REPORT

OF THE

STATE BOARD OF GEOLOGICAL SURVEY

OF MICHIGAN

FOR THE YEAR 1908

GEOLOGY

ALFRED C. LANE
STATE GEOLOGIST

BY AUTHORITY

LANSING, MICHIGAN
WYNKOOP HALLENBECK CRAWFORD CO., STATE PRINTERS
1909

MAY 18, 1910

BOARD OF GEOLOGICAL SURVEY

1908

EX OFFICIO:

THE GOVERNOR OF THE STATE,

HON. F. M. WARNER, *President.*

THE SUPERINTENDENT OF PUBLIC INSTRUCTION,

HON. L. L. WRIGHT, *Secretary.*

THE PRESIDENT OF THE STATE BOARD OF EDUCATION,

HON. D. M. FERRY, JUNIOR.

SCIENTIFIC ADVISERS.

Geologists.—Dr. L. L. Hubbard, Houghton; Prof. W. H. Hobbs, Ann Arbor.

Botanists.—Prof. W. J. Beal, Agricultural College; Prof. F. C. Newcombe, Ann Arbor.

Zoologists.—Prof. W. B. Barrows, Agricultural College; Prof. J. Reighard, Ann Arbor.

PERMANENT STAFF

LANSING

ALFRED C. LANE, State Geologist.

W. F. COOPER, Assistant.

H. R. WIGHT, Clerk.

HOUGHTON

A. H. MEUCHE, Engineer in Charge.

CONTENTS

Papers included.

TENTH ANNUAL REPORT

OF THE

STATE GEOLOGIST

ALFRED C. LANE

TO THE

BOARD OF GEOLOGICAL SURVEY

FOR THE YEAR 1908

BY AUTHORITY

LANSING, MICHIGAN
WYNKOOP HALLENBECK CRAWFORD CO., STATE PRINTERS
1909

CONTENTS.

LIST OF ILLUSTRATIONS.

PLATES.

FIGURES.

REPORT.

To the Honorable the Board of Geological Survey of the State of Michigan:

Gov. Fred M. Warner President.
Hon. D. M. Ferry Jr., Vice-President.
Hon. L. L. Wright, Secretary.

Gentlemen:—I beg to present herewith this my tenth report for the fiscal year from July 1, 1907, to June 30, 1908, inclusive, and for the field season of 1908.

FINANCES.

The following is the usual statement of expenditures from the annual appropriation:

	Salary.	Field.	Office.	Total.
July	$566.50	$106.28	$28.49	$701.57
August	673.47	395.78	58.19	1,127.44
September	453.00	125.25	48.61	626.86
October	659.26	468.09	18.30	1,145.65
November	399.21	50.14	47.94	497.29
December	460.73	4.82	33.29	498.84
January	427.90	8.38	63.16	499.44
February	599.40	6.51	85.59	691.20
March	410.30	1.45	59.93	471.68
April	510.70	.....	50.80	561.50
May	410.40	4.48	24.95	439.83
June	654 80	27.77	56.43	739.00
Total	$6.225.67	$1,198.95	$575.38	$8,000.00

In addition to this we had:
For year 1907-8, $3,000.00. Bal. remaining Nov. 1, 1908, $0.01.
For year 1908-9, $1,000.00. Bal. remaining Nov. 1, 1909, $224.93.

With this the Milford and Howell quadrangles have been completed and the Mason quadrangle begun, bringing the survey up to the Agricultural College. The Calumet Special has been continued, but practically without special aid from the fund for joint topographic survey, but rather in appreciation of the international importance of McNair's and Hayford's work on gravity.

Owing to the United States and State using different salary tables for fractional parts of a month (producing friction out of all propor-

tion to the few cents involved) the two statements are not precisely the same.

The $1.000.00 for the biological survey has been expended under the charge of A. G. Ruthven, Chief Field Naturalist of your Board, mainly in Huron county.

Balance remaining Nov. 1, 1908, $214.66.

On Nov. 1st there remained in the current appropriation for 1908-9, $4,666.85.

PUBLICATIONS.

At present practically the sole official publication of the Board is its annual report.

The report for 1907, the text of which is all printed, contains:

My executive report with notes on peat, coal, lime and cement.

A report on molding sands by Ries and Rosen.

A popular account of the surface geology of the state as a whole, with (as Plate XII of the same) a map covering the Lower Peninsula. This plate was authorized by the State Board of Auditors only on November 25th.

A report on the geology and biology of Walnut Lake, a lake accessible to a large population and an attractive spot for nature study. Its study has also furnished a clew to the distribution of whitefish in our smaller lakes.

A special edition of maps of the surface geology of the Lower Peninsula has been asked for by the Agricultural College people and a map of the Ontonagon county mining district (the region of the Mass, Adventure, Michigan, Lake and other properties) was of current interest. But owing presumably to the condition of the state treasury, the Board of Auditors did not see fit to authorize them. With your consent the use of this latter map for reproduction was offered to the public press and through the Hancock Evening Copper Journal the firm of Gay & Sturgis issued an edition of the same. The conditions were that the edition was for *gratuitous distribution* and that a part of the same was furnished our office without the advertising matter which they naturally ran to pay the expense. The distribution was certainly more effective than a state publication could have been, and saved our office much time and postage. No criticism has been received and it seems better that our work should be promptly published thus than be prolonged until out of date, even though the form of publication is hardly dignified.

