediately bounding Lake Superior upon its north coast are almost invariably either well defined trap or altered syenite, while the decidedly primary rocks usually appear in ranges of hills to the north of these; thus following the reversed order of the rocks upon the south coast.

The character of the trap rocks of Lake Superior has perhaps been sufficiently described to answer the purpose for which this hasty sketch is intended; and I will only add, that they are usually distinctly jointed, and where they approximate to the sedimentary rocks, then is not unfrequently so distinct a cleavage, opposed to the joints in direction, as to give the appearance of stratification. The jointed structure of the trap rocks sometimes, though rarely, passes to what may be termed a rudely columnar structure. Upon one of the long rocky points forming the north easterly extremity of Isle Royale this rock assumes the columnar form, and the columns are tolerably well defined, having a height of from eighty to ninety feet. The columns are also seen, but less perfectly developed, forming the coast of a small rocky island two or three miles south from the point last alluded to. These are the only points in the trap of Lake Superior where I have noticed the rock to assume this form.

METAMORPHIC ROCKS

The general direction of the rocks composing this group, has already been described, and they are confined

exclusively to the range of hills lying upon the south-east side of the granitic rocks. The general direction of these hills is southwest and north-east.

The outline of the hills of the metamorphic group is less broken than either the granitic or trap ranges, but these rocks sometimes rise in abrupt conical peaks, closely resembling those of the granitic rocks.

The area of country occupied by rocks of this group, is less than that of either the primary or trap, the general average width not exceeding six to eight miles. The precise limit of the group in a south-westerly direction, is not known.

It has already been stated that Chocolate river is the boundary on the south-east, between these and the sedimentary rocks, and that they extend in a north-westerly direction from this stream to the granite, against which they rest. The group is made up of an alternating series of talcose and mica slates, sometimes graduating into clay slates, with quartz and serpentine rocks, the quartz rocks constituting by far the larger proportion of the whole mass. Since it would be nearly impossible to describe the alternations of these several rocks, in such a manner as to be understood, without the aid of a diagram, or section, no attempt will be made to do so.

The cleavage of all these rocks is usually north or north. 10° west, at an angle, which, in the main, varies but little from 80°, but the mass of the group appears to dip regularly to the south or south-west. The talcose slates and quartz rocks alternate frequently with each other, and with the rock which has been called serpentine rock less frequently.

The quartz rock is usually distinctly granular, though it is sometimes compact, with a conchoidal fracture. It usually separates by cleavage, into masses, or strata, having a considerable degree of regularity, and varying from a few inches to several feet in thickness. The rock is usually more or less regularly jointed.

The rock which, for the sake of convenience, I have denominated serpentine rock, bears a close resemblance to greenstone, being essentially composed of granular feldspar and hornblende, with which serpentine is intimately blended. This rock only occurs in the talcose slate as we approach the granitic region, and possibly a more close examination may show it to be a simple series of dykes, lying parallel to the line of cleavage of the slate rocks.

The metamorphic rocks are occasionally traversed by trap dykes. The group of rocks under consideration has been comparatively little examined, and the more minute details connected with it, will be taken up at some future time.

CONGLOMERATE ROCK

The lower of the sedimentary rocks, to which I have attached this name, appears to be invariably connected with, or to rest upon, the trap rock, nor has it been noticed, to any extent, in connection with either of the

other lower rocks, for it wholly disappears as we approach the granitic and metamorphic groups. Of all the sedimentary rocks this is the most variable in thickness, and not unfrequently does a few miles make a difference of several hundred feet. The conglomerate rock may, without doubt, be considered as a trap-tuff which was gradually deposited or accumulated around the several conical knobs of trap during their gradual elevation, and which would necessarily occupy the complete spaces or valleys between the several irregular ranges of knobs or hills.

If we regard this conglomerate rock in this light, we will at once perceive why the rock should be variable and irregular in its thickness.

The pebbles of which the mass of the rock is composed, consist of rounded masses of greenstone and amygdaloidal trap, of which the former make up by far the larger proportion, and scarcely a pebble of any other rock than trap enters into its composition. These pebbles vary in size from that of a pea to several pounds weight, but the average size may be stated at 1½ to 2 inches in diameter. The pebbles are usually united by a mixed calcareous and argillaceous cement, more or less colored by iron, and so firm is this union, that the most compact and tough of the greenstone pebbles, will frequently break through as freely as the cement, and crevices and narrow veins are frequently seen passing indiscriminately across the pebbles and cement. This fact is the more worthy of notice, since the pebbles are almost without exception made up of the hardest and most indestructible portions of the trap rock.

The conglomerate rock can scarcely be said to occur in such form as to be well defined, in any portion of the country excepting upon the northern flank of the outer trap range before referred to. On the outer or northern side of Keweenaw point, the conglomerate commences near the extremity of the point, and extends several miles westwardly, forming a series of abrupt and precipitous cliffs upon the immediate shore, as also a range of well defined hills, a little in the interior, which hills have an elevation varying from 200 to 300 feet. After appearing for a few miles upon the coast, this rock gradually stretches into the interior, following the line before described as the most northerly boundary of the outer trap range of hills, and invariably occupying a place to the north of this range, and it may be observed, nearly or quite continuously, as far as Montreal river, which stream it crosses at a short distance above its mouth, thus making its complete length within the limits of Michigan, computing its southerly curve, something over 140 miles; but the rock does not cease at Montreal River, for it may be seen at short intervals in the interior as far westwardly as the head of Lake Superior.

At the trap knob of Presque Isle the conglomerate is imperfectly developed, but on the south-westerly side of Isle Royale it is more perfectly developed, flanking the hills of trap upon the southerly side.

The conglomerate rock is imperfectly stratified, in masses of immense thickness, and it dips, upon the south shore of Lake Superior, regularly to the north, and north-west,⁴² usually at high angles varying from 30° to 85°, while upon

⁴²This variation in the dip is in conformity with the variation in the direction of the trap hills.

Isle Royale and the north shore, the dip is reversed, being south and south-easterly, or in other words the rocks upon all sides dip in the direction of the lake basin.

Upon the south shore of the lake, the thickness of this rock was not estimated at any point west from Montreal River, a little east from which it attains its greatest thickness, being, as estimated, 5,260 feet. In addition to the great variations in thickness, over comparatively small districts, the formation wedges out as we pass easterly along the range, and so rapid is this change, that near its easterly prolongation the thickness was estimated at something less than 1,000 feet.

The greatest estimated thickness of the rock upon the north coast is a fraction less than 2,300 feet.

I have already stated that this rock is frequently traversed by dykes of trap, which are usually parallel to the line of stratification and dip of the rock. These dykes, which have sometimes a thickness of 50 to 60 feet, and even several hundred feet, are sometimes continuous for many miles, and are many times repeated. In addition to the dykes just alluded to, the rock is frequently traversed by veins of a more recent date, which traverse alike the trap and conglomerate rocks, always at very high angles with the line of bearing of the conglomerate. These veins, which are usually more perfectly developed near the line of junction of the two rocks, or for a distance of a few thousand feet upon each side of the junction, are clearly true veins, and, since, with a few unimportant exceptions, they are the only veins belonging to this range which are metalliferous, they will be considered more fully under a separate head.

MIXED CONGLOMERATE AND SANDROCK

This rock formation is made up of an alternating series of conglomerate and red sandstones, which rest conformably upon the conglomerate rock last described, dipping with that rock into the bed of Lake Superior. The mixed rock was not noticed upon the north side of the lake, or upon Isle Royale but upon the south shore the rock was traced continuously for a distance of about one hundred and thirty miles, extending from a few miles westerly from the extremity of Keeweenaw point to Montreal river. It follows the line of the conglomerate before described, stretching from Keweenaw point in a south-westerly direction, and again curving to the north-west forming, as it were, a crescent between the points before mentioned, the result of which is, that the rock only appears for a very limited distance upon the coast of the Lake, at Keweenaw point.

From a point about eighteen miles easterly from Montreal river the rock wedges out rapidly as we proceed westerly from that point, and as we continue towards the head of Lake Superior, the rock wholly disappears, or becomes merged in the conglomerate rock below, and the sand rock above. The greatest observed thickness of this rock, is 4,200 feet.

The conglomerate portion of the mixed rock consists of strata of conglomerate, varying from a few feet to several hundred feet in thickness, and it is composed of materials in all respects resembling those constituting the conglomerate rock before described, and these materials are united by a similar cement.

The sandstone portion of the formation occurs in strata, of very nearly corresponding thickness, and the two rock may be said to form nearly equal portions of the complete mass. But the material of which this sandstone is composed, differs widely from that of the true sandrock lying above, for while the latter is chiefly made up of quartzose materials, the former is composed of materials bearing a close analogy in composition to those of the conglomerate rock itself; or in other words the sand consists chiefly of greenstone, so much comminuted as when cemented to compose a coarse sandstone. It will thus be seen that the members of this formation differ only in the degrees and fineness of the material, and the character of this material will explain sufficiently why the true conglomerate, and the mixed rocks are referable to the same origin, for the materials of the several members of the group have their origin from the; trap rock, and as a whole, may, perhaps be regarded as a trap-tuff.

The coarser conglomerate of the formation is scarcely separated by lines of stratification, and the strata appears usually in mass embraced between the strata, of sandstone, but the stratification of the latter rock is perfect, and it bears evidence of having been deposited in shoal water, in the very abundant, perfectly defined ripple marks which it exhibits through its complete range.

No fossils were noticed in connection with either the mixed rock, or the conglomerate lying below it.

Dykes of greenstone occasionally appear in the mixed rock, but less frequently than in the rock below. These dykes almost invariably occupy places between the strata of the rock, and correspond in position to the direction and dip of the rocks by which they are embraced, or in other words, the rocky matter composing the dykes appears to have been injected in a plane corresponding with that of the stratification of the embracing rock. As in the conglomerate below, these dykes have produced very great changes in the color and structure of the mixed rock bounding them upon either side.

In addition to these, the mixed rock is occasionally (though less frequently than the rock below,) traversed by veins or cross courses of a more recent origin than the dykes, (which latter they usually cross at a high angle), their course usually being at an angle of at least

sixty degrees, opposed to the line of bearing of the mixed rock. These cross veins are usually made up of calcareous spar or a sub-granular limestone, and more rarely of some variety of quartz and imperfect trap rock, the latter of which is usually of the amygdaloid variety.

RED SANDSTONE AND SHALES

That rock to which I have applied the name of red sandstone is emphatically the chief rock that appears upon the immediate coast of the south shore of Lake Superior, and the same remarks will apply, in a more limited degree, to the complete coast of the lake. A traveler proceeding westerly along the coast, from Grand Island to the head of the lake, would imagine he had seen little else than red sandstone, and in fact, were he to confine his examinations to the immediate coast, he would see no other rock for nineteen-twentieths of the distance. From Grand Island westerly to the mouth of Chocolate river, no other rock is seen in place, and from Chocolate river to Keweenaw point, embracing the complete width of the primary, metamorphic and igneous ranges, the hills forming these groups are almost invariably surrounded or flanked at their bases by this sandrock, so that even along this portion, the hills are, for a large proportion of the distance, cut off from the lake by a narrow belt of the rock under consideration, and westerly from Keweenaw point to the head of Lake Superior no other rocks appear upon the coast, if we except several trap dykes in the vicinity of the Porcupine mountains, and a series of more recent deposits of clay and sand that appear west from Keweenaw point. This sand rock also occurs upon the southerly side of Isle Royale.

The material of which the red sandrock is composed differs widely from that of the sedimentary rocks before described, for while the rocks last referred to are made up of materials clearly of trappean origin, and in which the material is very rarely quartz, the rock under consideration is composed of materials, the predominating portions of which are clearly derived from the granitic and metamorphic rocks, and in which quartz occurs abundantly, though with this, there is usually associated more or less sand, that has all the characters of the comminuted trap, constituting that portion of the mixed rock before referred to. Magnetic iron sand sometimes becomes a constituent of the red sand rock, and occasionally continuous strata of several inches thickness, are almost wholly composed of this material. The material composing this rock is usually cemented by calcareous matter highly colored by the peroxide of iron, though not unfrequently these are associated with argillaceous matter.

While the chief mass of the rock is a coarse grained, somewhat compact, sandrock, there are portions of the formation where there are well formed red and grey flags, and red and green shales, forming, as it were, beds of a very considerable thickness, and occupying large districts of country. These red and green shales are more largely developed in that district extending from Granite point westerly to Keweenaw bay, and upon the

south side of Keweenaw point, extending from the head of the bay to near the extremity of the point they are particularly largely developed. These shales more usually occur in alternating bands of deep red and green colors, the red usually largely predominating, and they are made up of argillaceous matter, with sand, the whole of the materials being of extreme fineness.

On the south-east side of Keweenaw bay, near its head, an argillaceous rock appears, and extends for a short distance along the coast which is an anomaly. The rock is evidently embraced in, or rather may be said to constitute a member of the sandstone series, but it differs widely from any other rock seen in connection with it. This argillaceous rock sometimes appears in the form of a slate, though its most usual form is that of compact strata, frequently of several inches thickness, and which closely resembles indurated clay. A peculiar appearance is given to this rock by the innumerable layers or very thin strata, which, compose the mass, being of different colors, sometimes red, grey and dark brown, alternating in the same hard specimen.

The material of which this argillaceous rock is composed, possesses an extreme degree of fineness, and is so soft as readily to be cut with the knife, which qualities render it a fit material for the manufacture of pipes, to which purpose the Indians of the country have long applied it. It has also been applied to use in sharpening tools, but its softness is a serious objection to its use for that purpose.

A similar argillaceous rock also appears at several other points in the interior, or southerly from that already described, but as yet I have been unable to determine its thickness at any point. The finely represented bands or zones, which may fairly be supposed to represent the original lines of deposition, are very much contorted, and in such a manner as to lead to the conclusion that this change must have taken place very soon after the deposition of the rocks, and while they were still in an unindurated state.

The rocks belonging to the red sandstone formation, bear the evidence of having been almost universally deposited in shoal water, for ripple marks occur abundantly at all points where the rock takes on the decided character of sandrock, and these ripple marks may frequently be seen, for many rods together, as distinctly and clearly defined as they are at the present day in the loose sands forming the bottom of some of the shoal bays of Lake Superior. Fossils are rare in the red sandstone, and in fact, I have never seen any other than *fucoides*, of which there are three species, that are tolerably well defined.

The red sandrock is less frequently traversed by dykes of trap than either of the rocks before described, though dykes were sometimes noticed traversing the whole of the several rock formations, up to and including the red sandstone. Upon portions of the north coast, where the conglomerate and mixed rocks are more frequently wanting, and where the red sand rock is brought, more

nearly in contact with the trap, these dykes are of more frequent occurrence. It is deserving of remark, that where the lower rocks are either wholly or in part wanting, the red sandstone usually becomes of a deep brown color, and the material of which the sand is composed, gradually changes from that before described to greenstone.

I have already stated that the sandrock, at its westerly prolongation, attains its greatest thickness, which is estimated at 6,500 feet, but as the rock continues easterly, it gradually and quite regularly diminishes in thickness, and beyond Saut de Ste. Marie, the thickness is very inconsiderable. The average rate of diminution which takes place in the thickness of the rock as we proceed easterly, was shown by a great number of observations, upon the south-westerly portions of the coast of Lake Superior, to be a fraction over fifteen feet to the mile, but this rate of decrease could not be satisfactorily estimated upon the lower or easterly half of the coast. The red sandrock thins out as we proceed southerly or inland from the coast, at a still more rapid rate, as was most satisfactorily shown, where it is connected with the several primary, metamorphic and trap ranges of hills, for all or nearly all the valleys, after passing the outer or northerly range of trap hills, are based upon this sandrock, and since we have every reason to believe that this sandrock was deposited in part, during the gradual elevation of the several chains of hills, it would follow, that over those districts which were last elevated, the rock would attain its greatest thickness. I have already alluded to the order in which the several ranges of hills appear to have been uplifted, and since more particular reference will be made to this hereafter, I leave the subject for the present.

The red sandrock south from Lake Superior, as well as upon the immediate coast, dips regularly northerly, while that upon the north coast dips invariably southerly, or, as has already been said of the lower rocks, this rock dips, upon all sides, regularly into the basin of the lake. The quantity of dip is exceedingly variable, being always very much increased as it approaches the trap, and diminishing as it approaches the primary and metamorphic ranges.

The line of cleavage of some of the members of the lower sand rock and shales is frequently irregular, and opposed to the true stratification of the rock.

UPPER OR GRAY SAND ROCK

The only remaining rock which separates the red sandrock from the limestones lying to the south, is a gray or brownish sandrock, that is almost wholly composed of grains of quartz, usually feebly cemented with calcareous matter. The composition of this rock differs from that of the lower sandrock, in being more exclusively quartz, while in epoch of deposition, the rock under consideration should not be confounded with that of the red sandstone. It has already been stated that the red sandrock of the south coast, dips regularly northerly, while the upper or gray sandstone dips equally regularly

south or south-easterly, in which respect the last mentioned rock conforms to the limestones resting upon it, while it rests itself upon the uptilted edge of the red sandrock below.

I have already stated that, this rock was first noticed, rising in hills, at a point not far distant from Riviere St. Marie, and south-east from Point Iroquois; from this point, it stretches westerly in an elevated and very regular chain of hills, that are upon the coast, as far as Tequoimenon bay; westerly from which the shape of the coast is such that these hills do not again appear upon it until we reach that precipitous portion of the lake coast known as the Pictured rocks, where the fury of the waves, aided by frost, has acted upon the feebly cemented material of which the rock is composed, to such an extent as to leave large portions, of what was originally the northern escarpment of these hills, along this coast, in high mural and overhanging precipices. Westerly from the Pictured rocks the ranges of hills, which are composed or made up of this rock, stretch in a south-westerly direction, passing completely to the south of the primary, trap and metamorphic regions. The westerly prolongation of this rock has not yet been determined.

The upper sandrock, like the lower, abounds in clearly defined ripple marks, and its line of cleavage is very irregular, frequently being opposed to the line of stratification over very considerable districts of country. Two indistinct species of fucoides were all the fossils noticed in connection with it.

I was unable to obtain any observations upon the thickness of the upper sand rock, which were satisfactory, but from the imperfect observations which were obtained, I was led to conclude that the average thickness as far westerly as the Pictured rocks, does not vary very far from 700 feet. The upper sandrock, like the rocks before mentioned, wedges out as we proceed, in an easterly direction.

TERTIARY CLAYS AND SANDS

As in the lower, so in the upper peninsula, the older rocks are more or less covered by deposits that may be severally arranged under the above head. To these deposits it is my intention at the present time barely to allude.

Stratified clays and sands, similar to those skirting the borders of the lower peninsula, are seen at many points, and continue for long distances upon the coast of Lake Superior; and they are also largely developed at many points in the interior of the country. These deposits sometimes attain a thickness of from 200 to 800 feet, and they are spread over the less elevated portions of the district. The character of these clays and sands bear a close resemblance to those described in a previous report, as occurring upon the lower peninsula.

ECONOMICAL GEOLOGY

Rocks

The series of limerocks resting upon the sandrock last described, were noticed in the report which was laid before you at a previous session, and the limits of the present report will not permit me to refer to them, more fully, at this time. My observations will, therefore, only include those rocks which lie below the limestones, it will be borne in mind that the whole of the group of limestones are embraced in the southerly portion of the upper peninsula, and that their outcropping edges do not reach within many miles of the coast of Lake Superior. This is an important fact, for it shows the whole of the northern part of the upper peninsula to be deficient in materials for the manufacture of lime, which are, in truth, wholly wanting.

Materials adapted to the purposes of building, abound, throughout the district of, country under consideration, and though they vary exceedingly in value for that purpose, yet no portion of the country can be said to be without a supply.

Among the most valuable of the materials for this purpose, the syenites and syentic granites deservedly rank first, and they occur of a quality which may be advantageously worked at various points in the primary range. Some of the syenites near the coast of the lake are so situated as to be readily quarried, and they may be made to furnish a beautiful and durable material for building. The color of these syenites is usually a very dark gray, from the predominance of hornblend in the composition, but this is by no means invariably the case.

The metamorphic group scarcely furnishes a fit material for use as a building stone, for the structure of its schists would be an effectual bar against their use, and the difficulties of working the quartz rock will, probably prevent that rock being applied to that purpose.

Some of the compact greenstones and altered syenites of the trap range, may be made to furnish an excellent building stone, which, although in powers of resisting the action of disintegrating agents, may be less than that of the unchanged syenite, nevertheless possess a very great degree of durability. The greenstone ranges of hills frequently for very considerable distances, are made up of rock in which the jointed structure is so perfectly developed, that regular blocks, of a convenient size for building may be obtained, with comparatively little labor.

The conglomerate rock is scarcely applicable to use for purposes of building.

A very good building stone may be obtained from many portions of the lower, or red sandstone formation, and though the cement of this rock is usually not very perfect, yet, frequently, such changes have taken place in the rock, that it has almost taken on the character of granular quartz rock, in which cases, its durability is very much increased. The strata of this rock are usually of a

convenient thickness to admit of being easily quarried, and they are so regular that the stone will require but little dressing.

The upper, or gray sandrock, being almost uniformly but feebly cemented and sometimes decidedly friable, is of less value as a building stone than either of the rocks before mentioned. Those portions of the upper sandrock where the calcareous cement is perfect, but not sufficiently hardened, might be rendered much more capable of resisting the action of the elements if allowed to remain under shelter a sufficient length of time to allow this change to take place.

The value of the limestones of the southern part of the peninsular, for the purposes of building, as also for the manufacture of lime, was mentioned in a previous report upon the geology of that district of country. As has already, been stated, these limerocks do not reach within many miles of the coast of Lake Superior, and it is certainly to be regretted that the shore of the northern portion of the peninsula is destitute of this important material. Nor have I seen any marls of sufficient extent in the district, to admit of application to any of the purposes to which it is applicable, or to supply, even in part, the deficiency in limestone. All the lime which would appear to be capable of being applied to practical purposes is that of the calcareous spar, composing the veins traversing the sandrock, and these are not only rare, but they are also of very limited extent.

MINERALS AND MINERAL VEINS

In considering this portion of the subject, I propose to treat the minerals of the different formations separately, so far as the same can be done, and, although this method will necessarily cause some repetition, it will enable me to show, more perfectly than could otherwise be done, the connection between those minerals that may be regarded as of practical value, and the rocks to which they belong.

As a whole, the rocks of the upper peninsula are deficient in number of minerals, though some few individual species occur abundantly.

Minerals of the Primary Rocks

The following list can by no means be regarded as perfect, but it will serve, at least, to convey an idea of the small number of minerals which are found in connection with the rocks of this group:

Schorl,	Mica,
Tourmaline,	Feldspar,
Hornblende,	“ red,
Actynolite,	Quartz.

Minerals of the Metamorphic group of Rocks

Quartz, common,	Iron, scaly red oxid of,
“ milky,	“ hasmatite,
“ greasy,	“ pyritous,
“ tabular,	Steatite,
Serpentine, common,	Novaculite.

Of the minerals enumerated as occurring in the metamorphic rocks, the milky variety of quartz is abundant, sometimes composing almost entire ranges of hills. The novaculite is also abundant, but of a coarse variety. This last is associated with the talcose slates. The remaining minerals appear either disseminated or forming druses in the quartz rock, though sometimes they occur in thin beds or veins, in the talcose slate, which beds conform to the line of cleavage of that rock. Although the hæmatite is abundantly disseminated through all the rocks of the metamorphic group, it does not appear in sufficient quantity at any one point that has been examined, to be of practical importance.

Minerals of the Trap Rocks

Quartz, common,	Steatite, common,
“ smoky,	Asbestos,
“ milky,	Amianthus,
“ greasy,	Calcareous spar,
“ radiated,	Copper, native,
“ mamillary,	“ pyritous,
“ drusy,	“ black,
“ amethystine,	“ red oxid of,
Chalcedony,	“ azure carbonate of,
Carnelian,	“ green carbonate of,
Jasper,	“ “ ferruginous,
Agate, common,	Lead, sulphuret of,
“ fortification,	“ carbonate of,
Augite	Iron, pyritous,
Actynolite,	“ red oxid of,
Serpentine,	“ hydrate of,
“ pseudomorphous,	“ silicate of,
Chlorite, common,	Manganese, ferruginous oxid of,
“ earthy,	Silver, native, (very rare,)

Since a consideration of the minerals contained in the trap, will also involve a portion of those embraced in the conglomerate, the mixed rock, and red sandrock and shales, I will, before referring minutely to those of the trap rocks, lay before you a list of those which occur most frequently in the sedimentary rocks last mentioned. The fact that veins of mineral matter, traversing the trap, are frequently continued across the several sedimentary rocks, and that dykes are of frequent occurrence in these latter rocks, would lead to the influence that there would be a considerable degree of resemblance in the character of the minerals embraced in these dykes and veins, in both the trap and sedimentary rocks and to a certain extent, this inference would be true; but it should be borne in mind, as has already been stated, that the veins, in traversing the several upper rocks, undergo very great changes in mineral character.

Minerals of the Conglomerate, Mixed Rock and Red Sand Rock

Calcareous spar,	Copper, native, ⁴⁴
Quartz, common,	“ pyritous, ⁴⁴
“ milky,	“ blue carb. of, ⁴⁴
“ drusy, ⁴³	“ green carb. of, ⁴⁴
Chalcedony, ⁴³	“ earthy green carb. of, ⁴⁴
Carnelian, ⁴³	“ black, ⁴⁴
Jasper, ⁴³	Zinc, siliceous oxid of,
Agate, ⁴³	“ carbonate of,
	Iron, pyritous,
	“ black oxid of, (cemented iron sand,)
	“ red oxid of,
	“ hydrate of,
	“ silicate of,

Mineral veins of the Trap, Conglomerate, etc,

In order to render the subject of the mineral veins traversing the above rock, so far intelligible as may be in my power, I have already been particular to define, as far as could be done without maps and sections, the relation which the trap rocks, together with the superincumbent conglomerate, mixed

⁴³Occasionally occurring among the pebbles constituting the mass of the conglomerate.

⁴⁴Chiefly in those portions of the veins traversing the conglomerate.

sand and conglomerate and red sandrock bear to each other, and it will be necessary, in considering the mineral contents of these rocks and the veins traversing them, to keep this relation constantly and clearly in view.

It will be recollected, that the north-westerly range of hills, commencing at the extremity of Keweenaw point and stretching from thence in a south-westerly direction into the interior, were referred to as being more clearly of trappose origin than either of the other ranges, and that the rock of the southerly portion of this range is either compact greenstone or altered syenite, while that of the northerly flank is almost invariably either an amygdaloid or a rock approaching to loadstone.

The several ranges of hills to the south of that last alluded to, are either well formed, compact greenstones, altered syenite or, (as we approach the primary range,) imperfectly formed granites. So far as the several ranges of hills, lying south from the northerly range, are concerned, they would appear to be, as a whole, deficient in minerals, and the rocks are not apparently traversed by veins or dykes of any more recent date than that of the uplift of the northerly trap hills.

Veins clearly of a date posterior to the uplift of that portion of the trap rock last mentioned, are of frequent occurrence, and these veins not only traverse a portion of the trap range, but also pass into the conglomerate, and sometimes completely across the three sedimentary rocks, immediately above the trap, thus having an unbroken length of several miles. The class of veins to which I now allude, where they occur in a connected or continuous portion of the range, rarely vary more than 12° to 15°, from a right angle to the line of bearing of the

sedimentary rocks, and in pursuing this course, they necessarily cut across the dykes of trap before alluded to as so frequently appearing between the strata, and conforming to the dip of the lower sedimentary rocks.

That the veins under consideration belong to a single epoch, is inferred from the fact, that none have been noticed with other veins crossing them, as also for the reason that none have ever been noticed with dislocations, heaves or disturbance of any kind, save what may be referred to causes connected with their immediate origin.

That these veins must be regarded in the strictest sense as true veins, cannot be doubted, and that their origin or source over the extended district alluded to, has been the same, is inferred from the perfect identity of their mineral contents; for a description of one of these true veins may be said to be essentially a description of the whole. Thus, while the mineral contents of the different portions of the same vein change as the rock traversed changes, the corresponding portions of different veins almost invariably bear a striking and dose resemblance to each other.

These veins, as has already been stated, where they traverse connected ranges of the trap, are regular in course and direction, but when they are connected with a single uplifted knob of that rock, they are irregular and can scarcely be defined, appearing, in the latter instance rather as matter injected into the fissures of a shattered mass of rock, than as connected veins.

The importance of carefully studying the relation which these veins bear to the rocks which they traverse, as also the relation which they bear to the numerous trap dykes, together with the few contemporaneous veins noticed in the trap, is very much increased by the circumstance, that these veins are more or less connected with, or rather contain, metallic materials, which, it may be fairly inferred, will hereafter become of very considerable practical importance. In fact, so far as we may be enabled to judge from the examinations already made in this district of country, it is confidently believed that most, if not all the metalliferous veins of the upper peninsula, belong to veins of the epoch of those under consideration. It is true that native metals, more particularly copper, are sometimes found, in place, occupying the joints or natural septæ of the greenstone, but in these instances, the amount of metal is always comparatively small, and, with one or two exceptions, I have invariably been able to establish some connection between the native metal occupying these joints and the termination of some metalliferous vein that traverses other portions of the rock not far distant, and it is believed that the metal filling these joints has invariably resulted from the action of causes precisely analogous to those which have placed similar metals in the veins to which I have alluded.

The earliest as well as all travelers who have visited the district of country under consideration, have not failed to make frequent allusion to the loose masses of native

copper that have been occasionally found scattered over it, nor has any one failed to allude to the large boulder or loose mass of that metal upon the Ontonagon river. Almost invariably, the opinion has been expressed, from the frequent occurrences of these masses, that the metal must be abundant in the country. But, after all, the true sources from which these masses had their origin, or the relation which they held to the rocks of the district, would appear to have never been understood; and all, or nearly all, that was known of their true relations, was left to conjecture. The result of this has been, that while some have excessively magnified everything connected with the subject of which, in truth, nothing was known, another class, equally far from what is really true, have regarded these masses of native copper as boulders transported from high northern latitudes.⁴⁵

As far back as 1831. and 1832, I had occasion to pass no less than three times, along the south coast of Lake Superior, as also to ascend several of the important tributaries of that

⁴⁵The vast area of country over which the boulders of native copper, from the district under consideration, (together with its westerly prolongation,) have been transported, is worthy of remark. They are not of unfrequent occurrence in the sand and gravel of the southern peninsula of Michigan, and since the commencement of the geological survey, many of these masses have been met, some of which weigh from seven to eight pounds. In the vicinity of Green Bay, a mass was discovered, some ten years ago, which weighed 140 pounds, if my memory serves me correctly. Loose masses of a similar character have been met with in various other portions of Wisconsin, as also at various points in Illinois, Indiana and Ohio. In these cases, the occurrence of these masses of native copper are no more indications of the existence of veins of the metal in the immediate vicinity, than are the immense numbers of primary boulders scattered over the southern peninsula of Michigan indications of the existence of primary rock in place, in the district where they are found.

lake, and during these years, I passed by three different routes widely separated from each other, completely across to the Mississippi river. It is true that these journeys made through a complete wilderness, uninhabited except by savages. We necessarily made under circumstances that admitted of only very general observations; but the result of these previous examinations have proved of immense service to me, in aiding the labors of the past season. I allude to these journeys and examinations at this time, in order to show you the difficulties by which a full understanding of the subject under consideration is surrounded, for I became satisfied at that time, not only that the subject was not understood by the mass of those who had traversed the country, but that even the natives of the country had no knowledge of the true sources from which the transported masses of copper had their origin.

During the time of the examinations referred to, a, bare glimmer of light was thrown upon the subject by an examination of some small masses of copper, found occupying the joints of the greenstone; as also by the examination of a single vein in the conglomerate, containing the ores of copper, which has since been found to be the termination of a vein that is somewhat obscurely continued from the trap region. While these examinations were sufficient to enable me to draw the

inference that the masses of native copper came chiefly, if not wholly, from the trap, and more rarely from those sedimentary rocks resting immediately upon it, it was supposed that this occurrence would follow the general law, and that if, together with the other ores of the metal, would occur in greatest abundance near the line of junction of this rock, with the overlaying sedimentary rocks. Nothing, or at least very little, was known of the true extent or range of the trap rocks, and the very great inaccuracies in the published maps of the country, rendered it almost impossible to apply even the data on hand to such purpose as to relieve the embarrassment.

With a full knowledge of these difficulties, I determined, during the past season, to endeavor to surmount them by so far adding to our geographical knowledge of the coast of the lake and its immediate vicinity, as to enable me to place whatever geological observations of importance might be made, in such condition that the relation of the several parts might be understood. Having sufficiently accomplished this, I proceeded to a very minute examination of the several rocks overlaying or resting against the trap, together with a determination of the thickness of the several members and their rate of decrease or wedging to the east. With these data I was enabled, by noting the dip of the rock upon the coast, to determine, with sufficient accuracy for the purposes to which the rule was to be applied, the line of junction between the trap and conglomerate rocks. This rule, when put in practice, enabled me to decide, with a very considerable degree of certainty, this line of junction, when the rocks were covered with a very considerable thickness of detrital matter, and when so covered, I was enabled, by traversing the country, on the line of bearing of the upper rocks, the more readily to gain access to such points as would admit of examination.

