SEVENTH ANNUAL REPORT

OF THE

STATE GEOLOGIST,

ALFRED C. LANE

TO THE

BOARD OF GEOLOGICAL SURVEY

FOR THE YEAR 1905.

ACCOMPANYING THE PRECEDING PAPERS.

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ILLUSTRATION.

ANNUAL REPORT FOR 1905.

OFFICE OF THE STATE GEOLOGIST,
LANSING, MICHIGAN, Dec. 14, 1905.

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

HON. F. M. WARNER, *President.*
HON. W. J. MCKONE.
HON. P. H. KELLEY, *Secretary.*

Gentlemen—I beg to submit my report[1] for the fiscal year July 1, 1904, to June 30, 1905, in continuation of previous reports, and for the calendar year for 1905. This disparity of dates is in order to give time to make up the figures and at the same time give prompt account of the last field season.

The following is the usual tabular statement of expenses from the annual appropriation (Act No. 133, Session of 1895):

FINANCES.

	Salary.	Field.	Office.	Total.
July	$835 16	$266 64	$63 42	$1,165 22
August	1,031 16	267 66	24 33	1,323 15
September	886 59	368 65	44 90	1,300 14
October	581 77	105 33	26 33	713 43
November	423 00	23 46	27 63	474 09
December	378 50	36 50	19 23	434 23
January	375 42	34 06	32 91	442 39
February	365 60	.....	37 20	402 80
March	488 79	.....	40 41	529 20
April	354 80	.....	20 50	375 30
May	328 79	.....	5 55	334 34
June	424 80	61 79	19 12	505 71
Supplementary	.....	.....	.....	.....
Total	$6,474 38	$1,164 09	$361 53	$8,000 00

Our expenses to December 14, 1905, are $3,488.80. Beside this we have expended; from the appropriation for the joint topographic survey with the U. S. Geological Survey (which has been expended in mapping areas—Marquette and Detroit), Act 251, 1905, $1,996.58, and from Act 178, Session 1903, $499.65.

[1] A full abstract of this report was published in the "Michigan Miner" for March, 1906.

The last legislature in authorizing your Board to conduct a biological survey (a study of peat producing plants), in amending the act in the very last days of the session, made the appropriation therefor $1,000 for the year 1905, and $1,000 for the year 1906. Although the obvious intention of the legislature was to provide for the field season of 1905 and of 1906 respectively, the ruling of the Auditor General's department is that it legally applied to the year ending June 30, 1905, and must be spent *or contracted for* by that time. Under the circumstances the wisest expenditure seemed as follows: Prof. C. A. Davis of Ann Arbor had been for some time studying the plants of the peat bogs, especially in the Lower Peninsula, and had prepared an elaborate thesis thereon. This we agreed to purchase on condition that he would complete the same by spending his whole summer in travel and further investigation of the plants and peat bogs of the Upper Peninsula, without further expense to us, and hand in then a complete report on the distribution of the peat producing flora of the State. This he has done and I recommend it to you for publication as part of the report for 1905.

The expenses for printing are as follows:[1]

Appropriation Section 1, Act 271, Session 1901		$2,800 00
Expended (p. 118 annual for 1904 and p. 307, annual 1903) previously	$1,949 17	
Finishing up report for 1903	126 20	
Expended up to July 1, 1905	$2,073 41	
Appropriation Section 1, Act 178, Session 1903:		
First half—		
Expended up to Oct. 27, 1904		$655 90
For annual for 1903	$93 30	
For miscellaneous	35	
For Volume IX	552 25	
Expended to July 1, 1905:		
For Volume IX	51 99	
For annual for 1903	531 06	
Total	$583 05	
Total		$1,238 95
Second half—		
Binding of Volume IX	$487 50	
Incidental	105 00	
Annual for 1903 and 1904		
Total		$1,238 41

[1] Owing to the allotment for the annuals for 1903 and 1904 being insufficient, I had to cancel the printing done on the Douglass Houghton report, paying for the little that had been done (fortunately the printer had been very slow) out of my own pocket, and use the balance of the appropriation, Section 1, Act 231, Session 1901, to finish Volume IX and the two annuals, which included a number of expensive maps.

PUBLICATIONS.

This year shows a better record than last as to publications. The annual report for 1903, containing contour maps of Bay and Tuscola counties, and of Ann Arbor showing also the wooded areas, with a report on the Soil and Forest types of the Michigan Forestry Reserve, by B. E. Livingston, a discussion of the water resources of the lower tier of counties by W. F. Cooper, and of the Upper Peninsula, and of the propagation of heat into the ground, which affects mine and well temperatures, etc., papers on the copper bearing formations, etc., was finally finished by the Robert Smith Printing Co.

The new state printers, the Wynkoop, Hallenbeck, Crawford Co., also pushed through the annual for 1904, which contains a paper on the failure of the wells along the Lower Huron river by M. L. Fuller, an account of the geology of the north shores of Lakes Huron and Michigan by I. C. Russell, and my personal report, which contains besides notes on current accumulation of facts regarding wood substitutes, coal, gold mining, wells and borings, an account of the recent committee on the iron bearing rocks.

Volume IX of our reports consisting mainly of Grimsley's monograph on the gypsum has also been published although it was nearly ready a year ago.

Of the joint topographic survey sheets has been issued that of Grosse Point, covering the Detroit Water Works and Belle Isle Park—Lon. 82° 45′-83°, Lat. 42° 15′-30′ N. Eight other sheets may be expected soon.[1]

I have carefully studied not to make our publications unduly expensive and think I have succeeded fairly well. It must of course be remembered that our small editions make the cost per copy high. Yet there is no use in running off large editions, increasing the total cost, simply to reduce the cost per page or volume. If the object were to advertise the resources of the State to a large class, like that of prospective emigrants, it would be different. We do have quite a large call for the small map which we use also as a letter back.

But as I understand the situation, the better plan is to put on record and in the libraries where they could be consulted by all, and in the hands of those teachers who have interest enough to ask for and use them, important facts that may be discovered regarding the resources and geology of the State, and depend upon the journalist and magazine to spread abroad those matters which are of interest to a wider circle.

I am consulted (gratis) very frequently in my office regarding boring and raw material of various kinds. With the facts in our reports readily at hand I can often give information worth perhaps a good deal of money to the inquirer, and ultimately lead to an increase in the taxable property of the State. Yet the information in question would be of similar value to comparatively few.

The main object should be to get the facts into the hands of those who can appreciate them, and I believe that can be done by making the subject and author of each paper conspicuous and the Board acting as publisher and using the ordinary channels of the book trade. The work on gypsum by G. P. Grimsley for instance will find its way into the hands of those interested much quicker when thus entitled than as Part 2, of Volume IX of the report of the Geological Survey of Michigan.

I believe it might also be well to place the publications of the Board on sale at a commission with booksellers in central towns and towns imme-

[1] Now out, Nov., 1906, apply to Director U. S. Geol. Survey, Washington, D. C.

diately interested. I have no doubt many dwellers on the St. Clair Flats would be glad to buy Mr. Cole's report did they but know of it.

I may also mention (see note on co-operation below) the fact that soil maps have been issued by the U. S. Department of Agriculture, in addition to those of Allegan county and Pontiac, around Alma, Saginaw and Bay City, Owosso and Munising.

The College of Mines at Houghton has also issued a pamphlet on Michigan minerals and rocks to accompany their loan collections which should be invaluable to teachers.

LEGISLATION.

The last legislature passed an act extending the work of the Board to cover a biological survey, that is a study of the distribution not merely of the rocks but of the plants and animals, its relation to their environment and the welfare of man. In consequence it became difficult for me to estimate what amount of money might be needed for expenses. I had therefore to ask the legislature to let the report come out of the general funds under the same law that covers those of numerous other boards. This is Act 44 of the Public Acts of 1899, and was amended by Act 297 of the Session of 1905 in section 14 by adding "State Board of Geological Survey" "not to exceed 1200" at the end. These 1200 copies are to be distributed "by the head of the department," about 125 copies are issued for the State Library and about 200 for the Secretary of State in addition. Thus volumes uniform with those bound in green are suspended until further action, and reports will be of the same general style as those annual reports issued at intervals since 1892.

But there is no curtailment in the size of the printed page, merely in the margin, and somewhat in the quality of the ordinary paper. But I hope that there will be no deterioration so far as the illustrations are concerned.

The Board of Auditors I think intelligently appreciate that the quality of the illustrations is essential in a report of this kind.

A further sum was granted to continue the joint topographic survey of the State.

Below will be found copies of the acts providing for the biological survey (No. 250) and the joint topographic survey (No. 251). It hardly seems worth while to reprint the act regarding printing for a single line amendment.

Another act which may mean work for the geologist in future is one regulating the use of flowing wells. (Act No. 107.) This is the third act respecting such matter that has been passed by the legislature, the others being one regulating abandoned salt wells, and another regarding artesian wells, which seem intended to cover the same ground as the more recent bill. Water is one of the essentials of life and unquestionably in the future the State will have to step in more and more to regulate problems involving conflicting claims on the use of water, for the greatest good of the greater number. A stream may be used for drinking and for sewage disposition. It is not healthy to use it for both! Wells are commonly used as sources of water supply, but in many cases they may be efficiently used as drains. Many a little pocket marsh can be effectively drained in that way. But the two uses may clash.

A free use of water as a motor for a hydraulic ram may appreciably lower the head elsewhere. Now while the respective rights to surface water are

pretty well settled little has been determined regarding rights to underground water, an animal "*ferœ naturœ*," perhaps according to the common laws, the ways of which it used to be thought one could find out. Much has been done, however, in this connection of late years, especially by the U. S. Geological Survey, in gathering the facts which are the prerequisite to intelligent legislation. This applies as well to the streams of the State. The people should soon decide whether they prefer to use them as sources of water or sewers. That they should continue long to be used for both will become with our increasing population and intelligence incredible, unless both products are systematically filtered.

ACT NO. 250.

AN ACT to provide for a biological survey of the State, making appropriations therefor, and to provide a tax to meet the same.

The People of the State of Michigan enact:

SECTION 1. That the Board of Geological Survey as constituted by act number sixty-five of the laws of eighteen hundred sixty-nine, as amended, is hereby authorized and required to make under the general direction of the State Geologist, appointed by them, a thorough biological survey of the State, embracing a determination of the range and distribution of the various plants and animals inhabiting the State and the relation to their environment and the welfare of man.

SEC. 2. The powers and duties of said board relative to the expenses incident to such biological surveys, and the publication thereof shall be the same as they now are relative to the geological and mineralogical survey of the State.

SEC. 3. The annual report of progress now required of the Board of Geological Survey shall include an account of the progress of said biological survey and there shall be printed of the same, the same number as, and under the same conditions as, the report of the Board of Fish Commissioners as provided in act number two hundred twenty-five of the Public Acts of nineteen hundred three.