Other publications regarding or including our work are as follows:

A. C. Lane:

Statement to Citizens' Committee regarding Saginaw water supply;[1] statement regarding the results of molding sand work of Rosen;[2] letter on mine waters;[3] notes on Ann Arbor Folio;[4] genetic connection of certain granitic dikes;[5] the ophitic texture;[5] mine waters (which contains a large number of analyses[6] by various authors):

[1]Pp. 27-28 of their Proceedings, and Saginaw daily papers, Jan. 16-19, 1908.
[2]Lansing Journal, Jan. 23, 1908, and other papers.
[3]Calumet News, April 18, 1908, and other Houghton and Keweenaw county papers.
[4]Michigan Miner, May, 1908.
[5]Bull. Geol. Soc. of America, 1908, pp. 644-648.
[6]Proceedings Lake Superior Mining Institute, Vol. XIII, pp. 63-152.

W. F. Cooper: Michigan Topographic Surveys,[1] Pleistocene Beaches of Saginaw county,[2] the Saginaw-Grand Ship Canal.[3]

A. W. Grabau and others (W. H. Sherzer).

New Upper Siluric Fauna from Southern Michigan with W. H. Sherzer, C. S. Prosser, A. C. Lane.

Nomenclature and Subdivision of the Upper Siluric strata of Michigan, Ohio and Western New York.[4]

WORK READY FOR PUBLICATION.

There have been handed in, ready with a little revision, for the report of the Board for 1908:

A report on Mt. Bohemia, by F. E. Wright.

A report on the Development of Mining Machinery and the Geological Factors Therein, A. H. Meuche.

A report on the Ecology of Isle Royale, by Chas. C. Adams.

A report on the Algonquin Beaches of Lake Huron, by W. M. Gregory.

A report on the Monroe Group in Southern Michigan, the group of the strata traversed by the new salt shaft, by W. H. Sherzer and A. W. Grabau, may perhaps be included.

While a large mass of data regarding the copper-bearing rocks has been accumulated, publication in official channels seems to meet the needs of those interested and the size and expense of the annual reports seems to be now more than the Board of State Auditors will stand!

With modern methods of typesetting and preparing copy, the compositor is getting to be a part of a mere machine for turning typewritten copy into leaden slugs. The old fashioned compositors and proof-readers who knew more of composition and spelling than most authors are becoming extinct. The demand is becoming more and more insistent that the typewritten copy shall be letter perfect. Again, the demand of engineers for large scale maps can be as cheaply met for small editions of 500 or so by blue prints or brown prints from Van Dyke negatives.

Finally the ease with which photographs can nowadays be taken, and the widespread familiarity with the simple technique required, favors the transmission with each report of a lot of photographs. These are not all first-class photographs, nor such as reproduced by the half tone process will explain much or add materially to conclusions of the report. In many cases pen and ink sketches would really illustrate better. Yet they are not without value as unimpeachable witnesses to the conditions and facts mentioned in the report. It is important that the original data upon which a scientific investigation is based should be accessible and on file for certain specialists. But the circle of these is limited compared with those who are interested in and can understand only the conclusions.

It is a question whether the time is not at hand when authors can give their reports a winnowing process before publication whereby the complete report with all data shall be typewritten in as many copies as convenient, with all the photographs and prints of the illustrations

[1]Michigan Engineer for 1907.
[2]Tenth report Michigan Academy of Science.
[3]Michigan Miner, November, 1908.
[4]Bull. Geol. Soc. Am. (1908), pp. 540-556.

full size, while only certain chapters embodying the conclusions, the data of wide interest, and a selection of the illustrations, and maps on a relatively small scale are published, *with a reference to the fact that fuller data may be obtained by those interested.*

CO-OPERATION.

We have continued the policy of co-operation with the agencies and individuals studying the natural resources of the state listed in my last report. And in addition the new work of the Board of Health, that of water testing under State bacteriologist Dr. M. L. Holm, has been a great help to us. The laboratory office is on the same floor as that of mine in Lansing. He has made at our request a number of tests of waters which are or might be used for water supply, the results of which are of use to us, and for which our thanks are due to him and to Dr. F. W. Shumway, Secretary of the Board.

In one case a geological fault in the strata seems to be indicated by the character of the waters on the two sides.

It is also true that a number of things more or less depended upon by chemists as guides to the safety of the waters such as chlorine, nitrates, nitrites, ammonia, etc., can only be thus used with due regard to the geological conditions, and this is especially true in Michigan. Dr. Holm feels this quite strongly. Thus our intercourse has been of mutual help, and such water testing work should only be done in close co-operation with competent geological advice.

WATER.

We agree that unfiltered surface water is *not* a desirable city supply. Under that head we also include waters of the Great Lakes.