These observations soon showed me that this line of junction between the trap rock, and the south edge of the conglomerate, instead of pursuing a course parallel to the coast, only continued its parallelism for a few miles westerly from the extremity of Keweenaw point, after which for a long distance, it recedes from the coast rapidly. These facts served to explain in part, why the subject of the origin of the masses of copper had remained a mystery, for the country through which this line passes is hardly ever passed over, even by the Indians, and probably large portions of it have never been passed over by whites, but in addition to this, the obscure character of the metalliferous veins is such, that they would scarcely attract the observation of the traveler whose attention was not called especially to the subject, for many of the richest ores are so far from having the appearance of the pure metal that they would be the last suspected to contain it in any form.

That the connection of these ores with the containing rocks was not understood by the English mining company, whose attention was turned to this subject, at an early day, is to be inferred from the fact that they commenced their operation at Miners' river, where the rock is the upper or gray sand-stone, which has never

been observed to contain mineral veins; and also on Ontonagon river, near the mass of native copper, at which point a shaft was commenced and carried about 40 feet through a reddish clay, at which point the red sandrock was reached. Now, although the metalliferous veins sometimes pass from the trap across the red sandstone, these veins in the red sandrock have never been noticed to contain any other ores than those of zinc and iron, unless it be at the immediate point where the vein crossing comes in contact with a dyke of trap, which condition does not exist at the point alluded to, on Ontonagon river. What indications could have induced these Quixotic trials at the points where they were commenced is more than I have been able to divine, and as might have been anticipated, the attempts resulted in a failure to find the object sought.

Having thus, in a general manner, set forth the obscurity by which the subject of the true source of the transported masses of native copper has been surrounded, together with some of the reasons which have served to prevent its being fairly understood, I will now proceed to a general sketch of the metalliferous veins of the district, so far as the same have been examined; premising that our knowledge of them is still deficient in very many important particulars, which can only be supplied by a careful and continued examination of the subject, which, in fact, can only be said to be but just commenced.

I have had occasion to refer to the outer or northerly range of hills, or those from which the metalliferous veins may be said to spring as being composed of trap rock, and lest what has been said may not be fairly understood. I will repeat, that the more southerly part of the range is uniformly composed of compact greenstone, under which head I not only include true greenstone, but also those forms of altered granular gneiss and gneissoid granite, which sometimes are associated with it, while the outer or northerly portion of the same range is usually composed of an amygdaloidal form of trap. The cells of the amygdaloid are usually filled with the different varieties of quartz, carnelian, chalcedony and agate, and sometimes, though more rarely, with native copper or with calcareous spar, though they are sometimes entirely empty, constituting a perfect toadstone.

The metalliferous veins cross this range or trap, usually very nearly at right angles to the prolongation of the hills, and are frequently continued in the same course, across the upper or sedimentary rocks, thus crossing the latter at an angle varying but little from their line of bearing. While the continuity, of course, of the vein, may remain perfect in its complete passage from the greenstone across the several members of the conglomerate, mixed and red sandstone rocks, the character and mineral contents of the vein undergoes essential change, and not only does the vein appear to be influenced in its mineral contents, but also in its width, for, as a general rule, the width of the vein increases as we proceed northerly, or from the greenstone. Thus, a vein which may appear of only a few inches in width, or as a bare

line in the southerly or greenstone portion of the range, increases in width rapidly as it approaches and passes across the amygdaloid, and at or near the line of junction between the amygdaloid and the sedimentary rocks it will frequently be found to have attained a thickness of several feet, while in its passage across the sedimentary rocks it is usually either still further increased in width, or becomes so blended with the rock itself, as to render it difficult to define its boundaries.

These metalliferous veins, like those which occur under similar circumstances in other portions of the globe, do not continue uninterruptedly of any given width, for great distances nor is their width increased regularly, for they frequently ramify or branch off in strings, that pursue a course generally somewhat parallel to the general direction of the main vein, and which eventually again unite with it. Sometimes these ramifications or branches destroy, as it were, for considerable distance, the whole vein; but they at length unite again, and the main vein is, after their junction, as perfectly developed as before.

While traversing the most compact, southerly portions of the greenstone, the veins are most frequently made up of a very compact and finely granulated greenstone, sometimes associated with steatitic minerals and silicate of iron, under which circumstances they usually are destitute of any other metallic mineral, but occasionally, instead of the materials above mentioned, their place is supplied by native copper, without vein stone or matrix, and usually free from nearly all earthly impurities, but almost invariably incrustated with oxyd, or carbonate of the metal. Those portions of the vein traversing the greenstone, in which native copper occurs, under the circumstances above mentioned, are invariably thin, rarely exceeding three to four inches in thickness, and usually considerably less, and they are liable to very considerable variation in width from the divergence caused by the vein traversing the joints of the rocks, where these joints produce the same character of change as is produced by the ordinary ramification of a vein.

As these metalliferous veins traverse the northerly portion of the range or approach the sedimentary rocks, they undergo a gradual change in width as well as in mineral character, and it has been noticed that where the amygdaloid is most largely developed, the vein, as a general rule, has not only a greater width, but also has its mineral contents more perfectly developed, a circumstance which might fairly have been inferred from the fact that those points where the amygdaloid occurs most largely, may be regarded to have been so many centres of intensity of action at the time of the original uplift of the range, from which circumstance they would remain in a softened state, or in such condition as to admit of the more perfect formation of these cross veins for a longer space of time after that condition has been passed at other points.

In the outer or amygdaloid portion of the rock, the vein is almost invariably accompanied by a veinstone of quartz, involving all the varieties before mentioned, as

associated with the trap rocks, which quartz, though occasionally it occurs massive, of several feet in width, usually appears in the shape of a series of irregularly ramifying and branching minor veins, that may be said to constitute the main vein. These subordinate veins of quartz, which may be stated as the true veinstone, vary from a mere line to several inches in thickness, and in the aggregate they may be said to constitute from one-third to one-half the total thickness of the vein. In their branches and ramifications, they sometimes include portions of the rock which they traverse, at other times they embrace imperfectly formed steatite, with silicate, carbonate and red oxyd of iron,⁴⁶ and occasionally, though more rarely, it is associated with carbonate of lime, usually assuming the form of an opaque rhombic spar.

As the main vein traverses the conglomerate and overlaying rocks to, and including the red sandstone, these veins, as a general rule, undergo still farther changes, for very soon after entering the conglomerate, the veinstone changes from its quartzose character, and is made up either wholly of calcareous matter, mostly rhomb spar, or of this mineral with occasional ramifications of quartz, the whole usually including, and sometimes investing fragments of the conglomerate or the pebbles of that rock, separated.

As the vein is continued still farther in the direction of, and into the red sandstone, these changes are still noticed, and eventually the vein is found to be composed either entirely or mostly of calcareous spar, and eventually so completely is

⁴⁶The latter closely resembling the Gossan of the Cornish miners.

its metalliferous character lost, that it would not if examined singly, be suspected to be any portion of a metalliferous vein.

The metalliferous character of these veins is most largely developed almost directly at or near to the line of junction of the trap and sedimentary rocks, and they rarely continue without considerable change, for a greater distance than one-fourth to one-third of a mile, on either side of the line, though a, few veins were noticed in which, in the southerly or trap extension, the character of the vein continued for a distance of over a mile, nearly unchanged, while in its passage through the conglomerate, for half that distance, its character was also perfectly preserved.

The mineral character of the veins is somewhat varied in those having different degrees of thickness, though it is difficult, if not impossible, to lay down any rule which would characterize this change. The different veins vary very greatly in width, ranging from a mere line to 14 or 15 feet—the greatest observed width of any single vein.

In the descriptions of the veins given above, I only intend to include those which are most perfectly developed, for, in addition to these, there are also many which are imperfectly formed and short, and in which many of the above characters are in part or entirely wanting. These,

latter are usually of little practical importance, and thus far have been comparatively little examined.

Of the metallic minerals occurring in those portions of the *true* veins which traverse the trap rocks, together with that portion of the conglomerate immediately resting upon or against the trap, by far the most important, consist of the several ores of copper, with which iron occurs, disseminated in the forms before described, and occasionally, though very rarely, native silver has been detected, associated in the same vein. After as minute an examination of the subject, as circumstances will permit, I am led to the conclusion, that the only ores of the metallic minerals, occurring in those portions of the veins, which traverse the rocks last alluded to, which can reasonably be hoped to be turned to practical account, are those of copper.

In these portions of the veins, the metal referred to, occurs very frequently in the form of native copper, with which are associated the red oxyd, azure carbonate, green carbonate, and more rarely what may be denominated copper black, and still more rarely, pyritous copper. *None* of these have been noticed in a crystalline form.

It must not be imagined that these several minerals make up the whole or even any very considerable portion of the entire length and breadth of the veins, in which they occur, for they are distributed in bunches, strings, and comparatively narrow sub-veins, in a manner precisely analagous to that in which these ores are usually distributed, in similar rocks in other portions of the globe. The quartz veinstone, before described, has always so much of the green tinge communicated by the carbonate of copper, that it cannot fail to be detected; but the presence of disseminated native copper, in this veinstone, would, at first, hardly be suspected, and it is not until a fresh fracture has been made, and the mineral closely examined, that the numerous dark points and minute threads are discovered to be copper in a native state. Large portions of this quartz veinstone, (when the included metal can scarcely be detected by the naked eye,) when examined with a glass, are found to contain very dedicate threads of native copper, that traverse the quartz in every possible direction, and so completely is this latter mineral bound together, that it is fractured with difficulty, and its toughness is very greatly increased.

The specific gravity of this veinstone is very considerably above that of ordinary quartz, and usually, the difference is so considerable, even in those masses where the copper can scarcely be detected by the naked eye, as to be apparent to even the most careless observer. But in addition to this finely disseminated condition of the native copper in the veinstone, it is also disseminated in a similar manner through the rocky matter embraced by the veinstone and in the amygdaloid and conglomerate portions of the rocks, it sometimes extends for a distance of from two to three feet into the rocky matter on either side of the veins, sometimes completely, or in part, filling the cells of the amygdaloid rock.

The conditions above described refer to the main portions of the veins only, while there are other portions in which the copper appears to be concentrated in larger masses, constituting bunches and strings, and in which places the sides or walls of the veins are sometimes wholly made up of thin plates of native copper. In these portions of the metalliferous veins where the metal appears, as it were, to be concentrated, it also occurs, much in the form before described, except that the masses of metal vary from the merest speck to that of several pounds weight. In opening one of these veins, at a concentrated point, the observer, unless he had previously examined other portions of the vein, would be led to erroneous conclusions as to its richness, a source of error which cannot be too strongly guarded against; for while the vein, for a short distance, may be found to be exceedingly rich in mineral, the mineral in another portion of the vein may either wholly or in part disappear, a condition which is similar to that observed in those veins of copper that have been extensively worked and found to be most productive, on the continent of Europe and the Island of Great Britain.

The excess of native copper (compared with the other ores) which occurs in *these portions* of the veins, is a peculiar feature, for it may be said, in truth, that other ores are of rare occurrence. In those portions of the veins traversing the trap, and where other ores do occur, it is usually under such circumstances as to favor the presumption that their origin is chiefly from that which was previously in a native form; for the carbonates and oxyds, almost invariably appear either investing the native copper, or intimately associated with it, though they sometimes appear in distinct sub-veins. Pyritous copper is so rare in connection with the trappean portions of the veins as scarcely to deserve notice.

I have already stated that native silver, occasionally, though very rarely, occurs in the trappean portions of these veins, intimately associated with the copper, but it is in so minute quantities as to render it probable that it will not prove of any practical importance. Other mixed compounds of this metal occur so rarely as scarcely to deserve notice.

Leaving the trap rock, the character of these veins, as they traverse the conglomerate, undergoes important changes; for not only does the veinstone become gradually changed, from quartz to calcareous spar, but the amount of native copper diminishes, and its place is either supplied wholly or in part by ores of zinc and calcareous spar, or wholly by this latter mineral. There are, however, occasional exceptions to this *general* rule, for occasionally the place of the native copper in the veins, in their passage through the conglomerate, is supplied by a variety of complex compounds of the same metal, which compounds are of exceeding interest; but this change would appear always to be intimately connected with, or to bear some relation to, the dykes of trap which traverse the conglomerate rock. Several instances of this kind were noticed upon the northerly side of Keweenaw point, either directly upon or near to

the coast, as also at several other places in the interior, westerly from Keweenaw point. A vein which may without doubt be referred, to as one of this character, (though in consequence of intervening bays and lakes between it and the ranges to the south, its connection with the main range has not been seen), will serve to illustrate the character referred to.

This vein, which reaches the immediate coast of the lake, upon the easterly cape of the bay known to the voyageurs as the Grande Marrais of Keweenaw point, terminates, so far as examinations can be made, in the coarse conglomerate rock. The coast of the lake, for many miles on either side, is made up of abrupt cliffs of a similar rock, the rock as usual, being made up of coarse rolled pebbles of trap, chiefly cemented with calcareous matter, which is usually associated more or less with the red oxyd of iron. Immediately south of the coast a heavy dyke of trap traverses the conglomerate, which dyke corresponds in position with line of bearing and dip of the conglomerate rock.

The vein, which, at its termination upon the immediate coast of the lake, has an extreme width of about 10 feet, may be traced in the bed of the lake, in a direction north 5° east, for a distance of several rods, after which, in consequence of the depth of water, it is completely lost. This vein at the point where it appears upon the coast, may be said to be in a concentrated state, or in a condition analagous to that before described, where the native copper occurs in the condition of bunches and strings, though the condition in which the metallic minerals occur is essentially different from that in the trap, for, instead of native copper, we have several mixed forms of the green and blue carbonates of copper and copper black, more or less intimately associated with calcareous spar, and in the adjoining rock, and in small ramifying veins occasional small specks and masses of native copper, weighing from 1 to 8 oz. occur, but these are by no means abundant. No quartz occurs as the veinstone, and none of the ores have been noticed in a crystalline form.

It has already been stated, that these true veins, in traversing the conglomerate, frequently almost loose their character, and it becomes difficult to define their absolute width, or in other words, it would appear as if, at the time of the formation of the veins, the conglomerate had not been perfectly cemented, the result of which would be, that the mineral matter, which, under other circumstances, would constitute a perfect vein, would frequently appear in only an imperfect one, or the mineral which would, under other circumstances, make up the vein itself, may have been injected latterly through the interstices of the rolled masses constituting the conglomerate, in which case the mineral would, in fact, take the place of the ordinary cement, thus simply investing the pebbles of the conglomerate. Now, although at the point under consideration, a wide and remarkably distinct vein is developed, the rock, for many feet on either side, has the interstices between the pebbles filled wholly, or in part, with various mixed and

irregular forms of the ores, accompanied by calcareous matter, as before stated, and with occasional specks and small masses of native copper.

Those veins traversing the conglomerate take on a similar character to a greater or less extent rather frequently, but the place of the copper is more usually supplied by the siliceous oxyd, and more rarely by the carbonate of zinc, which compounds, sometimes may be seen forming a perfect or partial cement to the rock, for considerable distance on either side of the main vein. These ores of zinc, like those of copper, are uniformly amorphous, and almost invariably more or less associated with some form of carbonate of lime, with which they may, under some circumstance, unless closely examined, be confounded.

Although these copper and zinc ores occasionally appear in considerable quantities, in those portions of the veins traversing the conglomerate, they usually embrace or simply encrust portions of the rocky matter; or rather the rocky matter and those ores appear to be coarsely and mechanically mixed. These veins furnish beautiful cabinet specimens of the blue and green carbonates of copper, and more rarely of pyritous copper, together with the other varieties mentioned.

Having already devoted a larger space to the consideration of these veins than had been intended, I will simply add, that in pursuing their course northerly, across the mixed rock and the red sandrock, their mineral character is nearly or quite lost, the veins as before stated, being made up either entirely of calcareous spar of that material containing very meagre ores or zinc.

The district of country to which these veins have been referred, thus far, only comprises the ranges of hills south of Lake Superior, but veins of a very similar character, and of similar mineral contents, also occur upon Isle Royale. The order and changes in the character of the veins upon Isle Royale is necessarily reversed, or in other words, the southerly point of the vein corresponds to that of the north point, in the district south of Lake Superior. The mineral veins of Isle Royale have not been examined with sufficient care to enable me to determine with much certainty their average width or value. Those examined were mostly narrow, the widest not exceeding eighteen inches, but in these the mineral contents are essentially the same as in those upon the south side of the lake.

Native copper, in very thin plates was occasionally noticed occupying irregularly the joints of the compact greenstone of Isle Royale, but invariably in comparatively small quantities. It should, however, be noticed of Isle Royale, that the veins, so far as examined, are less perfectly developed in their passage across the conglomerate and that they very rarely contain any traces of zinc.

Upon the north shore of the lake, no attention was given to the subject of mineral veins, but from the character of the geology of that district, it may be inferred that they

will also be found in portions of it, and that, where they do occur, they will be uniformly either directly upon or not far from the coast of the lake.

In addition to the regular veins already described, irregular veins frequently occur, traversing the whole, or portions, of the outliers of trap, or those knobs which appear to have been elevated singly; and although these veins may without, doubt, be referred to the same epoch as the regular veins before described, they nevertheless frequently differ considerably in mineral contents.

The limits of the present report will not permit a separate description of these several distinct trap knobs. I will therefore confine my remarks to that already referred to, as occurring upon the south coast of Lake Superior, immediately northwest from Riviere Des Morts, and which forms the promontory known as Presque Isle.

In nearly all those portions of this knob, where the trap, conglomerate and sandstone are exposed in such a manner as to permit examination, each of the rocks are seen to be traversed by innumerable irregular ramifying veins, which in the sandstones are made up of quartzose and calcareous matter; but many of which, near the junction of the igneous and sedimentary rocks, are metalliferous, and this metalliferous character is more fully developed as the veins are extended into the trap rocks.

The metalliferous portion of these veins, rarely exceed three to four inches in width, and they ramify in such a manner that the mineral uniformly occupies situations similar to bunches or strings at the junction of the ramifications. The minerals contained in the metalliferous portions of the veins are sulphuret and carbonate of lead, earthy, green carbonate of copper, pyritous iron, and more rarely pyritous copper. Occasionally there is a quartzose, or mixed quartzose and calcareous veinstone; but more usually the several metallic minerals are blended in a base of rocky matter. The sulphuret of lead is distributed in the form of small cubic crystals, while the other metallic minerals are usually distributed either in irregular masses or investing portions of the rocky matter. These associations are referred to, as showing the character which these irregular veins assume, rather than from any supposed value which they may possess for practical purposes.

In addition to the minerals referred to, the trap of Presque Isle occasionally contains asbestos, common serpentine and imperfect agates, the two former minerals usually occupying the narrow joints of the rock.

Before referring to the economical considerations connected with the veins which have been described, I will briefly refer to another situation in which the ores of copper have been observed in intimate connection with the trap range of rocks.

The southerly side or greenstone portion of the trap range appears to have been elevated in such a manner as to have caused but little disturbance to the sandrock lying between that and the range of simply altered rocks

lying still farther to the south; but near to the junction of the sandrock and greenstone there is usually a red slate resting against the trap, and which may be said to fill up, in a measure, the irregularities in the ranges of hills. This slate, which is sometimes seen of 100 to 200 feet in thickness, though usually it appears as a mere band, is traversed by irregular and imperfect veins, of what may be denominated a ferruginous steatite, containing placentiform masses of greasy and milkish quartz, that sometimes contain more or less of the ores of copper. The earthy carbonates of copper are also sometimes so intimately connected with these veins of steatitic matter as at first to be scarcely recognized. More rarely, distinct, very thin veins of green carbonate of copper occurs, well characterized, in this red slate, though these veins are never of any great length. The red shale extends, more or less perfectly, along the whole length of the trap range, skirting that range of hills upon the south, but I have not yet been enabled to devote sufficient time to its examination to enable me to determine whether any portion of these veins can be regarded as of practical importance. The examinations which have been made would lead me to look unfavorably upon these veins, and I regard them as having an origin completely distinct from that of the veins which traverse the northerly escarpment of the trap rock.

Having thus considered all the general circumstances under which the several ores of copper, zinc, lead, iron, manganese and silver have been noticed in connection with the trap rock and the sedimentary rocks, immediately resting upon it, it becomes important to consider how far inferences may be drawn from these examinations, as to their occurrence in such quantities as to be of practical importance. I have already stated that so far as regards the ores of lead, iron, manganese and silver, I am led to conclude that at one of the points examined do they occur in veins, or otherwise, sufficiently developed to warrant favorable conclusions as to their existence in sufficient quantities to be made available, and from all that is now known of the country, I am led to infer that neither of these, unless it be iron, will be so found.⁴⁷

The examinations which have thus far been made of those portions of the veins containing ores of zinc, have not been extended sufficient to enable me to determine with much satisfaction, their extent as a whole. At several points in the veins, these ores are sufficiently abundant to admit of being profitably worked, but I would be unwilling, from an examination of a few points, to attempt to determine the character of the whole.

In considering the practical value of the copper ores of the upper peninsula of Michigan, where we are as yet compelled to judge from our examination, of what may be said to be the simply superficial portions of the veins, we can arrive at no safe conclusions, except by comparison of the district with those districts similarly situated, which have been extensively worked in other portions of the globe. Comparisons of this character, to be really useful, must necessarily be sufficiently minute

to enable us to understand the relations which the ores in the district compared bear to each other in all respects, which circumstances renders it necessary that a degree of minute information should be at hand, that is not at all times to be obtained. As the information on hand, with respect to the copper and the veins of Cornwall, England, is more minute than that of any mineral district known, I propose, in order to avoid confusion, to confine my comparison to this district, simply premising, that however closely the two districts may resemble each other in character, it does not follow, as an axiom, that because the district with which we compare our own has been largely and profitably productive, that of

⁴⁷These remarks are intended to apply directly to the trap region. Beds of bog iron ore occur, east from Chocolate river, which probably may at some future day be profitably worked.

Michigan must necessarily be so too, for it will be seen, as the subject is pursued, that there are not only several points in which it is impossible with our present knowledge of that of Michigan, to institute comparisons, but there are also some points on which there is a considerable degree of discrepancy.

The comparison instituted, in the main, is intended to refer rather to the character and contents of the mineral veins of the two districts than to the geology, although some genera] reference becomes necessary to the geology of the districts to render the comparison perfect. The topography of the Cornish district bears a close resemblance to that of Michigan, both districts being marked by their irregular and broken outline, and by the occurrence of more or less frequent, nearly insulated knobs, rising to a considerable height above the elevation of the general ranges.

Although the older rock of Cornwall, or that from which the metalliferous veins of the district may be said to have their origin, is more distinctly granitic than that of the metalliferous region upon Lake Superior, the elements of which the rocks are composed, may be regarded as essentially bearing a very close resemblance; a resemblance, which it is conceived, would have been still more perfect had the granitic rocks of Cornwall been subject to the action of secondary causes similar to those of the region under consideration. The rocks resting upon or against the granitic rocks of Cornwall, consist of clay slates, hornblende rocks, &c, which bear little real analogy to the rocks resting directly upon the trap of Lake Superior, but it is conceived that the composition of these upper rocks has little bearing upon the origin of the metalliferous veins, and may be regarded as in a measure unimportant; and however much these rocks may differ, they are traversed alike by the metalliferous veins of the lower rocks in such a manner, that the close resemblance cannot be mistaken.

It is a matter of history that the ores of the have been, more or less, extensively raised in the mineral district of Cornwall, from the earliest settlement of the Island of Great Britain, but the working of the veins of copper at an early day, does not appear to have been carried on to

any very considerable extent. The great importance to which the produce of copper from the Cornish veins, (in a district which, compared with the mineral district of our own state, is of very small dimensions,) has arisen, will be shown from the accompanying table, which I have reduced from the official returns included in the several years, and which table, it will be seen, shows for a series of years, the average annual amount of copper produced from the ore, the average amount for which it sold, together with the amount per cent, of copper contained in the ore, and the average value of the copper, per pound, at the smelting house. This table, which has been drawn with great care, from data that can scarcely lead to incorrect results, will not only serve to show the large aggregate amount of the metal produced, but it also shows, from the low average per cent, of metal contained in the ores, (if we had no further knowledge upon the subject,) that much capital must be required for, and a large amount of labor applied to the raising and smelling of these ores; a circumstance which should be carefully borne in mind, in all that relates to the mineral district of Michigan.

Table showing the average annual produce of the Copper Mines of the County of Cornwall, England, from 1771 to 1822.

YEARS.	Average No. of tons of ore per year.	Av. No. tons copper produced per year.	Average amount per year for which sold.	Av. per cent copper produced from the ore.	Av. val. of the copper per lb.
					c. m.
1771 to 1775—5 years.	28,749	3,449	\$ 846,283	12	10 9
1776 to 1780—5 "	27,580	3,309	826,609	12	11 1
1781 to 1786—6 "	34,354	4,122	962,380	12	10 4
1796 to 1802—7 "	51,843	5,195	2,125,046	10	18 2
1803 to 1807—5 "	70,923	6,160	3,174,725	8	23
1808 to 1812—5 "	70,434	6,498	2,886,835	9	12 9
1813 to 1817—5 "	82,610	7,272	2,878,723	8 8	17 6
1818 to 1822—5 "	94,391	7,757	3,111,811	8 2	17 9

The general resemblance in the mineral contents of the copper veins of Cornwall and those of Michigan, is for the most part, very great, though in some respects there is a considerable discrepancy. It should, however, be remarked that some difficulty exists in comparing the mineral veins of Cornwall, where several of them have been worked to depths, varying from 1,000 to 1,500 feet, with those of Michigan, where the examinations are nearly superficial.

In making these deep excavations, not only in the county of Cornwall, but also in the copper districts of Bohemia, Hungary, Silesia, Transylvania, Saxony, &c. (some of the veins in the latter district having been explored to a depth very considerably greater than those of Cornwall,) an immense mass of facts has been accumulated, with respect to the general formation and mineral character of veins, or lodes of copper, which facts have led to an understanding of many of the contingencies connected with its associations, so universal, that when applied to this mineral, they may be regarded as general laws, that may fairly be inferred to govern, with more or less certainty, all those lodes or veins which have similar geological relations. Though a general consideration of those relations of the veins of other countries, may perhaps be regarded as somewhat foreign to the present

report, I deem it more advisable to refer to these general laws in such a manner as to leave the reader to judge by comparison, the condition in which the ores of Michigan may be fairly inferred to occur, rather than to draw conclusions directly, and in so doing it will also become necessary to refer to some of the characters of mineral veins, or lodes, in general.

Veins are usually divided into two general orders, viz: "*contemporaneous veins*, or those which are formed at the same time as the containing rock, and true veins, whose formation is supposed to be subsequent to that of the rocks which are contiguous to them." A true vein may be defined to be "the mineral contents of a vertical or inclined fissure, nearly straight, and of indefinite length and depth."⁴⁸ The contents of a true vein, as a general rule, differ widely from the character of the rocks which it intersects, though this does not invariably hold good, and the vein also, as a general rule, has well defined walls.

The contents of contemporaneous veins, bear a much closer resemblance to the rocks which embrace them, and as a general rule, they are shorter, more crooked, and less perfectly defined than true veins.

The metalliferous veins being contained under the head of true veins, it is to these that the whole of my remarks will be directed.

Metallic veins are the repositories of most of the metals excepting iron, manganese and chrome, which occur more frequently and abundantly in beds than in veins. The thickness of metallic veins varies from a few inches to many feet, and the same vein also varies in thickness in different parts of its course, sometimes contracting to a narrow string of ore and then expanding again to a width of many feet. The deposits of metal in the veins are as irregular as the widths of them, and so much, so as to render the profits of mining proverbially uncertain. Ore is generally found to occupy certain portions of the veins only, differing constantly in extent, whether the length or depth on the course of the vein be considered, or the portion of its width which is filled up by it. No veins occur which are regularly impregnated with metal to any great extent, and when ore is found, it is in what the miners aptly term bunches or shoots, or in interspersed grains and strings, which are more or less connected with, or embraced in, veinstone, that, according to the rock which the veins intersect will be fluor spar, calcareous spar, quartz, &c. The unproductive parts of veins, even in the most profitable mines, generally far exceed in extent the productive parts, but that mine is considered to be rich which has either frequent or extensive shoots of ore, and the great art of the miner consists in tracing

⁴⁸Carne, on the mineral veins of Cornwall.

and working the valuable accumulations of the metals, with as little waste of labor and expense on the poorer portions of the veins as possible. "In the mines of Cornwall the ores of copper and the commonly occur in detached masses, which are called bunches of ore, and

the other parts of the vein being unproductive are called *deads*."

The depth to which metallic veins descend is unknown, for we believe no instance has occurred of a *considerable vein being worked out in depth*, though it may sink too deep to render the operation of the miner profitable, or it may branch off in a number of strings which are too much intermixed with the rock to be worked to advantage.⁴⁹ Some veins appear to grow wider while others contract as they descend.

The superficial part of a vein generally contains the ore in a decomposing state, and it frequently happens that the ores in the upper and lower parts of a vein are different; thus, "in Cornwall, blende or sulphuret of zinc often occupies the *uppermost* part of the vein to which succeeds tinstone, and at a greater depth copper pyrites." When a metallic vein, in its descent, passes through different kinds of rock, it is frequently observed that the products of the vein vary in each bed, and when it passes through regularly stratified beds of the same rock there are particular strata in which the vein is always found most productive. This change in the productiveness of mineral veins is more particularly noticed at or near to the transition from unstratified to stratified rocks; thus granite, syenite, and those rocks which have a graniti-form structure are frequently noticed to contain metals at or near their junction with stratified formations. On the other hand the veins which traverse stratified rocks are, as a general law, more metalliferous near such junctions than in other portions.⁵⁰

Where a rock is crossed and penetrated by a great number of small veins in every direction, the whole mass is some-

⁴⁹Koenig.

⁵⁰Lyell. Necker.

times worked as an ore, and is called by the Germans a "*stockworke*." Where the ore is disseminated in particles through the rock, such rocks are also worked for the ore, when it exists in sufficient quantity.

As a general rule, those metals which are oxydable at ordinary temperatures, or which readily combine with sulphur, *rarely occur in a metallic state*, but are usually found in combination either with sulphur, oxygen or acids. The chief ore of copper raised from the mines of Cornwall, is the yellow sulphuret, though the blue and green carbonates and arseniate are more or less distributed; native copper and the oxyds are also, though more rarely, found.

By a comparison of what has been said upon the character and mineral contents of metallic veins in general, I trust a just view of the real condition in which the ores of copper are invariably found, will have been conveyed, and that, by the aid of this we will be enabled to examine, without undue expectations, those mineral veins which occur within the limits of our own state. In the main, the resemblance between the character and

contents of the copper veins of Cornwall and Michigan, so far as can be determined, is close; the veinstones (with the exception of fluor, which I have never observed in the latter,) are essentially the same: but in instituting this comparison, it should be borne in mind that the metallic veins of Cornwall have been in progress of exploration for centuries, and that shafts and galleries have been carried to great depths, while of those of Michigan, simply superficial examinations have as yet been made, and these in a wilderness country, under circumstances of the utmost embarrassment, and attended with the most excessive labor, privation and suffering.

In respect to the character of the ores which occur in the two districts, there are important differences, for while pyritous copper is the most important workable ore, not only in the Cornish mines, but also in those of other portions of our globe, it is comparatively a rare occurrence in the mineral district of Upper Michigan; for, as I have already mentioned the mineral of the trappean portions of the veins in the latter district, is essentially made up of strings, specks and bunches of native copper, with which more or less of the oxyds and carbonates are associated; while those portions of the veins traversing the conglomerate are characterized by the occurrence of the oxyds and carbonates, with occasional metallic and pyritous copper, or the places of all these are supplied by ores of zinc, associated with more or less calcareous matter. In the thin mineral veins of Presque Isle, pyritous copper is more abundant, where it is associated with sulphuret of lead, as before mentioned.

The occurrence of this native copper in the veins, and the manner in which it is associated with the veinstones, in all respects corresponds with the ordinary association of the other forms of ores, in those veins that have been extensively worked in other portions of the globe; but I confess that the preponderance of native to the other forms of copper, was regarded as an unfavorable indication, at least until this had been found to be more or less universal with respect to all the veins. It should, however, be remarked, that in those portions of the veins where the quartz of the vein and the accompanying rock are very compact, the native form is much more common than in those portions where the veinstone and accompanying rock are more or less cellular and soft.

The worked copper veins of Cornwall, are stated by Mr. Carne, to average from three to four feet in width, and to have a length, as yet, undetermined. But few have been traced for a greater distance than one to one and a half miles, and but one has been traced for a distance of three miles.