SEC. 4. To carry into effect the conditions of this act, the sum of one thousand dollars for the year nineteen hundred five, and one thousand dollars for the year nineteen hundred six, is hereby appropriated to be drawn from the treasury as needed. The accounts of the members of the board for official services and all other expenses authorized by law shall first be certified to be correct by said board, and shall be paid out of the State treasury upon the warrant of the Auditor General from the fund appropriated for that purpose: Provided, No part of said appropriation shall be used for printing reports.

SEC. 5. The Auditor General shall add to and incorporate in the State tax for the fiscal year ending June thirty, nineteen hundred five, the sum of one thousand dollars, and for the fiscal year ending June thirty, nineteen hundred six, the sum of one thousand dollars which, when collected, shall be credited to the general fund to reimburse the same for the money hereby appropriated.

This act is ordered to take immediate effect.

ACT NO. 251.

AN ACT providing for the extension of the work of the State Board of Geological Survey and making an appropriation to meet the expense thereof, and providing a tax to meet the same.

The People of the State of Michigan enact:

SECTION 1. That the Board of Geological Survey, as constituted by act number sixty-five of the laws of eighteen hundred sixty-nine and acts amendatory thereof, is hereby authorized to confer with the director or representative of the United States Geological Survey and to accept its co-operation which this State in the preparation and completion of a contour topographical survey map of this State, which is hereby authorized to be made. Said board shall have power to arrange with the director or representative of the United States Geological Survey concerning this survey and map, its scale, method of execution, form and all details of the work, in behalf of this State, and accept or reject the work executed by the United States Geological Survey. And it is hereby provided that said map shall accurately show the outline of all townships, counties, and extensive wooded areas, in this State as existing on the grounds at the time of the execution of

these surveys; the location of all roads, railroads, streams, canals, lakes, and rivers; and shall show by contour lines the elevation and depression of the surface of the country. For the purpose of making the surveys hereinbefore provided for, it shall be lawful for the persons employed in making the same to enter upon all lands within the boundaries of this State, but this act shall not be construed as authorizing any unnecessary interference with private rights.

SEC. 2. That there be and is hereby appropriated for the purpose described in the preceding section of this act, and for the work of the board, as heretofore authorized, the sum of two thousand dollars for the year ending June thirty, nineteen hundred six, and the sum of three thousand dollars for the year ending June thirty, nineteen hundred seven.

SEC. 3. The several sums appropriated by the provisions of this act shall first be certified to be correct by said board, and shall be paid out of the State treasury upon the warrant of the Auditor General from the fund appropriated for the purpose: Provided, That bills for expenses for printing and publication shall, after approval by the board, be presented to the Board of State Auditors, and after allowance by them audited by the Auditor General: And provided further, That the expenditures for the topographical survey shall not be in excess of that expended by the United States Geological Survey from the United States treasury.

SEC. 4. The Auditor General shall add to and incorporate in the State tax for the fiscal year ending June thirty, nineteen hundred five, the sum of two thousand dollars, and for the fiscal year ending June thirty, nineteen hundred six, the sum of three thousand dollars, which, when collected, shall be credited to the general fund to reimburse the same for the money hereby appropriated.

This act is ordered to take immediate effect.

ACT NO. 107.

AN ACT to regulate the use of artesian and other wells; to prevent the waste of waters therefrom, and provide a remedy therefor.

The People of the State of Michigan enact:

SECTION 1. Any artesian or flowing well, the water of which is unnecessarily allowed to run to waste in an unreasonable manner to the depletion or lowering of the head or reservoir thereof to the detriment or damage of other wells supplied from the same head or reservoir, shall be deemed a nuisance, and its owner and the owner of the land on which it is situated shall be subject to all the actions for abatement and damages in favor of the person or persons injured that are or may be provided by the law for other nuisances or tortious acts.

SEC. 2. Where any well is supplied by a head, reservoir, stratum, or vein or by percolating waters common to other springs or wells, and the owner thereof or his lessee or licensee puts its waters to a use unreasonable or unnecessary, in view of the condition and situation of the land on which it is situated, and through such unreasonable or unnecessary use, lowers or depletes the head, pressure, or supply of water of any spring or well dependent on the same head, vein or stratum, to the detriment or injury of the owner or any person entitled to the use thereof, the well so unreasonably and unnecessarily used, shall be deemed to be a nuisance, and its owner and the owner of the land on which it is situated shall be subject to all the actions for abatement and damages in favor of the person or persons injured, that are or may be provided by law for other nuisances or tortious acts.

SEC. 3. Where any decree is rendered under this act declaring any well a nuisance because of the waste or unreasonable use of its waters and directing the abatement thereof, such decree shall specify in some practicable manner the daily amount or volume of water that may be used or allowed to flow therefrom without violating such decree, and specify such reasonable time as to the court shall seem just within which the provisions thereof shall be carried into effect: Provided, That any such decree may be reopened at any time after entry on the question of reasonable use on a proper showing of change of circumstances or other equitable reason therefor.

This act is ordered to take immediate effect.

BIOLOGICAL SURVEY.

Upon the passage of the biological survey act I invited leading and easily accessible biologists, who had been active in behalf of the bill, to consult

with me as to what should be done. There were present Mr. G. M. Bradford of Bay City, Prof. J. B. Dandene, W. B. Barrows, and J. W. Beal of the M. A. C., C. C. Adams and C. A. Davis of the University, Bryant Walker of Detroit, and A. C. Lane.

Dr. H. L. Clark of Olivet, E. N. Transeau of Alma, and Drs. Reighard and Newcombe of the University were represented by letter.

The general opinion was that it would be wise to have an advisory committee, regarding the Biological Survey especially, to consist of one member from outside the State institutions to be nominated by the council of the Academy of Sciences, and one each from the Botanical and Zoological Departments of the Agricultural College and University. If it were deemed wise to have this advisory committee include the whole scope of the survey a geologist from the University and College of Mines might be added. It was deemed proper that hereafter in running heads and citations the term "Michigan Survey" be used, and the proposition of the State Geologist that all the papers should be published in one volume per year, each paper to be issued as ready with a separate date of issue, but to be paged continuously for a single year seemed generally satisfactory.

Among the propositions for work were the following: (1) A study of the distribution and present abundance of venomous snakes in Michigan. (2) A study of the plants most concerned in the production of peat. (3) A biological survey of some small area of which we already have a soil map of the department of agriculture. (4) A botanical study of Bay county. (5) A study of the trees and shrubs of the State, probably in co-operation with the forest reserve. (6) A study of the edible fishes in connection with the study of certain select and typical lakes. (7) The State Geologist also suggested that in connection with any or all of this work biologists might be attached to geological parties working in the Upper Peninsula. (8) It was suggested that Mr. Bryant Walker give a report on the Molluscs of the State. To this Mr. Walker said that he could in a short time prepare an account of the land snails of the State, but that it would take considerable more time to cover all the fresh water fauna; that he had already acquired cuts, however, of a very large number of species.

There seemed to be a very general consent that *one* of the pieces of work undertaken should concern the fish resources of the smaller lakes, but some difficulty in deciding just how this would be at present undertaken.

The State Geologist will thankfully appreciate suggestions.

CONSTITUTION OF THE BOARD OF GEOLOGICAL SURVEY.

There has also been some talk to me, in connection with this enlargement of the scope of the work of the Board, of lengthening the title so as to include Natural History and changing my own title also to that of Director, enlarging the membership of the Board by appointees from the scientific departments of the State institutions. While I recognize that would tend to keep a closer check on my scientific work and be a stimulus to me, and while I feel and appreciate the help that such members would be to me in the broader field now before us, which the attainments of no *one* man may span, yet there are certain practical difficulties which ought not to be forgotten. The present Board are ex officio and the expenses of the same are a minimum—only about $100.00 a year. Many members have not drawn a cent from the State Treasurer for their work on the Board. At a time when accusa-

tions of graft, often well founded, spread like wild fire even where ill founded, it is worth noting that not one of the Governors with whom I have been associated has used his position on the Board for personal profit or to pay political debts.

One reason then that might be urged for such an enlargement of the Board, to "take it out of politics," can therefore only be brought forward as a guard against future rather than a remedy for present or past evils.

Human nature I have found much the same whether occupying professional chairs or political posts. Some men are selfish, some unselfish. Some work for themselves, others work for the cause.

It would be difficult to enlarge the Board and give all interests due representation without making it unwieldy, hard to obtain a quorum, and expensive to have meetings.

Lengthening my title or that of the Board would mean a slight addition to the expense, and I find upon examination that there is plenty of precedent for biological work in connection with a geological survey and nominally supervised by the "State Geologist." Possibly good results could be obtained by selection of official advisers or consulting scientists, somewhat as is the system in Wisconsin, and I would recommend that this Board adopt such a plan tentatively on its own initiative, and then later if it works satisfactorily it might be incorporated as a part of the law. I submit to the careful consideration of the Board the following series of resolutions by which such a plan might be inaugurated.

Resolved, That this Board select six official scientific advisers, two geologists, one at least of whom shall be a resident of the Upper Peninsula, two botanists (not connected with the same institution), and two zoologists (not connected with the same institution), whose expenses shall be paid, but who shall receive no pay for their advice. These may, however, be employed by the Board in other work.

Resolved, That while the State Geologist shall still continue to be the executive officer of this Board, it will make no permanent appointment and no permanent contract for scientific work without consultation with the scientific advisers immediately interested, and accordingly while the State Geologist shall conduct the preliminary negotiations he shall present the proposed contract or appointment to the Board with the written endorsement or opinion of the two advisers most interested, and he shall also report to them all temporary appointments and provisional arrangements, which as heretofore he is authorized to continue until the Board and advisers have had a chance to pass upon them.

Resolved, That at the stated meeting of this Board in March, or at such adjourned meeting thereof as may be duly called for the purpose, the official scientific advisers of the Board be authorized, expected and requested to meet with it to advise with regard to the work of the following summer, the expenses of the ensuing year, and any other matters that they may see fit. At such meeting the State Geologist shall be present, with estimates prepared.

Resolved, That in the first instances the heads of the geological departments at Houghton and Ann Arbor be requested to be or to nominate the geological advisers, while the council of the Michigan Academy of Sciences nominate the other four.

WORK IN HAND.

The following is the state of the work in hand:

A paper on the Ecology of Isle Royale and the Porcupines by C. C. Adams is in the printer's hands.

W. F. Cooper's report on Bay county still awaits publication. The economic chapter has been printed in the Michigan Miner.

C. A. Davis' papers on the distribution of the peat producing plants has been handed in, but returned for revision and to keep up to date, as the printer is not ready for it.

The manuscript of W. M. Gregory's report on Arenac county has been partially handed in.

The report of W. H. Sherzer is still awaiting the topographic base which is, however, now practically complete, for the Detroit, Wyandotte, and Romulus sheets of the joint topographic survey and the four sheets into which the Wayne quadrangle has been divided, Dexter, Ann Arbor, Saline, and Ypsilanti will soon be issued.