In comparing surface water and artesian water the fact that the latter is usually harder and causes the use of more boiler compound and soap or separate soft water systems, should by no means be forgotten. The saving of the hard water which may readily amount to a cent a thousand gallons for large and important uses, may pay for the cost of adequate filtration of soft water. At any rate it will go a long way toward it. *One important exception to the harder character of artesian water is the relatively soft water that can be obtained from the Potsdam (Lake Superior) sandstone,* by the towns along Green Bay[1], which have thus no excuse for their high typhoid rate.

WORK OF THE YEAR.

The State Geologist has several times been called upon for advice regarding water works, and has made one special trip to Saginaw. Without usurping the field of the Board of Health or the hydraulic engineer, we have tried to give that class of help for which we may naturally be asked.

Most of his time has been spent in examining specimens sent in and reporting their nature. The bulk of these have been samples from wells and from drill cores in the copper country. A fund of geological information not otherwise to be obtained has been gathered, and while im-

[1]See report for 1903.

mediate needs are answered by private correspondence, special conclusions from these larger pieces of work should find their place in special reports.

There was a meeting of State Geologists at Washington, D. C., last spring at which an association was organized and important steps taken to promote harmony in names. The visit of the Geological Society to Albuquerque gave opportunity to collect some desert sands to compare with the Sylvania sandstone. The visit of the Lake Superior Mining Institute to Minnesota gave an opportunity to study some rocks and cores which have parallels in Michigan. On the way back a stop to visit the Wisconsin-Michigan boundary line (Fig. 3.) yielded results of so much interest in connection with the question of the relation of the copper bearing rocks to the Lake Superior sandstone that the place was revisited later with Leith and Martin of Wisconsin University. These trips were not at the expense of the state.

A two days visit at the suggestion of Hon. Geo. Shiras, III, was made to a salt lick not far from Marquette, of interest both from a geological and biological point of view. (Fig. 1.)

Studies of the salt in mine waters have been presented to the Lake Superior Mining Institute, and reprints of this obtained which may serve until the state is ready to issue a larger report with data collected to date.

Visits were made and field work done in connection with the party of A. H. Meuche beyond the Victoria, and F. E. Wright in the Porcupines. In view of the probable use of the same at once a preliminary map is submitted herewith. (Plate I.)

Dr. F. E. Wright has spent the season in the Porcupine Mountains finishing the field work for his report. In this he received technical assistance from E. S. Larsen, Jr., and the State Geologist. L. Squance was also employed. With the State Geologist a brief trip was made to the Lake Gogebic region north of Berglund where as Wadsworth noted these are interesting porphyry intrusives.

A. H. Meuche has had charge of the Houghton office, and of a party in the field continuing the examination of the Copper Range from the Victoria mine on. He prepared the map of the Ontonagon county mines published, and has assisted in the examination of drill cores, and has made important correlations of the Ontonagon county lodes.

Karl and Leon Meuche and Harold E. Mitchell, and for a short time Dr. R. E. Hore, assisted A. H. Meuche.

Analyses have been made by Dr. A. A. Koch, of the College of Mines.

The topographic survey was in charge of the U. S. Geological Survey, around Calumet, under A. M. Walker, and around Howell and Milford A. M. Walker and C. D. S. Clarkson. With them were employed J. DePuy, Leigh D. Townsend, C. B. Kendall, R. H. Wilson, S. R. Archer, R. C. Gaylord, J. W. Matthewson, S. L. Fuller, Perry K. Miller and Frank A. West.

Harry R. Wight has had charge of the correspondence, and in fact of the whole Lansing office, during the extensive absence of the State Geologist in the Upper Peninsula and elsewhere, and has assisted in editorial work, preparation of Mss., blue printing, etc.

W. F. Cooper had practically almost complete editorial charge of the report for 1907, and has also continued work on Saginaw county.

Of those employed a part of the time or on contract, the following report may be made:

Profs. W. H. Sherzer and A. W. Grabau have studied the salt shaft section and the adjacent outcrops.

Prof. C. A. Davis has been engaged by the U. S. G. S. as peat expert, but has practically finished his Tuscola county report.

RECOMMENDATIONS REGARDING LEGISLATION.

The consideration of natural resources is of ever increasing importance and of even wider popular interest, as emphasized by the White House conference this year, to which a number of State Geologists, and the President of this Board were delegates. It occurred practically at the same time as the meeting of the Association of State Geologists above mentioned.

This is the field of your Board and your increasing work should receive adequate consideration by the legislature. The reports for 1906 and 1907 have already fully set forth our needs for a new building, especially for the care of drill cores. These have cost $5.00 a foot for private parties to obtain, and are of permanent geologic value. Such a building (which should even then be built with an eye to future enlargement) might easily cost $30,000.00.

The topographic survey has now reached the Agricultural College and should certainly be extended to include the neighborhood of the State Capitol. For this $5,000.00 will be sufficient. If, however, the region of the Kalamazoo or Mt. Pleasant Normal is to be covered, and more especially if the region between Grand Rapids and Saginaw, where the deep waterway is proposed, is surveyed, and this is the first step towards an adequate detailed estimate on the project, six thirty-minute quadrangles, say 6,000 square miles, should be surveyed. Taking fifteen-minute quadrangles, however, the area might be reduced to 3,000 square miles, and the state's half of the cost to about $33,000, to be met by an equal sum by the Federal government. But inasmuch as the U. S. Geological Survey has only been having about $100,000 available for such joint topographic surveys, and adjacent states like Ohio, Kentucky and Illinois have been calling for $10,000 and $20,000 a year therefrom, it is quite doubtful if they can at once meet such an appropriation unless the Federal appropriation for such purposes is also raised. Thus whatever is given should be given as a lump sum, available until exhausted as fast as it is met by the general government.

