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, 1843 (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 the 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 indispensible.

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 state; but a slight mis-step 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.

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 neces-

sary 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 indispensible in the construction of the strictly geological maps, and in the great variety of general drafting which will be almost constantly occuring 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 ON 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,

The source from which each document is taken is indicated below the title. The spelling, punctuation, capitalization and general typographical features have been preserved except in case of obvious error, or when the meaning would not be clear.—Ed.

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 myself $2,478.25

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 on 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, $3,000.00

Cr.

May 5. By Cash, $1,500.00
July 1. do. 1,500.00

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 same 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 reconnoisance 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 timbered 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 invariably 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, Stigmaria, and Calamites, together with small masses of carbonaceous matter, associated with the sand rock. A little north of the village, clay ironstone occurs, dissemenated 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 lithodomous 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 counties 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

Underlaying 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 state.

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 Gibralter, 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 of 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 fœtid. 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

[1]The genera Terebratula, Producta, and Cyathophyllum, were observed both in the eastern and western portions of that state; Orthocera, Bellerophon, Sarcinula, Spirifer, Natica, Encrinus, 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 nobs 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 five 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

[2]It 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 refer-

ence 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 deposite 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 a yellowish sand, as is also the alluvial deposite 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 exam-

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

[4]Since 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.

ination 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]

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, as 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 quantity 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 preplexity, 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 or 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

[5]For 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

[6]The 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.

[7]The 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 maunfactured, 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 1, and which it will be recollected was taken under most unfavorable circumstances, three hundred and thirty-seven gallons, nearly, to produce that

[8]The 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 state. But it 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.

[9]Tax 12½ cents per bushel.
[10]Tax 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.[11]

Location	No. 1	No. 2	No. 3	No. 4	No. 5
	Tittabawassa riv. 80 rods below Salt R., Midland co. T. 15 N., R. 1 W., sec. 25.	Tittabawassa R. half mile above Salt R., Midland co. T. 15 N., R. 1 W., sec. 24.	Mouth of Salt R. of the Tittabawassa, 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	152.77 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 "

[11]Equal to three and a half wine pints, nearly.

TABLE NO. 1.—(*Continued*)

Location	No. 6 Kent co., three miles below Grand Rapids T. 6 N., R. 12 W., sec. 3.	No. 7 Kent county, near Grand Rapids T. 6 N., R. 12 W., sec. 3.	No. 8 Kent county, near Grand Rapids T. 6 N., R. 12 W., sec. 3.	No. 9 Kent county, near Grand Rapids T. 6 N., R. 12 W., sec. 10.	No. 10 Kent co., Grand Rapids 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 "
Solid matter	255.05 "	202.00 "	136.36 "	227.27 "	101.00 "

TABLE NO. 1.—(*Continued*)

Location	No. 11 Gratiot county. Source of navigation of Maple river, N. side. T. 9 N., R. 2 W., sec. 26.	No. 12 Gratiot county. Source of navigation of Maple river, S. side. T. 9 N., R. 2 W., sec. 27.	No. 13 Clinton county. Maple river. Clinton salt works. T. 8 N., R. 4 W., section 15.	No. 14 Clinton county. Clinton salt works lower marsh. T. 8 N., R. 4 W., section 15.	No. 15 Washtenaw Co. Saline. 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 "	9.21 "	7.40 "	8.45 "	5.95 "
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 "

[12]Foreign.

TABLE NO. 1.—(*Continued*)

Location	No. 16	No. 17	No. 18	No. 19	No. 20
	Macomb county, Salt river of Lake St. Clair. T. 3 N., R. 14 E., section 2 & 11.	Macomb county. Salt river of Lake St. Clair. T. 3 N., R. 14 E., section line between 2 & 11.	Macomb Co., Frankfort. T 3 N., R 13 E., Sec. 31.	Macomb county. T. 3 N., R. 12 E., Sec. 13.	Wayne county. 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 "	3.03 "	5.72 "	2.75 "	7.97 "
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 "
Solid matter	159.09 "	146.46 "	151.50 "	106.06 "	50.50 "

[13]Foreign.