Dr. W. C. Gordon is preparing his report on the Black River section. Mr. F. E. Wright made a short trip to Mt. Bohemia this fall to visit it before writing up his final paper.

Copy for the nine-sheet map of the surface geology of the State, on a scale of six miles to the inch, is nearly ready for four of the sheets. During the summer Prof. Russell covered what territory of another sheet lies within our borders, that around Wisconsin. Frank Leverett of the U. S. Geological Survey, assisted at various times by W. C. Gordon, G. L. Tower, and C. A. Davis on behalf of the State, covered another sheet. I hope to begin publication of this map this winter.

Incidental to this work Frank Leverett prepared a report on the flowing wells of the district covered by him,[1] which supplements my 1903 report in a partial way. The flowing wells of the Lake Michigan shore deserve greater attention and advertising than they receive. The whole shore from the Garden peninsula to Drummond Island has the physical attractions that have made Mackinaw favored for years. It is separated from the torrid breezes from the south by cool waters; and sparkling "fountains" should furnish uncontaminated water, and eliminate typhoid, that bane to summer resorts which so often have makeshift sanitary arrangements.

CO-OPERATION.

Referring to previous reports regarding co-operation and their policy regarding the same, I merely give an account of what has been done so that those who wish to keep track of the progress of investigation may know where to look. I do not try to assign or claim exact credit. In some cases as in the book on Michigan Rocks and Minerals the assistance is almost wholly from our already published material, or that acquired by the authors when members of this survey.

In other cases, as in stream gauging, simply advice and casual assistance, like the occasional detail of a man paid by the U. S. G. S. has been lent, while in others financial support and unpublished material has been turned over.

[1] U. S. Geological Survey Water Supply paper No. 160.

U. S. GEOLOGICAL SURVEY.

Hydrographic division. Mr. Frank Leverett has compiled an extensive report on the surface waters and shallower wells of the Lower Peninsula, practically to take the place of my U. S. Water-Supply paper No. 30,—now long out of print and *scarce*. All our material in that line was put in his hands, and his report is now in the hands of the editor. We have, as mentioned, furnished him assistance in the Upper Peninsula. But from him I think we received more than we gave.

In Water-Supply and Irrigation Paper No. 145, pp. 44-45 and 129 to 144, are papers regarding water problems in Michigan, the latter being similar to our first paper in our 1904 report by M. L. Fuller.

Water-Supply and Irrigation Paper No. 149, pp. 65-69, contains a list of deep borings in Michigan largely compiled from us.

The records of flows and gaugings are contained in Water-Supply and Irrigation Papers

49, pp. 243-259, 1900.
75, pp. 110-113, 1901.
83, pp. 285-288, 1902.
97, pp. 431-498, 1903.
129, pp. 17-67, 1904.
See also pp. 294-296.
See 22nd annual report, part 4, p. 261.

Water-Supply and Irrigation Paper No. 102, pp. 489-512 contains data similar to Cooper's paper in our annual for 1903. Water-Supply and Irrigation Paper No. 114, pp. 242-247 is practically a summary of my W.-S. & I. P. No. 30, out of print. I looked over the proof. It has a geological sketch map of the Lower Peninsula.

In connection with the collection of deep well records we have been collecting and dividing samples from Ypsilanti, Adrian, St. Joseph, and other points.

TOPOGRAPHIC SURVEY.

The condition of the joint topographic survey at the beginning of the year was given in the following statement by the United States Geological Survey:

By the terms of an agreement entered into between the Director of the United States Geological Survey and the State Geologist of Michigan, dated August 17, 1901, the sum of $2,000 was allotted by the State, and the Director of the United States Geological Survey made an allotment of $4,000 for the co-operative topographic survey of Michigan during 1901 and 1902. Under the terms of an agreement signed May 27, 1903, provision was made for the expenditure of $1,700 by the State, and $2,500 by the Federal Survey for the government fiscal year ending June 30, 1904. By agreement signed May 25, 1904, the State allotted $1,000 and the Federal Survey $3,200, for the fiscal year ending June 30, 1905. The total expenditure in co-operation by both the State and Federal governments on this survey to date has been $14,400.

Prior to co-operation the survey of seven quadrangles was completed, covering 963 square miles within the limits of the State, and atlas sheets representing these have been published by the United States Geological Survey. These are: Crystal Falls, Iron River (Mich.-Wis.), Maumee Bay (Ohio-Mich.), Menominee Special (Wis.-Mich.), Sagola, Toledo (Ohio-Mich.), and Whitbeck. Three others covering 422 square miles within the State were compiled; namely, Ned Lake, Passage Island, and Perch Lake. The survey of two special districts, Gogebic Iron Range (Wis.-Mich.), and the Marquette Iron Range, covering 194 square miles within the borders of the State was also completed.[1]

[1] This mapping was done in connection with studies of the iron ranges and was not found to be satisfactorily accurate.

The result of co-operation to the close of 1904 is a complete map of 1,687 square miles represented on the Dexter, South Lyon, Saline, Ypsilanti, Grosse Point, Detroit, Wayne, Wyandotte, and Romulus atlas sheets. Of these the Ann Arbor sheet, a two-mile reduction of the first four, has been published. Including work done by the United States Geological Survey alone previous to co-operation, the mapping of 3,266 square miles within the borders of the State has been completed.

The results of the above mapping are being published at the expense of the United States Geological Survey. Each atlas sheet is approximately 16½ by 20 inches.[1] Differences of elevation are shown by contour lines. The sheets are engraved on copper and are printed from stone in three colors; black for all artificial features, as roads, railways, houses, etc.; blue for all water features, as lakes, rivers, etc.; and brown for contour lines representing the surface relief, or the shapes of slopes of hills, valleys, etc.

The published sheets are sold at five cents each, or $3.00 per hundred.

During the year the Wayne and Grosse Point sheets have been published, the latter including Belle Isle and the Detroit Water Works. The other maps have been held a short time to incorporate some recent detailed surveys of the Huron river, but a number should be out this winter.

The balance of the appropriation of 1904-5 was spent in revising the work along Detroit river and starting work near Marquette. For various reasons I requested that a quadrangle near Marquette, which was largely water, be surveyed. It seemed that the Upper Peninsula should share in the work. No more fitting place could be found than the neighborhood of the Normal School, for the teachers and pupils would then have the advantage of a good local map in studying geography. The area required to complete a sheet was comparatively small, and the primary triangulation already done. Finally by completion of this sample we could have something upon which to base estimates of the cost and value of such work in that region.

I enclose extracts from correspondence concerning the same from which it will appear that the cost has been unexpectedly high.

September 18, 1905.

It seems that we have gotten into real trouble in the Marquette region, in so far as the work has proven to be the most difficult and expensive that we have encountered anywhere. Mr. Sutton and I have both every confidence in Mr. Whitman, who has had wide experience under the most adverse conditions of mapping in such regions, and Mr. Whitman finds it impossible to make more than half the mileage we have made in the worst of the Adirondacks and the Maine woods. In consequence the work will cost considerably more than estimated, and to complete the Marquette sheet will take quite a little of the $1,250 which we had allotted for topographic work in the Pontiac region and neighborhood. In that region we are now completing all the primary control which you and I planned, and I doubt that we will do much topographic work.

Very respectfully,
(Signed) H. M. WILSON, Geographer.

November 18, 1905.

I am informed by Mr. J. M. Whitman, assistant topographer, that on behalf of the Cleveland Cliffs Iron Co. of Ishpeming, Michigan, you requested of Mr. Whitman an estimate of the cost of making a topographic map, scale about 2,000 feet to the inch, of the iron range in Marquette county, Mich., with a view to your offering co-operation towards the making of such surveys.

As the results of this past season's experience on the Marquette sheet, we find that in this particular region it will be as cheap to make a survey on a larger scale of 1:24,000 as on the smaller scale heretofore employed in that region by us, of 1:62,500. The cost of mapping the Marquette sheet was about double that of the most expensive work heretofore surveyed by us under like conditions; namely, $55.91 per square mile. I believe that we can safely estimate on the mapping of the area which you have in mind as costing about $55.00 per square mile for topography, but there will be the additional cost

[1] About 320 square miles.

for primary triangulation which is lacking in that region, so that the total expense will be about $60 per square mile.

I believe that the Survey would be willing to accept an offer of co-operation in doing this map work providing the area of survey in such an expensive region were limited. In this case I understand that the area is about forty by eight miles.

Very respectfully,

(Signed) H. M. WILSON, Geographer.

December 20, 1905.

I have the honor to make the following preliminary report of the co-operative topographic survey of the State of Michigan for the year 1905-6:

ALLOTMENTS.

Senate Bill No. 148[1] of the Legislature of Michigan, authorized the Board of Geological Survey of the State to coöperate with the United States Geological Survey for the making of a topographic map of the State, and appropriated $2,000 for the year ending June 30, 1906, for the prosecution of this survey, providing the United States Geological Survey expended an equal amount on the same work. On behalf of the federal bureau I allotted a like sum.

This work was prosecuted under an agreement signed by the Acting Director of this Survey June 20, 1905, and by you June 28, 1905, in which it was agreed to extend the terms of the agreement of May 27, 1903, to cover coöperation for the fiscal year ending June 30, 1906.

RESULTS.

In correspondence between yourself and Mr. H. M. Wilson, Geographer, of this Survey, under dates of June 28 and 29, 1905, plans were made for the prosecution of this work, and such plans have been carried out so far as the funds available would permit.

From the expenditure of the money provided for this cooperation a complete and accurate map has been made for publication on a scale of 1:62,500, with a contour interval of 20 feet, of 47 square miles of the area of the State, which represents the completion of the Marquette sheet, lying in Marquette county. During this mapping 70 trigonometric points were located; there were run 110 miles of spirit levels, in the course of which 788 elevations and nine permanent bench marks were established. There were also run 374 linear miles of road traverse, every bend and every house being accurately located. The topography of this region is probably the most intricate and detailed which the Survey has ever mapped. As a result the time required and the cost were exceptionally high. The resulting map is so intricate that a small edition will be published on the large scale of 2,000 feet to one inch, in order that all the results procured by this Survey may be legible.

In addition to the above considerable preliminary control was run on the Pontiac quadrangle, in Oakland county, resulting in 79 miles of spirit levels, in the course of which 468 elevations and 15 permanent bench marks were established. There were also run 322 linear miles of road traverse.

A large portion of the available funds were devoted to extending primary control for future mapping. Such control was extended over five 15-minute quadrangles, situated in Lapeer, Oakland and Livingston counties. There are the Howell, Highland, Pontiac, Rochester and Orion quadrangles. In the course of this survey 202 miles of primary traverse were run; 17 azimuths were observed and 18 metal tablets were set to mark the geodetic coordinates, all of which will be computed.