The work of the biological survey is fruitful and should be continued with an appropriation of about $2,000. Detailed estimates will be later submitted. The collections acquired are of such a different character from those of the geological survey, that the rules covering their care and distribution should be different. There is no reason at all why they should be a part of the same collection. The Museums of the University and of the Agricultural College should be made the permanent recipients, and if as seems true upon careful reading of the acts legislation is necessary to make this legal, such action should be taken.

The work of the geological survey is such as to bring prominently to view the importance of many of the legislative recommendations of the

commission of inquiry on the state tax lands. Most especially is to be recommended the withdrawal of all such lands from sale until their value to the state for the purpose of regulating water power and floods, and the production of oil, gas, coal, etc., shall be adequately investigated. In particular is this advisable until the state has adopted some policy of licensing and control for exploration for gas, such as outlined in my report for 1907.

With an expression of appreciation for the advice of the Board of Scientific Advisers and the faithful work of my fellow employes I would close this executive part of my report and add a few notes on matters of current interest not reserved for inclusion in separate scientific reports.

During the year we have received, as a gift from Mr. and Mrs. Frederick Towle of Detroit, original notes, papers and memoranda of Bela Hubbard, who did a very large part of the Douglass Houghton Survey. These papers contain data of decided historic and scientific interest. The reports of that survey are exceedingly rare and should be reprinted with the help of these original notes. There are also meteorological and anthropological data of value.

BRICK.

While there are large areas of excellent shale for brick in the state,[1] yet the scarcity of lumber is such that all the lumber substitute industries are doing well. The sand-lime brick industry is firmly established. Some hints of value may be given by reprinting with notes, extracts from a very practical address in the Clay Record for April 30, 1907, with running comments as to their applicability in Michigan.

Extracts from an Article on "Proper Mixture and Mixing for Making Sand-Lime Brick[2]," with comments.

"It is said that any sand is suitable providing it consists principally of material containing silicic acid, which is the case almost everywhere, and more especially with bank or river sand and sandstone rock.[3] A large portion of calcareous marl[4] will make the sand useless, as the substance can not participate in the chemical transformation into silicates of lime. On the other hand sand composed of small pieces of limestone[5] has produced a very firm hard brick, when mixed with a small portion of finely ground clay in addition to the hydrated lime, but I do not recommend this sort of mixture, because the brick of such a composition are not as refractory[6] in case of fire in building in which they have been used. * * * *

"We are also told that a small amount of fine loam will be of no disavantage. Again I differ with that theory, because I have seen sands

[1]See previous reports, especially Volume VIII, Part I.
[2]Clay Record, April 30, 1907.
[3]Stamp sand, especially that of amygdaloid mines, is not high in silicic acid and should not be used where exposed to alternate wet and dryness. The sand of the Great Lake shores and the sandstones of the Lake Superior (Munising) and Marshall and Saginaw (Coal Measures) formations are highest in silica, but the dune sands are round and even sized.
[4]Bog lime.
[5]Many of the glacial sands and those along the Niagara and Dundee outcrops are limey. In fact most of the overwash gravel sands are limey until they are leached.
[6]That is they melt readily.

in which the individual grains were coated with a very fine loam or clay dust. This coating prevents the lime from coming in contact with the silica, consequently making an improper bond and a punky brick.

* * * * * * * * * *

"Again, some very good looking and hard brick have been produced from sand and loam mixed, but I would not care to use such brick in a building, as they would disintegrate by frost or fire.[1]

"A high percentage of silica is very necessary, and without it you cannot expect to get good results. Candidly speaking, it is a hard proposition to get perfectly clean sand in the ordinary bank[2] on account of the vegetable matter and the soil on the surface, that caves down as the bank is worked. In such cases it is better to remove all the top of the soil, prior to working the bank.

With river sand you may get a good quality for a short time, and when freshets come and deposit mud and slime on top of your sand, you are really up against a bad proposition. My advice in working river sand is to get it out in large quantities and keep a supply ahead, so that it is unnecessary to go into the river immediately after a freshet for your daily supply.[3]

"Sea sand is being used for brick making, but some have used it to their sorrow.[4] Sea sand that comes in contact with the salt water will not make good bond with the lime; again, this class of sand is of the round grain variety.[5] The only sea sand that is practical to work is that which has been away from the sea water for years, and has been purified by the elements.

* * * * * * * * * *

Another matter of great moment in selecting sand is, to get it of varied sized grains.[6] If it were possible to get proportioned as follows, you need not worry about the results: 20 per cent passing 20 mesh, 20 per cent passing 40 mesh, 20 per cent passing 60 mesh, 20 per cent passing 60 mesh, 20 per cent passing 100 mesh screens, providing it is a clean, sharp sand, and you are using a high calcium lime in your mixture, in proper portion, you will get good results. Where you use a coarse sand of nearly one size grains, you will not be able to make a compact brick, impervious to water.

