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A BRIEF HISTORY OF THE GEOLOGICAL AND BIOLOGICAL SURVEY OF MICHIGAN: 1837 to 1872, BY R. C. ALLEN; 1872 to 1920, BY HELEN M. MARTIN.

The Geological Survey of Michigan is almost as old as the State itself. It was established in 1837 by Act No. 20 of the first Legislature. The first Survey was terminated in 1845 by the untimely death of Dr. Douglass Houghton, the State Geologist. In 1859, the legislature provided for its continuance but the outbreak of the Civil War interrupted the work in 1861; it was resumed in 1869² soon after the close of the war.

THE FIRST GEOLOGICAL SURVEY 1837-1845

For the earliest organized statements concerning the geology of Michigan we are indebted to Dr. Douglass Houghton and his assistants. Such explorations as were made prior to 1837 were purely geographic although some disconnected observations on rocks, minerals and soils were noted even in the accounts of the travels of the Jesuits. The explorations conducted by Alexander McKenzie in 1789, General Cass in 1819, Major Long in 1823, and H. R. Schoolcraft in 1831³ should be mentioned. The accounts of these travels are rich in descriptions of the country on the routes of travel which, however, were confined to the water ways and in Michigan mainly to the coast of the Northern Peninsula.

¹Act No. 206, Public Acts, 1859.

²Act No. 66. Public Acts of 1869.

³Dr. Douglass Houghton accompanied Schoolcraft as physician and botanist to the expedition to the sources of the Mississippi River. An interesting account of this expedition has recently come into the Keeping of the Michigan Historical Commission in the form of Houghton's original notes kept in diary form.

A proper appreciation of the work of the first Survey should view it in relation to the condition of the country, the state of advancement of the natural sciences and the general regard in which they were held by the people. In 1837 there were less than 24,000 people of European descent in Michigan. These were mainly in Detroit and the sparsely settled counties south of the Grand and Saginaw rivers, a few settlements along the coast as at the Soo and Mackinac, and isolated groups of huts occupied by traders and trappers. The coast was only roughly charted, the northern two-thirds of the State was an unsurveyed wilderness including all of the Northern Peninsula and practically nothing was known of its interior into which very few white men had ever penetrated. Michigan was viewed generally in the East

at that time as an unhealthy land of alternating muskeg swamps and sand hills and the Northern Peninsula was thought to be fit only for the habitation of savages. The Geological Survey was created for the purpose, among others, to act as an agency through which these damaging false beliefs could be effectively laid at rest, for Michigan was suffering a loss of good settlers in consequence of them.

Geology had not then become, as now, a common branch of instruction in schools and colleges. The literature of the subject was meagre and not in general circulation among the people. Its principles were generally unknown even among the more learned elements of the population. Even the educators of those days as a class had slight regard for the natural sciences, believing that a study of the classics and mathematics is alone requisite to a liberal education. But geology especially was viewed in active hostility by a large element of the academicians and the clergy. The former denied not only its value as an applied science but its cultural value as well, while the latter interpreted its teachings as contrary to revealed truth and therefore in contravention of the tenets of religion.

It is therefore noteworthy and interesting that the first of the departments of the State government to be created by statute was the Geological Survey. This is a fine testimonial to the courageous intelligence of the first Legislature. But the Survey is not to be viewed as an entirely spontaneous work of the law makers, for the history of those years makes clear that Dr. Douglass Houghton is not only responsible for the idea and plan but it was also through his personal influence on the individual members that the Legislature became willing to commit the people to the undertaking.

The history of science, like political history, is founded in the lives of individuals. Now and then men emerge in bold relief on the background formed by their contemporaries. Such a man was Douglass Houghton, the first State Geologist of Michigan.⁴ He died an untimely death by drowning in Lake Superior in 1845, aged only 36 years.

Houghton was one of Michigan's great pioneers and most devoted public servants. He combined the skill and learning of the physician and scientist with marked business ability, executive capacity and political sense. He was a fine writer and probably the intellectual peer of his day in the West. As a geologist he was little known outside of Michigan, which is unfortunate for his memory. He has left enough of his writings to warrant the belief that, had he lived to publish his complete report on the geology of Michigan, he would have taken rank with the foremost geologists of his time.