The total expenditure upon this work to date has been $3,810. The balance, $190, will be expended by the first of January upon completing the office drafting and computing the results.

Very respectfully,

(Signed) CHAS. D. WALCOTT, Director.

I shall not make any further recommendation regarding Upper Peninsula work, until the Marquette sheet has been issued and we have studied it critically, and have had time to determine its relative value, and the value of the methods of work compared with others.[2]

[1] Act No. 251.

[2] Since presentation of this report, use of this map by myself and reports by others indicate the value of the map, and that it is incomparably more accurate than, for instance, those published with the Marquette Monograph.

It seems to me hardly fair to recommend work in so much greater detail than that used in the other parts of the State, unless the large property owners of the country to be covered bear the extra expense involved.

DEPARTMENT OF AGRICULTURE.

I submit also extracts from letters from the department of agriculture regarding cooperation. I have mentioned above that they have mapped areas around Allegan county, Owosso, Pontiac, Bay City and Saginaw, Alma, and Munising, which can doubtless be obtained from congressmen.

December 12, 1905.

In reply to your letter of December 8th I would say that we shall be glad to furnish you with 20 copies of the advance sheets of each Michigan area as the reports are published.

In regard to coöperation, it has been our custom and it is our desire in every case where information or advice is furnished us by any of the State organizations to give this fact full recognition in the text and also in the titles placed upon the maps, since these form a portion of each report. It is very probable that during the progress of our work in Michigan we shall desire to call on you for information, not only as we have been able to do in the past, but also to a greater degree in the future, and it will probably be no more than fair recognition of the services which you have rendered and can render to place your name and that of your organization on the maps, as I suggested in a previous letter.

Very truly,

(Signed) MILTON WHITNEY, Chief of Bureau.

December 18, 1905.

I have just received your letter of December 15th, in regard to the work which your organization is doing in Michigan. As you say, we do not usually find that a geological map constitutes a detailed soil map. Nevertheless, the relationships between the soils and the geology of any region are so close that the broad classification of the soils follows quite closely after the geological classification, even though certain details may be different. For example, soil series as we are establishing them generally follow the geological classification, and the soil types constitute additional subdivisions of the geological formations.

We shall be very glad to receive copies of the various sheets of your nine-sheet map as they are issued. They will be of considerable value to us in locating and carrying on our soil survey work in Michigan. We would probably not need more than a few copies for office use.

You can be of great aid to us, through your maps and your detailed knowledge of the geology of Michigan, and while we shall make maps of one sort and you maps of another, the relation between the two kinds of maps will be such that a thorough understanding of the similarity and the differences which exist will be of help to both of us. I am glad to get your note in regard to the presence of finely ground limestone in the glacial material of the southern peninsula.

Copies of our maps will be forwarded you as rapidly as they are published, and any parties placed in the State of Michigan will be referred to your office for whatever information you may be prepared to give. In case we can serve you in any way we shall take pleasure in doing so.

Very truly,

(Signed) MILTON WHITNEY, Chief of Bureau.

Our close relations with the State institutions continue. For instance the examination of the cross section of the Tamarack Mine below the Calumet conglomerate was accomplished jointly by Pres. McNair of the College of Mines and Mr. Corey of the geological faculty and myself and W. C. Gordon. We have had necessary analyses made by Mr. F. K. Ovitz at the University of Michigan and Mr. F. B. Wilson of the College of Mines.

The following is a statement of the persons employed or under contract to furnish work during 1905, and a brief statement of their occupation.

PERMANENT STAFF.

A. C. Lane, State Geologist, executive duties, consultation regarding deep wells (St. Joseph, Benton Harbor, Adrian, Alpena, etc.), and drill core records (Arcadian, Franklin, Tecumseh, C. & H., etc.), editing reports, field work in the copper country, water reports for Leverett and Battle Creek, studies on mine waters, and brines.

W. C. Gordon. Charge of Houghton office. Preparation of Black river report, assistance in examining Tamarack Mine sections, Arcadian drill cores, and contour map near Hermansville.

W. F. Cooper. Work on Bay county report, on deep well records around Wayne county with W. H. Sherzer, watching rock salt shaft near Detroit, etc.

Harry R. Wight, clerk. Taking letters, 1451, 1904-5, 592 to December 16, 1905, typewriting manuscript, shipping reports, reading well temperatures, etc.

The above is the permanent staff. The following gentlemen of special qualifications have been employed on contract:

Prof. I. C. Russell of Ann Arbor. A report on the surface geology of the sheet of the nine-sheet map of the State that includes Iron Mountain (spending the summer in the region).

Prof. C. A. Davis. A report on the distribution and ecology of the peat producing flora (spending the summer in the Upper Peninsula).

Prof. A. W. Grabau. A report on the fossils of the Traverse limestone, (so extensively quarried near Alpena and Petoskey).

Prof. W. H. Sherzer. A report on Wayne county.

Prof. W. M. Gregory. A report on Arenac county.

Prof. T. L. Hankinson has also been kind enough to do some fish collecting on Keweenaw Point.

The following assistants were employed temporarily:

F. P. Frapwell, with Prof. I. C. Russell.

G. L. Tower, with F. Leverett.

This does not include chemical analyses paid for as such or unskilled labor by the day.

The following were employed by the United States on the joint topographic survey:

J. M. Whitman, topographer in charge.

J. N. Williamson, levelman.

B. L. Sherman, C. A. Blanchard, Frank Gennell, Edward Gilbert, E. C. Garwin, H. M. Gillman, H. W. Peabody, W. H. S. Morey.

Even for temporary positions on the joint topographic survey it is necessary to file applications at Washington with letters of recommendation, which of course I am glad to give to properly qualified persons, especially graduates or advanced students of engineering in our State institutions but there are two important conditions to be noted. The applicant must be over 20 years of age and must promise to stay through the field season. The latter condition can often be arranged with the engineering faculties. For permanent positions, one must pass the Civil Service examinations.

THE OUTLOOK.

The first fruits of the biological survey—a practical report on Isle Royale and the Porcupines—is in the printer's hands. Next should follow Cooper's report on Bay county and Bradford's account of the flora of the same, and perhaps some of the sheets of the nine-sheet map of the surface geology of the State. Next perhaps will be Davis' report on the peat producing plants, Gregory's report on Arenac county, a report tendered us by C. H. Kauffman on the fleshy fungi (mushrooms) of the State, Davis' report on Tuscola county, Grabau's report on the Traverse limestones, Sherzer's report on Wayne county, will come in an exact precedence, which cannot now be decided. This annual report and the reprinting the Douglass Houghton reports must come in when they will cause no delay. A report on various recent investigations in the copper bearing rocks, and mine waters and other waters of the State, and on the prospects for oil, could be rushed through rather soon if there were any reasonable chance of prompt publication. Under the circumstances it seems well to keep them open for new material as long as we can.

Of course the results of work relative to deep wells and diamond drills belong first to those who do the work, and I can submit letters as to the value of our work this past year to those interested.

SCIENTIFIC NOTES.

Putting aside then work on the copper bearing rocks, and also notes on deep wells, whether for oil or water, for separate treatment, there are miscellaneous observations worth making a matter of record on subjects which may not have extended treatment for some time.

MAMMOTH AND MASTODON.

According to the Muskegon papers a skull with teeth and tusks, the skull measuring three feet eight inches was found on the place of C. L. McKay, two miles north of Moorlands.

On Oct. 25, 1905,[1] Joseph St. Johns "digging a drain on the land of Chas. Warren, a short distance from Bancroft, found the skeleton of a mastodon. While the bones were not in the best state of preservation he found the ribs, tusk, teeth and many other bones. One tooth measures $4\frac{3}{4}$ x $3\frac{1}{2}$ inches in size and weighs one and one-quarter pounds, the tusk measures 54 inches in length and measures 18 inches around at the large end. The bones were about four feet under ground imbedded in marl."

Prof. Walter B. Barrows also acquired for the Agricultural College the lower jaw of a mammoth (a young female probably) found near Grand river, two miles below Eaton Rapids. As it was in quite fair condition it was worth about $10.00. Mr. James Lucas, of the National Museum of Washington, issues a circular regarding the collection and valuation of such bones.

[1] Detroit News. I visited Bancroft and verified the item. They were found near the line between Sections 36 and 25, T. 6 N., R. 5 E., the section being two feet of muck, six inches of shell marl, then sand. The bones in the marl are much better preserved.—L.

STRONTIUM.

Strontium salts have a value in beet sugar manufacture and in making red fire. Prof. E. H. Kraus, newly appointed to the chair of Mineralogy at the University, has been studying the distribution of the strontium sulphate and sulphide[1] largely out of the State but also in Monroe county where it was described by Sherzer in the Monroe county report.[2] I think it worth while to call attention to the presence of strontium in the waters of Lake Superior as well as many of our mineral waters,[3] and particularly to the fact that Dr. Kraus attributes to the presence of celestite the "acicular," "vermicular" or "gashed" appearance of many dolomites. This appearance is, I may say personally, almost characteristic of certain dolomites of the Monroe (neontaric) group. It is therefore well to keep an eye out for accumulations of celestite which is accumulated in commercial quantities in the famous caves of Put-in-Bay, and also occurs in some of the Monroe quarries quite abundantly. It cleaves well, like calcite, but the cleavages are not equally good. It is heavier and often bluish, and may occur north of St. Ignace or on the islands north of Beaver Island.

In the 1904 report were given Ovitz's figures of analysis of the water of Swan Creek, Grosse Isle. The following is combined from the original figures, to correspond to the analysis given below and to the crystals found in a dried drop of the water.

SWAN WELL, GROSSE ISLE.

	Parts per million. Grams per metric ton.
Na Cl	30.7
K Cl	20.2
Na_2CO_3	25.5
$CaCO_3$	213.2
$CaSO_4$	1,559.7
$SrSO_4$	66.6
$MgSO_4$	361.8
SiO_2	18.8
$FeCO_3$	2.0
	2,298.5
Excess CO_2 (bicarbonate)	40.6
Water of crystallization	45.6
Total solids on evaporation	2,384.7

With these it is interesting to compare the artesian water at Put-in-Bay island. Apparently the sulphates are leached downward, are reduced by organic matter to sulphides, and sometimes decompose to hydrogen sulphide or even to sulphur, as Kraus says.

[1] American Geologist, Vol. 35, pp. 167-171, March, 1905; also Bull. Geol. Soc. America; American Jour. Science, July, 1904, Vols. 18, p. 30; 19, pp. 286-293, 1905; Science, Oct. 20, 1905, p. 502; Seventh Report Michigan Academy of Science; Z. fur K. XLII, Band 1, p. 1.
[2] Volume VII, part 1.
[3] Annual for 1904, p. 20; also Water Supply and Irrigation Paper No. 31.

PUT-IN-BAY ISLAND, OHIO. ANALYSIS OF VICTORY STRONTIA SPA WATER BY G. A. KIRCHMAIER, PH. C.