* * * * * * * * * *

"It has been thoroughly demonstrated that five per cent[7] of calcium hydrate, with a clean sharp silicic oxide, is a sufficient amount to make hydro-calcium silicate or sand lime brick. A proper amount is governed by the quality of the sand and the lime to be mixed, and when the

[1]Loamy or clayey, dirty sand is decidedly unsatisfactory.

[2]That is in high level of old beach or glacial sands. There is also more or less decay of those sands which are not all quartz which tends to weaken the brick.

[3]Little or no present river sand has been worked in Michigan, but the advice to be sure to keep out of the reach of freshets is worth noting.

[4]This does not apply to sand of the Great Lakes.

[5]Much of the lake sand is of this round grain, even sized variety, especially the dune sand. In such case regrinding is a great improvement. This is done at the Manistee plant described by J. J. Hubbell in the Michigan Engineer.

On the other hand, the glacial sands vary much in grain and there are often extremely fine sands. Data as to the proportion of grains of different sizes will be found in the U. S. Department of Agriculture soil reports and in the Ries & Rosen molding sands report (Annual report for 1907.)

The open, very porous sand brick will, however, stand frost better than some would expect but the corners are liable to chip in the handling.

[6]Much of the sand of the glacial over wash is quite varied in size.

[7]Six per cent or so is used in Michigan.

in
cla
the

‘
fro
bu
‘
car
sit
the
bai
soi
’
wh
you
sai
it j
dai
‘
the
not
rou
tha
pur

A
size
nee
cen
60
sha
pro
of
imp

“
hyd
hyd
by

[1]L
[2]T
of t
[3]L
to k
[4]T
[5]M
sand
desc
Or
fine
Dep
(An
[7]T
pect
[6]M
[7]S

mixture is made damp, a chemical combination takes place and forms silicate of lime.

* * * * * * * * * *

“If you use a high calcium lime[1] virtually free from magnesia and a clean sharp silica sand, you have an easier proposition than the fellow who has a magnesium lime and clean sharp sand, because he will get a chalky brick and you can rub the grains of sand from a hardened brick with your thumb and finger.

“Should your lime contain a high percentage of calcium and be practically free from magnesia, your sand round grained, you will not get a good brick, while if you are using a high magnesium lime and a loamy sand, either sharp or round grain, your troubles will be too numerous to mention.”

PEAT.

By C. A. Davis.

Thinking to supplement my former report to your honorable Board relative to the peat deposits of Michigan, I take this opportunity to write you briefly concerning the progress of peat investigation, and the industries based upon this, for the year 1908.

The most important, generally applicable announcements have come to us from Europe, as usual, and are two in number: (1). The Ekenberg “wet carbonizing” has been worked out sufficiently to demonstrate that it is a most promising commercial probability. The process, as you may recall, is, as its name indicates, a method of treating wet peat in closed retorts with superheated steam under more than 5 atmospheres (75 lbs.) pressure and at a temperature above 300° F. This carbonizes the peat without volatilization, and, after the process is complete, the water can be nearly all removed by pressure. Drying is completed artificially and the resulting peat substances is easily compressed into very hard, black, non-absorbent, heavy briquettes, which have a high fuel value and are much like coal.

This process has not been tried on actual commercial scale but was very exhaustively tested by the Swedish government, and the experts who made the tests report favorably upon the process and its results. The cost of establishing a plant equipped for this process, with a capacity of 100 tons of briquettes per day, is estimated to be somewhat more than $150,000, exclusive of the cost of the bog, and the cost of production at about $2.25 per ton.

(2.) The Frank Caro method of producing gas from peat with the recovery of ammonium sulphate as a by-product. This is exciting even more interest than (1) since it is in line with the recent advances made in the utilization of other low grade fuels as sources of gas for use in the producer type of internal combustion engines. The peat is dug and partially dried on the bog to about 40 per cent or 50 per cent moisture, and without other treatment is thrown into a gas producer of special construction, where for a considerable time it is heated with a mixture of air and excess of superheated steam. During this treatment practically all of the nitrogen of the peat is converted into ammonia, which is con-

[1]The Fiborn Quarry mine, much of that from Alpena and Petoskey and that from the Bay Port or Mayville limestone, and that from the Sibley quarries is of that nature. Much of the Monroe county lime and that of Manistique and the Niagara formation, and Green Bay generally is likely to be magnesian.

verted to ammonia sulphate by passing the gas through sulphuric acid, and recovered by concentrating the liquid. The pure peat gas, with a heating value of 145 to 155 B. T. U. per cubic foot, which is about that of producer gas from coal, may be used for the production of electric power or for any similar purpose. The important part of the discovery is that the ammonium sulphate recovered from a peat with slightly more than 1.5 per cent combined nitrogen which was used in one large experiment, was sufficient in quantity to pay the entire expense of the process, and give a small profit, leaving the gas which amounted to some 48,000 cubic feet per ton of dry matter of the peat, with 152 B. T. U. per cubic feet, as an additional profit.