The veins which I have examined in the mineral district of Michigan, exceed the average of those last mentioned, but the imperfect examinations which have been made, render it difficult to determine this with certainty. I have traced no one vein for a further distance than one mile, and usually for distances considerably less. It was not, however, supposed that

these veins terminated at the points where they were left, but the further examinations were abandoned at these points, in consequence of physical difficulties connected with the present condition of the country.

The native copper is frequently free from all foreign matter, and is as completely malleable as the most perfectly refined copper, but it more usually contains disseminated particles of earthy minerals, chiefly quartz. I have not been able to detect the alloy of any other metal, in a single instance.

The fatigues and exposures of the past season, have so far impaired my health, that, as yet, I have been unable to analyze as carefully, as could have been wished, the several ores furnished by the mineral veins of the upper peninsula, but sufficient has been done to show satisfactorily that the copper ores are not only of superior quality, but also that their associations are such as to render them easily reduced. Of those which have been examined, embracing nearly the whole, (and not including the native copper,) the per cent, of pure metal ranges from 9.5 to 51.72, and the average may be stated at 21.10. Associated with some of these ores I have detected a metal, the character of which remains as yet undetermined.

Were the analysis of the several ores of copper sufficiently perfected, I should deem it unnecessary to lay them before you at this time, for with what is now known of the district, it is conceived, the result would lead to erroneous, rather than to correct conclusions. The analysis of separate masses of ore, no matter how much care may be taken to select the poor as well as the richer ores, for the examinations, will usually be far from giving the average per cent, of what would be the product when reduced to practice. I have, in order to arrive at safe conclusions, not only analyzed, but also assayed many of them, but when we come to consider what constitutes the true value of a vein of copper ore, we will perceive why it is unsafe to judge of the whole by the analysis of small portions.

By reference to the previous statistical table of the product of the copper mines of Cornwall, it will be seen, that the average produce of the ores since 1771, has never exceeded 12 per cent, of the metal, and that from 1818 to 1822, it was only 8.2. This shows the aggregate, and it is well known that while many of the productive veins are considerably below this, the largest average per cent, of any single vein, in that district, it is believed, has never been over 20 per cent., and it should be borne in mind that this average is taken after the ores have been carefully freed from all the rocky and other impurities, which can be separated by breaking and picking.

The value of a vein may be said to depend upon the abundance of the ore, and the ease with which it can be raised and smelted, rather than upon its purity or richness. Upon this point, with respect to our own mineral region, public opinion would perhaps be more in error than upon any other, and most certainly we could

hardly look for a mineral district where the character of the ores was more liable to disseminate and keep alive such errors. The occurrence of masses of native metal, either transported or in place, is liable to excite, with those who have not reflected upon the subject, expectations which can never be realized, for while, in truth, the former show nothing but their own bare existence, the latter may be, as is frequently the case, simply imbedded masses, perfectly separated from all other minerals, or they may be associated in a vein where every comparison would lead to unfavorable conclusions, as to the existence of copper, in any considerable quantities. I have frequently noticed very-considerable masses of native copper, occupying the joints of compact greenstone, under such circumstances as I conceive might readily excite in many minds, high expectations, but a little reflection would satisfy the most careless observer of the uselessness of exploring these joints, under the expectation or hope of finding, them a valuable repository of the metal. Again, not only native, but also the other ores of copper occur in veins, either so narrow as to render it useless to pursue them, or so associated as to render it probable that exploration would not be attended with success.

While I am fully satisfied that the mineral district of our state will prove a source of eventual and steadily increasing wealth to our people, I cannot fail to have before me the fear that it may prove the ruin of hundreds of adventurers, who will visit it with expectations never to be realized. The true resources have as yet been but little examined or developed, and even under the most favorable circumstances, we cannot expect to see this done but by the most judicious and economical expenditure of capital, at those points where the prospects of success are most favorable. It has been said of the Cornish district, in respect to the supposed large aggregate profits, that "a fair estimate of the expenditure and the return from all the mines that have been working for the last twenty or thirty years, if the necessary documents could be obtained from those who are interested in withholding them, would dispel the delusion which prevails on this subject, as well as check the ruinous spirit of gambling adventure which has been productive of so much misery."⁵¹ And if these remarks will apply to a comparatively small district, which has been explored and extensively worked for centuries, with how much more force must they apply to the mineral district of our own state, I would by no means desire to throw obstacles in the way of those who might wish to engage in the business of mining this ore, at such time as our government may see fit to permit it, but I would simply caution those persons who would engage in this business in the hope of accumulating wealth suddenly and without patient industry and capital, to look closely before the step is taken, which will most certainly end in disappointment and ruin.

The extreme length of what I have denominated the mineral district, (within the limits of Michigan,) may be estimated at a fraction over 135 miles, and it has a width varying from one to six miles; but it must not be

imagined that mineral veins occur equally through all portions of it, for sometimes, for many miles together, none have been noticed; and the situation

⁵¹Hawkins on the tin of Cornwall.

of the country is such as to render it probable they never will be. The range and course of the mineral district has been so far defined as to render it unnecessary to say more upon this subject, to enable such persons as may wish to examine, to pass directly along its complete length.

I have thus far omitted to allude particularly to the large mass of native copper, which has been so long known to exist in the bed of Ontonagon river, less perhaps this isolated mass might be confounded with the products of the veins of the mineral district. That this mass has once occupied a place in some of these veins is quite certain, but it is now perfectly separated from its original connection, and appears simply as a loose transported boulder.

The attention of the earliest travelers was called to this mass of metallic copper by the natives of the country, and it has been repeatedly described by those who have visited it. The mass now lies in the bed of the westerly fork of the Ontonagon river, at a distance which may be estimated at 26 miles, by the stream, from its mouth. The rugged character of the country is such, that it is but rarely visited, in proof of which I may state, that upon my visit to it, during the last year, I found broken chisels, where I had left them on a previous visit, nine years before, and even a mass of the copper, which at that time had been partially detached, but which, for the want of sufficient implements, I was compelled to abandon, was found, after that interval, in precisely the same situation in which it had been left.

The copper in this boulder, is associated with rocky matter, which, in all respects, resembles that associated with that metal in some portions of the veins before described, the rocky matter being bound together by innumerable strings of metal; but a very considerable proportion of the whole is copper, in a state of purity. The weight of copper is estimated at from three to four tons.

While the mass of native copper upon Ontonagon river cannot fail to excite much interest, from its great size and purity, it must be borne in mind, that it is a perfectly isolated mass, having no connection whatever with any other, nor does the character of the country lead to the inference that veins of the metal occur in the immediate vicinity, though, as before stated, the mineral district crosses the country at a distance of but a few miles.

The occurrence of carnelian, chalcedony, agate and amethystine quartz, in the amygdaloidal portion of the trap, has already been noticed, and these minerals are considerably abundant. They frequently possess very great beauty and perfection, and when ground and polished they may be used for all the purposes to which those minerals are usually applied.

Minerals of the Upper or Gray Sandstone

Though the upper sandrock is largely exposed along that portion of the lake coast known as the Pictured rocks, rising to a very considerable height in precipitous cliffs, there have, nevertheless, been no minerals noticed in connection with it, except iron pyrites. Along a portion of the distance, however, the rock of the cliff is frequently colored by broad vertical bands, having a variety of tints, (which have given name to this portion of the coast,) and these bands have been, by some travelers, supposed to indicate the existence of important minerals in the rock; but the coloring matter of these bands is merely superficial. It chiefly consists of the oxyd and carbonate of iron, with occasional faint traces of carbonate of copper, both having been deposited from waters while trickling down the cliffs, the same having previously percolated the rock.

No mineral veins have been noticed in connection with this rock.

SOIL AND TIMBER OF THE UPPER PENINSULA

The impressions which have gone abroad with respect to the character of this region for purposes of agriculture, are, in many respects, exceedingly erroneous, for which reason, I am the more solicitous to call attention to the true character of the country, as it regards the natural productions of its soil and its capabilities for cultivation. It has generally been supposed that the whole country is wild and sterile in the extreme, and that, both from its high northern latitude and the rugged and broken character of its surface, it could never admit of the successful application of agriculture. This impression is, in great part, a mistaken one; for, while much of the country is, as has been supposed, extremely rugged, often presenting a rocky and sterile surface, and is besides exposed to the long and bleak winters of a high northern latitude, and to the cold winds of a vast and boisterous lake, yet, as I have already shown, a large part of the upper peninsula is far from presenting a rough and mountainous aspect; and much of the interior, at some distance from the lake shore, presents situations that are not only sheltered from the severity of the winter, but in soil and timber are wholly of a different character from what has been represented.

Much of the wrong impression which has been received, with regard to the timber and agricultural character of the country alluded to, has, no doubt, arisen from the circumstance that a judgment has been formed of the whole district of country, from the appearance of that part of it which lies more immediately upon the lake shore; and in fact, were we to form our estimate of the whole, from that only which is seen by the voyageur, in coasting along the shore, it would scarcely be possible to form any other than a very unfavorable opinion of the value of the country, in an agricultural point of view. Along that portion of the district which lies upon Lake Superior, about one-third of the entire coast, westwardly from Ste. Marie, is generally low and sandy, and thickly timbered with evergreens and white birch, which give to

it a somewhat gloomy and forbidding aspect. Still further westerly, and extending to the extremely westerly boundary of our state, the coast presents little else than an almost unbroken succession of rocks, bare, and worn by the fury of the lake, and the country, as seen from the water, appears to be occupied by an almost countless succession of irregular knobs, either nearly destitute of timber, or producing only a few stunted yellow pines and firs, or a growth of worthless poplars; while the southern shores of the upper peninsula, upon Lake Michigan and Green Bay, though differing in character, present a scarcely less forbidding aspect, in general, when viewed from the lake. But these unfavorable impressions are almost wholly, or in great part, removed when we penetrate into the interior, beyond these local influencing causes, and become acquainted with the real condition and character of the districts described.

The general aspect of the surface, over the whole of the extensive district under consideration, has been already laid before you, under the head of "topography of the upper peninsula." It may be remarked, in general, that sand is by far the predominating soil throughout the entire district. A soil of this description prevails over the north-easterly or sandstone portion of the upper peninsula. This district which, as has been already described, consists of extensive level plateaus or steppes, with scarcely sufficient irregularities of surface to prevent the formation of numerous marshes, may be said to be timbered, in the largest proportion, with the several varieties of evergreens, among which hemlock, cedar and firs greatly abound. Considerable Norway or pitch pine is interspersed, with occasionally large white pines, though in limited quantity. This region, nevertheless, comprehends many extensive tracts of the sugar maple, lying in body, and these trees are frequently of large size. Several species of oaks are also occasionally met with. Upon the whole, much of this portion of the peninsula is better adapted to the wants of settlers for agricultural purposes than might, at first view, be supposed, and may be safely relied upon as capable of producing those crops which are of the most importance to the settler. Wheat, in small quantity, is said to have been raised upon Grand Island, in a spot exposed to the utmost rigor of that northern climate, and some species of Indian corn may, no doubt, be successfully cultivated in the most sheltered situations.

The south-easterly portion of the upper peninsula, embracing the lower limestone district, has a soil more nearly approaching to gravelly, and the pebbles composing which are chiefly derived from the northerly outcropping edges of the limerocks. This soil, in consequence, contains much more calcareous matter than that above described, which adds greatly to its fertility. Clays occur to a very limited extent, and clay soils may be said to be in general, rare throughout the district under consideration. Beach and sugar maple are abundant throughout the portion of the district described, mixed with hemlock and birch.

The hilly district, referred to as embracing the whole of that portion of the upper peninsula which lies west of the mouth of Chocolate river, though broken by ranges of knobby and often barren hills, is very far from being wholly or even generally sterile; for the broad and gently undulating valleys, described as occupying the intervening spaces between these ranges of rocky knobs, have in general a soil of dark, rich and deep loam, and in many places are covered with large bodies of sugar maples of unusual size. With this timber is frequently intermixed oaks and large hemlocks, and extensive bodies of the latter timber occur, together with occasional pines. The streams of this district, where they wind through the bottom lands, between the ranges of hills which inclose the valleys, are frequently densely wooded with all the varieties of hard wood timber, and their banks exhibit deep alluvial loams, which, when once brought under proper cultivation, will be unexcelled for fertility even by the rich plains of our southern peninsula. These loams were sometimes observed to be underlaid by a red clay. As a whole, the soils of the hilly portion of the upper peninsula, may be said to be generally superior to those of the extensive easterly portion of the peninsula, and marshes are of less frequent occurrence.

For purposes of lumber, the upper peninsula of our state cannot be said to hold out such inducements as, from its situation, might be imagined. White pine, though sometimes met with in considerable quantity, was not in any instance observed to have obtained to more than medium size, and is not generally abundant. The Norway pine is found in much greater abundance and of fair size, but this species of pine is of comparatively little value, as an article of lumber.

FURS, FISH AND HARBORS OF LAKE SUPERIOR

In the general view I have attempted to give of the character and resources of that portion of our state bordering on Lake Superior, full justice cannot be done to the subject without adverting, however, briefly, to the fur and fish trade of that upper country.

It is well known that the American fur company has for a long series of years, occupied posts, at convenient points upon the lake, as well as throughout the vast territory of the north-west, for the trade with the natives in the furs of the country. Since the year 1835, the general depot of the northwest trade in furs, has been established at La Pointe, one of the Apostles' Islands, near the western boundary line of upper Michigan, and in addition to this, other posts, of a more temporary and minor character, have from time to time, been occupied at various points in the same region. These all formed parts, or, as it were, links of that extended and connected chain, with which this company had been enabled to bind to its interests such an immense extent of territory, and to draw into its storehouses those treasures, in furs, with which this whole region originally abounded. The character of the company, its immense resources, the perfect system that characterized its operations, as well as its distinguished success, are so

well known, and have so often been adverted to by travelers and historians, that I allude to the subject here only for the sake of exhibiting more perfectly the present condition of upper Michigan, and to show what is the extent of the inducements held out to individual enterprise in that region. Nearly the whole of this trade is now, as it has been for a series of years, in the hands of the company referred to, and it has been secured to them by a course of judicious management, as well as by a large command of capital, and so powerful continues to be the influence exerted by this company, as to leave little chance of success to individual opposition, and the trade must continue to flow, mainly in its present channel.

The trade in furs is, however, very far from being of that importance which it was formerly, for the amount of furs has for many years past, been constantly diminishing, as the country becomes exhausted of the game, and so rapid has been the falling off, that at the present time, the amount, of furs packed by the company, *at its station*, is scarcely half that which it was five years ago. At the same time, many important changes have been introduced by the company in the manner of conducting the traffic; the system formerly pursued, of granting credits to the natives on goods, sold at extravagant prices, a course not only unjust in itself, but destructive to habits of industry in the natives, has been entirely abandoned; goods are now sold at moderate prices, anticipating only reasonable profits, and an equally fair compensation is allowed for the furs. The company has, furthermore, entered fully into the measures of the government to prohibit the introduction of ardent spirits into the Indian country, and none is now employed in the trade; thus cutting off one of the chiefest sources of misery to the Indian population. I could not fail to notice that, since my last visit to the country, in 1832, the moral and social condition of the Indian population has greatly improved. This is owing, in great part, to the honorable and active measures adopted by the company, by which the means of subsistence among the Indians has been much increased, many evils that formerly existed have been removed, and an entire change has been brought about in their condition, and also to the exertions of the several very excellent and worthy missionaries, who have not only both by precept and example, been the means of introducing among them the meliorating influences of Christianity, but have laboriously devoted their life to this "work and labor of love."

The American fur company also, at an early day, turned its attention to the fish of Lake Superior, and they have since engaged largely in the business of fishing. Many half-breeds and Indians are employed in the business, and this has also operated favorably upon the natives, and no doubt contributed largely to the improvement observable in their condition. Fair, if not high, wages are paid the Indians, which operates as a stimulus to industry, nor can we award too high praise to the equitable course pursued by the company in this matter.

Lake Superior abounds in trout, white fish and Siskowit,⁵² the two former of which are larger and better flavored than any that are taken in the more southern waters, and the latter fish has been rarely taken at any other station on the lakes; the consequence of which facts is, that the barrels of this company sell in the market at a higher rate than those of the fisheries farther south; but, at the same time, great disadvantage results to the company from the necessity of keeping vessels constantly upon the lake, for the express purpose of the fish trade, thus greatly increasing the expenses and risks attending the business.

During the past season minor companies have been formed and have commenced the business of fishing upon this lake. Two vessels have been hauled around the rapids at the Saut, for that purpose, and as the fish are abundant, there is reasonable prospect that the fishing trade will eventually prove of great importance.

⁵²An undescribed species of the genus *Salmo*.

But cut off as Lake Superior is, from direct communication with the lower lakes, by an impassable rapid, this trade must continue to be carried on under great disadvantages, nor can the other resources of the upper country be fully developed so long as this barrier exists. The construction of the Saut Ste. Marie canal, which has been long projected, but the necessity for which seems to be not yet fully appreciated, would remove this obstacle to the growing importance of that great-region; and when this shall have been done, we may expect to see all the resources of our upper peninsula fully appreciated and made available.

Directly connected with this subject, is that of the *harbors* on the southern shore of Lake Superior; for while such a field for enterprize is opened in that region, it is of essential importance to know what are the facilities it affords for the safe navigation of the lake. Six vessels are already navigating its waters, in the prosecution of the fur and fish trade, and although hitherto, but few harbors have been known to exist, which may be sought as places of refuge, the extreme breadth of the lake does not fail to afford an extraordinary facility in its navigation, by allowing a great extent of sea room, and thus enabling vessels, in case of storm, to "run before the wind."

The harbor afforded by the group of Apostles' Islands, and which is taken advantage of by the American fur company at its present station, is deep and completely "land-locked," and for safety and convenience could not be excelled. The same may be said of the natural harbor afforded by Grand Island and the neighboring shore. Both these harbors have long been known and appreciated, and more convenient and safe retreats could not be wished for vessels driven by stress of weather to "make a port;" nor could harbors be desired affording greater conveniences for permanent stations.

I was enabled, during the past season, to effect a partial triangular survey of several points upon the coast, which seemed to promise advantages as harbors for vessels;

and the depths of the water were uniformly taken, also, at the mouths of streams. The result shows that, although the number of places offering advantages for secure harbors is somewhat limited along a part of the coast, yet that portion of the coast of our state lying upon Lake Superior, may be said to hold out as great facilities, in this respect as any equal extent of coast upon the lakes, it might be supposed that Keweenaw point, from its extreme projection northerly, as well as from the "rock-bound" character of its shores, would serve to add to the dangers of the navigation, but along this rocky coast are found occasional inlets into large bays, stretching behind the extreme outer barrier of rock, and these are almost uniformly deep and completely sheltered, and at some future time, may, with little or no expense, be converted into a series of complete and permanent harbors. One of these bays or inlets, distinguished on the map as Copper Harbor, was surveyed by a series of triangulations and soundings, and was found to afford a bay, convenient for anchorage, about two and a half miles in length, stretching parallel to the coast, and having a depth of from five to seven fathoms, and the entrance to which has an uninterrupted breadth of three-quarters of a mile, with a mean depth over the bar of twenty feet, and a maximum depth of thirty feet. These harbors, from their location with respect to the mineral district of the upper peninsula, as well as from the ease of access they will allow to vessels which are exposed "off the point," must eventually become of very great importance.

A natural harbor, of similar form to that above described, occurs upon a part of the coast east from the Pictured rocks, and in which the place of the cliffs of rock is supplied by cliffs or spits of sand. The bay here formed, behind the outer bar of sand and gravel, has a length of two miles, with an average depth exceeding six fathoms, and the water deepens so rapidly from the shore, that in most parts of it a vessel of the largest draught may approach so closely to the beach as that a landing might be effected without aid from the boats. The entrance into this bay has a width of three-fourths of a mile, but a bar of sand stretches across it, which would, at times in its present condition, render the passage into the harbor dangerous, for the average depth of water over this bar does not exceed six feet, though there is a depth in the immediate channel, which is comparatively narrow, of ten feet.

Safe anchorage for vessels may also be found in Keweenaw bay, a deep expanse of water, on the easterly side of Keweenaw point, and which stretches for many miles inland.

PROGRESS AND CONDITION OF THE SURVEY, &C.

Notwithstanding the very many physical difficulties by which the geological survey of the upper peninsula of our state is surrounded, we have, nevertheless, been enabled to accomplish a much larger amount of the work than reasonably could have been hoped; but there still remains much to be done before its geology and mineralogy can be fairly understood. Comparatively little

has heretofore been known of the range and extent of the several rock formations, and, while the labor of the past season has shown the most interesting of these to have a much larger area than we had previously been led to infer; it has also shown that the amount of work required, to enable us fairly to understand the geology and mineralogy of that interesting region, was considerably more than we had reason to look for.

The reports of the several assistants, will exhibit to you. the progress that has been made during the past season, in the surveys of the southern peninsula. Messrs. B. Hubbard and C. C. Douglass were engaged with me during the early part of the season in the upper peninsula; after which, they returned to carry forward the geological and topographical surveys of the lower peninsula. I was also accompanied, during a small portion of the season, by Mr. Frederick Hubbard, who acted as special assistant, and who has embodied a small part of his numerous observations in the form of a report, which is hereto appended.

The survey of the lower peninsula is mainly completed, but there are some few spaces, both in the geological and topographical portions of the work, which require to be filled up before the results can be fully laid before the public.

The drafting of the topographical portion of the survey has advanced steadily towards completion, and the several county maps are in progress of publication in conformity to your instructions.

While we had hoped to have been able to bring the survey to a close within the time originally contemplated, from the above statement of the progress and condition of the work, it will be seen, that some further time will be necessary for its final completion; but while this time will be essential to reach the object sought to be attained by our state, no further appropriation will be necessary for that purpose.

In closing this report, I feel it a pleasure to refer to the very many acts of hospitality and kindness which have been extended to us by the citizens of Mackinac, Saut de Ste. Marie, and La Pointe. By the aids received at these several places, we have been enabled to accomplish much that otherwise could not have been done, while we have, at the same time, received much that has ministered to our comfort.

To the agents of the American fur company in Lake Superior, I feel very deeply indebted; for, through their polite attentions, I have been enabled to examine districts of country which otherwise could not have been reached, and to them and the several mission families, are we indebted for all that it was within their power to do, to aid us in our laborious duties, or to render our situation comfortable.

DOUGLASS HOUGHTON,
State Geologist.

Report of Frederick Hubbard, Special Assistant

Utica, N. Y., November 20, 1840.

To Douglass Houghton, State Geologist:

Dear Sir—I submit to you, the results of a portion of the observations for the determination of latitudes, magnetic variations, &c, made under your direction, during the recent expedition of the state geological corps to the upper peninsula and southern shore of Lake Superior.

The subject of latitudes was made a matter of particular attention, no regular survey ever having been made by the general government of that part of the lake lying within the boundary of our state. By means of instruments, with which the expedition was furnished, the positions of the most prominent points of the coast have been fixed by celestial observations, and with sufficient care to furnish, connected, with the running meander, an accurate outline. Unfortunately, we were not furnished with the proper instruments for the determination of longitudes. This problem, always one of great difficulty, for our purpose, would have required a long series of the most careful observations, with the most delicate chronometers, and a greater devotion of time, than the circumstances of the expedition allowed. The ordinary lunar method, as practiced by navigators, is not susceptible of sufficient accuracy to be of service in a case of nicety.

Several rude attempts were made, however, with such means as we possessed, using a similar method, to fix the longitude of a few points; but I do not place sufficient confidence in the results to deem it of importance to lay them before you.

The latitudes in the following table were mostly obtained by measured altitudes of the sun, Jupiter and the polar star.

Table of Latitudes.

Ste. Marie Riviere.

W. side Drummond Island, (exam'pt, May 27,).....	45° 58' 26" N
E. side St. Joseph Island, (May 28,).....	46° 16' 45"
Pt. aux Pins, Little Lake George.....	46° 32' 29"
Saut de Ste. Marie, (head of rapids,).....	46° 31' 8"

Lake Superior

White fish point.....	46° 45' 18"
Grand Marais harbor.....	48° 40' 5"
Mouth of Train river.....	46° 25' 34"
Mouth of Chocolate river.....	46° 29' 33"
Mouth La Riviere des Morts.....	46° 35' 4"
Mouth Riviere Bay du Gres.....	47° 21' 36"
Rock harbor, extremity of Keweenaw point.....	47° 24' 32"
Mouth of Ontonagon river.....	46° 57' 5"
Mouth of Montreal river.....	46° 41' 19"
Village of La Pointe, Madaline Island.....	46° 44' 31"

Variation of the compass.—The results, in the subjoined table, were deduced from a comparison of the observed magnetic azimuth of the sun with his true azimuth, as calculated for the measured altitude and place of observation. This method is one of great accuracy, and is almost the only one upon which dependence can be placed, for results which shall not contain an error of more than two or three minutes, due to inaccuracy of observation. The angles were measured with a theodolite, containing a needle of great delicacy.

A small correction to the table is necessary, on account of the diurnal variation. This may amount to some 8' or 10' and possibly may be greater in some instances, when the observations were made during the warmest seasons. As I have not the results of any experiments on this subject, now before me, I have thought; proper to insert the date of each observation, and the hour of the day, that the correction may be made when the date can be obtained, with reference also to the metrological table kept during the survey.

By platting these variations upon the map of the coast, it will appear that there is a constant increase in the amount of deflection in passing westward, and at the same time that *the increment is not in proportion to the westing* but is in a decreasing ratio, the distance between the lines, connecting the points of the same variations, being greater as we recede from the line where the direction of the needle is due north.

From the observations in Riviere Ste. Marie, it appears that the line of no variation passes through that strait, crossing Drummond Island near its western, and St. Joseph through its central or eastern part, with a course about north by west. The determination of its exact position is a matter of considerable importance, and I regret that circumstances did not allow us, when in that vicinity, to spend more time in the investigation of this interesting subject. The tracing of its supposed irregularities, and the ascertaining of the laws which govern its changes, have for many years attracted the attention of the scientific world.

By marking upon the map the points of 1, 2, 3, &c, degrees of variation, and drawing through them lines parallel to the line of no variation, it will be perceived that there are, in a few cases, important deviations from the general regularity in which the deflections are found to increase. These differences are by far too great to be attributed either to errors in observation, to diurnal variation, or to the effect of atmospheric disturbing causes. I know not what influence the general topography of a country may have upon the directions of the magnetic needle, but it appears highly probable that something may be due to the outline of coast, to the unequal distribution of land and water, and to the influence of an open extent of sea, on the one hand, and of a mountain range upon the other. It might be suspected that these irregularities were the result of local attraction of metallic veins, or of some unknown disturbances in the more immediate vicinity, did they not always occur where they seem to have an obvious connection with the circumstances I have mentioned. In all these cases there is a deflection of the needle towards the open lake, tending, when the land lies to the west of the place of observation to increase the amount of easterly variations, and the contrary. Thus we find, about the Riviere des Morts, where the trend of the shore is northerly, at the several points to the east of the Keweenaw peninsula, and at the village of La Pointe, lying to the eastward of a high range of hills upon the mainland, a too great deflection towards the east, as if

the needle were actually affected by some repulsive influence existing in the land, or a contrary principle, in the water. One or two instances occur, where the attraction is to the west apparently from a similar cause.

Whether this is the true explanation of the difficulty, I will not pretend to decide. The subject is one that merits investigation, as having some bearing upon the science of terrestrial magnetism, many of whose principles are as yet enveloped in mystery.

Table of magnetic variations

				<i>Riviere de Ste. Marie.</i>	
May	27	4 h. 16 m.	P. M.	West side Drummond Island...	0° 9' E.
	20	8 30	A. M.	Small Island in Montreal channel.....	0° 12'
	30	9 16	"	Saut de Ste. Marie.....	1° 25'
				<i>Lake Superior.</i>	
June	8	5 15	P. M.	Grand Marrais harbor.....	3° 29'
	13	6 46	"	Mouth of Miner's river.....	3° 39'
	16	9 11	A. M.	Shore, half mile west Chocolate river.....	5° 36'
	18	8 00	"	Mouth of Carp river.....	5° 32'
	23	8 00	"	Mouth of Pine river.....	5° 36'
July	27	8 10	"	Bay on south side Keweenaw point, (at mouth first stream north Portage river).....	5° 37'
	30	5 40	P. M.	Mouth Riviere Bay du Gros.....	5° 24'
	13	4 40	"	Mouth of Ontonagon river.....	6° 33'
	16	4 30	"	Mouth of Montreal river.....	7° 43'
	18	5 40	"	La Pointe.....	8° 33'
	31	9 33	A. M.	Parisien Island.....	1° 11'

Accompanying this you will receive a map of the harbor of Grand Marrais and of Copper harbor, surveyed by your direction, while the geological corps were encamped at those places. That of Grand Marrais is made, exhibiting only the general outline, a few points being fixed by triangulation, and soundings taken upon the bar at the entrance. Of Copper harbor, a more thorough survey was made; as complete as the limited time of our stay would permit. The outline of shore, positions of reefs, &c, were accurately determined by a system of triangulations, and soundings made across the entrance, and throughout the interior. A mere glance at the map is sufficient to show how little is left for art to do, to render this harbor one of the most secure places of refuge from storms, to be found in any part of the lake.

Respectfully, yours,
F. HUBBARD.

Report of C. C. Douglass, Assistant Geologist

Detroit, January 4, 1841.

To Douglass Houghton, State Geologist:

Sir—In conformity with your instructions, I have the honor to report, that the examinations, assigned me to be performed in the northern portion of the southern peninsula, have been as nearly completed as circumstances would permit. The duties performed under your immediate directions, in the region of Lake Superior, delayed the commencement of this work until the season was so far advanced as hardly to allow sufficient time for the completion of the unfinished work in this portion of the state.

In prosecuting the examinations in this district, I have made collections of duplicate specimens of all of the rocks, together with their contained minerals and characteristic fossils, all of which are deposited, according to instructions, in the geological depot at Detroit, together with a transcript of my field notes.

Previous to making these examinations, it had frequently been reported to me that coal had been found by the Indians and traders in the high lands lying east from the Traverse bays of Lake Michigan. These reports were soon shown to be without foundation, for the reason that the whole of the rocks of this district, lie below those of the coal formation.

REMARKS ON THE GENERAL CHARACTER OF THE NORTHERN PORTION OF THE LOWER PENINSULA

The country north of township nineteen north, and east of the meridian, is, on the whole, but ill adapted to the purpose of agriculture, being chiefly composed of sandy ridges, with intervening swales, and cedar swamps; many of the latter, however, are merely tracts of moist ground, covered with so dense a growth of white cedar as to be rendered almost impenetrable. The country rises so gradually towards the meridian of the state, as to leave it generally flat and wet; but were the country cleared of its timber, and the water courses freed from flood wood, much of the country would be rendered dry, arable land.

A large portion of the immediate shore of the lake, is low land, either entirely or approaching to swamp.

High land was noticed lying at some distance back from the lake shore, between Presque Isle and the Cheboygan river, which belongs to, and forms a part of, the chain of high land that appears on Lake Michigan, between Point Wabashance and Little Traverse bay.

The greater part of the country, after passing west of the meridian, is of a character very different from that just described, in point of soil, face of country, climate, &c.

From old Fort Mackinac to the Manistee river, the land immediately upon the lake shore, and not unfrequently extending back for many miles, is considerably elevated, and occasionally rises, very abruptly, to the height of from one to three or four hundred feet. The country, (more particularly the northern portion,) continues to rise as we proceed into the interior, until it attains an elevation equal to, if not exceeding any other part of the peninsula.

This is more particularly the case in the rear of the Traverse bays, where this elevation continues for many miles into the interior, giving to the landscape a very picturesque appearance when viewed from some of the small lakes, which abound in this, as well as in the more southern portion of the state.

The tract of country under consideration, is based on lime stones, sandstones and shales, which are covered, excepting at a few points, with a deposit of red clay and

sand, varying in thickness from a few inches to more than four hundred feet.

The interior of the northern part of the peninsula, west of the meridian, is generally more rolling than that on the east. It is interspersed with some extensive cedar swamps and marshes, on the alluvial lands, and in the vicinity of the heads of the streams, and some of the lakes. The upland is generally rolling, has a soil of sand and clay loam, and is clad with evergreen timber, intermixed with tracts of beech and maple, varying in extent from a few acres to several townships.

Some of the most extensive: of these tracts are in the vicinity of the Cheboygan and Tahweegan rivers, their lakes and tributary streams. There are also large tracts of beech and maple timber lying between the head of Grand Traverse bay, and the Manistee and Muskegon rivers.

The elevated portion of land on the shore of Lake Michigan, known as the "Sleeping Bear," as well as the Manitou islands, which, when viewed, from a distance, have the appearance of sand, are found to be composed, (excepting the recent sand dunes,) of alternating layers of highly marly clay and sand. The clay is of a deep red color, and in many places its strata are much contorted.

The hilly region to which allusions have been made, is mostly heavily timbered with beech, maple, bass, oak, ash, elm, birch, &c, interspersed with tracts of hemlock and pine, and with an occasional cedar swamp. In the vicinity of Grand Traverse bay, this character of country extends into the interior for many miles bordering on a series of small and beautiful lakes, which vary in length from two to eighteen miles, and are in general free from marsh and swamp. This country, as also that in the interior of Little Traverse bay, is well adapted to the purposes of agriculture.