	Parts in 1,000,000.	Grains per U. S. Gal.
Strontium sulphate	579.00	33.755
Silica	2.50	.145
Iron	3.50	.204
Alumina	1.50	.087
Sodium chloride	19.20	1.119
Potassium chloride	15.60	.908
Magnesium carbonate	246.20	14.354
Calcium carbonate	440.60	25.690
Calcium sulphate	1,131.83	65.985
Total Solids	2,439.93	142.247

In this connection the following analyses may be of interest, which are of beds in the Woolmith quarry.

	1.	2.	3.	4.
Silica	1.77	1.30	0.58	20.14
Alumina Al_2O_3	0.01	0.16	0.37	.86
Ferric oxide (with ferrous)	.41	0.20		
Magnesia	20.84	19.79	18.11	15.32
Calcium oxide	29.65	31.14	25.18	19.56
Water—	0.12	0.18	.....	.....
Water+	0.48	0.57	.....	.....
Carbon dioxide	46.50	45.18	39.55	31.94
P_2O_5	tr.	tr.	.02	.....
SO_3	0.33	1.15	6.33	0.56
MnO	tr.	tr.	.....	.....
Organic matter with petroleum odor	pr.	pr.	.92	10.72
BaO	....	.....	.13	.07
SrO	....	.....	7.86	.66
Na_2O	....	.....	.11	.09
K_2O	....	.....	.05	.07
Cl	....	.....	.04	.03
H_2S	....	.....	tr.	.02

1. Is the tenth layer from the top. E. C. Sullivan.
2. Is the fifth layer from the top. E. C. Sullivan.
3. Is near the surface cover. Bed A. Dr. E. H. Kraus.
4. Is a porous, cavernous layer. Dr. E. H. Kraus.

It is notable how many constituents are found in analyses 3 and 4 not given in Nos. 1 and 2, presumably because not looked for, while 3 and 4 have their own gaps.

In Nos. 3 and 4 the molecular weights are for:

Calcium oxide	.4488	respectively	.3493
Magnesium oxide	.4487	respectively	.3795
	.8975		.7288
And for carbon dioxide	.89886		.7259

Showing how closely true dolomite they are. The barium and strontium are similarly combined with the sulphate.

BUILDING MATERIAL.

Limestone, clay, cement, etc. As usual numerous samples of clay come to me to test. They are generally the fine grained not sandy kind. Even if they are reported "free from lime"—like the extensive beds of S. F. Saxton near Traverse City, which are also reported free from grit on the low land, there is often a large percentage of limestone or dolomite flour. This though it will not burst brick, prevents it being hard burnt, and makes the brick generally light colored.[1] As I have previously said the depletion of lumber has meant growth of the brick industry, and plants have been established and enlarged, *e. g.* the Myerburg Terra Cotta & Brick Company, four miles south of Battle Creek; a factory at Twining; Britton (See analyses below.)

I made an interesting visit to the plant of the White Portland Cement Co. at Four-mile Lake, near Ann Arbor. They were working close to Four-mile lake, which was drained, and using the kiln process, hoping thereby to save heat used in evaporating the slurry. They were using a clay which came directly beneath their bog lime (marl) rising in the bottom like a knoll. The section was;

1 to 2 feet, peat.
1½ to 2 feet, bog lime with a layer of Unio.
Shells on top of the clay.
10 feet, blue clay.

South and southwest from the lake there is a long extent of swamp with two to seven feet of peat underlain by bog lime (marl) which is said at times to run up to 99.87% $CaCO_3$. This island of blue clay is very tough. The cement is said to stand 900+ pounds per square inch on a 28-day test. But the plant at last accounts was in difficulties. We have also received from Mr. Berger blue prints of surveys near Lakelands and Ann Arbor. And the following analysis of the bog lime from Ore Lake received through Prof. I. C. Russell, may be compared with that from Zukey, Bass and Lime lakes of Volume VIII, Part 3.

ORE LAKE.

SiO_2	0.53
Al_2O_3	0.14
Fe O + Fe_2O_3	0.96
MgO	1.10
CaO	51.87
Na_2O	0.1
K_2O	0.1
H_2O-	0.97
H_2O+	1.22
CO_2	42.30
P_2O_5	0.06
SO_3	0.14

The calcium and magnesium oxides require 41.95% of CO_2, so that there is over 90% $CaCO_3$.

[1] To make paving vitrified brick the fluxing material should not be anything which is readily fluid like lime and iron silicates, but something like the alkaline alumo silicates which, as Day and Allen have shown, are so viscous as to retain their angular form even when melted.

Mr. J. J. Wirtz (Jan. 28, 1904) sent us some information regarding lakes with bog lime (marl) near St. Ignace and within one mile of Lake Michigan, as follows:

1. SiO_2 0.90%, $CaCO_3$ 98.06; over 140 acres, lime from 15 to 25 feet deep near the shore and bottom, over 30 feet down farther out at about 20 feet, three to four feet of peat, then marl again.
2. SiO_2 1.10, $CaCO_3$ 96.28; close to shore 10 or 12 feet, near center to 28 feet, the marl very hard and firm, no water under ice and no dirt on marl, at about 20 feet a peat layer then marl again.
3. SiO_2 1.90, $CaCO_3$ 89.15, sample dirty, being taken from the shore with a shovel.

This would seem to be a promising deposit. But on the whole the tendency seems to be to neglect the marl (bog-lime) deposits and investigate the limestone. The reason may be found in Wentz's statement that "the cost of fuel in the dry process using rock" (limestone) "and shale is about 20 to 24 cents per barrel under normal conditions, but from 40 to 60 cents per barrel in the marl or slurry process."

For example the Standard Portland Cement Co. has been turning to Charlevoix, bringing it in line with the Elk Cement and Lime Co., which has practically moved to Petoskey as its base of supplies. This company originally looked up the Lakelands deposits then carefully examined Upper Herring lake and Little Platte lake in Benzie county and have given me a blue print of their soundings there which may sometime give us some idea of the rate of growth of such deposit of bog- or Chara-lime.

Analyses of the Herring lake deposits are as follows:

December 12, 1904. Upper Herring lake, Benzie county, Blaine township. Analyses of marl.

	1.	2.
Silica	10.15	14.92
Oxide of iron	.59	.77
Alumina	3.90	4.21
Lime	41.75	38.21
Magnesia	2.45	2.98
Carbon dioxide	35.51	33.32
Organic matter	5.65	5.59
Total	100.00	100.00

	3.	4.	5.	6.	Average of 8 samples.
Silica	1.92	17.74	19.43	29.40	1.70
Oxide of iron	1.42	1.33	1.33	1.45	1.00
Carbonate of lime	89.62	64.40	61.30	53.26	88.94
Alumina	.....	3.62	4.48	4.63	*
Carbonate of magnesia	2.45	5.79	6.96	7.95	none
Organic matter	4.59	7.12	6.50	3.31	8.36
Total	100.00	100.00	100.00	100.00	100.00

The deposits of marl and clay around Little Platte lake are shown by analyses by W. H. Simmons, the Bronson chemist,[1] given below. Note

* Combined with iron oxide.
[1] See also pages 297, 323 and 333 of Volume VIII, part 3.

especially the percentage of organic matter in the marls which does not hurt the finished cement but lowers the capacity of the plant. They are low in magnesia.

In the analyses of the surface clays, note the presence of variable amounts of magnesia, which is, however, low in No. 544 and 552, and 553. Nos. 592 to 595 already printed, are more nearly the common type.[1] Some of the clays, for instance No. 579, might be valuable clays for front and paving brick. The condition and amount of volatile matter would need examination.

Letters of F. H. Aldrich, Nov. 11, 1903, and Dec. 2, 1904. Clays found near Platte lake, Benzie county.

Report of analyses. Bed "A." Sample clay. Laboratory No. 579. Mark 48 W. J. G. Date of receipt, 10:30: 1900. Composition:

	579.	544.	552.	553.
Silica	58.02	57.58	62.14	57.00
Alumina	17.98	17.10	19.11	17.96
Iron oxide (Ferric)	4.02	5.23	6.44	6.04
Oxide of calcium	1.53	2.81	.14	3.94
Oxide of magnesium	1.37	.72	.96	2.43
Sulphuric acid (Anhydrid)	trace	.34	.17	2.43
Volatile matter	13.04	12.60	8.35	.34
Alkalies by diff	3.82	.....	3.33	.....

Sample marl. Laboratory No. 525. Mark 1. Date of receipt, 7:28: 1900. Composition:

		16.	17.	18.
Silica	4.34	3.56	2.52	3.25
Alumina, Iron oxide (Ferric)	1.58	.45	.51	.83
Carbonate of calcium	85.11	77.46	84.01	77.95
Carbonate of magnesium	.95	No trace	trace	trace
Sulphuric acid (Anhydrid)	trace	.58	.73	1.11
Organic matter	7.00	16.42	11.04	.....
	99.08			

Small amount of sand reported with silica.

Report of analysis. Samples marl. Laboratory Nos. 530, 531, 532. Mark, 10, 3, 4. Date of receipt, 7-28, 1900. Composition:

	10.	3.	4.
Silica	5.15	7.35	3.18
Alumina, Iron oxide (Ferric)	.48	1.07	1.10
Carbonate of calcium	86.43	82.19	79.17
Carbonate of magnesium	.73	.35	.19
Sulphuric acid (Anhydrid)	.55	.68	.85
Organic matter	6.50	8.00	15.00
	99.84	99.64	99.49

Respectfully submitted,

(Signed) W. H. SIMMONS.

Bronson, Mich., 8-12, 1900.

[1] Page 327 of Volume VIII, part 3.

Extracts from report on the property of the Standard Portland Cement Co., Charlevoix, Michigan, by the Robt. F. Wentz Engineering Company,

Toronto, Ont., May 23, 1904.

Standard Portland Cement Co., 812 Hammond Building, Detroit, Michigan.

Gentlemen: I herewith respectfully submit my report of the examinations of the various properties owned by you. The limestones properties are located west of the city of Charlevoix, in Charlevoix county, Michigan. The shale deposit is located near the village of Ellsworth, in Antrim county, about 10 miles south of the city of Charlevoix, and along the tracks of the Pere Marquette railroad. The proposed mill site is located on the west end of Pine lake, about one mile south of Charlevoix. From the above named properties we have selected a number of samples for analysis.

The result of the examination of these properties, raw materials and their locations, as herein briefly set forth, is conclusive evidence that a cement plant located on the proposed site will have many natural advantages.

PROPERTY AND RAW MATERIAL.

The limestone and cement rock deposits are situated one mile west of the city limits, and are bounded on the north by Lake Michigan.

The deposit consists of about 435 acres, at an elevation from 20 feet to 40 feet above lake level, and is composed of strata of limestone and cement rock of different and distinct chemical proportions, averaging from four feet to six feet in thickness. The different strata are remarkably uniform in composition, free from deleterious ingredients, practically inexhaustible, and extending to a known depth of several hundred feet. A large portion of the rock is exposed on the surface, some parts are covered with an overburden of 12 inches to 18 inches of earth and gravel. Because of these favorable conditions, the quarrying can be accomplished at a minimum cost.