As in all plants for gas production on any considerable scale, the cost of this type is large, and is estimated at not less than $150,000. This method of utilizing peat on a large scale is probably the most promising of any of those recently proposed and opens up great possibilities for the utilization of the larger peat beds of Michigan as sources of power to be used in the vicinity of the plant, or transmitted electrically, at a distance.

The fact that several of the analyses of Michigan peat show as high as 2.5 per cent, or more, nitrogen, indicates that aside from the power stored in her bogs, the state has a great amount of combined nitrogen laid down in them, which may be very profitably recovered in the form of ammonia sulphate, and be used in enriching her agricultural lands, since the salt is a very important constituent of high grade fertilizers.

During the past year there has been a rapid improvement in the type and efficiency of gas producers for making producer gas from fuels of the high grade to which peat properly belongs, and it is now possible to buy producers of the suction type which will use moist peat in units as low as 150 horse power. If the improvement continues, as it seems likely to do, it will be only a short time before the producer gas engine, capable of using air dried peat in the form of unshaped masses as dug, will be used in many small factories which are located near peat beds, in place of steam engines now in use.

There has been some activity in the manufacture of peat fuel in the state, although none of the large fuel plants were operated during the year. Mr. Karl Kleinstuck, of Kalamazoo, made something over 100 tons of peat blocks at his Elk Marsh Peat Works, and found ready sale for such of the product as he cared to dispose of, but reserved the greater part of it for his own use.

The plant of the Artificial Fuel Co., of Toledo, Ohio, located near Lambertville, Michigan, was in operation for a short time for the production of material for experimental purposes, but although fully equipped, the company have not tried to operate on a commercial scale until the electric railway crossing their property is completed. The litigation which has prevented this has been settled and the road will be finished early in 1909, after which the peat fuel plant will begin production on full time, if the present plans of the management are carried out.

Peat fuel has been made in some quantity also near Hudson, by the Metropolitian Artificial Fuel Co., of Toledo. The product made by this company was in the form of large blocks, poorly macerated and air dried.

It was bulky and friable, in the samples shown the writer, and apparently little better than cut peat, but considerable of it was sold.

Several new peat companies have been formed in the state, but they have not yet reached the producing stage. Among these may be mentioned the Consumers' Peat Fuel and Gas Co., of Detroit, which will operate in 1909, a plant at Bancroft. The plants at Chelsea, Bancroft and Eaton Rapids were not run during the season of 1908, and nothing was learned of the peat paper plant at Capac.

It is surprising that no attempts have been made in Michigan to make peat or "moss" litter, for use as bedding for horses and other stock. There is an abundance of the fibrous type of peat which is best adapted to this purpose, the processes of preparation are the simplest, and those who have given it a fair trial are enthusiastic as to its many good qualities, so that it would find a ready sale.

From the foregoing it is apparent that the peat question is still a live one, and that the men interested in peat development are still sure of the success they so well merit from their perseverance under many difficulties, and are expecting to establish an important industry and furnish the people of the state a good, efficient, auxiliary fuel at a low price.

The new developments discussed above, while requiring large capital, will in the near future doubtless reach the stages where capital will be available, and Michigan, with its extensive peat beds should be one of the first states to be enriched by plants based upon their exploitation.

SALT LICK.

The carving of wild animals for salt is a notable phenomenon. Thus when Hon. George Shiras, III, called my attention to some remarkable salt licks near his hunting camp, it was a matter I was glad to investigate for the benefit of the biological survey as well as because of the light it might throw on mine waters, oil and gas, and geological theories as to the origin of the deposits in question. This is perhaps the first attention we had paid to natural salt springs since the days of Douglass Houghton, who investigated a number as indications of salt. The licks in question occur at the head of Whitefish Lake. This region has been well described geologically by Rominger[1] but is very imperfectly shown on the maps so that we need to insert the following sketch figure.[1]

This lake is about 3 miles south of the flag station Deerton, on the Duluth, South Shore & Atlantic R. R. If this is as Gannett gives it 716 feet A. T., Whitefish Lake is about 796 feet A. T. It is not far from the Agricultural Experiment Station, Chatham, and is covered but not shown on the Munising soil map of the U. S. Department of Agriculture.

The river (Whitefish or Laughing Whitefish river) which drains the lake, flows over ledges and rapids of sandrock. Not far from the outlet on the east side there is exposed a flat ledge (Snake Rock) of white sandrock, about 100 feet square, just about at water level. The outlet is clogged with large blocks of sandrock.

The figure shows how long and narrow the lake is and it is deep.

[1]Volume I of these reports, Part 3, pp. 74, 75, 88-90.