Passing south of this rolling district, the country becomes less elevated, and more variable, the soil assuming a more sandy character, and being generally clad with evergreen timber. There are, however, exceptions to this, in some fine tracts of beech and maple, near the lake coast, also in the vicinity of some of the streams in the interior.

It is nevertheless true that there are many extensive swamps and marshes in this part of the peninsula; but it is to be doubted whether, upon the whole, they exceed in quantity or extent, those of the more southern part of the state. In point of soil and timber this portion of the state is not inferior to the more southern, and such are the advantages it offers to the settler, that the day is not distant when it will be sought as a place of residence by the agriculturist. The beauty of its lakes and streams is not any where surpassed. Such is the transparency of their waters as to permit objects to be distinctly seen at the depth of more than thirty feet.

The small lakes abound in the finest of Mackinac trout, whitefish, sturgeon, pike, bass, sun-fish, &c. The

transparency of the water is so great, that the Indians are accustomed to spear fish where the depth exceeds thirty feet.

That part of the peninsula situated north of Grand river, is usually regarded by many of the inhabitants of the more southern part of our state, as being either an impenetrable swamp or a sandy barren waste, and as possessing too rigorous a climate to admit of its successful application to the purposes of agriculture.

This is an erroneous opinion, and one which will most certainly be corrected as the facts with regard to this part of our state, come more fully to be known. The inhabitants of Flat, Rouge, Maskego and White rivers, and the Ottawa Indians, living on the Grand and Little Traverse bays, and on the Manistee river, have extensive cultivated fields, which uniformly produce abundant crops.

The country on Flat and Rouge rivers is generally rolling, interspersed with level and knobby tracts, but none is so rough as to prevent its being successfully cultivated. The timber in the vicinity of the streams consists of black, white and burr oak, which is scattering, and forms what is denominated openings and plains; small tracts of pine barrens, beech, maple and oak lands interspersed with tracts of white pine.

Settlements are rapidly advancing in this part of our state, and much of the land under cultivation, produces excellent crops of wheat, oats, corn, potatoes, &c, and so far as experience has been brought to the test, is not inferior to, or more subject to early frosts in the fall than the more southern counties in the state.

The soil varies from a light sand to a stiff clay loam.

The country on the Maskego is rolling, and may be considered as divided into beech and maple land, pine lands, pine barrens, oak openings, plains and prairies. Small tracts of the latter are situated near the forks of the river, about forty-five miles from its mouth, and between thirty and thirty-five miles north of the rapids of Grand river. Crops of corn, oats, wheat, &c, were here as flourishing as those of the more southern part of the state. Several families are settled on the prairies and along the valley of the stream. They have two saw-mills in operation, one at the forks of the Maskego river, and the other on a small stream five miles below.

The soil of the prairies and openings is sandy, while that of the beech and maple lands is a sand and clay loam.

The Indians of Grand and Little Traverse bays and vicinity, also obtain good crops of corn, potatoes, squashes, &c. Some of the most intelligent Indians informed me that their crops had never been known to fail entirely, and that they were seldom injured by frosts in the fall or spring. They also have many apple trees which produce fruit in considerable quantities.

This soil is strictly a "warm one," and exposed as the whole country bordering on Lake Michigan is to the influence of the southern winds, during the summer, and

parts of the spring and fall, it seldom fails to be productive.

GENERAL GEOLOGY

For convenience of description, I will arrange the several rock formations in groups, beginning with those that accupy the highest place in the series, descend to the lowest, or oldest rocks. Owing to the great accumulation of superficial materials, which has prevented perfect accuracy from being attained, these divisions may be liable to modification upon subsequent and more minute investigations.

Rocks of Lake Michigan		
	Townships.	
1		Tertiary and superficial materials. { 1. Boulders of granite, &c. 2. Clay, sand, &c.
2	T. 16, N.	Manistee limestone.
3	" 31-32 "	Shales. { 1. Light blue argillaceous. 2. Black, containing pyrites.
4	" 33 N. "	Corniferous limestone. { Containing beds of hornstone. Little Traverse bay limestone. { Beds of limestone, intermixed with clay and chert.
5	" 34 N. "	
6	" 34 N. "	Black bituminous limestone. Composed of congeries of shells.
7	" 34 N. "	Blue limestone, in thick regular layers.
8		Mackinae limestone. Very porous and much shattered.

Rocks as seen forming the coast of Lake Huron		
	Townships.	
1		Alluvium. { 1. Beds of rivers. 2. Incrusting springs. 3. Marl, tufa, peat, &c.
2		Tertiary and superficial. { 1. Boulders of granite. 2. Beds of clay and sand, &c.
3	20, 26 N.	Point aux Gres. Limestone. { Light colored arenaceous, containing septarea.
4	27 "	Shale. Black bituminous, containing pyrites.
5	28 "	Thunder bay limestone. { Beds of limestone and grey clay or shale, containing abundant fossils.
6	30, 31 "	Black bituminous lime-stone. Bituminous, composed of congeries of shells.
7	32, 33 "	Blue limestone. Compact and in thick strata.
8		Mackinae limestone. { Very porous and the upper portion much shattered.

It will be seen, by referring to the above sections of the rocks of lakes Huron and Michigan, that the same rocks, with one or two exceptions, occur on both sides of the state, having the same geological position; also, that they have very nearly parallel and uniform positions. And from these outcrops the rocks would appear to have a bearing nearly north 70° west, and south 70° east, which line of bearing corresponds with the outcrop of the black bituminous slate on the east side of Lake Huron in Upper Canada.

ALLUVIUM

Under this head may be included all those formations which are the result of causes now in operation. Such as beds of shells and tufaceous marls, deposition of silt at the mouths of streams, disintegration of rock strata, growth of peat, bog ores, &c.

Shell Marl

Is in general, composed of small fresh water shells, chiefly univalve with occasional bivalve, which multiply most rapidly in shoal ponds or pools of water strongly impregnated with carbonate of lime. For the accumulation of fresh water shells and shell marl, the waters of the streams and small lakes of the northern part of the state, are well adapted. This marl has accumulated in extensive deposits at the outlets and inlets of most of the lakes on the Cheboygan, Tahweegan and Pine rivers. There is also an extensive deposit of marl on the shore of Thunder bay, north of Thunder bay river.

Tufaceous marl is also rapidly accumulating at the rapids of the streams above mentioned, where the deposition takes place in consequence of the water here being much agitated. The carbonate of lime precipitated at these points, is usually in the form of tufa, which readily adheres to whatever it comes in contact with, thus forming balls varying from one to twelve inches in diameter. Most of these balls have a shell as a nucleus.

Tertiary and Boulders

Included in this division are alternating beds of red clay and sand which are nearly co-extensive with this part of the state. This formation overlays and rests unconformably upon the lower rocks of the district, and in which respect, it corresponds with the same formation in the more southern part of the state.

It forms the base of most of the high banks of both lakes Huron and Michigan, and is very finely exhibited at the Sleeping Bear, and on the Manitou islands of the latter lake. It also forms the base of most of the high knobs, in the interior of this section of the state. Most of this clay is very unctious and nearly free from grit, but contains lime in sufficient quantity to injure it for the manufacture of brick.

Primary boulders are very rarely met with on the upland; but those of a small size are very numerous on the shores of the small lakes, where there were also numerous boulders of limestones seen associated with them.

ROCKS OF LAKE HURON

Point Au Gres Limestone

This rock, is for the most part, of a light cream color, of a compact structure, and will afford a tolerable building material. It contains numerous fossils. From this point north, on the lake shore, to Sulphur island, rock was seen at intervals, forming the bed of the lake, which rock was referred to the sandstone formation. This space is undoubtedly occupied by sandstones and shales, the equivalent of those on the coast of Lake Huron from Point aux Barques south, to White Hock.

Limestone of a very siliceous character occurs on the Charity and other islands of Saginaw bay, where it was seen in contact with, and overlying, the sandstone, and

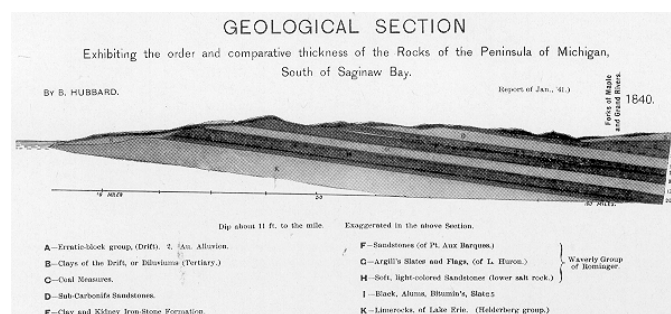
occupies the same superposition as the limestone at the rapids of Grand river.

Black Shale

A black bituminous shale was first seen at Sulphur island, and also extending along the shore of the main land, for some distance. It is highly bituminous, burning freely when thrown upon the fire, and contains numerous small nodules of iron pyrites. It may be considered as equivalent to the shales of western 'New York.

Thunder Bay Limestone

This limestone occurs at the south cape of Thunder bay, forming an abrupt cliff, which rises directly from the water to the height of twenty feet. It is composed of alternating layers of compact and shaly limestone, and fissile clay slate; the latter of which forms a considerable portion of the cliff, containing nodules of iron pyrites and chert. Most of the rock is of but little value for economical purposes. It contains numerous fossils, among the most characteristic of which, are the *Atrypa aspera*, and *prisca*, *Delthyus speciosa*, *Calymene bufo*, *Gorgonia*, *Millepore*, *Catenipora stellata*, *Cyathophyllum dianthus*, *Calamapora spongites*, *Pentremites pyriformis*.



[Geological Section near Saginaw Bay]

Black Limestone

This rock is seen cropping out at intervals on the lake coast, from Thunder bay island to Middle island, but it either occurs below the surface of the water or so little elevated above it, after leaving outer Thunder bay island, as to be difficult of examination.

Most of this rock is of an inferior character and furnishes a coarse, rough, building material, and is of very little value in an economical point of view. Some portions of it are of a sub-slaty character, highly charged with bituminous, while portions are nearly composed of congeries of fossils. It is undoubtedly the animal matter from the fossils that give to this rock its bituminous character.

Among the most characteristic fossils found in this rock, are the *Calymene bufo* Rowii and *Blumenbachii*, *Atrypa aspera* and *prisca*, *Delthyus speciosa*, *Calamipora favosa*, *Orthis*, *Cyathophyllum ceratites*, *Orthocera*, *Calamapora favosa*.

Blue Limestone

Limestone of a light blue color, and very compact, was seen at intervals between Middle island and Forty mile point, forming the bed of the lake, or but slightly elevated above the water. It is regularly stratified and very compact, and contains numerous fossils; among those ascertained were the *Atrypa prisca* and *aspera*, *Orthis*, *Euomphalus earinnatus*, *Cyathophyllum helianthoides*, *Flustra*.

Mackinac Limestone

In the vicinity of the Island of Mackinac, the upper portion of this limestone is chiefly made up of broken cemented fragments. The rock is of a light color, and the fragments of which it is composed frequently contain numberless minute cells. These were undoubtedly once filled with spar, which has been washed out of the exposed part of the rock, by the action of water.

Many of the more compact parts of this rock, when first broken, show numerous small veins of spar piercing it in every direction and owing to the porous character of the upper portion of this rock, it affords but a poor building material; while the lower part of the rock is more compact and has marks of regular stratification. This is more clearly exhibited on Round and Bois Blanc island, and where a much better building material can be procured, than any seen on the Island of Mackinac.

Hornstone, striped jasper, imperfect hogtooth spar, calcareous and fluor spar, and some very imperfect fossil remains, are occasionally found imbedded in this rock. The whole exposed portion, has the appearance of having been very much shattered by an irregular upheave.

Limestone of a similar character to that above described, was examined on the main land, to the west of Mackinac island, forming the high bluff known as the "Sleeping Rabbit;" also forming the bed of the lake west of old Fort Mackinac, and extending westerly as far as point Wabachance.

ROCKS OF LAKE MICHIGAN

Rock has not been found to outcrop in that part of the state north of Grand river, lying between townships seven and fifteen north, and west of the meridian. But were the superincumbent sands and clays removed so as to expose the rocks to view, they would be found to correspond with those passed over in going south-east from the rapids of Grand river to Monroe county, being a succession of sandstones and shales.

Near the Manistee river, in township fifteen north, limestone appears in elevated cliffs; which rock is probably referable to the same series as that of Monguagon, in the south-east part of the state.

Blue and Light Gray Shales

This shale crops out on Grand Traverse bay, (in township thirty-one north,) forming a cliff of from five to fifteen feet in height, is of a light gray or blue color; most

of it highly argillaceous, and is divided into thin laminae, varying in thickness from one-eighth of an inch to two inches. The thin laminated parts of the shale are very friable while the thicker layers are more compact and calcareous.

Minute crystals of spar were seen attached to and filling crevices in the most compact part of this shale. I was unable to detect any fossil remains in the shale.

Black Shale

This shale forms a series of abrupt cliffs, of from one to twenty feet in height, for the distance of nearly a mile on the coast of Grand Traverse bay, (in township thirty-two north,) being four or five miles north from the blue shale before described, and lies below it.

This shale is slightly bituminous, contains numerous nodules and specks of iron pyrites, is very friable, disintegrates rapidly before the action of the waves to which it is exposed, and closely resembles in character, composition and superposition, the shale of Sulphur island of Lake Huron, with which it may be regarded as identical in geological position.

This shale was also examined in the north bank of Pine lake, (in township thirty-three north, range seven west,) where it is but slightly elevated above the water of the lake; contains like the shales before described, numerous nodules and specks of iron pyrites, is slightly bituminous, and is equivalent; to the black shales of Lakes Huron and Michigan.

Associated with the shale at this point, are large angular masses of foeted limestone and shall connected together in the same mass: and these masses are frequently traversed by thin veins of pearl spar; the latter also filling the small cavities formed in the rock. The masses of foeted limestone above described, occupy places simply in the lower portions of the shale stratum.

Corniferous Limestone

The rock to which I have given this name is of a light gray color, regularly stratified in layers varying from one-fourth of an inch to twelve inches in thickness, and is very compact: some portions of it affording a good building material. It contains large quantities of imbedded hornstone, in layers, from one to twelve inches in thickness, and which breaks into small blocks on exposure to the atmosphere. This limestone is destitute of fossils, in that portion which was examined.

Little Traverse Bay Limestones

These limestones agree in geological position and character, with those of the cliff in Thunder bay, Thunder bay island and Middle island of Lake Huron.

The limestones of Little Traverse bay rise directly from the water, forming abrupt cliffs, varying in height from five to thirty feet, and for the sake of a more minute description, they may be sub-divided, and considered in a descending series as follows:

		Feet.	Inches.
1.	Blue silicious limestone, much of it very compact, and will afford a good material	9	2
2.	A confused mass of broken fossils imbedded in clay		
3.	Vesiculated chert, colored with iron	1	
4.	Flaggy limestone separated into layers, varying from one-fourth of an inch to an inch in thickness	8	
5.	Blue clay containing imbedded semi-crystalline grains of iron pyrites	8	
6.	Light blue limestone, below the surface of the water; thickness unknown; resembles the limestone of Middle island, Lake Huron		

Most of the limestones of this bay are of an inferior quality for economical use. They are very much shattered, presenting in that respect a strong resemblance to the sandstones of the southern part of the state. Some portions of the rock on this bay are so shattered, as to have the appearance of a mass of loose blocks. Fossils were found in a very perfect state; among the most characteristic of which are the *Atrypa prisca*, *Productus*, *Strophomena*, *Calamapora polymorpha*, *Cyathophyllum vesiculosum*, *Tsotelus gigas*, *sareinata*, *Ceripora verrucosa*, *Catenipora labyrinthica*.

Blue Limestone

This rock was found outcropping at the first point west of Pine river; also, south of the head of Little Traverse bay, and, is there of a light blue color. It is elevated a few feet above the water of the lake and stream, where it embraces the black bituminous limestone, next described. The latter occurs here, in two or three thin layers, which are filled with fossils.

The blue limestone is very compact, in strata varying in thickness from one to two feet. These strata are much warped, as if by irregular uplift, destroying all regularity of dip. It contains numerous fossils, analogous to those of Middle island of Lake Huron.

Black Limestone (Subordinate.)

Embraced in the blue limestones, is found the out thinning edge of the black limestones of Thunder bay island. It is seen in the bay beneath the waters, and between one and two miles south of the head of the bay, in the bed and banks of a small stream, where it consists of several layers, from two to twelve inches in thickness; is highly bituminous and is almost wholly composed of congeries of shells, which undoubtedly give to it its bituminous property. It burns when thrown upon the fire, with a brisk flame, so long as any of the bitumen remains, but the mass is not reduced in size by the burning.

It is the bituminous character of this rock, which has given rise to the reports that coal existed in the vicinity of the Little Traverse bay.

The Indians attach great value to this rock, for its inflammable quality; and upon inquiry being made of them, respecting it, they professed to be entirely ignorant of the existence of any rock of that character, in their region of country.

Deer Licks

Springs which have their waters slightly saturated with muriate of soda, and the salts of lime and iron, are occasion ally to be met with, in that portion of the state under consideration. In character and quality of water, they are equivalent to those which are found in Macomb and St. Clair counties, and cannot be considered as of much practical importance.

Ancient Lake Ridge

In prosecuting my examinations in the north part of the southern peninsula, portions of ancient lake ridges were met with, which were found to correspond with that whose character was determined by Mr. Hubbard, and described in his report of last year, as occurring in the southern part of the state. No large continuous ridge was met with, through the country examined by me, but rather a series of small ridges, which were found to be composed of water worn pebbles, gravel and sand, not unlike those composing the present lake beach, and having an elevation, as nearly as I was enabled to judge, of one hundred and forty feet above the present water level.

These ridges were found the most fully exhibited on the islands and on the main land bordering the straits of Mackinac, and occur under circumstances that would seem to show that the water of the lakes had subsided gradually, or, (which would produce the same effect,) the land had been gradually elevated.

COLUMBUS C. DOUGLASS,
Assistant Geologist.

Report of B. Hubbard, Assistant Geologist

Detroit, January 24, 1841.

To Douglass Houghton, State Geologist:

Dear Sir—Immediately upon my return from the portion of our state bordering on Lake Superior, where my services as assistant had been required during a large part of the season, I recommenced the detailed surveys in the organized counties of Michigan proper. These were conducted with a more especial view to the determination of the extent and value of the coal district of the peninsula. The counties in which minute examination have been made during the past season, are Barry, Clinton, Shiawassee, Genesee, Lapeer, St. Clair and Macomb; and examinations have been extended generally over other counties previously examined, in part, in order to the more full and satisfactory completion of the duties assigned me.

Maps of the Counties.—The labor of correcting, while in the field, maps of those counties which were assigned to my geological and topographical supervision, has been completed, and the plats are now in the hands of the state topographer, to be prepared for publication. A great mass of information, both of a practical and purely scientific character, and which could not be transferred

to the maps, nor be suitably embodied in the annual reports, has been compiled from my field notes, arranged for future reference, and for such use as may be found advisable in the final report on the survey. Particular attention has been devoted towards the full collection of all such details as would give a completeness to the several objects aimed at, in this department of the survey, and I may be permitted to say that no source of information, known to me, has been neglected, which could subserve interests of so important and comprehensive a character.

Purpose of present report.—The report of Mr. Douglass, of last year, embraced a general view of the extent of the coal bearing rocks, so far as then ascertained, and their details in the counties of Jackson, Ingham and Eaton; my own having been confined to the rocks below the lowest of the coal bearing-series. Without further recapitulation of the facts heretofore submitted than may be unavoidable, I propose, in the present report to exhibit a comprehensive view of all the rock formation, *throughout the organized counties* of the state.

The “*geological section*” hereto prefixed, will serve to exhibit, at a glance, the succession of the rock formations, from the universally superimposed sands and gravels, down to the great limerock formation of the southern portion of our state, bordering on Lake Erie. It is intended to show the rocky basis which would be exhibited to view, if the country could be cleft through, in a line from Lake Erie to Maple river, in Clinton county. The rocks in this section are grouped according to their distinguishing characters and relative position, and each group is distinguished by an alphabetical letter. The *sub-divisions* of some of the groups, are given in the body of the report.

GENERAL GEOLOGY OF THE ORGANIZED COUNTIES OF MICHIGAN

In the “section” alluded to the rocks, embraced within the district under consideration, are divided into groups, as follows:

- A. Erratic block group, or Diluviums.—a. Alluvions, ancient, recent.
- B. Tertiary clays.
- C. Coal measures.

Upper coal and shales.
Lower coal and shale.
Included sandstones.
Limestone stratum.
- D. Sub-carboniferous sandstones.
- E. Clay and kidney-ironstone formation.
- F. Sandstones, of Point aux Barques.
- G. Argillaceous slates and flags, of Lake Huron.
- H. Soft, light colored, sandstones.
- I. Black, aluminous slate.
- K. Limerocks, of Lake Erie.

These will now be considered, as nearly as may be, in their consecutive orders beginning with the highest in the series.

ERRATIC BLOCK GROUP, OR DILUVIAL DEPOSITS

These consists of sand, pebbles, and large water-worn masses of previously existing rocks, with occasional small, local beds of clay. They have a thickness varying from one to upwards of one hundred feet; they form a universal mantle to the rocks, and constitute the soils of all the interior counties.

As this whole deposit is one of transport by water, and is made up of the detritus and disrupted fragments of heterogeneous formations, its character depends upon that of the rocks from which it is derived. For instance, *sand* constitutes by far the greater proportion, and this circumstance may be, in part, accounted for, from the fact of the immense extent of sandstone rocks existing farther to the north; and in part, by the fact, further disclosed by the geological researches in the peninsula, that an immense thickness of rocks, mostly sandstone, which composed the upper series of the coal measures, has been broken up and removed from our geological series. *Fine gravel* constitutes the diluvium in the next proportion, and is the result of a similar abrasion of rocks of harder materials. Owing to the friable nature of the sandstones, as might be expected, few large boulders of that material occur. Limestone pebbles and boulders are abundant; a condition which also might be looked for, when we take into view the immense extent and thickness of the limerocks of our state, they being by far the most prominent formation above the primary.

These relations of the component parts of our diluviums, give a character to the soils of the peninsula, which enables us to compare them most favorably with those of most other states of the union. Though being very generally what may be denominated sandy or gravelly, and often answering in appearance to a description of soils which, in the eastern states, are considered as absolutely barren, the variety and due intermixture of their components, and more particularly the large proportion of carbonate of lime which is combined with them, either in the form of pebbles, or in a very comminuted state, impart to them unusual strength and fertility. The latter circumstance is that which so admirably a day is them to the growth of wheat, and in this respect, most of the soils of the peninsula may fairly be pronounced unrivalled.

Whatever may have been the causes which swept these materials over the face of the rocks, whether oceanic currents or bodies of floating ice, the character of these *diluviums*, as well as numerous accompanying facts, plainly imply that they came in a direction northerly from their present beds, and often from great distances. Consequently we find intermingled, as well as scattered upon the surface, numerous rounded fragments of those primary rocks which are known to exist in the peninsula of northern Michigan and in Canada, from the size of the largest “hard-heads” down to fine gravel. In proceeding from our state southerly, these deposits are found gradually to thin out, evincing a diminution of the sustaining power with the increased distance from the original bed of the transported materials. So that, while

the peninsula of Michigan has been most liberally supplied with an uncommonly deep and arable soil, made up of a variety of materials, the states of Ohio and Indiana, on the south, are in great parts destitute; its place being supplied by the clays of the next lower formation.

The deposition of these materials took place with or without apparent order and uniformity, according to the character of the existing surface, and other circumstances which may have governed the transporting forces. From this cause considerable variations are to be found in the depth, nature and composition of the diluviums, and hence, also, material differences are occasioned in the soils and other characteristics of the country. In many places a uniform stratification has taken place, as if the result of quiet deposition. This is more particularly apparent on the east and south side of the main ridge of the peninsula, and may be considered as a natural consequence of so considerable an obstacle as this partial barrier must have interposed to the force of northerly currents. Here, wells have been carried to the depth of 90 feet, through beds of stratified gravel.

Throughout all the diluviums, thin local beds of clay are of frequent occurrence, and occasional strata, of hard pan or cemented pebbles. These clays, unlike those of the tertiary, contain little or no lime.

Most of the country thus covered by the diluvial deposits, exhibits the action of strong currents and eddies in a very striking manner. Districts of many miles extent frequently present a continued and close succession of rolling knobs or cones of gravel, with deep intervening basins. The more ordinary character of surface is a gentle roll or slight undulation, occasionally subsiding to a perfect plain.

Except where a deposit of clay underlies, the growth of timber is almost invariably scanty, constituting what are denominated "oak openings." The character of their timber changes with the varying conditions of the soil, from white and black oak to burr oak or hickory, and the plains are frequently altogether destitute of timber. A dense growth of the usual hard wood timber sometimes occurs over isolated tracts, in swales, or along banks of streams. Of the character of country described are found the three most southerly ranges of counties, with the exception of those which immediately border the peninsula on the great lakes, together with parts of the adjoining counties, and the counties of Ingham and Eaton. All the latter have a sub-stratum of clay, belonging to the great deposit to be presently described, and in consequence differ very materially in surface, soil and timber.

To this extreme thickness and comparatively loose texture of the diluviums, may be ascribed the great abundance of springs, and consequently of the small streams which irrigate the whole surface of the state, affording abundance of that element so desirable to the farmer. An undulating surface gives to most of these a

sufficiently rapid flow to preserve a healthy current and to furnish a sufficiency of mill power. From the same cause, also, little difficulty is experienced in obtaining pure water by sinking of wells, and it may safely be said that Michigan is better supplied with living water, uniformly distributed, than any other state in the Union.

The vast numbers of small lakes for which Michigan is so remarkable, are due to the same causes. They occupy generally deep hollows, seemingly scooped out of the mass of diluvium, and are fed by the living springs that percolate through it. The number of these peninsular lakes is stated by the state topographer at not less than 3,000; being in proportion of one acre of water to every thirty-nine of dry land.

Another striking feature in the peninsula landscape, is the number and extent of wet prairies or marsh. Of these the proportion is much larger than of the lakes, and they often cover many miles of surface. These have their origin also from springs, issuing from the diluvium, aided often by the artificial dams of the beaver, and from being originally mere pools or shallow lakes, in time they become receptacles for beds of marl and peat. From the very tolerable hay which these prairies afford, and the very early supply of tender "feeding" for cattle, in the spring, the apparently waste places have been an invaluable aid to the settlement of the country. The primitive settler came hither, not to a desert waste or a "howling wilderness," but to lands cleared without aid from the woodman's axe, and verdant with unsown crops. He did not wait to provide pasture, but brought his herds and flocks with him, and the marshes furnished them ample sustenance throughout the year. And we hazard nothing in saying that these marshes, waste as many of them are now suffered to be, are destined to become still more valuable in sustaining the failing vigor of the country whose youthful prosperity they promoted. Their successful drainage is no longer a matter of experiment. Scarcely a marsh of much extent exists, which is not capable of thorough drainage, with comparatively small expense, and, when thus subdued, of furnishing a soil rich almost beyond comparison. The literally exhaustless beds of marl and peat with which these marshes abound, constitute another item of value no less important. But the consideration of these may more properly be referred to the head of *Recent Alluvions*.

But though affording a medium for the absorption of rain waters and their percolation through strata of gravel or quicksand, the diluviums are rendered sufficiently retentive, by the alumine contained in them, and by seams of cemented gravel and sand. Were it not for this, the moisture absorbed by our light, sandy soils, would soon be drained off and lost to the crops. A substratum of cemented gravel, retentive of water, is common to many if not all the prairies, and to this circumstance, may, no doubt, in great measure, be ascribed their accumulation of rich loam and consequent fertility.

Much curious inquiry has been excited on the question of the causes which produced the peculiar varied and open character of so large a portion of our peninsula. After the view which we have just taken of our diluviums, it may seem less a matter of surprise, that portions of the state should be adapted to the production of a dense growth of hard timber, and others only to the several species of oaks or to hickory, according to the continually varying conditions of the soil and its substrata. The existing analogies of the vegetable world, which exhibit similar results elsewhere, might lead us to infer these changes, and we may, without doubt, attribute to the peculiar characteristics of our diluvial envelop, and its varying conditions, the accompanying peculiarities in the natures of the country and the growth and character of its timber.

How far the impervious character of the "hard pan," which so generally, if not universally, forms the substratum to the prairies and plains, may account for the destitution or sparse growth of large trees, we are not altogether prepared to decide, and, therefore, avoid for the present, considerations which at best may be considered somewhat theoretical. Nor will we assume to decide, with confidence, upon the extent of the effects produced by the ravages of the annual fires which formerly swept over these tracts. It is but reasonable to conclude that all these, and perhaps other concomitant causes have operated together in producing the results we witness, while, according to peculiar circumstances, one of these several causes may have operated more or less powerfully than others.

Ancient Alluvion

As the consideration of that immense mass of materials to which has been applied the name of *diluviums* or *erratic block group*, was necessary, in order to a correct appreciation of those lesser deposits now to be considered, (which are associated with, and in fact compose a part of the former,) that important group claimed our first attention. We come now to the consideration of a class of deposits which may be called *alluvial*.

Some interesting facts in relation to the assumption that the waters of the great lakes were formerly at a much higher level than at present, covering a large part of the border portions of the peninsula, were noticed in my report of last year. During the past season a continuation of the "ridge," which is supposed to coincide with the beach of the ancient lake, has been traced through Macomb into St. Clair county, and further facts, confirmatory of the positions assumed last year, were observed in other more northerly districts. In the county of Macomb this ridge has been much broken up by crossing streams, and is very irregular, showing frequently the existence of large entering bays and curvatures of the coast. This was the more particularly noticed from the fact that elsewhere, so far as observed, the course of the ridge is very remarkably continuous and well defined. In this county, also, a number of inferior ridges of evidently similar origin, were observed,

between the main one and the present lake shore; leading to the supposition, that the subsidence of the waters did not take place gradually and constantly, but that sudden lapses occurred and the water line had been stationary at intervals.

The soil and detrital matter superficially covering that portion of the peninsula which is embraced between this ancient lake ridge and the present shores of the lakes, I have denominated *ancient alluvion*, to distinguish them as well from alluvions now in process of formation as from the immense mass of *diluviums* which overspread the whole interior of the State beyond this separating ridge.

The portion thus distinguished by alluvial deposits, embraces a broad belt of border country, varying in width from about 25 to 50 miles. It is, with small local exceptions, heavily timbered and very level. But, on passing the bounding ridge, there is, in general, an almost immediate change to a soil of coarser character, and a more undulating surface. This ancient alluvion is a deposit, from a quiescent condition of the waters, and similar to that which is now taking place in the beds of the present lakes. It forms, in general, but a thin mantle to the underlying formations, consisting often of mere ridges of sand, and owing to the deprivation of its lime, has, in general, less fertility than the diluviums.

The heavily timbered district is not altogether coincident with the extent of this alluvion, but is dependent chiefly upon the following cause. Throughout their whole extent, the alluvions are underlaid by the tertiary clays. These are a formation anterior to both the diluviums and alluvions, and are frequently found extending far beyond the old lake ridge. The country thus underlaid, is that which is almost wholly clothed with a dense growth of timber. This formation will be found described under the head of tertiary clays.

Recent Alluvions

Under this head, I shall here allude only to local beds of marl, bog ores and peat.

Marl occurs in the greatest abundance, universally distributed throughout the diluvial district, and consists of local deposits, which originate solely from the lime so profusely contained in the diluviums. Such beds are in constant process of formation and increase, wherever that ingredient exists. As it is present in a much less degree in the ancient alluvion, no extensive beds are consequently found throughout the district occupied by the latter.

Bog iron ores are deposits, originating in a similar manner, from the iron contained in the soil, which is dissolved out by the rain waters and collects in low grounds.

Peat beds are exclusively of vegetable origin, and are common both to the alluvial and diluvial districts.

The character, abundance, and value of the marl, peat and bog ore beds of our state, having been fully dwelt

upon in the reports of last year, I shall make no further remarks upon their practical applications. I cannot avoid, nevertheless, once again directing the attention of the farmer of Michigan to the fact of the unexampled abundance in which the two former occur, conveniently distributed for universal use as a manure, and urging the use of them, as the cheapest, and in most cases, the best of mineral manures, and which will be found a very important means of improvement in his agricultural economy.

Organic Remains

Bones of the mastodon were last year discovered, in the ancient alluvion, in the western part of Macomb county. They were mostly so much decayed as not to bear exposure to the atmosphere, and a molar tooth only has been preserved. Similar relics were, several years ago, disinterred on the Paw Paw river in Berrien county. There is now in possession of a gentleman in this city, a vertebral bone of enormous size, said to have been found, many years ago, upon the St. Joseph river, and which is pronounced by the State zoologist, Dr. Sager, to be the caudal vertebra of a whale. It measures in vertical diameter, including spinous process, 18 inches; transverse diameter, including lateral processes, 2 feet; diameter of body, 11 inches; length of body, 10½ inches; length of spinous process, 9 inches. Its weight is 21 lbs., which is probably less than one half its original weight, as the bone is partially decayed.