Many of the limestones in the northern part of the Lower Peninsula contain a high percentage of magnesia; some have inter-stratifications of magnesian limestone, and still others have pockets of magnesian limestone. Such limestone deposits used for the manufacture of Portland cement cause a great deal of trouble and involve large expense in selecting and separating them in the quarry. Your deposit is free from all the above named unfavorable conditions. Every sample that we selected and analyzed shows but a small per cent of magnesia.

The upper stratum is composed of a soft, crystalline, light colored limestone, which is easily crushed and pulverized. The second stratum is composed of a soft cement rock.

The shale deposit, as stated above, is located along the line of the Pere Marquette, about 10 miles south of the proposed mill site. This shale is most admirably adapted for the manufacture of Portland cement. It is very soft, free from grit, and contains but a small amount of moisture; it is accessible and can be quarried and prepared for the kiln at the lowest possible cost. The proportions of silica and alumina in the shale are also very good. This shale, used in connection with the limestone, will make a mixture from which the highest grade of Portland cement can be produced.

* * * * * * * * * *

The analyses of their material, the limestone,[1] from the Traverse beds,

[1] Report of Robt. F. Wentz, and letters Dec. 7, 1904.

one mile west of the city limits of Charlevoix, Michigan, are like numerous analyses from this horizon previously given. No. 2 is rather high in magnesia, and as I have before remarked, the coralline parts of the Traverse are the freer from magnesia. The Traverse formation is *not* altogether free from magnesian bands. Analyses of shale[1] from near the village of Ellsworth, Antrim county, must be weathered Antrim shale. I question if they would remain so low in organic matter to any great depth, and that would have to be considered in time. See the shale analyses 7 and 8.[2]

However, a stratum of shale, such as so commonly occurs in the Traverse, and is quite suitable for cement, has been found only fifteen feet from the surface near the limestone quarry and may be used.

ANALYSES OF LIMESTONE.

December 12, 1904.

Samples taken about one mile west of the city limits of Charlevoix, Mich.

	1.	2.	3.	4.	5.
Carbonate of lime ($CaCO_3$)	96.10	91.34	95.70	95.08	93.88
Carbonate of magnesia ($MgCO_3$)	1.20	4.62	1.60	0.96	1.52
Silica (SiO_2)	1.40	0.92	1.00	1.38	2.45
Oxide of iron and alumina	0.80	1.06	0.80	1.02	0.95
Sulphuric anhydride	trace	.....	trace	trace	trace
Organic matter, etc	0.50	2.06	0.90	1.56	1.20
Totals	100.00	100.00	100.00	100.00	100.00

From prospectus.	6.	7.	8.	9.
Oxide of iron and alumina	1.50	1.21	2.40	2.73
Carbonate of lime	95.64	96.03	87.86	87.42
Carbonate of magnesia	none	none	none	none
Silica	1.54	1.93	5.74	6.11
Sulphuric acid	.53	.40	.72	.69
Organic matter	.47	.36	2.98	2.73
Moisture by difference	.22	.07	.30	.32
Totals	100.00	100.00	100.00	100.00

[1] Page 561.

[2] Also an analysis of the Antrim shale from a well made for Francis H. Cloud yielded:

Moisture	1.21 per cent
Volatile hydrocarbon	16.34
Fixed C	5.55
Ash	77.55

The ash was mainly clay, some pyrite, no limestone.—L.

ANALYSES OF SHALE.

December 12, 1904.

Samples of shale taken near the village of Ellsworth, Antrim county.

	1.	2.	3.	4.	5.
Silica (SiO_2)	50.44	52.36	52.00	58.20	59.94
Alumina (Al_2O_3)	18.96	31.40	21.01	18.28	18.03
Oxide of iron (Fe_2O_3)	6.28	6.44	4.73	2.58	2.40
Lime (CaO)	4.69	3.36	4.72	2.63	2.82
Magnesia (MgO)	3.85	4.34	6.73	none	none
Carbon dioxide (CO_2)	6.36	5.61	3.05	11.72	10.53
Sulphuric anhydride (SO_3)	0.92	0.06	1.44	.73	.56
Moisture	4.08	3.28	2.60	2.12	2.28
Organic matter	4.42	3.15	3.72	3.74	3.44
Totals	100.00	100.00	100.00	100.00	100.00

	6.[1]	7.[1]	8.[1]
Silica	52.36	58.20	69.95
Alumina	21.40	18.20	9.26
Oxide of iron	6.44	2.58	2.71
Lime (CaO)	3.36	2.63	0.61
Magnesia (MgO)	3.85	2.24	1.03
Carbon dioxide	5.61	3.74	2.12
Moisture, organic matter and difference	6.98	13.33	14.32
Totals	100.00	100.00	100.00

The analyses of shale from prospectus and secretary and from Mr. Wentz show some errors in copying figures and I understand the originals were lost in moving office, so I give both sets. No. 1 appears to be correct. No. 2 is a more complete form of No. 6 with a typewriter's slip in the alumina evidently. Nos. 4 and 7 may be from the same original.

Mr. A. N. Clark of the Wallaceburg Sugar Co., gives the following analysis of the Amherstburg quarry, just across Detroit river from the Sibley and the same formation geologically.[2]

DUNDEE LIMESTONE AT AMHERSTBURG.

Calcium carbonate	98.50
Alumina and iron oxide	0.20
Magnesium carbonate	0.73
Silica	0.56
SiO_2	faint trace
P_2O_5	faint trace
BaO and SrO	none

We also owe to Mr. J. G. Dean, of Ottawa, the following analyses: (1) a surface clay near Saginaw with about one-quarter limestone flour as usual; (2) a surface clay exposed by the Au Sable river, probably leached and

[1] From Wentz.

[2] See annual 1903, p. 175.

superficial; (3) a clay of the Britton Pressed Brick Co. Note Mr. Dean's comments. (4) From the same horizon as the Bellevue limestone (Annual for 1903, page 174) but much more magnesian.

It will be remembered that the Michigan Alkali Co., who used the Bellevue quarry for a while for cement have sold it.

July 5, 1905. Analysis of Saginaw clay.

Silica	51.81
Alumina Al_2O_3 ..... } Iron oxide Fe_2O_3.... }	11.02
Lime $CaCO_3$	23.08
Magnesia $MgCO_3$	5.91
Loss on ignition	6.62

July 5, 1905. Analysis of clay from Au Sable river.

Silica SiO_2	54.40
Alumina Al_2O_3	24.00
Iron oxide Fe_2O_3	7.16
Lime CaO	3.05
Magnesia MgO	1.75
Loss	6.80

NOTE.—This was taken near the surface, other samples taken farther down were so sandy and limey that they were not tested.

July 5, 1905. Analysis of the Britton clay of the Britton Pressed Brick Co., Britton, Michigan.

Silica SiO_2	67.80
Alumina Al_2O_3	14.17
Iron oxide Fe_2O_3	5.37
Lime CaO	2.16
Magnesia MgO	.88
Loss on ignition	6.60
Sulphuric anhydride SO_3	....

NOTE.—This is an extra fine pressed brick clay, possessing many fine features, especially for color.

July 5, 1905. Analysis of Parma Limestone.

Silica SiO_2	2.36
Alumina Al_2O_3	trace
Iron oxide Fe_2O_3	3.28
Lime CaO	41.18
Magnesia MgO	8.72
Loss	42.28

Iron oxide and alumina weighed together but only a trace of alumina was present.

The Parma limestone is from a limestone deposit about one mile northeast of the village of Parma on the M. C. R. R. probably 300 acres in extent.

J. G. DEAN, Analyst, Ottawa, Canada.

SAND LIME BRICK.

I have mentioned these brick in previous reports. The business seems to have a good hold in the copper country. Here three shades are made, according as the lime is mixed either with (a) Lake Superior sand which makes a very white brick; (b) felsitic conglomerate stamp sand, the Albany and Boston conglomerate No. 15, mined at the Franklin Junior Mine, which makes a pink brick; or (c) amygdaloid and trap stamp sand, giving a brick of a bluish hue.

The last class of brick will, I fear, not be very satisfactory (amygdaloid and trap crumble and slake on exposure to the weather). The other two will be quite satisfactory in endurance, as they are pleasing in appearance.

The L. S. Sand Brick Co. were turning out about 20,000 a day (Sept. 4, 1905), and the brick are said to stand a crushing stress of 5,000, 4,500, 4,375, pounds per square inch respectively. It will be remembered that S. V. Peppel[1] found that in spite of high porosity sand brick stood frost remarkably well, and Buckley[2] shows that the size of the pores was an important factor in resistance to frost.

The following item from the Detroit Free Press[3] is interesting, not only historically but also because it gives the locations of buildings made by this process many years ago. One objection to them among engineers and builders has been their newness, and their uncertainty as to the durability of the brick:

"It will surprise some people to learn that there are buildings in the upper peninsula of Michigan which were erected forty years ago and the material used was the sand-lime brick. These brick were manufactured at Marquette at a plant erected on the lake shore near Little Presque Isle. The factory was built by Cornelius Donkersley and S. P. Ely. The latter was vice-president of the old Marquette, Houghton & Ontonagon Railroad Co. and at the head of several mining companies. He was a great traveller and it was on one of his trips in Europe that he learned of the method of making brick from sand and lime. He visited Germany and investigated the process. Returning, the plant was erected and operated a number of years. The machinery was crude and only one brick at a time could be turned out. These brick were not steamed but were laid carefully in the sun to harden. In putting them in a building they had to be carried on a pallet. Today they are as hard as granite blocks. The brick were large and cumbersome, weighing as much as four ordinary brick. The expense of manufacturing them and the low price of timber resulted in the closing down of the plant. Among the buildings which are now standing are the Presbyterian church on the main street in Marquette, which was built thirty-nine years ago, and the round house of the old Marquette, Houghton & Ontonagon Railroad, now the Duluth, South Shore & Atlantic."[4]

ROAD METAL.

The establishment of a highway commissioner is quite a step in advance which I gladly welcome. Michigan is rich in good road metal, and with only a little more expense, and more care and intelligence can soon have a good system of roads which is already begun. The Keweenawan traps are in many cases very convenient to water transportation. Not infrequently they are already crushed in mining operations, although the rock close to the mineral lodes is naturally not always of the very best quality in resistance. But they have good cementing power.

The limestone quarries of the northern part of the State and Bay Port and

[1] Rock Products, Louisville, Ky., and pamphlets.
[2] Building Stones of Wisconsin, issued by Geol. Surv. of Wis.
[3] June 25, 1905.
[4] Also store of B. Neidhart, S. Front St. and the old library building on Spring St. See Clay Record, Dec. 30, 1905, p. 30.