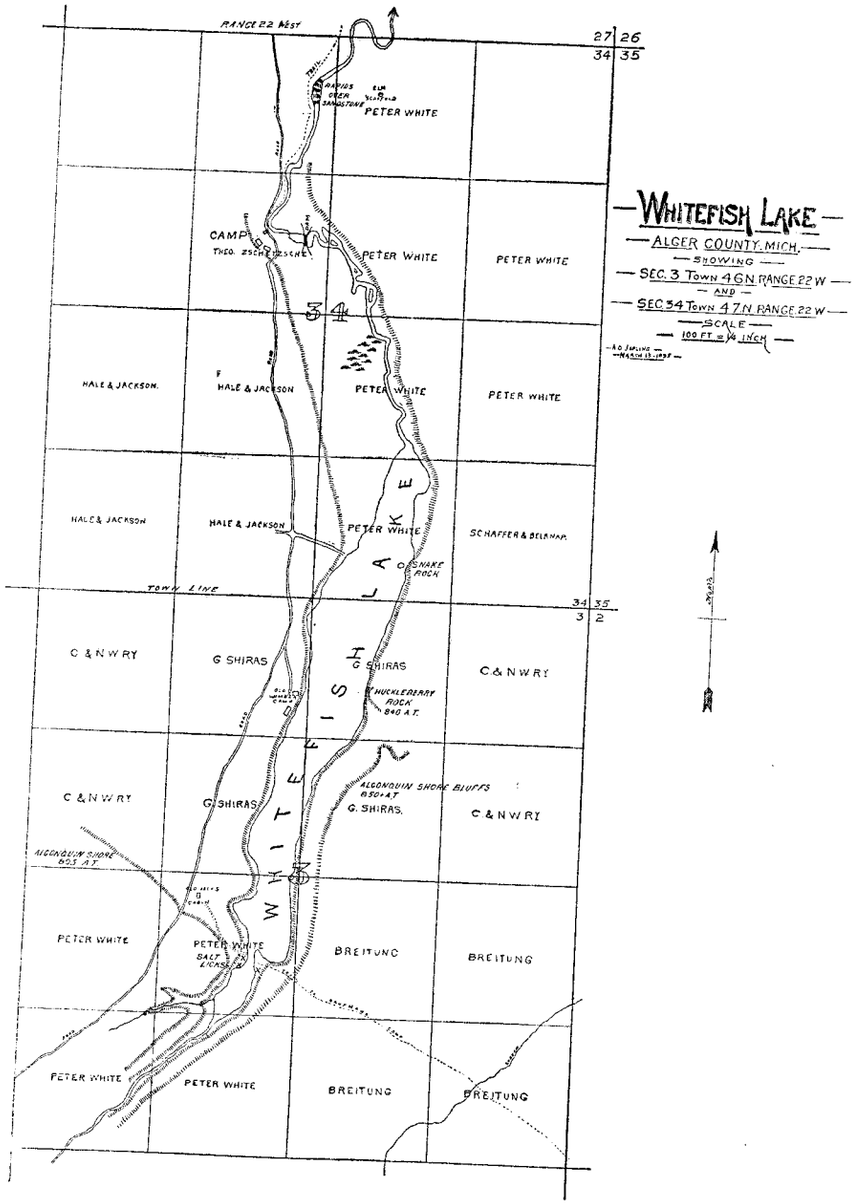

Fig. 1. Sketch Map showing location of Whitefish Lake Salt Licks.

It is said to be not less than 60 feet deep for a good part of the way. At the north end of the lake the level of the country is hardly 10 feet above the lake, but as we go south it rises somewhat, and south from Huckleberry rock the top of the bluffs 840 to 845 feet A. T. is a lake cut bench just below the well marked shore line of a vast lake of which Lake Superior is but a relic—the former Lake Algonquin. Near the head of the lake we find, on each side of this old shore line, back of which the country rises suddenly over greenish white sandrock and blue shale to 95 feet above the lake, or 890 feet A. T. The gorge of the inflowing river, which continues the lake, is thus quite deep, 100 to 150 feet. About four miles south it terminates in a series of falls something like 75 to 100 feet high. The sandstone beds exposed are all in that upper part of the Lake Superior (Potsdam) sandstones, that I propose to call the Munising sandstones. The section as given by Rominger is from above down, as follows;

6.	Massive but soft white sandstone in vertical cliffs	50
5.	Thin beds of soft white sandstone parted by seams of blue shale	75-100
4.	Thicker ledges with quartz pebbles, a few feet dark coarse conglomerate	
3.	Hard sandstones, coarse red-specked	4-20
2.	Argillaceous red sandstone 1 to 3 feet thick, and red shales	12
1.	Thin bedded sandstones and shales, white, or blotched white and red.	25

The bluffs at the head of Whitefish Lake show 5. Down to Huckleberry rock the bluffs appear to be capped by 3 or 4 and underlain by 2. The salty water must come near the line between 2 and 1. The length and narrowness of the lake and its vertical sides suggest at once that it has been formed like the gorge above, by the cutting of a stream. The apparently greater depth than at the outlet (like the gorge of Niagara and the "Dead Sea" in the Adirondacks) may be due to the plunge of an interglacial or preglacial waterfall.

The salt water occurs on both sides of the inlet at the head of the lake, at points about opposite, near where the cover over the sandstone thickens. It probably oozes from a given stratum. Or if it finds its way up by a cross fissure it must have spread through the strata for some distance. Tests under Huckleberry rock and at another point yet nearer but to the north do not show the abnormal chlorine to anything like the same extent. Neither does the river water, the lake water nor wells nor springs in the sides of the bluffs. It is also very interesting, almost surprising, to find that the water is not only saline but contains chlorine so much more than sodium that we are constrained to infer the presence of calcium chloride, the same salt which is found in paleozoic brines very widely and in the mine waters of the Upper Peninsula. It is therefore no indication of the ocean having entered this region during the postglacial depression.