TERTIARY CLAYS

These extensive deposits belong to an era subsequent to the removal of the upper coal bearing rocks. They cover all the border counties on the east and west slopes of the peninsula, and, in some instances, stretch far inland. These clays extend over more than two-thirds of that part of the state which lies south of Saginaw, Maple and Grand rivers, embracing nearly the whole of the counties of Ottawa, Allegan, Van Buren, Berrien, Monroe, Wayne, Macomb, St. Clair, Sanilac, Huron, Tuscola, Saginaw, Lapeer, Clinton, and Eaton, and a large portion of Ingham, Genesee, Shiawassee, Ionia, Kent, St. Joseph, Branch, Hillsdale, and Lenawee. The remaining portions of the counties last named, and very nearly the whole of Oakland, Livingston, Washtenaw, Jackson, Calhoun, Kalamazoo, and Cass, are destitute of this sub-clay formation, and their diluviums rest immediately upon the rocks.

A dense growth of timber almost invariably accompanies this formation, whatever may be the immediate soil. We find this observation applicable to large portions of Eaton, Ingham, Clinton, Shiawassee, and Genesee counties, though these counties are based in part on the sandstone rocks of the coal series, and have sandy, diluvial soils, while the sandstone country south of them presents little else than oak openings and plains.

These clays are an extension of the same formation which covers the western and northern part of Ohio, and the east and north of Indiana, and which constitutes the soil of a large proportion of those districts.

The upper portion is a gravelly, yellowish clay, varying in thickness from one to fifteen feet, and having an average probably not exceeding 5 feet. Beneath this is a similar clay of a blue color, and which in some places has been found to exceed in thickness one hundred and twenty feet. Both clays contain at least 20 per cent., by weight, of carbonate of lime, and this marly character injures them materially for the manufacture of bricks or pottery.

On the western slope of the peninsula, the place of the yellow and blue clays is sometimes supplied by clay of a reddish color, of great thickness. No fossils have yet been discovered in any of the clays of this formation.

Coal Measures

The rocks which include the coal beds of our state occupy, comparatively, but a small portion of that part of the state under consideration, and are embraced within the counties of Jackson, Calhoun, Ingham, Eaton, Kent, Ionia, Clinton, Shiawassee and Genesee. They consist of strata of sandstone, shale, coal and limestone. Covered as these rocks are, with thick deposits of diluviums and clays, they make out crops at but few points, and the determination of their order and extent has been a matter of no small difficulty. From the dip of the rocks composing these measures, there can be little doubt that the coal basin extends northerly beyond the counties named, perhaps as far as to the head branches of the Tittabawassee and Maskego rivers. But that country is as yet almost wholly unsettled, and though partial explorations have been made through it, since the commencement of the geological surveys, the thick mass of overlying materials has hitherto prevented a determination of the northerly extent of these rocks.

Limestone Stratum

As this stratum, from its position, (being the lowest in the series,) determines the extent of the rocks considered as composing our coal basin, I shall, for the sake of greater precision, give to it the first consideration.

A gray limestone, in irregular, detached beds, is found along the extreme border of the coal bearing sandstones. They are evidently relics, in place, of a thin but extensive stratum, and as no coal has been found below this rock, I have assumed it as the terminating rock of the "coal measures" proper of our state. Following this rock, as it makes its occasional appearance, the southerly limits of the coal basin may be traced by a line drawn from the Shiawassee river, at Corunna, through the easterly parts of Ingham and Jackson, between ranges one and two east to near Napoleon, in the latter county. It then turns westerly through town three south, ranges one and two west; from whence, taking a direction north-westerly, it pursues an irregular line, passing through Bellevue, in the south-west corner of Eaton county to Grand Rapids, in Kent county. Here the lime rock is more extended and a thickness has been determined to it of fourteen feet. The rock is characterized by the fossils *Nucula* and *Cyathophyllum vermiculare*. This stratum affords the only limestone for the kiln, or other purposes, except

occasional boulders, to be found in the interior of the state, and its value is the more to be appreciated as the formation is itself of very limited extent.

Lower Coal

But two continuous beds of workable coal are ascertained to exist in the state. The lowest of these lies at a small distance only above the limestone stratum, and is associated with a very thick bed of shale, which is also sufficiently bituminous to answer the purpose of an inferior coal.

Coal of Jackson County.—That portion of the lower coal bed which underlies a portion of this county, makes an outcrop in the valley of Sandstone creek, town of Spring Arbor, and has there been penetrated to the depth of three feet. The thick bed of shale opened at Jackson undoubtedly is associated with and belongs to this coal stratum.

Coal of Ingham County.—Passing down the easterly side of the basin the coal is again met with, in the north-east corner town of Ingham county, where it is embraced in a succession of shales and friable sandstone, cropping out in the banks and bed of the Red Cedar river. The coal has here been penetrated two and a half feet. But neither here nor in Jackson county is the entire thickness of the bed determined. "The coal at this point," as is observed in the report of Mr. Douglass, of last year, "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, for a considerable portion of the year, and opening a direct communication with Lake Michigan."

It may here be observed, that the coal of this lower bed, universally, has more than usual compactness and purity, and is equal to the best bituminous coal of Pennsylvania.

Coal of Shiawassee County.—The coal again makes its appearance at the border of the basin, near the county seat of Shiawassee county, where it crops out between thick and extensive layers of sandstone, in the banks of the small creek entering Shiawassee river. The coal has here a thickness of from three and a half to four feet, and is accompanied by shale, the entire thickness of which is not ascertained. This coal is very eligibly situated for mining. It is of excellent quality, and the dip is so slight that but little depth of excavation will be required. This is the only locality in the state where coal, to much extent, has been raised for economical use. Both the coal and associated shale are constantly employed to great advantage at the steam mill of Mr. McArthur, in Corunna, as well as by neighboring smiths.

From an area of eight by nine feet Mr. McA. raised four hundred and sixty bushels of coal and shale, and he informs me it can be sold at the county seat for ten cents per bushel.

The underlying limerock stratum makes an out crop about a mile south-west from this point, in a bed of probably many acres in extent.

Shales of Flint River.—The coal bed and its accompanying shale may be traced still further east, to the Flint river, in Genesee county. Here the former probably has nearly thinned out, as only loose masses are found, in the bed of the river. The associated black shale and slate may be observed in the river banks, (town eight north, five west,) where it attains a thickness of sixteen feet, and is underlaid by the sandrock.

The coal of the Shiawassee and Flint rivers appears to occupy the extreme edge of the coal basin, which here thins out into a wedge form, narrowing gradually until it terminates in a mere point, probably as far easterly as Lapeer county. The inclination of the strata is north-westerly, to an amount which would soon carry the coal beneath the surface; but appearances seem to warrant the conclusion, that at this point a large part of the rocks of the coal measures, continued northerly, have been entirely removed.

Upper Coal

The outcrops of this coal, within that part of the state under consideration are of small extent. It is found at the surface on or near Grand river, in the northern part of Eaton county, and with its associated shales and sandstones, occupies the central part of the coal basin, probably including the whole of Clinton and Gratiot counties. Except in the extreme southwest corner of the former county it lies too deep for examination,

Most of this coal is inferior in quality and thickness to the lower coal. It composes several layers, not exceeding in thickness from one to two feet each, and is embraced in alternating strata of dark gray shales, blue clay, sandstones and thin beds of argillaceous iron ore, exceeding in the whole twenty feet.

Coal of Eaton County.—Sections of the alternating strata of coal and accompanying rocks, taken on Coal and Grindstone creeks, were given by Mr. Douglass in his report of last year.

Am that report contained full local details of all of the coal-bearing rocks of Jackson, Ingham and Eaton counties, I shall here allude to the rocks of that portion of the state only in such a general manner as will be necessary in order to afford a comprehensive view of the extent and value of the coal measures of our state. By reference to the document alluded to, it will be seen that, though inferior in thickness to the lower coal bed, the several strata of coal exposed on the creeks above mentioned, have an aggregate thickness of from two to three feet, and no doubt, prove of importance under a more settled condition of that portion of the state.

Included Sandstones of the Coal Measures

Gray and yellow Sandstones.—The sandrocks included between the upper and lower coal are mostly of a coarse, quartzose character, and of a light gray or yellow

color. Most of the strata are friable, but harden on exposure. They are distinguished from the quartzose sandstone below the lower coal by containing impressions of the coal plants. These are referable chiefly to the genera *Lipidodendron*, *Stigmara* and *Calamities*.

These rocks are found outcropping at numerous points through the northern part of Jackson county, the western part of Ingham and eastern part of Eaton counties, and portions of Calhoun, Clinton, Shiawassee and Genesee. In all of the above named counties they occur in situations which admit of being economically quarried, and may often be obtained in firm blocks of any dimensions required. From this series of sandrocks was furnished the material for the construction of the State penitentiary at Jackson, and at several places, as at Napoleon, excellent grindstones are manufactured from it.

Red or variegated Sandstone.—This rock immediately underlies the upper coal and shales. Its outcropping edge is found in the valley of Grand river in the northern part of Eaton county, and in the banks of the Lookingglass river, in the adjoining towns of Clinton county, and in township seven north, six west, Ionia county. No fossil plants were discovered in this rock. It has been employed with advantage as a building material. The entire thickness of the included sandstones must be several hundred feet.

The following general section will exhibit, at one view, the relative order and thickness of all the rocks of our coal measures, above described, so far as a sub-division of them has been found practicable.

General Section, applicable to the coal basin of Michigan.

	Thick- ness.
	Feet.
Diluviums and tertiary clays	1 to 100
Brown or gray sandstone ⁵³	20
Argillaceous iron ore, in thin included beds ⁵³	1
Coal strata, alternating with friable slaty sandstone and thick beds of black shales and slate, ⁵³ in the whole probably	30
Red or variegated sandstone, (Clinton and Ionia counties) ..	Undeter- mined
Light gray, coarse, quartzose, micaceous sandstones. Generally in thick layers and forming ledges, mostly friable and easily quarried. (Seen at intervals along Grand river from Jackson to Grindstone creek, Eaton county)	
Coal and black bituminous shale, (Jackson, Ingham, Shiawassee and Genesee)	20
Blue, compact, slaty sandstone, (Shiawassee co.)	
Gray limestone, found in local beds, being relics in place of a once continuous stratum. (Encircles the coal basin from Grand Rapids to Shiawassee river)	14

The rocks in the above section embrace all those which are included in the division marked C, in the *geological section*, prefixed to this report.

SANDSTONES IMMEDIATELY BELOW THE COAL

These sandstones (marked D, in the plate,) as well as most of the formations below the coal, were fully described in my report of last year. I shall, therefore, now notice them only so far as to exhibit their relative

position in the series, viewed as a whole, and the extent of country occupied by them.

These sandstones, which, in the report alluded to, are described under the name of *fossiliferous*, *ferruginous sand-*

⁵³Counties of Clinton and Eaton.

stones, excepting in some of the uppermost strata, are generally fine grained and of a yellow color. Some strata of the latter abound in marine fossil shells, among which the genus *Nucula* is very abundant, and there were observed species of *Atrypa*, *Bellerophon*, *Euomphalis*, and *Pterinea*.

Though here classed as beneath the coal rocks, these sandstones are associated with that series of rocks which are usually regarded as belonging to the carboniferous era. They occupy nearly the whole of Calhoun county, the lower half of Jackson, and the northern half of Hillsdale county; through which counties their outcrops may be observed at numerous points, or they are reached in almost all the deep wells. It is probable, also, that these rocks occupy most of the eastern portions of Jackson and Shiawassee counties, east of the limestone stratum above described; and they make their appearance, at its eastern edge, on Lake Huron, near the entrance of Saginaw bay.

The aggregate thickness of these sandstones may be estimated at upwards of 300 feet.

CLAY, CONTAINING KIDNEY ORE OF IRON

This very valuable formation immediately succeeds to the sandstones above described, underlying them and cropping out at the extreme southerly bend of the basin, it occupies a part of the south-western portion of Calhoun county, the whole north-eastern portion of Branch county, or nearly so, and part of the western and central portions of Hillsdale.

It consists of an indurated, grayish brown clay, having much the appearance of a shally limestone or dark gypsum regularly stratified, in which are imbedded nodular masses of kidney ironstone. This is a rich and valuable ore and occurs at several points conveniently for working.

This formation is the lowest that is discoverable in this portion of the state, and is not certainly known to make an outcrop elsewhere.

For further description of this clay and its contained ore, I refer you to the annual report of the State Geologist of 1840, and to my own appended thereto, for many practical considerations relative to the value of the ore and its imbedding clay. This formation is marked F, in the plate.

SANDSTONES OF POINT AUX BARQUES

These are mostly a coarse, greenish gray or rusty yellow rock, in some of the layers approaching a conglomerate. They form cliffs along the shore of Lake Huron in Huron county, rising at Point aux Barques to twenty feet.

Fossils are rare, but *Atrypa* and *Calymene* were obtained. These sandstones occupy the coast north of town seventeen, being visible in ledges for, about twenty miles. The upper portion of the series contains numerous, small imbedded pebbles of quartz, so as to resemble a conglomerate of puddingstone, but no great thickness is observable of rock possessing this character.

An extension of the outcropping edge of these sandstones, it is probable, gives rise to that swell of land which forms the summit level of the peninsula, stretching in a south-westerly direction from Point aux Barques to Hillsdale county, where the green and yellow fossiliferous sandstones, above described, overlie it. But throughout this whole extent no outcrop of the rock is visible owing to the thickness of the diluviums.

These sandrocks, taken in connection with the formation next described, hold a place in the geological series, corresponding to the "waverly sandstones," and "conglomerate," of Ohio, but the deposition seems to have been made under somewhat differing circumstances. No well defined series is apparent in our state answering fully to the Ohio conglomerate; though the upper portion of the sandstones of Point aux Barques approach that character.

The whole thickness of these sandstones probably exceeds 250 feet. This group is marked F, in the plate.

CLAY SLATES AND FLAGS OF LAKE HURON

Alternating with the lower portions of the sandstones of Pt. aux Barques, are strata of slaty sandstone, approaching the character of slate; to which succeeds a compact, micaceous clay slate of a blue color. This latter rock continues to occupy the coast for about thirty miles, or from township twelve to township eighteen north, and rises in ledges of from five to fifteen feet.

The slaty sandstones intervening between these clay slates and the overlying coarser sandstones are of a flaggy structure in some of the layers, and from these were obtained those fine flagging stones which have been extensively used for three years past for pavements in the city of Detroit. Some of these strata are distinguished by *ripple marks*. No fossils have been discovered in this formation.

These slates and alternating sandstones may be considered as the upper salt rock of our state. They have been passed through, in boring for salt at Grand Rapids, and found, to yield strong supplies of brine. At this point they are found also to alternate with beds of gypsum and gypseous marls, as will, appear by reference to the table of the strata passed through, given on a subsequent page. The thickness ascertained to these slates, at that point, is about 170 feet.

SOFT, COARSE GRAINED SANDSTONE

A series of sandrocks answering to this description, and generally of a dark color, succeeds to the clay slates and shales last above described, and has been penetrated at

the borings at Grand Rapids, 230 feet. There are, as yet, no data for ascertaining the entire thickness of this series, since it does not make its appearance at any point on the coast of the peninsula, this rock evidently forming the bed of Lake Huron near its foot, and lying too deep for observation. In relative position and perhaps in character, this rock, or a portion of the series, corresponds with the lower salt rock of Ohio and Virginia, and is the rock from which, in these states, the strongest supplies of brine are obtained. The result of the borings in our own state, thus far, would seem to confirm the opinion that this rock is the equivalent of the lower salt rocks of those states.

BLACK, BITUMINOUS, ALUMINOUS SLATE

Underlying the sandstones above noticed, though, also, nowhere observed to make an outcrop within the portion of the state now under consideration, there is a well characterized black, bituminous slate. This rock makes an outcrop much further to the north, and is described by Mr. Douglass, in his accompanying report, to which I refer you. This slate contains much sulphuret of iron; it will burn readily, and in general character and position it agrees with the black shale stratum of Ohio and Indiana, but its thickness is probably not nearly so great.

LIMESTONES OF LAKE ERIE

This formation, which immediately underlies the black slate, is by far the most continuous and extensive rock formation in the western states. It is found outcropping in several district ranges throughout Monroe county, forms a considerable part of the lake coast and serves as a basis to the islands at the mouth of Detroit river, and is an extension of the rock formation which occupies the whole western part of Ohio and the northern and eastern portions of Indiana. It is found forming the bed of Lake Michigan at its head, and undoubtedly is the underlying rock of a considerable portion of the extreme south-western part of our state. The overlying tertiary clays conceal a great part of this formation.

The character and economical adaption of these limestones have been sufficiently set forth in former reports, to which, accordingly, I refer you for detailed information.

Among the fossils contained in the limerock, I distinguish the following genera: *Calymene* and *Asaphus*, *Cyathophyllum*, *Productus*, *Terebratula*, *Spirifer* and *Dethtyrus*, *Bellerophon*, *Atrypa*, *Strophomena*, *Orthocera*, *Encrinus*, *Retepora* and *Madrepora*.

In proceeding southerly from the outcrops of the slates of Lake Huron, a limerock is met with, which may be seen in the bed of a small stream near the lake coast, town nine north, sixteen east. In character and fossil contents it bears a resemblance to that of Monguagon, Monroe county, but its position would seem to indicate it rather as an included stratum in the series of sandrocks and shale, which are higher in the geological series.

The following general section will exhibit the order of succession and approximate thickness of the rocks

above described, *lying below the coal basin*, and is a continuation of the table previously given of the successive rock formations of the settled portions of our peninsula:

General section, applicable to all the rocks below the coal beds of Michigan in that portion of the peninsula included in this report.

		Mean thickness in feet.
D.	Sandstones of Jackson, Calhoun and Hillsdale. { Coarse quartzose, grayish sandrocks, Fine grained, ash colored and dingy green, interstratified with slaty sandstone and clay shales, Yellow sandrocks, colored by iron, and abounding in fossils,.....	300
E.	Dark gray and blue indurated clay, containing kidney iron. (Counties of Hillsdale, Branch, and Calhoun.)	45
F.	Coarse sandstone, or partial conglomerate, Yellow and greenish sandstones, (coast of Lake Huron, at Point aux Barques,).....	250
G.	Slaty, argillaceous sandstone, alternating with sandstone and clay slates, Blue clay slates and flays, with alternating gypsum beds and gypseous marls, (Lake Huron coast, below Point aux Barques,).....	180
H.	Soft, coarse grained sandstones, (occupies bed of Lake Huron at its foot,) exceeds.....	230
I.	Black aluminous slate, containing pyrites, (coast of Lake Huron at Thunder bay,).....	
K.	Gray limerock, fossils abundant, (west end of Lake Erie,).....	

The rocks in the above section embrace all those which are included in the divisions marked D, E, F, G, H, I, and K, in the GEOLOGICAL SECTION prefixed to this report.

DIP OF THE ROCKS

Great irregularities of dip are observable in all of our rocks, which circumstance has increased the difficulty of determining the precise relative position, extent, and thickness of the several strata. Many of the sandstones belonging to, and immediately underlying the coal, are much shattered, as if by a quick vibratory motion, and a similar cause has occasioned contortions of dip in most of the still older rocks. I have, therefore, refrained from noting the amount and direction of dip at the various localities mentioned. All the rocks on the eastern slope of the peninsula, south of Saginaw bay have a general dip north-westerly, while the dip along the southerly and westerly border of the basin of the coal bearing rocks, is such as to indicate the counties of Clinton and Gratiot as occupying nearly the central part of the coal basin. This being the case, the carboniferous sandstones, with their included coal beds, may be considered as extending far to the north of the Saginaw and Grand rivers, possibly as far as town 23 north, or to the head waters of the Maskego and Tittabawassee rivers. This supposition, the character of that region, as well as the dip of the rocks would seem to warrant. But the country alluded to, is, at present, in an uninhabited condition; the surface, moreover, is very generally level, and so completely overspread by the deposits of diluviums and tertiary clays, as totally to conceal the rock formations. Surveys have, however, been extended into that region so far as was practicable with the means afforded, and much valuable information in collected.

If I am correct in the above conclusion, the coal bearing sandstones, or strictly speaking, the *coal basin* occupy an extent of surface, nearly oval in form, whose centre very nearly corresponds with the true centre of the peninsula. The tract thus embraced is 150 miles in length, north and south, and upwards of 100 in extreme breadth; covering an area of about 11,000 square miles, or one fourth the entire area of the lower peninsula.

It may be added, that the average dip of all the rocks described, does not probably exceed 15 feet in the mile: though the dip may be said to vary, at different points, from 10 to 20 feet per mile.

BORINGS AT THE SALT WELL, GRAND RAPIDS

The borings for salt at the village of Grand Rapids, Kent county, commenced in the limerock stratum, mentioned above, [page reference omitted] as constituting the terminating rock of the coal basin. At this point, several of the next succeeding series of sandrocks appear to have thinned out, and their place is here occupied by alternating strata, of clay slates and sandstones, with gypseous marls and beds of gypsum. These continued to a depth of 190 feet, and below this the borings have been carried mostly through series of sandrocks, to the depth of 415 feet.

Two beds of beautiful crystalized gypsum were passed through, at a depth of about 60 feet, and were found to be from 4 to 6 feet in thickness. This gypsum, it will be recollected, from the notice of it in former reports, appears at the surface at Gypsum creek, three miles distant; showing an inclination to the rocks, at this point, of about 20 feet in the mile.

By reference to a map of the state, it will be apparent that the strongest brine springs, (among which are included those in the vicinity of these borings,) make their appearance along a line which will be found to correspond with the "synclinal axis," or axis of the dip of the rocks composing the great peninsula basin; a circumstance which would be looked for, from the fact that the ordinary law of gravitation would conduct the strong brines to the lowest levels of the rock strata. While, therefore, the depth to which the boring must be carried, in order to reach the lower salt bearing strata, will be greater than would be the case in some other portions of the state, the comparative strength of the brine obtained may be expected to be proportionably increased.

Through the politeness of the Hon. Lucius Lyon, I am enabled to subjoin a section of the strata passed through at the boring above mentioned.

Diagram of strata passed through at salt well of Hon. L. Lyon,
Grand Rapids

		Thick- ness in feet	Total depth, feet
1	Hard gray limerock, irregularly stratified, and in portions cavernous.....	14	14
2	Yellow sandrock, producing fresh water.....	6	20
3	Blue clay.....	2	22
4	Coarse, reddish sandrock.....	5	27
5	Blue clay.....	3	30
6	Clay slate, with thin layers of gypsum interstratified.....	11	41
7	Clay slate.....	18	59
8	Gypsum.....	4	63
9	Clay slate.....	2	65
10	Gypsum.....	6	71
11	Clay slate.....	3	74
12	Bluish sandrock, very hard, with sharp grit.....	8	82
13	Bluish clay rock, intermixed with particles of reddish rock, compact. This rock is strongly impregnated with saline particles.....	18	100
14	Sand and clay rock, alternating.....	7	107
15	Carbonate of lime and gypsum, combined, very compact.....	10	117
16	Gypsum.....	7	124
17	Clay slate.....	9	133
18	Gray sandrock, of very sharp grit, and hard.....	5	138
19	Clay rock.....	2½	140½
20	Gypsum, with vein of salt water.....	6½	147
21	Clay rock.....	6	153
22	Gypsum and clay slate, or gypsaceous marls, alternating.....	19	172
23	Gypsum.....	3	175
24	Clay rock.....	3	178
25	Gypsum.....	1	179
26	Hard sandrock, producing fresh water.....	1½	180½
27	Clay rock, free from saline matter.....	10½	191
28	Hard sandrock, very compact and of dark color.....	7	198
29	Soft sandrock, nearly colorless.....	18	216
30	“ “ of dark blue color.....	32	248
31	Loose, coarse grained sandrock, of reddish color, opening a very copious spring of fresh water..	17	265

Below the strata last noted in the above table, the borings have continued through a further depth of 150 feet, but the data received are not sufficiently minute to enable me to extend the table. From the information obtained, they would seem to have passed through mostly soft, light colored sandrocks of a coarse grain and with a sharp grit, and in the lower portions containing cavities into which the drill sometimes falls several inches. Particles of salt were brought up, and the rock yields a very strong brine.

All the strata, from the depth of 81 to 179 feet, or until the sandrock was reached, were strongly impregnated with saline particles, and yielded brine one-fifth saturated. These clay slates and marls may be regarded as the “upper salt rocks,” and they are thus shown to furnish a brine superior in strength to that of many of the salt wells of Ohio, and which, even could no stronger brine be obtained, is capable of sustaining a profitable manufacture.

The brine now obtained, at a depth below the above of about 230 feet, may be supposed to proceed, by veins, from the “lower salt rock,” lying at still greater depth, and from which the strongest and best supplies of brine in our State may be expected to be obtained.

The immense quantity of fresh or slightly brackish water which is discharged through the orifice, equal to a hogshead per minute, in the present state of the operations, renders it impossible to decide, with absolute certainty, what will be the full strength, as well as supply, of the strong brine; but from that which can be obtained, it is estimated, that of the brine which the well is now capable of furnishing, from fifty to sixty gallons only will

be required to produce a bushel of salt. This, it will be seen, is equal in point of strength, to that obtained from the salt wells on the Kenawha river of the Ohio, where the borings are carried to about the same depth, and at which arc- manufactured annually, from one to two millions of bushels of sail. Next to those of the State of New York the Kenawha salt wells are considered the best in the Union.

In addition to the quality of the brine obtained, the advantages for the manufacture of salt at the point under consideration, are not exceeded at those places in our country where the manufacture is conducted to the largest extent. The supply of wood for fuel and other necessary purposes is abundant, and will tend greatly to reduce the price for which the manufacturers will be enabled to furnish this article. And, though the whole matter may be said to be still in an incipient state, there is every reason to feel satisfied with the prospect, which so fair a beginning holds out to the state, for obtaining a result so very desirable, as that of supplying her citizens with this important article from the product of her own manufacture.

SUMMARY

Comprising general observations on the economical results of the survey

From the view we have now taken of the rock strata which compose the lower half of the southern peninsula of Michigan, it will be seen, that the geology is of an exceedingly simple character, while it is, at the same time, richest in the mineral wealth most important to an agricultural community.

Michigan occupies a portion of the great valley of the Mississippi—the richest in the world—and which is wholly occupied, by a broad extent of the rocks classed by geologists in the transition and secondary formations. Of these, the great limestone formation, (of which that of the west end of Lake Erie is a portion, and which concluded our view of the several geological groups which make up the organized portion of the state,) occupies the lowest place, and is the lowest and oldest of the rocks found on the lower peninsula of Michigan. The upper peninsula of our state, as will be seen by the report of the state geologist, is constituted of lower and still older rocks, and presents, in consequence, a very different aspect, as well as a different mineral character, from the lower peninsula.

The most important of the minerals usually associated with the rocks of those formations which compose lower, or Michigan proper, are iron and lead ores, coal, salt, gypsum and marls. There are no indications which would warrant the supposition that *lead*, in any valuable quantity, exists on the lower peninsula. At least it may be positively assumed that no ores of lead will be found throughout any of the present organized counties of the state. All the other minerals mentioned, exist, and some of them, as has been shown, in great abundance. The results of the examinations into the economical geology

of the state, as regards the most important of its minerals, I shall here briefly recapitulate.

IRON.—An ore of this mineral, under the form of kidney iron-stone, exists, chiefly in the counties of Branch and Hillsdale. It is sufficiently extensive to be of much value, and will give an average yield of about 30 per cent, of metal. This ore is embraced in the clay formation, of which an extended notice will be found in the geological report of 1840.

Iron, under the form of bog ores, is found in various parts of the state. The most extensive deposits, and those alone which it may be safe to assert will yield a rich profit, are at the county seat of Kalamazoo, near Concord, in Jackson county, in the county of Oakland, and perhaps Wayne. No furnaces, for the reduction of these ores, have yet been erected. It is shown, by the late census, that there are fifteen furnaces in the state for the casting of pig iron, requiring 614 tons, and the whole amount of iron imported, under various forms, is much greater. The cost of this importation, which in so heavy an article as iron, is very considerable, might and ought to be saved to the state, by a domestic manufacture from our own material. For more detailed observations, and an account of the localities in which this ore occurs, see geological report of 1840.

BITUMINOUS COAL will be found in abundance for all the wants of the state. The only locality where mining operations have been commenced is at Corunna, Shiawassee county, where this mineral has been already used to considerable extent, and, though in the midst of a heavily timbered country, is for many purposes preferred to wood or other combustible. Other points also, eligibly situated for the mining of coal, have been made known in Ingham, Eaton and Jackson counties, and it may be fairly inferred, from the facts already determined of the range of coal bearing rocks, that outcrops of the coal beds will be found at numerous other points than those now known in these counties, and that coal will also be discovered in several counties where it is not now known to exist, as though parts of Kent, Ionia and Genesee counties.

SALT.—There no longer exists any doubt that this mineral may be obtained at a cheap rate and in any required quantity, for supplying the great and increasing demand in our state. The operations commenced at the state salt wells near Grand Rapids, Kent county, and on the Tittabawassee, Midland county, are not sufficiently advanced to determine the extent of the anticipated profit of the manufacture. The strongest brine obtained, up to this time, at the salt well of Mr. Lyon, at Grand Rapids, will, without doubt, prove as productive as that of the best wells of Ohio and Virginia. So that the present results may be considered as certainly indicative of the success that was formerly supposed would attend the boring for salt, if properly conducted, within our State.

Michigan *imports* salt probably to the amount of three hundred thousand dollars annually, which large amount

of money might, as it soon will, be saved to the state, by the supplies furnished from her own resources. The average price of salt at the ports of entry, has been about three dollars per barrel for the last four years. But when the works now in progress shall have been brought into successful operation, supposing no stronger brine to be obtained than that above stated, the article of salt can be furnished at a much less price than it now costs the consumer.

GYPSUM.—An extensive deposit of this very valuable mineral occurs in the vicinity of Grand Rapids. The bed is here very extensive, is about six feet in thickness, and in quality is equal to the best gypsum of Nova Scotia. The same mineral is found elsewhere in our state, but this is by far the most important locality at present known, and one that affords every facility for quarrying and distributing the mineral over the state. A mill was erected during the past summer, and the ground plaster, for manure, is already manufactured in considerable quantities.

Though the above locality is the only one known at which gypsum occurs, *in the interior* of our state, yet from the ascertained geological character and dip of our rocks, and the associations of this mineral it may be presumed that gypsum and its associated marls will be hereafter disclosed at other points in the vicinity of the above bed, and that it will be found also to occur at other localities, in the interior, which are concealed from present observation.

SHELL MARL occurs in the greatest abundance throughout the state, but more especially among the marshes and lakes of the openings. It forms deposits, varying in extent from one acre to one hundred, and these are pretty widely distributed. Its exceeding great value and cheapness, as a *manure*, is far from being truly appreciated by our citizens. But the time is rapidly approaching when this invaluable mineral will be no longer despised because it is abundant, simple and cheap, and our state will then find, in her numerous marl beds, one of the richest treasures of which she is possessed. For a full account of the nature and uses of this mineral, the reader is referred to page 94 of the report of 1840, and to previous reports.

The character, applications and value of the rocks with which the above mentioned minerals are associated, together with other mailers of practical interest, connected with the geological structure of our slate, are so fully detailed in the preceding pages and in previous reports, that further allusion to them, in this place, is deemed unnecessary.

From the foregoing facts, it cannot fail to be seen that, while the soils of our state are admirably adapted to the various purposes of agriculture, and for the production of wheat—the most important product of the soil—superior to those of any known portion of the Union, Michigan possesses, also, within herself, all the mineral treasures that are really requisite for sustaining and renovating her soil, for supplying the wants of her homesteads, and for

maintaining those branches of domestic industry which are of the most importance to her people. Thus science discloses those treasures, buried in the earth, which art and industry may appropriate to increase the profits of labor. And though the objects of science are general in their nature, and not confined by the limits of districts or states, the legislator feels a peculiar interest in having those resources developed by its aid, which may be turned to the advantage of his rising commonwealth; commerce, agriculture and the arts receive a stimulus by the new sources of wealth and supply which it opens to the wants of each. In this view, the study of geology becomes one of the most universally useful that can occupy the attention of practical men.