Bellevue (and they might also be developed around Grand Rapids) make a road metal, not so hard, but tough and of good cementing powers, excellent under a finish coat of field stone spalls.

The boulders or "cobbles" of the fields show their hardness by having survived the glacial mill and ought at least to repay the cost of collecting them.

At my request, Mr. W. F. Cooper of our force collected certain samples for test by the U. S. Department of Agriculture, Division of Tests. The results are tabulated with some of the average results of the bureau for comparison below, and Mr. Cooper's notes on occurrence and those of the bureau on their quality, in quotation marks, with some comments of my own follow. The low per cent of wear, high hardness, and excellent cementing values with the exception of No. 1243 are notable.

The following letter is of interest:

WASHINGTON, D. C., January 6, 1904.

Mr. W. F. Cooper, Michigan Geological Survey, Lansing, Michigan:

DEAR SIR: I enclose the reports of tests, just completed, on your samples of rock. If the Michigan Geological Survey would care to have copies of all the tests we have made on samples from that State, we shall be glad to send them, as well as reports of all future tests.

I have had many inquiries from Chicago concerning trap rock for road building purposes. I understand that such rock occurs along the northern coast of Michigan. It would be profitable for anyone to supply Chicago with such rock, as the present price of granite per ton is $4.00.

Respectfully,

(Signed) LOGAN WALLER PAGE,
Chief of Division of Tests.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF PUBLIC ROADS, DIVISION OF TESTS.

1131. "Altered diabase from Tamarack No. 2 shaft, Calumet, Houghton Co., Michigan. A fairly hard and tough diabase, with high resistance to wear and fairly good cementing value. It is well adapted for highway and suburban traffic."

This shaft is connected with the Calumet conglomerate lode by long cross cuts traversing many melaphyre flows. From these cross cuts much of the road metal comes. It is thus quite a way from the lode and better in quality. It is what I call a melaphyre or ophite, composed mainly of augite and labradorite. See annuals for 1903 and 1904.

This road metal is widely used near Calumet and makes excellent roads. At the Whiting shaft of the Calumet and Hecla, which is similarly situated, all the rock not sent to the stamp mill for its value in copper is now put through crushers, and thus the accumulation of unsightly piles of waste rock is saved, while splendid macadamized roads are extending in all directions. Especially in connection with the new highway bounty law, this should be the most economical way of disposing of the waste rock.

1132. "An altered diabase from the Centennial mine, Calumet, Houghton county, Michigan. Rather soft diabase, with fair resistance to wear and good cementing value. Well suited for highway and country road traffic."

This was taken from the old dump of this mine on the Osceola lode, not the new workings. It is also a melaphyre. Its inferior hardness is probably in part original, being nearer the mineralized lode and more decomposed. It had also been longer exposed to the weather, and was in that respect different from the Tamarack rock. This appears to have led to a hydration that made it less porous and heavier.

1133. "Hornblende schist from Marquette, Marquette Co., Mich. A very hard and tough schist, with fair resistance to wear and high cementing value. Well suited for highway and country road traffic."

In the city of Marquette, however, this material is said to wash rather badly on the hillsides; on the other hand is very dusty in summer. This might be remedied by using crude oil and a heavy steam roller.

This is from the Keewatin or greenstone schist the oldest known sedimentary formation.

1243. "Dolomitic sandstone from Grand Island, Alger Co., Mich. A fairly hard but not very tough rock with a low cementing value. Under the action of wet rolling the binding power can be increased to some extent."

This probably comes from the Calciferous or Lower Magnesian formation, and is not a desirable road metal, relative to those easily obtained nearby.

1287 and 1288. "Limestone from the Wallace Stone and Lime Co., Bay Port, Michigan. A hard, tough, dolomitic limestone which should make an excellent road material. It should be rolled wet if possible."

This is very widely and favorably known in making the stone roads of the Saginaw Valley. See Huron county report, Volume VII, part 2, where further tests are given. It was also mentioned in the annual for 1902.

Its age is that of the Maxville limestone (neo-Mississippian or Subcarboniferous) the same as that of Bellevue and Parma.

MAXIMUM, MINIMUM, AND AVERAGE RESULTS

Number of samples.	Name.	Per cent of wear.			French coefficient of wear.			Hardness.		
		Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.
8	Amphibolite	4.7	1.5	2.6	26.7	8.5	18.3	18.1	18.1	18.1
28	Chert	27.9	2.7	11.0	14.6	1.4	5.4	18.8	18.3	18.6
27	Clay	.....	.....	.....	.....	.....	.....	.....	.....	.....
4	Conglomerate	12.7	3.5	6.6	11.6	3.2	7.6	.....	.....	.....
96	Diabase	6.3	1.2	2.4	34.5	6.4	18.3	18.5	5.3	15.2
19	Diorite	4.0	1.6	2.8	20.6	10.0	14.6	16.8	15.5	16.2
37	Dolomite	18.6	2.4	5.6	16.9	2.2	8.4	14.5	4.3	7.8
1	Epidosite	3.6	3.6	3.6	11.2	11.2	11.2	18.0	18.0	18.0
11	Felsite	3.4	1.9	2.6	21.3	11.9	15.2	.....	.....	.....
1	Flint	7.2	7.2	7.2	5.5	5.5	5.5	.....	.....	.....
89	Field stone	10.3	2.1	4.1	19.2	4.6	10.9	.....	.....	.....
13	Gabbro	5.4	1.3	2.8	30.8	7.5	15.6	17.5	12.9	15.5
38	Gneiss	8.1	1.7	3.8	23.0	4.9	12.0	17.8	10.5	15.0
62	Granite	14.8	1.6	3.7	25.6	2.7	11.3	18.1	12.5	15.4
59	Gravel	.....	.....	.....	.....	.....	.....	.....	.....	.....
142	Limestone	34.2	2.1	6.0	19.0	1.2	8.6	16.0	−70.6	2.9
4	Marble	14.0	3.8	6.9	10.5	2.9	7.6	11.5	−4.8	3.4
5	Marl	.....	.....	.....	.....	.....	.....	.....	.....	.....
3	Peridotite	4.3	3.6	4.0	11.1	9.3	9.9	11.6	11.6	11.6
29	Quartzite	4.7	1.6	2.9	24.5	8.5	15.1	18.2	12.6	16.3
11	Rhyolite	9.7	1.7	4.7	23.0	4.1	12.1	17.2	7.1	12.2
50	Sandstone	32.8	1.6	8.9	25.7	1.2	10.8	17.9	−130.0	−0.6
40	Schist	7.1	1.8	4.1	22.6	4.9	11.6	17.0	12.5	15.3
8	Shale	16.2	4.7	10.5	8.6	2.5	5.6	7.0	7.0	7.0
5	Slag	10.6	7.6	8.8	5.2	3.8	4.6	.....	.....	.....
9	Slate	6.9	2.6	5.0	15.2	5.8	6.9	15.8	−6.8	2.6
6	Syenite	3.2	1.9	2.6	21.0	12.6	16.1	16.5	16.5	16.5
1131	Altered diabase	.....	.....	1.96	.....	.....	20.41	.....	.....	12.5
1132	Altered diabase	.....	.....	4.16	.....	.....	9.62	.....	.....	5.3
1133	Hornblende schist	.....	.....	4.71	.....	.....	8.49	.....	.....	15.3
1243	Dolomitic sandstone	.....	.....	5.15	.....	.....	7.77	.....	.....	13.0
1287	Limestone	.....	.....	2.70	.....	.....	14.81	.....	.....	9.2
1288	Dolomitic limestone	.....	.....	.....	.....	.....	.....	.....	.....	9.5

PLASTER.

Naturally the gypsum business shares in the prosperity in building materials. The Acme Cement Plaster Co. has come to Grand Rapids and is reported to own 200 acres of plaster land. I am credibly informed that gypsum is found south of Grand Rapids convenient to mine.

PAINT.

An experienced paint man once told me that any material ground fine enough and mixed with good oil would make good paint. Reports of discoveries of paint materials are therefore not infrequent. Marl and the fine gritless clays which are so abundant are naturally ground and can be well used in this way. At times these clays are brilliantly ochreous from iron deposited by iron springs and in association with bog and iron ore.

The graphite slates of the upper Huronian which occur extensively in the Upper Peninsula in the upper Huronian or Animikie (neo-Huronian) are ground up into graphitic paint and can be used for foundry facings also. The

ON ROCK SAMPLES, CORRECTED TO JULY 15, 1905.

Toughness.			Weight per cubic foot.			Water absorbed.			Specific gravity.			Cementing value.					
												Dry grinding.			Wet grinding.		
Max.	Min.	Av.	Max. Lbs.	Min. Lbs.	Av. Lbs.	Max. Lbs.	Min. Lbs.	Av. Lbs.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.
9	9	9	193.4	187.1	190.2	0.62	0.04	0.32	3.1	2.9	3.1	36	3	9	73	11	31
21	11	16	184.4	124.7	155.9	11.1	0.46	2.34	3.0	2.0	2.5	36	1	11	106	5	27
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	500+	10	398	.....	.....	.....
.....	.....	.....	159.0	155.9	159.0	3.71	2.50	3.11	2.6	2.5	2.6	327	12	170	.....	.....	.....
54	4	26	199.6	162.2	184.0	2.73	0.04	0.32	3.2	2.6	3.0	301	2	32	500+	7	147
24	19	22	196.5	168.4	180.9	1.03	0.06	0.37	3.2	2.7	2.9	137	1	19	148	9	49
27	4	10	177.8	159.0	171.5	4.77	0.08	1.24	2.9	2.6	2.8	161	2	22	179	13	47
14	14	14	171.5	171.5	171.5	0.45	0.45	0.45	2.7	2.7	2.7	12	12	12	83	83	83
.....	.....	.....	174.6	159.0	165.3	3.13	0.02	0.84	2.8	2.5	2.7	101	2	34	.....	.....	.....
.....	.....	.....	162.2	162.2	162.2	0.20	0.20	0.20	2.6	2.6	2.6	31	31	31	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	46	5	17	16	16	16
22	10	16	193.4	171.5	187.1	0.71	0.04	0.26	3.1	2.8	3.0	131	1	23	.....	.....	.....
20	5	13	187.1	162.2	171.5	0.98	0.10	0.30	3.0	2.6	2.8	21	1	5	61	5	32
22	4	11	187.1	155.9	165.3	1.59	0.04	0.30	3.0	2.5	2.7	77	1	8	53	6	21
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	500+	1	82	.....	.....	.....
20	3	9	193.4	131.0	165.3	13.22	0.03	1.31	3.1	2.1	2.7	231	2	35	500+	14	63
9	6	8	177.8	168.4	171.5	1.04	0.16	0.52	2.8	2.7	2.8	15	5	10	77	71	74
2	2	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	500+	55	323	.....	.....	.....
12	12	12	221.4	199.6	212.1	0.33	0.27	0.30	3.6	3.3	3.4	14	3	9	30	25	28
30	10	21	190.2	159.0	168.4	1.30	0.06	0.31	3.1	2.6	2.7	47	1	9	200	2	32
33	6	20	177.8	134.1	162.2	5.87	0.03	1.80	2.9	2.2	2.6	38	1	13	37	10	23
47	3	20	193.4	123.4	162.2	11.60	0.02	2.09	3.1	2.0	2.6	323	1	42	500+	12	98
34	6	24	199.6	165.3	184.0	1.19	0.06	0.37	3.2	2.7	3.0	127	1	19	232	11	55
3	3	3	171.5	155.9	165.3	4.84	0.87	2.39	2.7	2.5	2.7	500+	9	278	.....	.....	.....
.....	.....	.....	171.5	140.3	159.0	4.10	0.04	1.56	2.7	2.3	2.6	137	2	42	262	31	123
22	5	14	177.8	168.4	174.6	0.68	0.15	0.43	2.8	2.7	2.8	202	7	81	.....	.....	.....
10	10	10	187.1	168.4	174.6	0.40	0.10	0.22	3.0	2.7	2.8	11	2	6	27	20	24
.....	.....	18	.....	.....	174.64	.....	.....	1.235	.....	.....	2.81	.....	.....	.....	.....	.....	39
.....	.....	.....	.....	.....	180.87	.....	.....	.42	.....	.....	2.91	.....	.....	.....	.....	.....	55
.....	.....	30	.....	.....	182.43	.....	.....	.136	.....	.....	2.93	.....	.....	.....	.....	.....	127
.....	.....	7	.....	.....	159.0	.....	.....	.45	.....	.....	2.57	.....	.....	1	.....	.....	20
.....	.....	12	.....	.....	165.3	.....	.....	1.34	.....	.....	2.64	.....	.....	10	.....	.....	49
.....	.....	12	.....	.....	165.3	.....	.....	1.35	.....	.....	2.65	.....	.....	8	.....	.....	50