The places frequented by the deer were in the sand flats of the delta of the Whitefish as it comes into the lake (Analyses 7-12). Here along certain fallen trees Mr. Shiras has observed the deer ranged in a row like cattle. Digging directly at the sandstone bluffs near by disclosed the same or stronger waters. The details of the tests follow:

1. Incoming river water (mg. per liter) by silver nitrate tablets has about 12

parts million of chlorine. The carbonates if all calcium, would (by sodium acid sulphate test) be about 50 per million.

2. The hardness of the outflowing water by soap test, if all calcium, would be about 80 per million.

3. A hole dug at the base of the bluffs near Huckleberry rock on the east side of the lake yielding water probably from the rock (temperature 55° F. where the lake was 66°) yielded by silver nitrate test,

Of chlorine ..... 30 parts per million
By soap test, hardness as calcium..... 49 " " "

4. The shallow (10 foot) well at Shiras' camp has so little chlorine that 250 cc is not enough to neutralize a silver nitrate tablet corresponding to 1.01 mg Cl.:. Cl is 4 parts per million. By sodium acid sulphate test the carbonates as Ca were 32 per million.

5. Water from the sandstone 60 feet above the lake has by sodium sulphate test of carbonate 40 per million.

6. A hole near the head of Buck Bay under the bluffs only a few feet from the licks was clayey and therefore not accurately to be tested, but contained no great amount of chlorine.

7. Sample of lick sent in Nov. 9, 1907, by George J. Shiras, III, tested by F. B. Wilson. Only a few cc of water available gave,

Cl	862 per million.
Total solids	2482
S (SO_3)	27
Mg	tr.
Ca., Na., etc.	present but not determined

At the time the sample was taken there was a pink scum on the water, probably organic, like a pink bacterial scum which C. A. Davis tells me he has noted on salt marshes. The lick itself was muddy with slime from the river and the tramping of the deer and full of fallen timbers, but we had dug with pick and shovel two shallow holes not over a foot and a half shoreward from the main lick.

8. The first hole closest to the lick gave Cl. 2370 per million by silver nitrate tablets and, by sodium acid sulphate, carbonates as Ca 100 per million.

9. Another hole not 10 feet off going down into the clear white sand of the decayed sandrock gave Cl. 1750 per million. The temperature was 57°—of the river 63°-65° on Sept. 11, 1908. A sample was taken also for preservation in a jug.

10. Over on the west side of the stream was another lick in a miry spot. This gave:

By silver nitrate test	Cl.	1200 per million
By soap solution, hardness as calcium	Ca.	82
By sodium and acid sulphate, carbonates as calcium	Ca.	235

Phenolphthalein does not indicate any sodium carbonate, nor does acetate of lead show any sulphides. The sandstone outcropped within 10 feet. There is quite liable to be urine contamination.

11. About 120 feet up stream under a log which projected over a sandy bottom was another place where the deer were fond of standing. Here we found:

By silver nitrate test	Cl.	1050 per million
By sodium acid sulphate test, carbonates as Ca		185

12. A sample taken to the College of Mines yielded Dr. A. A. Koch:

Cl.	
Ca.	1298
Na.	247
H_2S	572
	0

This would give 572 Na plus 885 C.=Na Cl.....1475
234 Ca plus 413 Cl.=Ca Cl_2..... 647

Leaving amounts of calcium (13 parts), magnesium, iron, etc., to be combined as carbonate or sulphate.

Allowing for the probable amount of such carbonates, say 238 per million, would make the total solids very much as in No. 7.

Owing to the very dry weather there may have been some concentration, and

there is even more likelihood of a dilution with surface water. But specimens 9 and 12 ought not to be very much affected. Analysis 7 shows clearly the dominance of chlorides over sulphates. In the presence of calcium chloride no stress can be laid on the sodium acid sulphate test, but the water is obviously much harder than the ordinary sandstone water.

A contamination by urine of wild animals is perfectly possible in 7, 8, 10, 11, not so likely in 9 and 12. But as in any case urine contamination would raise the proportion of sodium, the presence of a water containing not less than 1,000 parts of chlorine, and some calcium chloride oozing from a Cambrian sandstone where it is exposed under a relative thick cover, and not so leached as farther north seems with great probability to be the source of these salt licks.

Other natural salt licks or springs in Michigan were described by Douglass Houghton in his early reports. C. A. Davis reports one in Section 22, Wisner township, Tuscola. Mr. Shiras says there was one four miles up Sand river from the D. S. S. & A. R. R. track, and another about 300 yards from Deer Lake, near Onota.

Mr. Henderson reports some on Sec. 22, T. 49 N., R. 40 W. Another large one on the bank of a creek in Sec. 16, T. 49 N., R. 40 W. Another one mile south of the Copper Crown Mine Sec. 4, T. 49 N., R. 41 W. Then there is a well marked one about 200 yards west of the old tramway connecting the Union Mine with the Lake Shore in Sec. 22, T. 51 N., R. 42 W.

Very respectfully,
ALFRED C. LANE,
State Geologist.

INDEX.

INDEX.