In comparing the extent of our resources thus obtained, with the little that was known concerning them a few years ago, we have reason to feel satisfied with the prospect of future wealth and importance, which it has opened to us. If during the stirring times of an early settlement, so rapid as has been that of our state, for the past five years, less interest was excited by the development of our mineral resources than their importance might demand, a satisfactory cause may be found in the imperfect state of the knowledge hitherto obtained, and in the pressure of the more immediate wants of a new, somewhat fluctuating and unsettled community. During the period mentioned, however, the population of southern Michigan has advanced from a less number, probably than 60,000 to 212,000, a rate of increase unexampled even in the annals of a series of settlements, to the progress of which the world affords no parallel. Meanwhile the liberal course of our state policy has been steadily unfolding her resources, and, at this moment, notwithstanding the burden of a heavy debt, and the accumulated pressure of more widely felt financial difficulties, we are rapidly advancing in wealth, and are becoming awakened to the means of which we find ourselves possessed, for successfully competing with older states, in the departments of agriculture, commerce and manufactures. With lands among the richest in the world, well watered and advantageously situated for market, with water power abundant, and with an extent of coast and facilities for water transportation unequalled by any other inland state, and added to this, a population possessed of a large share of that character for enterprise which distinguishes their countrymen, nothing will tend more to give full efficacy and permanency to these advantages than to make more perfectly known, the value of our mineral resources. Our state is now sufficiently advanced to be able to avail herself, properly and with certainty, of the advantages alluded to, and there is every reason to believe, that these will not longer fail to command attention, and that the results will equal the most sanguine anticipations.

BELA HUBBARD, *Assistant Geologist.*

Report of S. W. Higgins, Topographer of Geological Survey

Detroit, January 24, 1841.

To Douglass Houghton, State Geologist:

Sir—In fulfillment of your instructions, I have, in the present report, brought together such observations relating to the magnetic variation in this state, as will, I trust, assist hereafter in affixing data to important facts. Further developments will require a prolonged period and additional observations. But the readiness with which the direction of magnetic lines may be ascertained, by the help of the solar compass, will render the labor and hazard of error a thousand fold less than any former method, and it is hoped that this compass will supercede everywhere, the necessity of depending alone upon the needle.

A great desideratum is obtained in having an instrument that will decide between antagonist forces, and indicate the inflections of magnetic lines, and determine mathematically, their amount.

From what has been advanced, an opinion is drawn in favor of magnetism being diffused throughout the particles which compose the mass of the earth, and against that of a magnetic nucleus at its centre. The modifications in the magnetic lines on the peninsula, are seen to be abrupt and irregular, where there are no indications of ferruginous matter, and in the absence of mountainous chains, equally as where mountains do exist.

But this subject when considered in connection with others, assumes no less importance. The changes which are silently and gradually progressing in the arrangement of the materials of the earth, are partly due to magnetic and electro-magnetic powers; other powers may co-operate in the production of general results; but the first are known to be active where there are metals and ores, and to these may probably be referred the arrangement and filling of mineral veins.

In an economical point of view, the level tracts and marshes in our state may be considered of great importance. Though the expense of clearing new lands is trifling, particularly our openings and plains, compared with the heavy timbered lands of the east, yet to drain the marshes and convert them into arable land, is still less expensive than either. There is little doubt of the success of operations in progress, by which many of them are becoming permanently dry, while others will require artificial aid. In either case large and valuable portions of the richest soil are reclaimed.

There appears to be throughout the state, a singular connection between the marshes and the openings and plains; where the one is found, the other is usually associated with it, while the timbered lands are comparatively free from either large or numerous marshes. The course of policy for the preservation of the timber on the openings, which must inevitably in time become lessened in quantity, while its value increases,

is to adopt those modes which will most speedily recover the tracts under consideration, and thus prevent the waste of timber which cannot be replaced.

In the report which follows, and in which I have alluded to the above subject with others, I did not feel at liberty to extend my remarks further than a del ail of fads.

VARIATION OF THE MAGNETIC NEEDLE.—*General law relating to magnetism—causes of the perturbations of the needle—experiment—opinion concerning local attraction—rule applicable in explanation of the needle's attraction on the peninsula—general correctness of the observation in the public surveys—example—conditions by which it is demonstrated—description of the line of no variation—its course independent—no correspondence in exterior lines—similar system of curves at Great and Little point aux Sable—BURT'S SOLAR COMPASS—Professor Loomis' report on annual changes in magnetic meridians—diffusion of magnetism, &c.*

The general law regulating the forces of magnetism, with its direction and intensity, has been untiringly studied, until by certain tests, it, has at last, been discovered that palpable effects are produced by the magnet on all substances whether organic or inorganic and there seem to be only two ways of accounting for the phenomena: "either that all substances in nature are susceptible of magnetism, or all possess particles of iron or some other magnetic metal, from which this property is derived."

The obvious perturbations of the needle, as seen in all situations at times, arise from many small causes combined, and which, so far as they exert their force, influence the greater power of terrestrial magnetism, whereby it becomes proportionally feeble, as these combinations are multiplied. Atmospheric changes operate still further, and in a more sudden manner, to affect the needle; but the first causes mentioned, are the most perplexing, and surveyors have attributed to local causes, that which is found to be inherent in all substances.

The following single experiment will evince how far local causes are concerned in general. If a small needle be constructed of any substance, and suspended between two magnets, it will be found to fix itself in a line in the direction of the poles of the magnets, and the number of oscillations in a given time, will usually determine in different needles, the quantity of matter susceptible of magnetism in each; thus an important discovery has been made by means of this active principle, whereby is detected the least insensible traces of iron, when all other tests have failed.⁵⁴

The opinion, then is an erroneous one, that mineral must always be present in masses to cause the aberrations of the needle. This is not necessary, nor is it the fact, for those minerals which are deeply buried can have no influence, inasmuch as their influence decreases inversely as the squares of the distance, and it may be said that the needle is wholly indeterminate in their neighborhood in respect to them, "since the resultant of

magnetic forces being then vertical," or nearly so, or nothing, "the horizontal element would be nothing."

If it is true, as has already been abundantly proved, that magnetism, electricity and gravitation are governed by the same laws, and that they decrease in the ratio of the squares of their distances from attracting bodies, if becomes difficult to define what is meant by "local attraction," in the common acceptation of the term, unless it be granted, that the regions where it has been met with so commonly, abound in ores, or metallic substances to a great extent, or that it has been the misfortune of the surveyor to come so nearly in contact with mineral masses, above or near the surface of the earth, as to occasion the utter temporary loss of the polarity of the needle.

It may be laid down as a rule applicable hereafter in explanation of most of the deviations of the needle which occur in the central and western portions of the state, (there being but few rocks in *situ* that appear on the surface, and those

⁵⁴Professor Farrer.

lime, slate and sand rock, and the geological structure of the peninsula, being such as to preclude all opinion of there being ores or metals, or any kind of minerals, except bituminous coal, marl, and the like, further than what is found in all alluvial and mountainless countries, and there being an utter impossibility of any masses other than what may be eratic, capable of producing any great effect;) that as the direction of the needle is the effect of a principal terrestrial force, its deviations arise only from those smaller secondary forces which we have said are inherent in all substances.

Many facts might be adduced in verification of the above supposition, from the thousands of observations which have been made during the course of the surveys of the public lands in the state. Entire lines have been measured from the southern to the northern boundary of the peninsula across its whole breadth on true meridians, and these lines have again been intersected by others running east and west, at right angles, each line having the magnetic variation recorded at intervals of every six miles, the points of intersection. Within the limits of these lines is included the whole area of the lower peninsula of Michigan (and by an exact enumeration of the meanders of the coast, in the intervals between the terminations of these lines, is obtained with the greatest accuracy, the number of square miles it contains;) now, from the collected observations, after rejecting those east of the principal meridian, mentioned in my report of last year as erroneous—and a few others that might be specified which are made to correspond to the measurement of fractional lines—an area of 41,304 square miles, is laid out with the accuracy of a map, and the magnetic meridians traced with the same facility as any other known and prominent feature; in fact we have a magnetic chart, indicating the declination of the needle,

over this extensive region, on parallels of equal distances of six miles.

Let us pause here a moment to satisfy the inquirer, who may have doubted even the ordinary correctness of the observations, generally, obtained by the men whose duty it has been to establish the standard and other exterior lines in the survey of our state. To this end the two examples mentioned in another part of this report, will be sufficient, though, as I have stated, others might, with equal propriety, be adduced. One of the examples consists of forty-nine townships, and the other of fifty townships.

These examples are all verified by actual measurement, and, as it was to be expected, one of them falls a little short, and the other has an excess, only of the links in a mile, above the convergence which all meridian lines have when run north. Now, if an error, the gross of which should amount to 15', had been made in their observations, the result would be a departure from parallelism in the lines, of thirty-five links to a mile, whereas, the result exhibits an error of less than 2' to a mile.

Now, it is obvious from the foregoing, that there must be one of two conditions, which have given precision to the examples we have adduced; either the magnetic parallels have become greatly diminished in intensity and accommodated themselves to the plane of astronomical longitude, or care and skill have been exercised to modify the effects produced by them.

The latter condition is the true one, as we shall shortly demonstrate. We begin, then, at a point where the line of no variation passes out of Lake Huron, and first touches the south side of Drummond Island. This island is one of the north-westernmost of the chain of the Manitous which divide the waters of the straits of Ste. Marie. It first touches the island near the meander post on the shore, between ranges 7 and 8 east, in township 41 north, and is the tangent point to a curve of $4\frac{1}{2}$ miles radius which it then makes on the island, the western extremity of the curve touching again the south shore of the island in the middle of the next township, in range 6 east, whence a reversed curve of $3\frac{1}{4}$ miles radius, approaches closely to the corners and one-fifth of a mile south of fractional township 41 and 42, ranges 5 and 6 east; thence on a course south 85° west 6 miles, intersecting township line 41 between ranges 4 and 5, near the meander post south shore of the island, which is another tangent point to a curve whose radius is $3\frac{1}{4}$ miles. Along this curve, at the distance of one mile, is the western end of the island, and at the meander post for fractional township 41 and 42, range 4 east; thence crossing the channel to the opposite side nearly, the curve terminates between Round island and the main land of the upper peninsula, one-fourth of a mile from the shore; thence another reverse curve of $2\frac{1}{8}$ miles radius, just sweeps along the edge of the shore, northward of Pointe de Tour, the western termination of the curve being in a lake, on the south-west corner of township 42 north, range 3 east; thence again the curve is reversed,

whose radius is $2\frac{1}{8}$ miles, crossing the south boundary of the same township, $1\frac{1}{4}$ miles from its western boundary; whence the curve is again reversed, with a radius of $2\frac{1}{4}$ miles, passing off the coast into Lake Huron again, passing over one of the small islands near Massacre island; thence ascending, it re-crosses the south boundary of township 41 north, in range 2 east, between sections 55 and 54. thence curving northwesterly, with a radius of $6\frac{1}{2}$ miles, it crosses the town line between ranges one and two east, $1\frac{1}{4}$ miles from south boundary; still slightly curving northwardly, on a course of 12 miles, it crosses north boundary line of township 45, range one east; thence two miles it intersects Monusco bay, and curving westerly, leaves the wafer, and crosses the southeast corner of town 45, range one east, three-fourths of a mile from corner post, in town 45, range 2 east; thence curving with a radius of $6\frac{1}{2}$ miles, enters, at the mouth of the Miscoota Sawgee river the Canoe channel of the straits of Ste. Marie, and crosses it, about one mile above the Nebesh rapids in that channel, touching the most westerly point of Great Sailor's encampment island, and keeping the western and northern shore, with a curve whose radius is eight miles; here its course is again reversed, and beyond this we have no sufficient data to pursue it farther.

It is believed, however, to pass directly on to the southwest point of Sugar island, keeping along its westerly side, and crossing again the straits of Ste. Marie on to the main land at the forks of the Montreal channel and Great Hay lake, five miles east of the Saut de Ste. Marie; thence irregularly over the granite formations, and in conformity to the littoral features of Goulais and Batcheewauanung bays, touching Michipicoten harbor; thence, leaving the eastern end of Lake Superior, it has been said that it becomes forked, taking the circumference of Hudson's bay, or that the variation is the same on the eastern and western sides of the bay.

We have now followed it from Drummond to Sugar island through its actual and determined course, leaving nothing to conjecture; and we remark that for that distance, it is as well determined as any other ascertained line.⁵⁵

This line, before touching Drummond Island, where we first commenced with it, may with almost equal certainty be traced down along its southern course in, and to the foot of Lake Huron; although, for the reason that it is confined to the lake, we may not always ascertain its distance from the shore.

The course it would now take in the diminished part of the lake, approaching the straits of Mackinac would be somewhat analogous, it is presumed, to that in the straits of Ste. Marie. This fact is proved from observation, first on the island of Mackinac, on the west, and along the north-east and east shore of the peninsula, south of and opposite Drummond Island. It makes a large curve, which approaches the end of the lake, without touching Mackinac, and receding from it, descends south-easterly to the termination on the coast,

of the town line between ranges four and five east, in town thirty-six north, where the variation is $1^{\circ} 55'$ east. The same variation is found at the termination of town line thirty-four north, ranges six and seven east; thence east, eight miles, at

⁵⁵The hour should be noted as 10 o'clock a. m. for observations on this line.

Presque Isle, it is imperceptible. On Thunder bar point it is $45'$ east, the line of no variation, passing between the lighthouse on the outermost Thunder bay island, four miles from the shore, and this point; its course thence is to the outlet of the lake, near Fort Gratiot, where it crosses into Upper Canada.

From the fact that the line of no variation passes through a part of our state, we are in some measure better able to determine the rationale of another system of curves found elsewhere on the peninsula, particularly on its western side, at the Great and Little Pointe aux Sable, where a greater intensity is observable on approaching Lake Michigan from the east.

Under the ordinary ideas of magnetism, it would not have been believed that a line so curved as we have described, could have existed, without ascribing its irregularity to some corresponding cause of local force.

Although the upper peninsula of Michigan differs from the lower, in regard to its geological features, the conclusion might be drawn that at the line of junction of the rocks of the Riviere Ste. Marie, as described in your third annual report, where it is well defined as at, and through the outlet of the lake, the magnetic lines would be deflected, somewhat with the line of bearing of these rocks in a distance of thirty miles; but its course on the contrary appears to be independent of them, crossing them at right angles, and without regard to their character.

Another peculiarity is, that corresponding curves, exterior to the line of no variation, on either side bear no comparison. At the head of Great Sailor's encampment island, at the distance of two miles west; the variation is $1^{\circ} 10'$ east; and opposite the middle of the same island, at one mile east of the line, it is $40'$ west; at five miles, 1° west, and at six miles, $1^{\circ} 10'$ west; one mile south of Monusco bay, the distance of one and a quarter miles east of it, the variation is 1° west; five miles west, $2^{\circ} 35'$ east only, and the curve mentioned as again entering the lake between towns two and three, as well as the curve which passes around the edge of the shore above Pointe de Tour, have no variation at their centres, but on approaching either way, east or west, variation increases to $30'$, and then again decreases to 0, on touching the line of the curve.

The same peculiarities are observed on the western side of the lower peninsula, particularly at Great and Little Pointe aux Sable, where the intensity increases, and the curves, though larger, exhibit as little conformity. It is evident that the needle "hauls to the land," to use a nautical phrase, for at these points, the increase of

variation amounts to 3° in thirty miles, exceeding 6° at the points, while the increase is but 1° for the whole breadth of Lake Michigan, the variation being but 7° in Wisconsin on the opposite shore.

The instrument used in ascertaining the particulars we have been stating, is one totally different in its principles and construction from the common compass, and is not even dependent for its accuracy on the needle. It was invented by Judge Burt, of Macomb county, and the Messrs. Burt have given me the results of observations made by them with this instrument, during most of the last summer. The needle is used with this compass only when the sun is obscured by clouds; when the sun shines the needle is screwed fast, and the time then consumed in obtaining the true meridian, is not longer than that ordinarily taken by a needle to settle, while it is infinitely more correct.

I had intended to have given a description of this valuable Invention, but to do this clearly, without an accompanying drawing, was found impracticable. It is called the "solar compass," and consists chiefly of three arcs, one of which is graduated to the ecliptic, the other to the complement of latitude, and the third to the sun's declination, whereby, if the latitude be known, the others are known, viz: the sun's declination, and the apparent time, and consequently the magnetic variation; or if the sun's declination only be known, then the latitude, and the others are known; or if the time be known, the others can be ascertained by an almost instant adjustment.

We have not only now been enabled to adduce facts confirmatory of the general principles of terrestrial magnetism, but to enter considerably into detail on the subject of magnetic variation. A variety of reasons seemed to require this, the principal of which was, the definite course obtained of the line of no variation, and the consequent illustration of other lines on either side of it being also irregular; demonstrating a system of curves, and a series of distinct and separate centres of attraction. This has been effected over no very limited space, and is free from all that might be considered empirical.

It is believed that in accuracy and fullness of detail these observations exceed all that has been hitherto attained, nor am I aware that the line of no variation was ever before traced continuously for any great distance, or that other observations have been taken, than at those points, where it has been crossed by the surveyor or mariner.

It has been pretty well determined by Professor Loomis, of Western Reserve college, Ohio, that the "present annual changes of variation, caused by the retrograde motion of the needle, which commenced everywhere as early as 1819, and in some, places as early as 1793, is about $2'$ for the southern states, $4'$ for the middle and western states, and $6'$ for the New England States." This is true in general of the magnetic lines in this state where they are at a distance from the line of no variation, as at Detroit. Here the decrease or amount of

retrograde motion is 4 4-10' annually; the line of no variation has been quite stationary, at least for the last eight years, at points where it was known at that period. While, therefore, we observe a greater intensity as we approach nearer to the line of no variation, we likewise observe the distance to increase between the lines of equal variation, and while the first is stationary, the latter is retrograding.

While the paralllism which takes place in needles, proves that the magnetic force of the terrestrial globe may, like that of gravitation, act in parallel lines, we see also an exception. The lines of gravitation are always perpendicular to the surface of the sphere, while the lines of magnetism, which like gravitation, never cross each other, are composed of every variety of curve.

Though the diffusion of magnetism be general, it is by no means equal. It is found at the equator and at the poles, an interposed space equal to the earth's radii, and for this space no loss is apparently felt in its force, and it is not more difficult to conceive an exerting force through this, or a greater interposed space, than that the hand should communicate motion to a stone with which it is demonstrably not in contact.

If, then, magnetism be a real power, at what distance does it terminate? Can we give it an inferior level, and determine its final bounds, connected with solar light and heat? Does it not emanate from, and is it not governed by that great central source, the sun, which controls the more palpable and grosser materials of which the planetary system is composed, which effects every change either in the interior or exterior of this globe, and to which every element is subject, and by which are conducted in silent processes, all changes and revolutions, since time began?

DIURNAL VARIATION

The following table of diurnal variation was sent to me by honorable William A. Burt, who is in the constant practice of keeping a meteorological table in connection with his observations on the magnetic variation; the results are the same as noticed in my former report, though not then in detail. These observations were made in lat. 42° 43', N., long. 5° 24' 30" west, from Washington.

Table of Diurnal Variation, taken in Macomb County, Michigan.

1839	Thermometer			Weather		Magnetic variation				
Day	5 1/2 A. M.	1 P. M.	6 1/2 P. M.	A. M.	P. M.	Winds	5 1/2 A. M.	1 P. M.	6 1/2 P. M.	
July	12	60°	70°	62°	Clear	Light showers	W. S. W.	1° 42'	1° 28'	1° 42'
	14	59°	72°	67°	do.	Flying clouds	N. W.	1° 42'	1° 26'	1° 33'
	15	(at 5. 33 1/4)	73°	64°	Cloudy	Light showers	N. W.	1° 32'	1° 28'	1° 28'
	16	55°	71°	66°	do.	Some cloudy	W.	1° 38'	1° 28'	1° 30'
	17	52°	69°	65°	Clear	do.	W. N. W.	1° 30'	1° 28'	1° 30'
	18	55°	83 1/2°	80°	do.	Clear	W.	1° 41'	1° 28'	1° 35'
	19	56°	89°	82°	do.	Flying clouds	S. W.	1° 40'	1° 28'	1° 35'
	20	63°	80°	74°	do.	Cloudy	S. S. W.	1° 40'	1° 25'	1° 35'
	21	70°	82 1/2°	77°	do.	do.	S.	1° 42'	1° 28'	1° 30'
	22	72°	86°	75°	Cloudy	Some cloudy	W.	1° 40'	1° 28'	1° 35'
	23	65°	88°	77°	Clear	Clear	E.	1° 41'	1° 23'	1° 35'
	24	72°	86°	77°	Rain	do.	W. S. W.	1° 43'	1° 23'	1° 35'
	25	69°	83°	80°	Clear	do.	N. W.	1° 41'	1° 15'	1° 32'
	26	66°	88°	79°	do.	Cloudy	W.	1° 40'	1° 23'	1° 35'
	27	50°	80°	76°	do.	Showers	W.	1° 41'	1° 30'	1° 37'
	28	61°	80°	80°	Clear	Clear	W.	1° 42'	1° 24'	1° 30'
	29	66°	87°	78°	Cloudy	do.	W.	1° 41'	1° 21'	1° 30'
	30	60°	90°	79°	Clear	Showers	W.	1° 41'	1° 25'	1° 33'
	31	62 1/2°	76°	72°	do.	Clear	W.	1° 40'	1° 24'	1° 33'
	August 1	48°	79°	76°	do.	do.	W.	1° 40'	1° 24'	1° 28'

Note.—July 19, at 12 h. 30 min. P. M., variation 1° 10'; at 12 h. 45 min. var. 1° 15'; at 1 h., var. 1° 28'. July 24, at 6 h. 10 min. P. M., shower commences, var. 1° 45'; at 6 h. 40 min., shower past, var. 1° 25'. July 27, at 5 h. 45 min. P. M. shower rising, var. 1° 47'; shower past, var. 1° 37'.

COUNTY SURVEYORS—law respecting them—Judge Burt's compass—magnetic meridians—disappearance of original lines.

From the statute⁵⁶ regulating the duties of county surveyors, it becomes indispensable to possess themselves of one of Burt's solar compasses; for it is made their duty to be acquainted, before entering upon a survey, with the absolute variation of the needle, at the time and place where the survey is to be made, and to note the same upon their certificates, and no returns are either lawful or can be received as evidence in any court, without it. It may be supposed that this might be dispensed with, when it is known that the surveyor in the subdivision of a section, must be governed by the section and quarter section posts already established, and that the business of dividing a section, therefore, is merely intersecting these posts with his line, without the power to change them when wrong; and when smaller divisions are required, of taking equal distances between them, whether the full complement of acres be wanting or otherwise.

But though most surveyors have a meridian line for their own accommodation, generally in their immediate neighborhood, from which they can determine the magnetic changes, yet when their duties require them in opposite parts of a county, where the variation not unfrequently differs a degree,

⁵⁶Part first, title second, chapter third, section sixty-nine, revised statutes. In all surveys made as aforesaid, the course shall be stated, according to the true meridian, and the variations of the magnetic meridian shall also be stated, with the day, month and year.

Sec. 70. The surveyor and his deputies may demand and receive for their services, the following fees, to-wit: for each mile actually run with the compass, and measured with the chain, three dollars: *Provided*, That the necessary chainmen and markers be furnished by the surveyors or his deputy, at the request of the parties requiring the survey; but if the chainmen and markers are furnished by the party for whom the survey is made, or if the chainmen and markers be not necessary, then the surveyor and his deputies shall receive for each mile run, seventy-five cents, &c.

it is obvious that time must be devoted to an observation of some star to obtain the variation, if it be a clear night, or if otherwise, the survey must be suspended until a more favorable time. Besides all this, his pay is fixed at a stated, price per mile, and that price barely a compensation. Now, either to make the business desirable, and at the same time to fulfill the conditions of the law, he must have a ready method of getting the variation, or must spend his time in so doing, without an equivalent for his labor; and while the law remains as it is, no instrument besides the solar compass can enable the surveyor with profit, completely to fulfill the intent of the statute.

This question is of no less importance now, than it will be in future, when all traces of the original lines shall have been lost, which is the case already, wherever the county has become settled, and roads or fields have been opened along the boundaries of section lines.

AREA OF THE LOWER PENINSULA OF MICHIGAN—*former maps and descriptions erroneous—definite information now obtained.*

We have now the means of ascertaining, with the utmost degree of accuracy, the precise area of the lower peninsula, an accuracy characteristic of the plan pursued where the general government has the control of the surveys. These surveys afford the greatest facility in determining the boundaries and extent of every portion over which they have been made, from an eighty acre lot to a whole territory; and such has been their progress within the last three years, that there remains only the small fraction of thirty-six townships unsubdivided; but these, being mostly in the interior, present no difficulty in determining at once the exact number of square miles contained within the boundaries under consideration. I have with extreme care, multiplied together every fraction, and find the whole amount to be 41,304 square miles or 26,434,560 square acres.

In giving the above estimate, we cannot avoid the opportunity of confronting its results with the compilations of draftsmen and geographers, who, in relation to the peninsula, have heretofore, in the main, copied such estimates as have fallen in their way, whether right or wrong. But little care has been exercised, even by those who ought to have been better acquainted with the errors which have always characterized not only the maps, but the descriptions of the peninsula. It is to be hoped that the period of such errors is now passed, and that while most existing publications become obsolete, they will be replaced by correct ones; for it is not the much to say, that *now*, not only correct, but precise and definite information can be obtained, and wherever a dependence shall be placed upon former maps and descriptions, so far will their numerous and universal mistakes be the means of leading into important errors.

ELEVATION AND DEPRESSION OF THE WATER IN THE GREAT LAKES—*the maximum for 1838, 1839, and 1840—lowest stages of water of longer continuance than the higher stages—evaporation—semi-annual alternations—effects of winds—the apparent tides for fortuitous—reaction of the waters—table of elevation and depression for 1840.*

The last year is the second since the unusual elevation of the waters of the lakes; since which time there has been yearly a remarkable coincidence in the ratio of their subsidence, the more unlooked for, when taken in connection with the causes which tend to equalize the amount of falling water, in the form of rain, snow, and dew, with the constant action of evaporation.

In bodies of water like these lakes, slight changes in the seasons produce visible effects, in as much as they have no equalizing under-currents.

The quantity of rain must have been much less, and the evaporation more, than for many years past, to have produced the decrease mentioned below. This decrease amounts in the first year to one-quarter of the total rise,

and in the second to one-half, making the proportion each year as thirty-three to forty-four nearly.

The maximum of August, 1838, was five feet three inches above that of 1819; that of 1839, three feet eleven inches; and that of 1840, two feet seven and one-half inches. The ratio of decrease, therefore, between the highest water in 1838 and 1839, is one foot four inches; and between the highest water in 1839 and 1840, one foot three and one-half inches.

Its rate of decrease is much more rapid than that of its increase from 1819 to 1838. In 1830 it was only two feet above the level of 1819; in 1836, three feet eight inches; having risen one foot eight inches in six years. In 1837, it was four feet three inches; increase, seven inches; in June, 1838, five feet; increase, nine inches; and in August of the same year, five feet three inches. Having been nineteen years in attaining the maximum of five feet three inches, and only two years in reducing that height one-half, or to the average year of 1833. Thus the rapidity of its decrease in two years, equals the increase of five years.

I have not been able to ascertain whether the decrease of former years was thus sudden, or whether the period of the minimum, or lowest stage of water, continues for any great length of time; it is quite probable, however, that it does, and that the overflowing of the lands caused by the maximum rise, is but temporary, and only for one year, whence immediately commencing its decrease, it arrives very soon at its former standard, and remains there with little variation. Indeed, this is the more probable, from the example of the last three years, and from the appearance of long and undisturbed processes in the growth of trees and vegetation, with the formation of permanent channels in the interim, as well as the security felt by those who have erected buildings and planted orchards formerly, upon those lands which were inundated.

The diminution in a given quantity of water, exceeds by evaporation, all the supplies which it receives from rain, that is, the average amount of falling water is equal per year to 33 inches; evaporation will reduce it to 44 inches, when fully exposed to the sun and air. One season of extreme south would, upon the expanse of these lakes, produce an extreme depression, while the contrary would have the effect of producing a corresponding rise. It cannot be a matter of so much astonishment that such expanded areas of water, subject to such influences, should be greatly affected; the wonder is, that they do not oftener present greater fluctuations than they do, the equal and almost unvarying stage at which we find them, is due to the uniformity of the seasons, and the systematic order in which nature is conducted in all her works.

The semi-annual alternations observable in summer and winter, arise from other and well known causes. In summer, the supply is unchecked, and the consequence is, an increase to the height of 30 inches, or thereabouts; when in winter, these supplies are again checked, a

consequent depression follows. Measurements to ascertain exactly these semi-annual fluctuations, have never been thought necessary. Besides, it is not uncommon for ice, in large bodies, to collect at the outlets of the lakes, and, for the time, prevent the usual discharge, and a lower stage of water, is the consequence, than otherwise would be. When this occurs in the chain of lakes, as it frequently does at the outlet of Lake Huron, in connection with a west wind, as in 1824 and 1831, it diminished the depth of the Detroit river, opposite the city, to over ten feet, widening the beach more than twenty rods, and making it practicable (except in the immediate channel,) to cross without danger, on foot, from the American side, to Isle au Cochons or Hog Island; and a further proportional decrease took place in Lakes Erie and Ontario, while the pent up water flowed back into Lakes Huron and Michigan. For these reasons, and the want of uniformity in the temperature of the winter months, the minimum height is not to be depended upon.

Besides all this, the effect of winds sometimes acts in favor, as well as against the other irregularities. The geographical position of the lakes is such, as that, allowing them to prevail from the same point, at the same time over them all, (which is, by no means, always the case) they produce a variety of results. A west wind forces the water of Lake Erie into the Niagara river, at the same time, the waters from the foot of Lakes Huron and Michigan are forced into the straits of Mackinac, and these again are met by the waters of Lake Superior through the straits of Ste. Marie. Hence the straits which conned Lakes Huron and Erie have all the indications of a tide, though irregular as to time, as well as to the amount of its elevation and depression, and it has often both risen and fallen in about, the same proportion, and sometimes in the same period, as the lunar tides in those rivers which empty into the ocean. But whenever these tides take place, either in the lakes themselves or in the straits connecting them, they are fortuitous, and are the results of accidental disorder, common throughout the lake region.

Another feature may be observed of the lakes, different in nothing from the *ground swell of the ocean*—the reaction of the water, after having been pressed by the wind for a few days or hours in one direction.

The most favorable points for noticing this reaction, is at an inlet or bay; Lake Superior, which has the largest surface, presents the most marked traits. Here, while the explorations by the geological corps were in progress, the past season at the mouth of the Grand Marais river, which empties into a bay one mile wide and two miles long, having an outlet of a quarter of a mile wide into the lakes was observed the returning waters from the west, in wide undulations. The effect upon the smooth surface of the bay was a gentle elevation, which arose to one foot or more for a period of fifteen minutes, then subsiding, again returned at equal intervals of time, until the lake, after a lapse of a few hours, resumed its natural level.

Table of elevation and depression in the waters of the Lakes, Compared with that of June 1, 1839.

			Feet.		Inches.	Foot.		Inches.
1838.	August	21	Highest stage of water.....			5		3
1839.	January	1	Decrease.....		3	8		1
1840.	July	31	Highest stage.....		3	2		3
1840.	January	30	Decrease.....				2	7 ½
1841.	January	1	Decrease.....		2	1		6 ½

DETAIL OF THE ELEVATION AND DEPRESSION FOR 1840.									
			Feet.		Inches.	Feet.		Inches.	
1840.	January	30	Height of water.....						9
	April	25	Increase.....		1	5	2		
	May	9	" Rain and wind from N. E., fluctuations from 15 to 18 in.....			1 ½	2	3 ½	
	"	19	" Same.....			1 ½	2	1 ½	
	June	8	" Wind west, season dry and hot.....			1 ½	2	4 ½	
	July	4	" Light showers, weather same as last observation.....			3	2	7 ½	
	"	22	Decrease, much rain in June and July, on Lake Superior.....			3 ½	2	4	2
	September	1	" Season dry, little rain.....			2	2	2	
	"	13	" ".....			1 ½	2	1 ½	
	"	20	" Wind west, river fell suddenly.....			4 ½	1	9	
	October	1	Increase, heavy rain last 24 hours.....			4	1	9 ½	
	"	12	Decrease, do.....			3 ½	1	9	
	"	20	Moderate.....			1 ½	1	0	
	November	10	Increase, do.....			1 ½	1	10 ½	
	"	24	Decrease, freezing, wind moderate from west.....			4 ½	1	6	
	December	10	Increase, ice made in river in considerable quantities.....			1 ½	1	6 ½	
	"	21	Decrease, river blocked up by ice, no wind.....			2	1	4 ½	
1841.	January	1	River nearly closed, wind moderate from west.....			10		6 ½	6 ½

MARSHES—their origin—once inhabited by the Beavers—their enlargement and diminution—other causes of their production—without timber—their uses—marl—peat—rich soil—cause of the subsidence of the water on them—instances of their becoming dry—causes still in operation—irreclaimable marshes.

It is perhaps a matter of less difficulty than is generally supposed, to account for the existence of most of the marshes that so abound in this and other portions of the west. We may consider them as level tracts, so continuous often as to be but little broken for many miles, and which expand, or become narrow as the base of the hills and higher grounds, approach or recede; while the latter seem to stand as distinct and sharply defined as islands, whose shores are fringed by a line of limber, and whose foliage waves over the tall grass beneath, and which borders the very margin of this timbered belt, at times receding like deep indented bays, and again projecting in detached islands, and peninsula points, not unlike the meanders of an actual arm of the sea or lake—the level grassy surface being substituted for their waters.