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
Muriate of soda	83.94	86.98	83.49	71.35	72.01	73.47	66.88	64.51	79.12	58.86	65.23	64.52	75.60	74.50	80.46	87.40	84.36	82.89	84.05	76.13
Muriate of lime	4.85	2.14	4.45	8.24	6.38	8.65	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	5.39	11.42	9.94	1.64	6.77	17.60	9.83	5.84	6.10	7.65	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	3.93	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

[14]For the location of the several springs, see corresponding numbers in Table No. 1.

[15]Foreign.

TABLE NO. 3

Showing the solid contents of one hundred cubic inches[16] 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	.....	.....
	Grains	Grains	Grains	Grains	Grains	Grains
Muriate of soda	2246.05	551.52	2016.33	3780.34	3419.78	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
Silex	1.30	.....	.....	.....	Carb. of iron und.	.....
Solid matter	2326.29	622.93	2185.18	3921.85	3879.94	1089.89

[16]Three and a half wine pints nearly.
[17]The analysis of the waters from the state of New York, is given upon the authority of the late Dr. Chilton. See Silliman's Journal, Vol. 7.
[18]Upon 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	22.96
Carbonate of lime	.11	.38	.02	.15	.....	.....
Sulphate of lime	2.38	5.83	5.40	2.72	.....	.....
Sulphate of soda	.....	.....	.....	.....	.....	10.80
Silex	.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 deposites 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.

[19]My 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 deposites 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 ex-

tent 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 were 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. and 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 reconnoisance 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, petrifactions, 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 petrifactions 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 deposite 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 incrusted with a hard stony coat, or is there a grey or yellowish rock forming near the spring, by deposite 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 deposites 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 deposite 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 ice-houses, 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 three, 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.

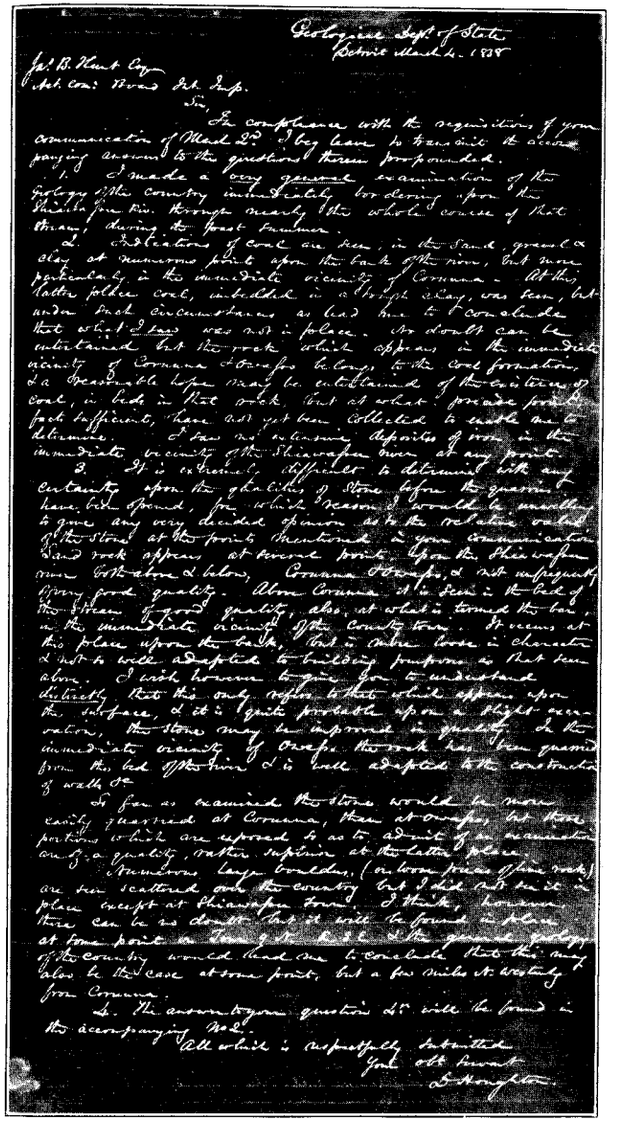
17. The name of the county, township, section, and part of section should be distinctly marked on a small label, which should be enclosed in the wrapper of the specimen, and all information regarding the rocks, sand, clay, brine springs, &c. should designate the precise section on which they occur.

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.

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 character 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 to contain pebbles of lime, while the latter 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 interests, 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 insiduous 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 states 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 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 agricultur-

ist; 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 results 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, 1383.

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