quantity thus required is not very large and could possibly be rapidly enlarged to meet an increased demand.

IRON ORE.

It is neither easy nor of general value to give an account of iron ore developments. Explorations are now in the hands of a few large companies, who either employ geologists all the time simply as such or hire the most eminent expert assistance, and generally employ engineers who have received first class geological training. The diamond drills are steadily at work making miles of records a month, and there is but little that the official geologist can do but gather up and coordinate the work of the various companies, so far as it may be accessible to him. I may refer also to the reports of the Commissioner of Mineral Statistics and the Monographs of the U. S. Geological Survey.

In a general way it may be said that there are two notable tendencies. The first is to open bodies of ore like Sec. 21 south of Ishpeming, formerly considered too low for work, but which are free from objectionable ingre-

dients like phosphorus and sulphur, and contain only fluxing ingredients like silica in addition to the iron.

A second tendency is to explore below the first found ore bodies finding other beneath. For instance in the Gogebic Range the ores lie in the ore bearing horizon but are generally bounded below by a dike. Under the dike comes a barren formation. Now it has been found at the South Colby and elsewhere that by persevering down another ore body which may not be conspicuous at the surface may be found resting on a still lower dike.

A sketch may make this clearer. Prof. Pumpelly tells me that the Newport Mine, in which he is largely interested, was never looking better than at 2,000 feet.

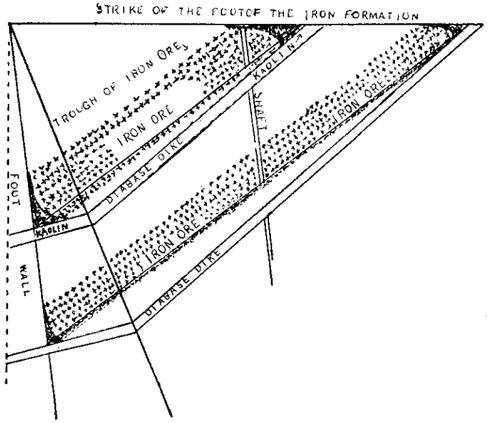

Figure 169. Illustrating the occurrence of iron ore on the Gogebic range.[1]

About 34 million tons came down from Lake Superior this year.

In view of the size and the ready accessibility of the iron ore deposits of Lake Superior it is safe to say that the bog ore deposits which are found in numerous places in both peninsulas, and generally run high in phosphorus are of no present commercial value. They sometimes run well up in manganese, but some of the Upper Peninsula iron ores are manganiferous, and sorted out for the manganese.

Sample of bog iron ore from C. L. Nelson.

Ferric oxide	21.24
Manganese calculated as Mn_2O_3	2½%

Balance of the material is silica and other insoluble substances.

COAL.

The production of coal has decreased this year, though the work of testing goes steadily on, spreading north from Bay City and also east and west from Saginaw. Within the limits marked out by geologists as the coal basin (see map) coal is not infrequently reported as also struck in drilling for water,[1] and is occasionally, but I believe always mistakenly, reported

[1] So at Flint, Detroit Times, Oct. 20, 1905; Shepard, Detroit News, Oct. 11, 1905; probably only in drift, and it is just about in the line of the ice motion from the Bay county fields; Montrose township, Genesee county, L. C. Compton, at 230 feet, Detroit Journal, Oct. 28, 1905; Nashville, July 19, 1905; two miles north of Standish, Detroit News, Oct. 30, 1905, at 94 feet.

from outside.[1] At best the development of our Michigan field is no bonanza to anyone and it is a pity to waste money on utterly hopeless endeavor, rather than put it where there is at any rate a ghost of a show.

I have said the drift covering makes not only slow and expensive exploration, but difficult shaft sinking. The very wealth of water which is a valuable asset for Michigan as a whole, has made the sinking of a shaft for rock salt near Detroit, and the sinking of coal shafts, often very hard. The Auburn Coal Co. have lost two shafts in quicksand. The highest grade of experience in handling water is needful for anyone who wants to mine in Lower Michigan.

No developments have indicated any coal seams very much younger than the horizon of the Upper Verne,—the Pottsville.[2] Apparently the Verne coals are more wide spread and tend to be poorer in quality on the whole, though higher in volatile combustible and more readily coking.

Analysis (1) is an analysis of a sample sent us by Mr. H. G. Wheaton[3] from the Carbon Coal Company's mine on the Thomas Mulvaney farm, east of Jackson.

The seam is said to be about 3½ feet thick, at about 45 feet depth with a poor soft roof and frequent clay slips. It was opened in 1904 by T. M. Johns & Son. From the amount of sulphur and the color of the "ash" it is practically iron oxide from sulphide of iron in the coal and there was no *clay* ash. Such a coal should be much improved by washing.

Some years ago H. J. Williams made for me some tests on coal from the Wenona mine to see how it would behave for washing and coking.

No. 2 is the analysis of the sample he received. It made a good coke, hard, silvery, resonant, which contained about 10.36% of ash and 2.11 of sulphur, showing that more than half the sulphur remained with the fixed carbon. Washing reduced the pyrite from 4.65% to 2.53% the slimes were 4.40% and the analysis of the washed and dried coal, assuming that the moisture was the same, is given in analysis No. 3. We also give analysis (4) by Prof. G. A. Koenig of coal from the same mine and one by D. P. Shoner (5) of the coke. Dr. Koenig reported that with *hot* ovens it would lose more S. and make a blast furnace coke and classed 56.80 of it as coke, 42.11 as gas and tar, 1.09 moisture.

I should not feel that I was fair to the State in printing an analysis of the Jackson coal, which was one of the first coals developed, and the quality of which was long deemed so representative of Michigan coal that it has given its reputation a black eye hard to remove, without also putting beside it some analyses of a better seam, and I have chosen for that purpose analysis of the Saginaw seam at St. Charles made by F. S. Kedzie, published by the Robert Gage Coal Co.; (6), and one from the What Cheer Coal Mining Co. (7), which we have not hitherto published.

[1] Sanilac county.
[2] See Volume VIII, part 2, pp. 42-47.
[3] May 16, 1905.

COAL ANALYSES.

Number	1.[1]	2.[1]	3.[1]	4.[1]	5.	6.[2]	7.[2]
Location	East of Jackson.	Wenona.	Wenona washed.	Wenona G. A. K.	Wenona coke.	Robert Gage.	What Cheer.
Moisture	5.67	3.78	3.78	1.09	1.68	2.37	2.864
Volatile comb.	45.06	41.18	41.40	42.11	3.12	35.67	91.283
Fixed carbon	43.85	49.34	50.48	50.89	79.46	58.47	
Ash	5.42	5.70	4 34	5.91	15.74	2.46	5.853
Sum	100.000	100.000	100.000	100 000	100.000	100.000	100.000
Total S	5.16	2.50	1.82	1.95	1.41	1.03	.128
Iron				1.71			
Fe_2O_3 from S	5.98						
Clay calculated	.00	3.57		3.41			
Pyrite calculated	10.58	4.67	3.41	3.66			
Corrected C. fixed carbon	83.75	87.98					
Hydrocarbon							
Coke		55.04		56.80			
P					.01		
C				72.74			
H				5.27			
N				1.51			
O				12.26			
Obs. Calorimet Parr	12.989					13.438	
Lane (146.6 (f+v) + 40 S)[3]	12.500						

[1] Verne seam.
[2] Saginaw seam.
[3] See Volume VIII, part 2, p. 120, Coal of Michigan, by A. C. Lane.

The following set of analyses of drillings through the Verne coal are of interest, because they give some idea of the distribution of the sulphur and ash in the different parts of the seam, and help to show how persistent the relatively high percentage of volatile matter and low percentage of moisture (good points) and large amount of ash and sulphur as compared with the Saginaw seam (bad points) are:

COAL DRILLINGS IN THE VERNE COAL.

Number	8.	9.	10.	11.	12.	13.
Location	No. 7 6″ to 3′	No. 23 0″ to 6″	No. 23 4″ to 1′10″	No. 23 1′10″ to 4′4″	No. 20 0′ to 7″	balance 7″ to 3′8″
Moisture	1.74	0.71	0.92	0.87	1.49	6.27
Volatile comb.	44.70	40.57	42.25	40.22	42.45	42.78
Fixed carbon	44.81	42.30	44.68	40.33	36.70	41.19
Ash	5.61	14.12	9.57	15.34	15.88	6.98
Total S	3.15	2.21	2.59	3.24	3.49	2.78
Sum	100.000	100.000	100.000	100.000	100.000	100.000

G. B. WILCOX.

I trust that these gleanings from our note books and records giving glimpses of the manifold development of our raw materials may be of enough current value and interest to warrant the brief notice I have given. But of course our chief work lies in the larger and more formal papers with maps, etc., which you allow me to submit independently, so as to make more clear the credit and the identity of each author.

To them and to all my fellow employes and many others my thanks are due.

Very respectfully,
ALFRED C. LANE.