Most of the marshes, however extensive, were once the habit a lion of the heaven, and were nothing more than expanded and shallow lakes of water. The stream that is now found universally to flow through them, was anciently at a lower level, which is sufficiently indicated when the depth of vegetable mould is penetrated and (he former surface exposed. This depth is found to vary from one to many feet.

From the well known habits of the beaver, we may suppose their first labor was to raise a dam sufficiently high to protect them from attacks by land, and as the bottoms of the lakes became filled up by the decay of grass and roots, an additional elevation of the dam became necessary, and this gave a greater area to the lakes, which continuing to spread, the adjacent land whose, relative level could be but little above the ordinary banks of the stream, was overflowed, leaving those islands, bays, and peninsula, points we have alluded to, to give an indescribable beauty to the landscape.

A process of enlargement or diminution of the marshes, is constantly going on according as the original cause is

either operating or has ceased: The latter is the case within, and to a great extent around, the neighborhood of permanent settlements. The beaver is nowhere to be found, excepting at the sources of Thunder bay river, and some other minor streams, on the lower peninsula: but Mr. Burt informs me that he found them within twelve miles of the coast north of Mackinac, in considerable numbers, where they had newly inundated the country to the depth of several feet.

Another cause of the stoppage of the streams, is the falling of timber across them, which becomes permanently fixed by the superincumbent pressure of the waters.

A long series of years, if not ages, must have elapsed to produce the filling up of these ponds by the decayed vegetation, and the destruction of so large a body of timber as that which once covered the ground they occupy, little or no vestige of these forests remaining, even of a fossiliferous character.

The benefit of these marshes to the country, consists not altogether in their picturesque and verdant appearance, or in the rural charm with which nature clothes them, so far from being practically useless, they, in great measure have, to this day, been the pasture grounds of the domestic herds, which otherwise could not have been supplied in the first settlement of the country. Their first use has been to sustain, by their spontaneous crops, the dependent husbandman, placing him beyond the care and labor of opening new fields for his supplies.

Another value, which will hereafter be better known and appreciated, is derivable from the immense beds of marl, so universally found in them; with its uses, as a cement and manure, thousands are already acquainted. It is well, known to be peculiarly adapted to our soil as a manure, and its quantity is inexhaustible.

Another characteristic production of the marshes, is the peat with which they abound; this may in future be found useful as a fuel, and may supply the place of that article when other sources are exhausted.

Nor need I here announce, what is so well known, (and which results from the fact of the composition of the soil, being made up wholly of decayed vegetation,) their surpassing richness, or that when, by artificial drains, or otherwise, they have been made arable, the experiment of planting and sowing for years, has attested them the most valuable and enduring lands in the state. So much is this the case, that their acquisition by those who understand them best, is more eagerly sought for than the richest of the woodland.

Numbers have yearly become dry, so as to be brought under cultivation, which have heretofore been known only as wet meadows, and where their yielding oozy muck could with difficulty be made to support the weight of a man, they have now no other water upon them than the original stream, and that no longer spreading over the whole surface as formerly, but confined to its proper channel.

The causes which will ultimately have a tendency to drain the great portion of them, is slow in its operations, but nevertheless, is sure. The operation may be expedited by artificial means; either, by straightening the usual serpentine course of the streams, or by enlarging their outlets, or which is the most effectual method, by removing the embankment, or beaver dam. These may, in almost all cases, be found by examination, though they are in a measure concealed, from the long period of their standing, and the materials of their construction, having become overgrown and covered with rank grass and mould, accumulated through long periods of years.

The law of fluids—the property of water to preserve its level—the natural and uniform effects when opportunity can be given for its operation, in level and sunken districts, will drain the superfluous waters from a higher to a lower level, leaving the surface dry. Thus, as I am informed, parts of the extensive meadows on the river road, in the southern towns of Shiawassee county, for miles, have the last year produced for the first time, crops of wheat, which, under my own observation, three years ago, were too wet to allow of crossing upon them; and in the adjoining townships, in the northern parts of Livingston county, small lakes have altogether disappeared. On the farm of Gen. Van Fossen, two of these lakes contained about three-quarters of an acre each, and were intended expressly for stock water for his cattle; these and several small marshes in the same county, have all since become fields. The marshes, in these instances, were all drained by the natural decay of old dams, or the wearing effects of the waters, in deepening the channel, and thus returning to their ancient level.

Further instances might be noticed, occurring in several counties in this state. In Branch county, several former marshes have actually emerged from a depth of two feet below the surface of the water. In these cases, the relative level has so changed within about seven years, as to be at present at a height of two feet above the water.

Here a second cause has been operating with the first, and which has given a greater rapidity in producing the effects we have mentioned, that is, the preservation from fire of the crops of wild grass; for if this is allowed to fall and decay, the continued accumulations formed by it, will have a tendency to alter and raise the level yearly, and but a short period of time will be necessary to complete the process.

Trees of a deciduous growth can never be supposed again to grow upon them, and hence they will always have the appearance that *natural prairies* present, with the advantages of a uniformly rich soil, which all natural prairies have not. They will likewise necessarily always receive the wash of the higher grounds.

Suggestions in relation to the cause of the late gradual decrease of the waters of the great lakes, in connection with the disappearance of these smaller lakes and drying of the marshes, have been offered, attributing both to the

changes in the seasons only, so that a recurrence of circumstances hereafter that shall produce a rise similar to the one of 1838, in the great lakes, will also, it has been supposed, produce a similar submergence of the marshes, and fill again the small lakes. But I apprehend there is no connection between the causes which have acted on the one, and those which have effected the other. It is true that the three thousand interior lakes, especially those of any considerable magnitude, have had their ebbs and flows in the same ratio, and at the same time and from the same causes, as the great lakes; but it should be remembered that no new instances of marshes being formed, have been discovered, but on the other hand, when the waters of the lakes were rising for years, and were at their maximum, an equal progressive subsidence was taking place in the waters of the marshes.

The number of irreclaimable marshes is comparatively few, and their areas are circumscribed to the dimensions of the lake which originates them, and to the basins which inclose them. In the first case the lake is central and cannot be approached; the vegetation which had taken root in their margin, has been so often reproduced, as to contract the actual dimensions of large lakes, and confine the remaining open space of water to a small extent. This is in consequence of a floating, buoyant covering, fixed by the fibres of roots, which, having been first-supported by and around the shore, has, in deep water, no other support than what the surface of the lake itself affords. Hence, where these lakes become entirely covered over, as in Sanilac, Cheboygan and Presque Isle counties, and in some other instances, to a greater or less extent, the weight of a man causes a depression and a wave-like and trembling motion to some distance round. The surveyor, who is often compelled to cross them, well knows the feelings of insecurity they create. It may not be said of them, as was said of some travelers from London, on their journey to the north, who, on arriving at Dumfriesshire, in Scotland, concluded, from the appearance of the mountains there, that *the world was finished no farther*, and returned quietly home.

These subterranean lakes are nothing less than immense reservoirs of water; their coolness and purity exceed those whose surfaces are exposed, and being fed by springs, also serve as fountains to streams that rise in distant places.

S. W. HIGGINS,
Topographer to Geological Survey.

Glossary of technical terms used in this report is omitted here, being practically a duplicate of that printed after Bela Hubbard's report dated Jan. 26, 1839. See ante.

REPORT OF THE STATE GEOLOGIST RELATIVE TO THE COUNTY AND STATE MAPS

(*House Documents, 1841, No. 35*)

OFFICE OF THE STATE GEOLOGIST,
Detroit, February 4, 1841.

To the Speaker of the House of Representatives:

Sir—I have the honor to acknowledge the receipt of a resolution from the house of representatives, calling upon "the state geologist to furnish a statement of the forwardness of the maps in the topographical department, saying what maps are finished and what are unfinished, and at what time a copy of the state map can be furnished to the members of the house.

The above resolution, which I suppose to have been intended to elicit, general information with respect to the topographical maps of our state in progress, may be most conveniently answered by a consideration of the subject under three somewhat distinct heads, viz:

First. The state of forwardness of the field work.

Second. The condition of the work in the drafting office, and

Third. The progress which has been made in the engraving and publication.

In order that the relation which these several portions of the work bear to each other may be clearly understood, it may not be misplaced to allude briefly to the several relations which the officers of the two departments bear to each other, together with their separate duties.

It should be borne in mind, that the act of 1830 and 1837, which directed a geological survey of our state, did not include either a topographical survey or the projection of any map excepting such as were strictly of a geological character. As the work progressed, it was found that those who were engaged in the geological surveys could, by the addition of the necessary duties, carry forward not only a geological, but also a topographical survey of the state, and without any very considerable additional expense, excepting the salary of a draftsman or topographer. Since the services of a draftsman would be required more or less in the geological department, it was deemed to be for the best interests of the work, to add to the department an officer to perform those duties, and at the same time to direct the preparing of county maps for future publication. This step was taken by the honorable legislature, during the session of 1837 and 1838.

It will thus be seen that the topographical part of the department consists simply of a draftsman, who never engages in field work; and whose duties are wholly confined to reducing to form, the field notes as returned by the several officers of the geological department proper. The topographical part of the work is, therefore, completely dependent for all materials, upon the geological department, or in other words, the two duties,

although nominally distinct, are performed by the same persons.

The above remarks, it is conceived, will sufficiently explain to you the reasons for the consideration of the subject under the three heads.

1. *The state of forwardness of the field work.* That portion of the labor connected with the construction of accurate topographical maps, which involves the principal duties, requires the longest time for its accomplishment, and upon which the value of the maps, for accuracy and fullness of detail, must depend, has wholly to be performed in the field; and until the field work is fully completed, the final drafting and publishing of these maps would be comparatively of little value, nor for the interests of our people or for the credit of the state, as well as those engaged in the work, should it be required. In other words, it should be the desire of all, that those plans be fully carried out by which these maps may be made to possess as great a degree of accuracy as the nature of the work will admit.

The field work in all the counties, of which it is proposed to publish separate maps, is very nearly brought to a close, but there are portions of some of the counties, which still require a considerable amount of labor in the field, before they can be safely published. This is more particularly the case in several of the counties east from the meridian, and has arisen from the fact, that in consequence of the very erroneous manner in which the original United States surveys were made, in a portion of the country east of the meridian, the topographical duties have so far increased as to render it impossible for those engaged in the work, perfectly to accomplish both works at the same time. Added to this, the intricacy of the work in the border counties, upon the east, is vastly increased by the constant succession of "old land claims".

Of those counties of which there is field work still to be done, the principal are Monroe, Wayne, Macomb, St. Clair, Oakland, Lapeer, Genesee and Saginaw; in addition to which, there are occasional townships in the more western counties, not yet completed.

2. *The condition of the work in the drafting office.* The topographer has drafted, so far as the same can be done, all the field work returned up to the commencement of the last year, as also much of that which has been returned for the year 1840. The topographer will be enabled to furnish drafts of those counties in which the field work is completed, more rapidly than the engravers will be able to complete their portion of the work, at the same time that the topographer will be enabled to progress steadily in bringing up the other unfinished drafting which is now before him to be done.

3. *The progress which has been made in the engraving and publication.* By an act approved March 28, 1840, a sum "not exceeding two thousand dollars was appropriated for the purpose of" publishing a "map of the state and the several counties therein, as the manuscript maps of the same shall be completed", &c.

The second section of said act directs that the "said money shall be expended under the direction of the state geologist, in the employment of an engraver or engravers, and in the purchase of the necessary implements and materials, or in the contracting for and engraving of plates for maps", &c.

The third section of said act provides that the state geologist "shall cause to be executed and published, a map of the lower peninsula, as soon as practicable after the completion of the United States survey", &c.

And the fourth section of said act directs the disposition which shall be made of the maps when published, and the manner in which the same shall be done.

In order to carry out the instructions contained in said act, I visited, with as little delay as possible, the principal establishments for map engraving, in Washington, Philadelphia and New York, and after careful examinations in each of these cities, I made a conditional agreement with Mr. Stone, of Washington city, who is the chief engraver of the United States topographical bureau, and whose work is believed to be unexcelled by any in our country. Mr. Stone as well as all those to whom I made proposals, was unwilling to make any permanent arrangement for the engraving of so large an amount of work, until, he had engraved at least one of the county maps, and I was unwilling to do so, until I had seen specimens of his engraving upon the character of the work which was to be done.

Under the conditional agreement which was made, I forwarded Mr. Stone, immediately upon my return to this city, a map of Lenawee county, with directions to have proof forwarded me so soon as the engraving should be so far advanced as to permit it. The map had scarcely been forwarded, when I took my departure for Lake Superior, and during a space of something over five months, I had no means of communication with either the topographer or Mr. Stone; the result of which was, that during this time no further action could take place. The county was in that time engraved, and the first proof corrected and returned to Mr. Stone, immediately after I reached Detroit, on my return from Lake Superior; with which proof I also forwarded maps of the counties of Washtenaw, Jackson and Calhoun, the engraving of which, as I learn from Mr. Stone, has been nearly completed, but of which no proofs have yet been received. The counties of Hillsdale, Branch, St. Joseph, Cass, Berrien, Kalamazoo, Ingham and Eaton, are in such condition, as that the matter can be furnished more rapidly than the engraving can be faithfully executed.

The difficulties and embarrassments connected with these publications, if the work be well done, are very great, and the most careful, minute and repeated corrections of the proofs are required, all of which require time and labor; for unless this be done, the maps will be little less than a bundle of errors.

Mr. Stone writes me that he will be able to furnish the proof of one county, for each two or three weeks, which will enable you to judge of the progress which can be

made in the work, he says, at the same time, that he is desirous to keep the several persons who are engaged upon the separate portions of the same map as steadily at work as possible, in order that they may preserve a perfect uniformity of style, and, as he quaintly expresses it, "keep their hand in".

The third section of the act, authorizing the publication of these several maps, directs a state map of the lower peninsula to be published as soon as practicable *after the completion of the United States surveys therein*. Although the United States surveys are not yet complete, (for which reason the present publication of the state map would be contrary to the *express instructions* contained in the act referred to,) I have nevertheless caused to be projected, upon the scale contemplated by said act, a state map of so much of the peninsula as the present condition of the United States surveys would permit. In order to accomplish this, I have been compelled to send to the general land office, at Cincinnati, Ohio, for a perfect transcript of all those surveys which had been drafted, but not yet returned to the several land offices of Michigan.

This state map has been drafted from the township plats that have been carefully filled up, and corrected, during the progress of the geological survey, and will, I trust, prove minutely accurate. The draft of this map now extends to the north boundary of township thirty one north, and with the exception of some few important data, not yet received from the general land office, the materials are on hand for the completion of the whole map, with the exception of thirty three townships in which the United States surveys are not yet completed. These United States surveys, will, as I am informed, be completed early in the coming spring.

The time requisite for the engraving and final correction of the proof of this map, will probably not be less than three months, and although it is desirable that what has already been drafted should be forwarded to the engraver at as early a day as possible, I am deterred from so doing for the reason that the engraving of the state map, added to the several county maps which are in readiness to go forward, will involve liabilities exceeding the amount which has been placed at my disposal for that purpose. Under this contingency, and even doubting whether in the strict letter of the act, I would be authorized in commencing the engraving of the map in question, until the United States surveys are completed, I have determined to await your pleasure upon the subject.

So fast as the several maps are completed, it is proposed to present them to the public for sale, and there can be no doubt, if the whole be judiciously conducted, that they will yield a very handsome return of profit to the state. But, in order to do this, the same careful economy must be pursued that an individual would pursue under similar circumstances. All purchases of materials should be made in quantity, and the paper, which will be the greatest item of expense, should not only be purchased of the manufacturer, but

should also be purchased in quantity sufficient for the entire work. This will not only insure uniformity of appearance, and prevent disappointment from the use of an inferior article, but will also save some 30 per cent of cost. Stocks of paper, of the kind required, of a uniform quality, and in sufficient quantity, could scarcely be obtained in any of the cities of our United States, and the engraver advises as a matter of economy, that the paper be *manufactured* to order.

A map of the southern peninsula of our state, cannot, under any circumstances, be in readiness short of three or four months from the time the draft is placed in the hands of the engraver, and in that event the map would be defective in the thirty-three townships before mentioned, which, by a delay of some eight or ten weeks farther, might be added.

Since the act authorizing the publication of these maps does not direct in what manner I shall communicate with the honorable legislature in relation thereto, I have taken the opportunity offered by the resolution from your honorable body, to answer those inquiries somewhat more at length than the resolution would seem to call for, and in order to embrace the whole in one communication, I will simply add that of the amount which has been placed at my disposal for the above purposes, I drew from the treasury, on the 14th day of November, 1840, and sum of \$500, of which sum, but a small portion has as yet been expended, and that the remaining \$1,500 has not been drawn from the treasury.

All of which is respectfully submitted.

DOUGLASS HOUGHTON,
State Geologist.

1842

REPORT OF THE STATE GEOLOGIST RELATIVE TO THE STATE SALT SPRINGS

(House Documents, 1842, No. 2)

OFFICE OF STATE GEOLOGIST,
Detroit, January 5, 1842.

*To the Honorable Senate and House of Representatives
of Michigan:*

I have the honor to lay before you the accompanying statement of the progress which has been made in improvements at the state salt springs, since the date of the last report, from this department on that subject.

In conformity with the provisions of a joint resolution of your honorable body, approved March 1841, relative to the improvement of the state salt springs, (see joint doc. 1811, pages 235 to 254,) the contracts (of which said resolution refers were fully confirmed, and the work, which for a space of more than eighteen months had been arrested, was again commenced, and up to a very recent day has been continued according to the provisions of the contracts.

At the salines on Grand river, Kent county, the work so far as contracted for was completed and accepted on the 23d day of December last. The work consisted of the furnishing a cast iron tube, having a diameter of nine inches, and sinking the same to the surface of the rock at a depth of 40 feet; and of 260 feet of rock boring, making the entire depth of the well 300 feet.

At the salines on Tittabawassa river, Midland county, where the amount of earth boring was originally computed at 100 to 150 feet, very great difficulties and embarrassments have been encountered in sinking the iron tubes, in consequence of the character of the materials passed through, and the contractor, after a space of nine months of continuous labor has only been able to reach a depth of 139 feet.

The character of improvements required for developing the salt deposits of our state, have been so fully laid before you in the several reports from this department, that it is scarcely necessary again to call your attention to this subject, except to refer to the fact that, to render these works fully available, it will be indispensable to continue the borings until the shafts shall have passed very nearly through the lower salt rock, for it has already been stated that water possessing the maximum strength cannot be looked for in the upper deposits. At the point selected for the state well on Grand river, it is estimated that the shaft should be sunk to a depth of seven hundred feet, and at Tittabawassa river to a depth (in round numbers,) of six hundred feet.

At the state salt springs on Grand river, the upper salt rock has been perforated and an abundant supply of salt water flows from it, but since there has been no expectation of obtaining water of sufficient strength to rest upon from these upper rocks, there has been no attempt to separate the salt water from admixture of fresh springs, by tubing or otherwise. The amount of salt water flowing naturally from the nine inch tube of the state well, when the borings had been carried to a depth of three hundred feet, was shown, by *actual measurement*, to be one hundred and thirty gallons per minute, an amount almost incredibly large, and unequalled by any rock boring within my knowledge, in any *other* portion of the United States.

The salt water thus discharged, though much reduced by the influx of fresh springs, nevertheless contain a larger proportion of salt than could have been reasonably looked for at this depth; an amount which, were it properly separated from admixture with the fresh water springs, would be considerably more than that contained in the water originally used for the manufacture of salt in the great salt district of Kanawha, Va.

A careful analysis of this mixed water, taken when the state well had been sunk to a depth of 285 feet, shows that one hundred and ten gallons and a half, nearly, of the water, contains a bushel of salt.⁵⁷ No analysis of the water of this well has been made since it has been sunk below the depth above given, but admitting the amount of salt in it to be no greater at 300 feet than at 285 feet,

the water which is discharged contains an amount of salt very far beyond what could reasonably have been looked for, and which if properly separated would be amply sufficient to supply the present population of the entire western portion of our state.

These facts alone, it is conceived, are sufficient to sustain the original position assumed relative to the salt deposits in this portion of our state; but there are still further proofs of the correctness of these estimates, for during the time that work upon the state reserves was suspended, individual enterprise was directed to a determination of the same subject. At a point about three miles distant from the state salt well, Hon. Lucius Lyon commenced boring upon private lands, and after an unremitting labor of eighteen months succeeded in reaching a depth of 661 feet. In boring to this depth the well has passed through the upper salt rock, the intermediate fresh rock, and into the lower salt rock, and although the boring has not yet been carried to a sufficient depth in the lower salt rock, there has nevertheless been a good supply of salt water obtained, and this of a quality which when freed from the admixture of fresh water, from the upper springs, by tubing, will admit of the profitable manufacture of salt.

The amount of water discharged from this well, although it has not been determined by actual measurement, may be estimated to exceed in quantity that discharged at the state spring. The salt water from Mr. Lyon's well is very largely

⁵⁷I deem it unnecessary, for the purpose of the present report, to give details of the entire composition of the waters from the several springs referred to.

mixed with fresh water which enters in springs, from the immediate fresh rock, and the partial tubing which has thus far been done, has not, I conceive, been sufficient to prevent its reducing the maximum strength of the brine very considerably.

A jet of water flowing from this well is so great as to render it nearly impossible to sink any vessel, unconnected with drilling poles to such a depth as to procure brine free from fresh water of the upper springs, and in order to procure water as concentrated as circumstances would permit, for analysis, an open tube, of a diameter considerably less than the well, was sunk to a depth of 415 feet, and, the upper end of the tube (at an elevation of about 15 feet above the point where the boring was commenced,) was closed with a faucet, which was afterwards opened and turned so as to permit a discharge of three hundred gallons of water per hour, by measurement, and from this, water was obtained for analysis. Of the salt water thus obtained about eighty-two and a half gallons contain a bushel of salt.

At the salt well on Tittabawassa river, where as yet the boring has been confined to earth, or alternating strata of clay, sand, gravel and bowlders, with which were mixed fragments of coal, the character of the water has undergone considerable changes as the tube which was sunk passed through the several strata furnishing the

water. Thus at one time the water would be nearly free from, and at another very much impregnated with saline materials. At the last dates, and when the well had reached a depth of 139 feet, every 221½ gallons contained a bushel of salt. At a depth of 98 feet the water contained about one-fourth more salt than at 139 feet, but by sinking the tube all the springs excepting that at the very bottom of the tube have been shut off.

The above statements relative to the well on Tittabawassa river are made simply for the purpose of exhibiting the state of forwardness of the work, and it should be borne in mind, as has been stated in previous reports upon this subject, that no salt water of very considerable strength can be expected from simple earth boring.

In referring to the amount and character of salt water discharges from the several wells to which reference has been made, it should be recollected that the prevalent opinion that this is simply an increase of the water formerly discharged from springs at which the improvements were commenced, is wholly incorrect, for at neither of the points where these borings have been made was there any spring apparent upon the surface previous to the sinking of the wells.

To enable you to compare, in a satisfactory manner, the strength of the salt water from several of the salt districts of our country, with that already obtained in this state, the accompanying table exhibits the number of gallons of water required for the manufacture of a bushel of salt in these several districts; but in comparing these, it should be borne in mind that with the salt wells of New York, Ohio and Virginia, a long series of years has been required to procure water of the strength exhibited, and that the wells in Ohio furnishing the water referred to, are sunk to a depth varying from eight hundred to one thousand feet. The fresh water in these wells has been completely shut off, while the salt water from the wells of Michigan is reduced by the influx of a very large amount of fresh water, that there has as yet been no attempt to exclude. And again, it should be recollected that the borings in our state have not yet reached a depth at which we should look for salt water of a maximum strength. In the well of Mr. Lyon, this point has already been so nearly reached, that water of sufficient strength has been obtained to be profitably used for the manufacture of salt, and which, when separated from the upper fresh springs, by tubing, will without doubt considerably exceed that used in the great salt district of Kanawha, Va., in 1834.

		41 to 45 gallons of water give a bushel of salt.	
At the best salt wells in New York			
do	salt wells of Kanawha, Va., (average,)	70	do
do	salt wells on Muskingum river, O.,	50	do
do	springs on Grand river, Arkansas,	80	do
do	Lyon's salt well, Grand river, Mich., at 66 ft., (fresh water not separated,)	82½	do
do	state salt well, Grand river, Mich., depth 239 feet, (fresh water not separated,)	110½	do
do	state salt well, Tittabawassa river, Mich., earth boring, 139 feet,	221½	do
do	Conemaugh, Pennsylvania,	300	do
do	Nantucket, (sea water,)	350	do

Since the fund appropriated to the improvement of the salt springs is not disbursed by the department over which I am placed, any particular reference by me to the condition of the appropriation would be uncalled for. Under the provisions of the contracts before referred to, I have certified to the performance of an amount of work by the contractor at Grand river, sufficient to cover the sum which was directed to be expended at that point. Of the amount set apart for the improvement of the springs on Tittabawassa river, there remains in the treasury the sum of \$2,586.57, not covered by estimates.

The improvement of our state salines has now, it is conceived, progressed so far as to satisfy the most skeptical, who will examine the subject, of eventual perfect success, and under these circumstances, it is hardly necessary to call your attention to their great importance, or the necessity of a speedy completion. At Grand river, the work is now in such a state of forwardness, and the machinery in such condition, that if continued without interruption or unforeseen accident, it may be completed early in the coming summer, and at a comparatively small expense; but if the work, at this stage, be delayed, a very considerable additional expense will be incurred. The work at the well on Tittabawassa river cannot be completed at so early a day.

The plan which was adopted by your honorable body, of contracting for the work to be done at the salines, has been productive of good effect; but while I would recommend a continuance of this plan, there should be some provision made for such contingent expenses as may from time to time arise. During the time that the work on these springs was lying still, a space of eighteen months, I was compelled to keep men in employ to preserve the machinery, &c, from destruction, and to provide means for their subsistence and compensation, and by the provisions of the act directing the letting of the contracts, I was required to advertise for proposals, have contracts drawn, &c, for the expense of which sufficient provision was not made; and now that the contract for that portion of the work contracted for at Grand river has been completed, I am held responsible for the preservation of the property, without the power to apply a dollar to that specific purpose, and would respectfully ask your direction in the matter. So also it has been necessary in order to secure some portions of the works from danger of destruction, to do several items

in the way of repairs, which were not included in the original contracts, and to which no part of the appropriation could be applied. Nothing of this kind has been done which could with safety be avoided, and nothing but what would have subjected me to just censure had I omitted to have done. For these accounts, though the sum be small, provision should be made, together with instructions as to the disposition that shall be made of the springs when the work is carried to completion.

DOUGLASS HOUGHTON,
State Geologist.

REPORT OF THE SELECT COMMITTEE, IN
RELATION TO THE REPORT OF THE STATE
GEOLOGIST

(House Documents, 1842, No. 19)

The select committee to whom was referred the report of the state geologist, would respectfully report:

That your committee have had under consideration the several subjects referred to in the report of the state geologist, together with the condition of the geological survey of our state, and are happy in being able to say, that the field work, together with the drafting, and other parts of the survey upon the plan originally contemplated, are nearly completed; and that the point is now nearly reached when these labors may be laid before the public. It will be seen by reference to the report of the state geologist, that the duties required to be performed by the assistants in the survey, has been so nearly accomplished that all those engaged in the work have been discharged excepting the topographer and draftsman, and it is estimated that the amount of surveys required to close up detached portions of the work, together with the chemical analysis and drafting, may be accomplished by the geologist and topographer, without further assistance during the current year.

It further appears that the fund applicable to this object has been exhausted, a circumstance attributable in part to a diversion by the legislature, of a portion of the funds to objects not legitimately belonging to the geological survey. In order to reap the full benefit which it is conceived will be derived from this work when the details are made public, your committee deem it indispensable to the best interest of the state, to make such provision for the completion of the works as the circumstances may require, viz: an amount sufficient to cover the salaries of the geologist and topographer, together with the incidental expenses of the office.

The committee have also had under consideration the subject of the publication of the maps of the several counties referred to in the report of the state geologist, a subject which your committee consider of deep interest to the citizens of our state. It appears that the publication of these maps has been delayed in consequence of the difficulties connected with the remittance of moneys to the engravers and paper

makers; but these obstacles, we are informed by the state geologist, he hopes to overcome at an early day, for which reason no legislation will be required upon this subject.

In the opinion of your committee, the geological department has discharged its various and complicated duties in a highly satisfactory manner; and the disbursements of the different appropriations made for the prosecution of the geological survey, has been made with a wise and judicious economy which forms a pleasing contrast with most of the expenditures in other departments of the state.

The unfinished maps of the different counties alluded to, will, when completed, contain the most desirable information, and give a minute description of every section of land; the measured length of every fractional line; the exact course of every meandered and other streams, defining the boundaries of all swamps and marshes, designating the oak openings, prairies and timbered lands, and the more prominent ranges of hills. Also, an index to all beds of marl, peat, coal, sand and limestone, gypsum, iron and other ores, with a profile of each town and county above the levels of lakes Huron and Michigan, besides many other descriptions not found upon any previous engravings, and more minute, perhaps, than is found upon the maps of any other country.

The importance of a small appropriation for the completion of this work, was made sufficiently manifest to your committee from the fact that in addition to the revenue which the treasury will receive from the sale of these maps, they may be completed and published by some individual for his personal benefit, and thus deprive the state not only of the money which it has already expended, but of one of its few remaining sources of income.

In conclusion, your committee would submit the following resolution, making the necessary appropriation for the completion of the geological survey, and embracing a remuneration to the state geologist for his services as superintendent of the state salt springs, a labor which belongs not legitimately to his official duties as state geologist, but which he has heretofore performed without any compensation.

Resolved, That the committee on ways and means be instructed to include in their general appropriation bill, the sum of twenty-two hundred dollars for the completion of the geological survey, and for the supervision of the state salt springs.

F. C. ANNABLE,
Chairman of Select Committee.

ANNUAL REPORT OF THE STATE GEOLOGIST
(Joint Documents, 1842 No. 9)

OFFICE OF STATE GEOLOGIST,
Detroit, January 25, 1842.

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

I have the honor to lay before you the accompanying report, relative to the progress which has been made in the geological and topographical surveys of our state, since the date of the last report from this department. In this communication my remarks will be confined almost exclusively, to the condition and wants of the department, leaving the details of what has been accomplished for the final report, upon the whole work.

During the current year the geological and topographical surveys have progressed steadily toward completion, though in consequence of the reduction of the number engaged in the work; which became necessary in consequence of the comparatively small amount of funds applicable to that object, the amount of work accomplished has been somewhat less than that of the preceding year. The labor so applied has been chiefly devoted to the westerly portion of the upper peninsula, including a part of that which may be designated as the mountainous district of our state, while the smaller portion of the labor has been directed towards the closing up and completion of the surveys upon the lower, or southern peninsula.

In connection with duties assigned me relative to the boundary line between our own state and Wisconsin, I have been enabled to complete a very perfect Geological section of nearly 180 miles in length, crossing from the mouth of Montreal river of lake Superior, to the mouth of the Menominee river of Green Bay, a district highly interesting both in its geological and topographical features. This section crosses the upper peninsula somewhat further west than any of the sections I have heretofore made.

In addition to this a large amount of work has been performed in the mountainous region stretching from Montreal river to Ontonagon river, and extending southerly from lake Superior, a distance of some forty miles, including what may be termed the *westerly* portion of the copper district, within our state. This district had been but partially examined the preceding year, the examinations of that year having been more particularly directed to a district of country lying east from it.

Several geological sections have been completed across this intricate region, and notwithstanding the many obstacles imposed by the mountainous and wild character of the country, the surveys of this district have been completed with as much minuteness as an adherence of the original plan of the survey would permit. In addition to the several geological sections completed, all the rivers entering lake Superior between and including the two streams mentioned, have been

carefully examined to their very sources, and the Porcupine mountains have been traced out through almost their entire range.

These surveys of the westerly part of the upper peninsula have added much valuable information to that before collected respecting the geology and topography of that interesting portion of our state, and have served to add confidence to our previously expressed opinion respecting its value for its minerals and for agricultural purposes. The general geological and mineralogical character of this country was so fully given in a previous report, that it is not conceived to be necessary, at this time, to make further allusion to it, except to add that the copper ores associated with the altered conglomerate and sandstone rocks, in this portion of the range have been found to be more extensive than was originally supposed. In character these ores closely resemble those heretofore described as existing in the Keweenaw [sic] point range; but associated with these ores, or in the rocks of the immediate vicinity, several minerals have been found in abundance, which have been comparatively rarely noticed in other portions of the range. Among these are prehnite, stellite, lomonite, heulandite, harmotome, &c, the first mentioned having been noticed in veins varying from 16 to 18 inches in thickness.

The *southerly* range of mountains traversing the upper peninsula, and which in a previous report has been referred to, as commencing a point a little north westerly from the mouth of Chocolate river of lake Superior, has been found to be continued in a south-westerly direction, with a gradually diminished altitude across the Menominee river of Green Bay, into the territory of Wisconsin. This chain of mountains through a portion of its course has a direction nearly parallel to that of Green Bay, and frequently approaches to within 25 or 30 miles of the coast of that bay. It will be recollected that the northerly portion of this mountain range was described as being composed of sienitic and gneissoid granites, flanked to the south by mica, talcose and chloritic slates and quartz rock, the separate members of the group being frequently traversed by dykes of trap, and with occasional knobly hills of the latter rock. Presque Isle of lake Superior, made up of trap and altered sandrock, in which rocks were found numerous small ramifying veins of the sulphurets of lead, copper and iron, was referred to as a portion of this mountain range.

This southerly chain of mountains, with its hills and dykes of trap, though the elevation in a south-westerly direction is considerably lessened, preserves very nearly similar geological characters to that portion before described, and the rocks, in the vicinity of the trap, were frequently found to contain similar minerals to those observed in the vicinity of lake superior. The direction of this range is such as to leave no doubt but the low knobs of syenitic granite in the vicinity of Puckaway lake of Fox river, and the more elevated knobs of trap and altered rock lying a short distance to the north, in Wisconsin, belong to the same system of rocks, and since the hilly

district of the Wisconsin river would fall within this range, it may be fairly inferred that the disturbance of the stratified sandstones and limestones of this region may have originated from the same causes which have produced the more elevated mountains on the south of lake Superior.

This subject possesses a high degree of interest, from the fact that within the limits of this range would fall, the lead district of Wisconsin and Iowa, and this inference is rendered the more probable from the remarkable similarity in the character of the contained minerals.⁵⁸ Thus far I have been unable to trace any portion of the great limestone formation of the upper peninsula, to any near proximity to this range, where the same traverses that portion of Michigan, and thus far in tracing the range westwardly no considerable deposits of lead have been found until the lower rocks are covered by heavy deposits of limestone; which would lead to the inference that these upper deposits have performed an important part in *arresting* and *fixing* the minerals referred to, and which

⁵⁸It should be recollected that the outer or northern range of mountains of lake Superior constitutes what has been called the true copper district, and that in this district no lead and none of the ores of which sulphur is a constituent, have been noticed, while in the southern range, in Michigan, the ores are almost entirely sulphurets, and lead occurs more abundantly than copper.

minerals may fairly be inferred to have had their origin from the lower rocks, to which reference has been made. If the position thus assumed be tenable, we can scarcely look for heavy deposits of lead within that portion of the southerly range of mountains traversing the upper peninsula of Michigan, for the reason that the upper formations are wanting, at least they are so through all that portion of the district that has been minutely examined.

In the surveys of the upper peninsula east from Chocolate river, I have derived very great assistance from Hon. Wm. A. Burt, who, during the last two years has been engaged in surveying the United States township lines, for through his kindness I have been enabled to locate and determine, much more minutely than could otherwise have been done, the range of the several rock formations over a very large district of country.

The field work of the geological and topographical surveys, upon the plan originally contemplated, is now mainly completed, on a few detached portions remaining, where points have not been sufficiently settled, and since the completion of these will not require the service of assistants, the board has been so far reduced that there now remains attached to the survey only the assistant in the topographical department.

Although, as has before been stated, the amount of field work remaining to be done is comparatively small, there still remains much to be done, in arranging the materials accumulated, for a final report upon the entire work. For the chemical analysis there was originally no provision made, and this duty which in the geological surveys of

most of the states has been performed by a distinct officer, in this state has devolved upon the principal of the survey. Heretofore the press of business in the other departments of the survey has prevented a proper attention to the analytical portion of the work, much of which is still unfinished and will require a considerable amount of labor for its completion.

The drafting from field notes, returned from the geological survey proper, has progressed as rapidly as circumstances would permit, but since in the topographical department there has been only a single assistant, the amount of drafting has continued to accumulate upon his hands, and there yet remains an amount to be done which can scarcely be accomplished in an entire year.

The fund applicable to these objects is now absorbed, and there will be required for the completion of the limited amount of field work, drafting, analysis and contingent expenses, a small appropriation.

By an act of the honorable legislature, approved March 28, 1840, the state geologist was directed to "cause to be published a map of the state, and of the several counties therein," and the sum of two thousand dollars was appropriated to that object. Immediate steps were taken for carrying out the provisions of this act, and most of the separate organized counties of the state have been drawn, upon a scale of four miles to the inch, and are now ready for the engraver. Of these, six counties have been engraved, viz: Hillsdale, Lenawee, Branch, Calhoun, Jackson and Washtenaw, and the maps would have been thrown before the public, as fast as the engraving would permit, had not the condition of the treasury made it impossible for me to place funds in such shape, without submitting to a rate of discount which would be unwarrantable, to enable me to procure the materials necessary for the publication. Had these circumstances not prevented, in addition to the counties before mentioned, those of St. Joseph, Cass, Berrien, Monroe, Allegan, Kalamazoo, Van Buren, Oakland, Livingston, Ingham, Eaton, Barry and Shiawassee, would all, or nearly all, have been published before this date.

By the act authorizing the publications referred to, "the state geologist, auditor general, and state treasurer, are authorized to adopt such measures for the sale and distribution of the maps as to them may seem expedient," and it is confidently believed that the sales of the same will speedily replace in the treasury the amount which may be drawn for their publication. Under whatever circumstances this subject may be viewed, it is deeply to be regretted that the amount appropriated for this purpose cannot be realized in such a way as to secure the publication at once, for it is conceived that the best interests of the state call for a dissemination of the information which these maps contain, and that this should be done as speedily as possible.

No portion of the fund set apart for the publication of maps has been drawn since the date of my last report

upon *this* subject, and there remains in the treasury, applicable to that object, the sum of fifteen hundred dollars.

Under the provisions of a joint resolution, approved February 2, 1841, I was instructed by the executive of the state, to act as commissioner upon the part of this state, in relation to the boundary line between Michigan and Wisconsin, and this duty has been performed so far as circumstances would permit the same to be done. The resolution, which contemplated the performance of this duty by the state geologist, made no provision for such expenses as would be incident thereto, and, in consequence, it became necessary, in order to carry the provisions of the resolution into effect, to divert a portion of the funds set apart for the geological survey, to that purpose. In addition to the injustice which is thus done in charging to the account of the geological survey, expenditures which do not legitimately belong to it, the effect has been to absorb an amount which was absolutely required for the operations of the department.

All which is respectfully submitted.

DOUGLASS HOUGHTON,
State Geologist.

1843

ANNUAL REPORT OF THE STATE GEOLOGIST

(Joint Documents, 1843, No. 8)

OFFICE OF STATE GEOLOGIST,
Detroit, January 31, 1843.

To the Hon. Legislature of Michigan:

I have the honor to submit the following report of the condition of the geological survey of our state, and the progress which has been made towards the completion of the same.

Since the date of my last report, upon this subject, I have been chiefly engaged in arranging and putting in shape, the immense amount of details, both geological and topographical, which have been accumulated during the progress of this work; in analyzing and studying the immense collection of specimens illustrating the geology and mineralogy of our state, a large portion of which specimens had remained unopened until the past summer; and in the chemical analysis of our soils, minerals and rock specimens. This work, preparatory to the final report upon these subjects, involves a much larger amount of labor than had been estimated, a labor which no one, unless intimately connected with this work, could fully appreciate.

In addition to the office work above mentioned, a small amount of field work has been done, consisting chiefly, of closing up and connecting points where the work was incomplete.

The field work for the entire survey is completed, with the exception of some few points where the work still

wants connecting, and which will not involve any material expense.

The work in the topographical or drafting office, during a portion of the year, was suspended, in consequence of the absence of the topographer, who was engaged for several months in "locating" lands for the state. Notwithstanding this delay, a large amount of drafting has been accomplished, and that portion relating strictly to the topographical survey is so far advanced that a very large portion of the work is now ready or may soon be made ready for the hands of the engraver. There, remains in addition to the amount of drafting yet to be done for the topographical and geological maps, a very considerable amount of drafting, such as ideological sections, &c.

The publication of the state and county maps, as directed by the legislature, was long ago commenced, and the engraving of several of these maps had been completed before the date of my last report, but the inability to procure such funds as would enable me to purchase paper for striking them off, has caused much delay in the publication, and in fact for a time virtually suspended all action upon this subject. Notwithstanding this embarrassment in procuring such funds as could be applied to this purpose, such arrangements were made as led me to hope that. I would have been enabled, before this time, to lay before the public, for sale, according to the provisions of the act directing the publication, an edition of each of six of our most populous counties. The reception of these maps was prevented by the early closing of navigation, and although such arrangements had been made as led me to hope they would be transmitted by the overland route, they have not yet come to hand.

This series of state and county maps, it is hoped and believed, will be more full and perfect than any which have heretofore been published, of any equal portion of our Knifed States; and there, can be no doubt, but when once spread before the public, showing as they do the general character of soil, timber, &c. &c, they will do much to disseminate a knowledge of the immense capabilities of our state, and the advantages which she offers to the emigrant; and that, they will in that way afford efficient aid towards increasing her population.

The delay which has occurred in the publication of these maps has been a source of deep mortification and regret to me, but circumstanced as I have been, it has been utterly out of my power, until within a few months past, to make such arrangements as would enable me to move forward with the work. When the maps already engraved shall have been thrown before the public, it is hoped and believed that a sufficient amount will be received from their sale, to enable me to proceed with the engraving and publishing of the balance without further embarrassment, and that they will more than pay the expenses incident to their publication.

The selection by the state of extensive tracts of land in some of the newer counties, and proposed early

disposition of these lands by sale, renders it highly important that maps of the counties where these selections have been made, should be completed at the earliest day possible; and I have made arrangements to carry this into effect. Although the older counties have legitimate claims for the first publication of their county maps, it is conceived the interests of the whole state will be advanced by the course proposed.

The engraved plates, of these maps will remain nearly as perfect after the proposed edition shall have been worked off, as they were at first, and as other editions may, from time to time, be wanted, the names of newly organized towns, new roads, &c, may be added without difficulty, and at an expense nearly nominal.

I deem it unnecessary, at this time, to lay before you the details of work done, or to give further description of portions of our country which have been passed without notice, in the very general reports which have heretofore been made to you, for I hope in due time to offer a final and systemized report, that shall embrace, in a condensed form, all that has been accomplished.

The geological and topographical surveys of our state which have been carried forward by a corps, few in number compared with that furnished by many of the other states, and extending as it does over an area greater than that claimed by any of them, has been a work of immense labor. To accomplish the end desired, the most constant and untiring industry has been required, added to which it has been necessary, during protracted periods, in a wilderness country, to dispense with the ordinary comforts of life; but suffering as I have from the severe duties incident to this work, the labor has been rendered light by the hope that in aiding to develop the resources of our state, in placing on maps her geology, topography and the character of her timber and soil, her settlement might be increased, and something added to her prosperity and wealth.

The condition of the fund placed at my disposal for this department is as follows, viz:

	Dr.	Cr.
By amount in my hands at close of last fiscal year		\$1.42
Amount appropriated for 1842.....		400.00
		\$401.42
To amount paid sundry bills connected with surveys in upper peninsula, chiefly for 1841.....	\$250.61	
Rent of topographical office and contingent expenses for the same.....	50.33	
Drafting paper, stationery and binding of platt books for topographical office	74.83	
Postage	19.47	395.24
Balance in hands of state treasurer.....		\$6.18

There will be required for the current year, an amount sufficient to cover incidental expenses, of a character similar to those above enumerated, which may be estimated at three hundred dollars.

I have already laid before you a general report upon those attached duties connected with the improvement of the state salt springs, which cannot be considered as forming any part of the geological survey. These duties, which have cost me much labor and anxiety, have drawn deeply upon that time which should have been more directly occupied in the geological survey. At present, however, these attached duties interfere comparatively little with the other portions of the work, but heretofore they have done much to retard its progress.

All which is respectfully submitted.
DOUGLASS HOUGHTON,
State Geologist.

REPORT OF THE STATE GEOLOGIST, RELATIVE TO
THE STATE SALT SPRINGS
(Joint Documents 1843, No. 9)
OFFICE OF THE STATE GEOLOGIST,
Detroit, January 23, 1843.

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

In conformity with the provisions of an act placing in charge of the Geologist the state salt springs, I have the honor to submit the following report of their present condition, and the progress which has been made in their improvement.

At the state salt springs on Grand river, Kent county, the work has been steadily progressing in the manner directed by the legislature, and had not a serious accident occurred, which gave rise to a delay of more than three months, the work at this point would have been mainly completed.

The character of the improvement at this point has heretofore been so fully detailed to you that it would seem unnecessary, at this time, to say any more upon that subject, and I will only add that the plan originally proposed has been rigidly adhered to. The entire depth of the well at the date of the last estimate for work performed under the contract for boring, was 786 feet, and at this date it may be estimated at something over 800 feet; of which 40 feet is earth boring, secured by an iron tube nine inches in diameter; and the balance rock boring.

Since the date of my last report upon this subject, the quantity of water discharged from the top of the iron tube, in the well on Grand river, has been very considerably increased, and now exceeds two hundred gallons per minute; in addition to which there is good reason to conclude that a considerable amount is discharged laterly through an opening in the rock, and that it reaches the surface at a distance from the well, and not only has the quantity of water been augmented but it has also been very considerably increased in strength.

As the water now flows from the iron tube it is mixed with all the fresh water entering the well above the upper salt rock, by which its strength is very much reduced, a difficulty which will be easily overcome by properly tubing the well.

The borings at the present time are in what has been dominated the lower salt rock, which is that formation from which we hope to obtain the best salt water. The rock has thus far proved to be of so close a texture as to admit a comparatively small amount of water to pass through it, for which reason the increase in strength and quantity of water has not been as great as had been looked for, but notwithstanding this compactness a vein furnishing a very tolerable supply has been struck in this rock.

In continuing the work, it is of the utmost importance that the borings be carried entirely through the lower salt rock, to the underlying formation, a task which, if no unforeseen accident occurs, will soon be accomplished; after which the tubing out of the upper and comparatively fresh water will be completed, and then and not till then, can the capacity of the well be fully and entirely determined.

It is now satisfactorily shown that the place of the salt water in the sub-carboniferous rocks is as was originally set forth, and that the supply of water is abundant; and it is further shown that the character of the water is such as will admit of the manufacture of salt at such rates as will enable our citizens to compete with that manufactured abroad. As has been before stated, the precise strength and quantity of water that can be furnished by the state well, on Grand river, cannot be fully determined at this time, for which reason I have not deemed it advisable to enter into detail upon this subject.

At the state salt springs on Tittabawassa river, no farther progress has been made in sinking the well, and no disbursements have been made except such as were required for keeping the machinery in repair, and in securing property from decay. The reasons for this suspension of work are contained in sections seven and eight of "An act relative to the state salt springs, and the lands granted for the use of the same," approved February 16, 1842.

In conformity with instructions contained in an act making appropriations for the improvement of the state salt springs, nearly the entire of the work has been done by contract, and certificates for the amount due on such contracts have, from time to time, been issued by me, according to the provisions of the contracts, the contractors receiving from the Auditor General warrants for the same.

The amount of unexpended appropriations will be amply sufficient to complete what will be required for the improvement of the salt springs, and the act relative to the same, approved February 16, 1842, is believed to place in the hands of the Executive sufficient power to enable him to direct all that will be required to make the springs available.

In conclusion, permit me again to call your attention to the present condition of our seventy-two sections of salt lands, a very large portion of which will never be required for the purposes for which the grant was made. It is a fact well known that a portion of these lands were selected for their intrinsic value as farming lands, in connection with their advantageous situation. Some of these lands are under cultivation, as farms, and have in this way been considerably improved, while, on others, there has been wanton destruction of timber, without adding to the value of the lands by cultivation.

It is conceived that the present condition of these lands is such that they are drawn back upon the country where they are located, at the same time that they are exposed to constant waste of timber by depredation. True economy would dictate the necessity of some action in relation to these lands. [Last paragraph and schedules A and B omitted].

DOUGLASS HOUGHTON,
State Geologist.

1844

ANNUAL REPORT OF THE STATE GEOLOGIST
(*Joint Documents, 1844, No. 11*)

OFFICE OF THE STATE GEOLOGIST
Detroit, February 15, 1844

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

I have the honor to lay before you the accompanying report of the condition of the geological and topographical surveys of our state, and the progress which has been made towards the completion of the same during the past year.

A portion of the season has been devoted to connecting the work upon the upper peninsula, and completing the skeleton of the surveys of that part of our state, but by far the greater amount of work has been performed in the office, in compiling and arranging the materials for the final report upon the geology and topography, and in the completion of the maps, together with the figuring of sections and fossils illustrative of the several group of rocks of our state.

The drafting of the several county maps, according to the plan directed, has mainly been performed, and excepting some slight additions, these are now ready for the engraver. Of the county maps, four have been engraved and struck off, and are now in market. Ten additional counties have been placed in the engravers hands, and I had reason to hope that these would have been completed and ready for sale before the close of navigation. In this I have been disappointed, but now hope to be able to lay these additional ten counties, making, in all, maps of fourteen counties, together with the state map, before the public at an early day in the ensuing spring.

The best interests of our state render it of much importance that the maps of those counties in which her lands are now offered for sale are situated, should be published at the earliest day possible. The engraving of some of these is now in progress, but to hasten this work, it will be important that a small appropriation be made to cover the first cost of some portion of the engraving, paper and press work. An appropriation of \$1,000 to \$1,500, will cover all that will be required to be paid out of the treasury before a sufficient amount will be realized from sales to enable the work to progress without further demand upon the treasury, and I confidently believe that the proceeds of the sales of these maps will fully refund to the state the cost of their publication.

This series of state and county maps, it is hoped and believed, will be more full and perfect than any that have heretofore been published of any equal portion of our United States, and there can be no doubt that when placed before the public, showing as they do the general character of the soil, timber, &c. &c, they will do much to aid in disseminating a knowledge of the immense capabilities of our state, and the advantages which she offers to the emigrant, and that thus they will afford efficient aid towards increasing her population.

In addition to the ordinary duties of the geological survey, the extra duty required, at your last session, of furnishing the state land office with township maps, has been performed, so far as calls have been made by the commissioner, and these duties have occupied much of the time of the topographer.

I have already stated that the field-work of the geological and topographical surveys of the lower peninsula is completed. The final report upon this portion of the work, together with all the maps and sections, will, I trust, be ready for the press during the coming summer. The engraving of the geological sections, fossils, &c, will occupy some time, and it is desirable, in order to prevent delay in this respect, that this portion of the work, preparatory to the final publication, should be commenced at the earliest day possible. In order to hasten this, I have made a temporary arrangement for the wood cuts, with a wood engraver who is fully competent, and who is now engaged in this duty, but in order to continue this work, some provision will be necessary.

The surveys of the upper peninsula have been completed less perfectly than those of the southern or lower peninsula, and while the grand outlines have been arrived at as fully as will be required, it is very desirable that these outlines should be filled up with more minuteness than has hitherto been done. The geology and topography of that portion of our state, lying south from Lake Superior, is much more complex than that of any other portion of our state, while, at the same time, it possesses a very high degree of interest, not only in a scientific point of view, but also in consequence of the intrinsic value of its mineral resources. To develop minutely its topography, geology and mineralogy, in such

a manner as its great importance makes desirable, would require a larger amount of expenditure than our state is well able to appropriate to that object, and we can only hope to accomplish it by some extraneous or indirect means. The United States linear surveys afford a fine opportunity for accomplishing this in a way which will render the work exceedingly perfect, and at the same time will be attended with little expense. All that would be required would be simply a permission from the commissioner of the general land office of the United States, to the geologist of Michigan, to require the deputy surveyors to make certain observations during the progress of their survey, of a character which would connect the geological survey of our state with the linear survey of the United States. I hope to perfect such an arrangement in this particular, as will enable me to produce more perfect geological and topographical maps of the upper peninsula than have ever been constructed of the same extent of territory in our United States.

Of the amount of \$300 appropriation placed at my disposal for the geological and topographical survey, there has been expended during the fiscal year the sum of \$220.47, chiefly for rent and expenses of the topographical office, paper, postages, &c, the vouchers for which are deposited in the office of the auditor general. In addition to such provisions as you may see fit to make for the engraving of the several county maps, the wood engraving and publication of the final report, there will be required for current expenses of the survey, during the ensuing year, an amount not exceeding \$400.

All of which is respectfully submitted.

DOUGLASS HOUGHTON,
State Geologist.

1846

REPORT FROM GEOLOGICAL DEPARTMENT

(Joint Documents, 1846, No. 12)

OFFICE OF STATE GEOLOGIST, TOPOGRAPHICAL
DEPARTMENT.
Detroit, 7th January, 1840.

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

I have the honor to report the completion of the catalogues and maps of the school lands contemplated by the act approved March 1st, 1845, which is as follows:

Sec. 1. *Be it enacted by the Senate and House of Representatives of the State of Michigan*, That the State Geologist be and he hereby is authorized and directed to ascertain the quantity of land the State of Michigan is authorized to select in addition to, or in lieu of the sixteenth section under the act of Congress entitled "an act to appropriate land for the support of schools in certain townships and fractional townships not provided for, approved May 20, 1826, and the act of June 28,

1886, admitting this state into the Union, and report to the next session of the legislature.”

It will be seen by the report of M. E. Van Buren, Esq., to whom this work was given in charge, that the quantity of land the state is entitled to in lieu of fractional section sixteen, and for townships deficient in section 16, of the lower peninsula, is twenty-nine thousand seven hundred and twenty-nine acres. And to this amount must be added such deficiency as may be found in sixty-nine unsurveyed townships which remain.

In the statement under the head of “available school lands”, and following remarks, the total school lands of the lower peninsula, amount to seven hundred and fifty-nine thousand five hundred and eighteen acres.

If to this we add the school lands of the upper peninsula, which will amount to nearly half a million acres, we have a truly noble fund.

As in consequence of the lamented death of Dr. Houghton, late state geologist, some legislative action will be called for in relation to the future disposition of the state survey, and in the absence of the annual amount from the head of that department, I have deemed it proper to accompany this report with some observations which may be important under present circumstances. With this view I applied to Bela Hubbard, Esq., late assistant to Dr. Houghton, in the department of geology proper, and have received from him such information as was deemed of most importance. Mr. Hubbard had undertaken in part the preparation of the final report on the geology of Michigan, under the direction of Dr. Houghton, for which purpose all the field notes and other information collected during the progress of the state surveys, were placed in his hands, and he is now engaged, at the request of the administrators, in the supervision of the geological portion of the returns of the late surveys made by Dr. Houghton, under contract of the U. S. government.

It is doubtless well known to your honorable body, that the period originally contemplated by the act for accomplishing a geological survey of this state expired in 1843; since which time the state geologist, under a greatly reduced appropriation, has been actively engaged in carrying forward the work to its completion, more particularly in that portion of the state denominated the upper peninsula, in the prosecution of which work he has fallen a martyr to his zeal, perishing at his post, and when almost in full view of the attainment of objects so anxiously sought, and so dear to the interests of Michigan. The immense amount of labor required to be performed in the progress of this survey, and its great importance to the people of the state, as also the important results it was developing in the region on lake Superior, necessarily retarded the completion of the work beyond the period first contemplated. This delay, however, so far from prejudicing the work, has only tended to perfect the information already obtained, as well as to add to this amount.

The annual reports from the geological department, have from time to time given information of the progress of the survey, together with some of the practical results; though necessarily in a very partial and imperfect manner, it being intended to combine, in a condensed form, the whole amount of information collected into the final report, at the close of the whole work.

So far as regards the lower peninsula, all the field work has been for some time completed, and all the field notes, specimens and other materials are on hand, the results of an extended and laborious research, and forming a mass of materials, which are now in readiness to be compiled for final publication.

Materials are also on hand for the final report of the Upper Peninsula, so far as the surveys have extended, in that very complex and interesting region, and the whole is far advanced towards completion.

A large amount of engravings and lithographs for the final report are completed, and the whole, it is thought, can be finished within another year. Most of these are, in a style of art, superior to anything of the kind ever executed in this country.

The great importance of this work, so worthy of an enterprising, enlightened and free state, is no doubt fully realized by your honorable body. That by it the varied resources of the state are better developed and made known, and in particular the character of its superior agricultural and mineral advantages, and the manner in which those advantages can be best secured and perpetuated. While the knowledge now shut from the public eye, or confined to but few, will thus become widely disseminated among the people who are rightly interested in its possession, and additional inducements will be offered to new settlers, such a work will form a noble monument of enterprise and liberality which Michigan will be the first of the western states to achieve.

Connected with this subject are other considerations, showing the value of the materials which have been amassed, by those associated in this department, and the importance of their preservation in such form as to continue to be made available to further the interests of the state. I will only now allude to the completion of the locations of state lands, under the appropriation by Congress, a portion of which it has been proposed to locate in the mineral district, under the direction of the state geologist; the furnishing of information to the legislature relative to the lands, minerals or other resources and interests of the state, in matters of importance annually arising, (of which the information herewith presented relating to the school sections is an example,) and for which annual calls have generally been made upon the department; the completion of the series of state and county maps, which had been commenced under the direction of the head of this department, the drafts of many of which are now in the hands of engravers, and the materials for all of which are drawn in a good degree from the private notes and maps

of those engaged in the survey, and are now in readiness for publication. Under proper direction, the department will be constantly receiving accessions of information, and of geological and other specimens, and it will be at once perceived that the suitable, systematic, preservation and arrangement of all these materials will, of itself, be of exceeding importance to the people of the state, and will demand the continued consideration of your honorable body. All of which is respectfully submitted.

S. W. HIGGINS,

Principal Assistant, and Topographer of the Geological Survey.

Detroit, January 5th, 1846.

*To S. W. Higgins, Principal Assistant, and
Topographer of the Geological Survey:*

Sir:—By the act of March 1st, 1845, the State Geologist was authorized and directed to ascertain the quantity of land the State of Michigan is entitled to in addition to or in lieu of the sixteenth section, and to subdivide fractional sections sixteen into such lots and fractions as may be suitable and convenient for sale, and to make maps of the same.

In compliance with the instructions of the late Doctor Douglass Houghton, I took charge of the work above referred to. His melancholy decease makes it proper, that to you, his principal assistant, I should report the result. Though this, as every other work in which he was engaged, lost in Dr. Houghton its directing mind, yet I believe the results as given in the accompanying books, maps, tabular statements, &c., are correct, and embody all the information desired upon this subject.

My attention has been confined entirely to the lower peninsula, and the accompanying statements have referred to it alone. The survey of the upper peninsula, is but commenced, and although, an immense amount of work was done the past season under the direction of the late Dr. Houghton, and the energetic Surveyor General, Hon. Lucius Lyon, yet a vast amount remains unsurveyed, and it was therefore deemed advisable not to include it in these statements.

The books, maps, &c, above referred to, comprise the following, viz:

1. Two registers of all the school lands of Michigan.
2. Two volumes of maps, each containing one hundred and seventy maps of fractional sections sixteen, subdivided.⁵⁹
3. A tabular statement of all the townships of the lower peninsula, with reference to section sixteen, marked A.
4. A tabular statement of all the school lands of the lower peninsula, marked B.

⁵⁹One volume not finished, yet to be lettered and bound.

5. A tabular statement of the available school lands of the lower peninsula, marked C.

6. A condensed tabular statement of the quantity of land the state is entitled to in lieu of fractional sections sixteen, and for townships deficient in section sixteen, of the lower peninsula, marked D.

7. A statement in detail of the same, marked E.

8. Letter from the Hon. Jas. Shields, Commissioner of the General Land Office at Washington, relative to Indiana reservations, marked F.

9. Letter and statement of "locations", in lieu of fractional sections sixteen, &c, from Hon. D. V. Bell, Commissioner of State Land Office, at Marshall, marked G.

The registers are duplicates, and are intended, one for the office of the State Geologist, and the other for the State Land Office. They are calculated for all the school lands of the State, whether *sections sixteen* or *locations* made *in lieu*, and are divided into *two parts*—the *first* is headed "Description of section sixteen in all the townships of the State of Michigan;" and *second*, "Fractional townships deficient in section sixteen, and fractional sections sixteen, in the State of Michigan." Under the *first head* are exhibited:

- 1st. Each township in the state, (completed for the lower peninsula.)
- 2nd. Quantity in each township—whether it is a "*full*" township or "*three-quarters*," or "*half*," &c.
- 3rd. Quantity in section sixteen.
- 4th. Deficiency in section sixteen.
- 5th. Amount to which entitled to in lieu.
- 6th. Deficiencies, where located.
- 7th. Deficiencies, (location in lieu of,) when confirmed.

Under the *Second Head*, all the fractional townships deficient in section sixteen, and all the fractional sections sixteen, are recapitulated, with the same details of quantity, &c, as given under the first. When the deficiencies now reported are located, and the survey of the Upper Peninsula finished, and the deficiencies there ascertained, and locations made in lieu, and all entered, these registers will comprise complete catalogues of all the school lands of the State.

The two volumes of maps are also duplicates, and are designed, one to accompany each of the registers. They contain each, one hundred and seventy maps of fractional sections sixteen, exhibiting the meandered lakes and streams, and the contents of each fractional subdivision. The meanders of the lakes and rivers, and the calculations of the contents of the subdivisions, are all based upon the original field notes in the office of the Surveyor General, in this city.—These calculations were a work of great labor and care, not only from the important interests involved in them, but also from the careless and imperfect manner in which many of the early surveys were made. In your report of 1840, you had occasion to remark that the "fairest portion of the State was sub-divided with evident want of skill, and with

a carelessness in the first surveyor, (Wampler,) which has already resulted in a vast amount of trouble and absolute loss to a portion of our citizens. This carelessness and want of skill is very evident in the meanders of the rivers and lakes; in many instances, "the variation between the actual and proposed course is so great, as to render it nearly impossible to make the work close."⁶⁰

The Tabular Statement marked A., shows the whole number of full and fractional townships of the Lower Peninsula to be *twelve hundred and sixty-eight*, and the statement of "all the school lands" is made up from the table according to the following provisions of the act of Congress of May 20, 1826:

"There shall be reserved and appropriated for the use of schools—

"For each township or fractional township, containing a greater quantity of land than *three quarters* of an entire township—one section.

"For a fractional township, containing a greater quantity

⁶⁰Dr. Houghton's Report, 1839.

of land than *one-half* and not more than three-quarters of a township, *three-quarters* of a section.

"For a fractional township containing a greater quantity of land than *one-quarter*, and not more than one-half of a township, *one-half* section.

And for a fractional township containing a greater quantity of land than *one entire section*, and not more than one-quarter of a township, *one-quarter* section of land."

The quantity of land the state is entitled to in lieu of fractional sections sixteen, and for townships deficient in section sixteen, of the Lower Peninsula, is *twenty-nine thousand seven hundred and twenty-nine acres and sixty-eight one hundredths*, as shown by statements D and E. To this amount must be added such deficiencies as may occur in *twenty-eight* townships not yet subdivided, and *forty-one* townships of the surveys of Riley & Rosseau, which, if they were ever made, have been found so incorrect, that the Commissioner of the General Land Office has ordered them to be cancelled and the ground re-surveyed.

The statement of "Available School Lands" includes, of course, such as may have been sold and the fractional sections sixteen which have heretofore been withheld from sale as they were not subdivided, all difficulty on that score being now removed. They amount to *six hundred and eighty-six thousand one hundred and nine acres*.

By reference to the statement (B,) it will be seen that the whole amount of school lands of the Lower Peninsula is *seven hundred and fifty-nine thousand five hundred and eighteen acres and 69-100ths*, and when those of the Upper Peninsula, which are estimated at fully one-half as much, or about *three hundred and eighty thousand*,

four hundred and eighty-one acres, and 31-100ths, are added, we have for the total school lands of the state, *one million, one hundred and forty thousand acres, (1,140,000.)* which, at the minimum price as fixed by law, of five dollars per acre, would proclude the sum of *five millions and seven hundred thousand dollars*, and that again at the legal interest of *seven per cent* would yield an *annual income of three hundred and ninety-nine thousand dollars*. Although these lands may not all bring the fixed price of five dollars per acre, yet as nearly all of them are of the first quality for agricultural purposes, or valuable for their timber or mineral resources, their product may be anticipated to approximate very nearly to the sum named, and it must afford high satisfaction to the hardy pioneers who first reared their cabins amidst the uncultivated wilds of the "beautiful Peninsula", and endured all the hardships and privations incident to new settlements, to see their children thus amply provided for in that great essential under a free government—*education* and the enterprising emigrant from the eastern states, accustomed to look upon the advantages of schoolhouse and academy as more than counterbalancing the disadvantages of a stubborn soil and rigorous climate, may turn with confidence to Michigan, satisfied that from her prolific and easily tilled soil, he will receive an abundant return for his labor—that in her richly endowed schools and university, means of education are provided for all.

A great deal of the work was done in the office of the surveyor general, and it gives me pleasure to acknowledge the kindness of the late and present surveyor generals, and the clerks in the office, who afforded me every facility in their power. [Tabular statements A, B, C, D, E, F, and G, omitted, also certificate of true copy by Thos. H. Blake of the Gen. Land Office].

M. E. VAN BUREN.