⁴For a biography of Houghton consult: A Memoir of Douglass Houghton, 1889, Alvah Bradish.

Although the organization of the first State Surveys of Massachusetts (1830), Tennessee (1831), Maryland (1834), New Jersey, Connecticut, Virginia (1835), Maine, New York, Ohio, and Pennsylvania (1836), preceded

that of Michigan by from one to seven years, their results were as yet only meagerly available and were therefore of little aid to Dr. Houghton in planning for the labors which opened before him in the wilds of Michigan. It is an interesting fact, as well as an evidence of Houghton's genius, that as early as 1838⁵ the Survey had been organized on the plan that in the main essentials exists today in Michigan and in a number of other States. This plan provided for geological, topographical, zoological, and botanical departments, each in charge of a specialist under the direction of the State Geologist. The departments of botany and zoology did not survive the second year of their organization, on account of straightened finances and the hostility of the Legislature to labors which promised no early practical benefit to the material progress of the State; they were abolished in 1840 by legislative enactment⁶ over the strong but futile protests of Dr. Houghton.⁷

⁵Act 40. Public Acts of 1838.

⁶Sec 1. Act 40. Public Acts of 1840.

⁷See Communication from the State Geologist Relative to the Geological Survey. March 7, 1889. Senate Document No. 25, 1880.

The law of 1837 contemplated the completion of the survey in four years, but it was soon apparent that a long time would be necessary for even a cursory examination of the entire State. Nevertheless a large part of the field work was actually accomplished in 1842 and the funds which were thereafter expended were drawn from the unexpended balance,⁸ not including small sums devoted to engraving. The incompleteness of the U. S. linear surveys which were then in progress in Michigan also contributed to delay the work, for Houghton depended on these surveys for skeleton maps of the townships on which to plat the physiographic and geologic features of the country.

In fact, Dr. Houghton conceived the idea of enlisting the land surveyors themselves in the service of the geological survey, and "derived the idea of accomplishing a thorough geological, mineralogical, topographical, and magnetic survey of the new lands of the United States contemporaneously with the government surveys." As the act making provisions for the State Geological Survey expired in 1842 leaving still a large territory in the Upper Peninsula unexplored, Dr. Houghton set about effecting a plan which he had previously conceived of connecting the linear surveys with the minute geological and mineralogical survey of the country. In 1844 he laid his plan before the government. Its feasibility was at once comprehended, and Houghton was given a contract of running 4,000 miles of lines at a price but little, if any, exceeding that which would have been paid for a linear survey alone.⁹

⁸The actual expenditures of the Houghton Survey from 1837 to and including 1846 were only \$32,829.03.

⁹Memoir of Douglass Houghton by Bela Hubbard, American Journal of Science, Vol. 55. p. 221. 1848.

The system was abandoned after his death, but enough had been done to show that had the system remained in

operation to the completion of the surveys we should have been possessed of information which was acquired several decades later, with vastly greater expense and labor.

The published results of Houghton's Survey appear in seven annual reports to the Legislature and a number of short communications relative to the development of salt springs and other subjects. The final report was well along towards completion when it was interrupted by the death of Dr. Houghton. The state topographer immediately impressed upon the Legislature the importance of entrusting the completion and editing of the final report to Dr. Houghton's chief assistants. The Legislature responded¹⁰ by authorizing the Governor to appoint a suitable person, but no appropriation was made to defray his expenses and remuneration. Whether the appointment was or was not made we do not know, but it is certain that the work was not done, and a vast collection of notes, sketches, maps, and manuscript, representing eight years of unremitting toil by Houghton and his assistants, was lost.¹¹

¹⁰Joint Resolution No. 26. 1846.

¹¹In the Annual Report of the State Geologist, 1861, Dr. A. N. Winchell reports that "on the decease of Dr. Houghton his administrators employed Messrs. William A. Burt and Bela Hubbard to complete reports on the geological results of the work for 1845 from the field notes of that year. Mr. Burt's report was prepared from his own notes and Mr. Hubbard's from those of Dr. Houghton. These two reports unfold in an admirable manner the geological studies of the trap and metamorphic regions of Lake Superior, and anticipate results which were afterwards worked out by the United States Geologists. The notes and maps of three townships were in Dr. Houghton's possession at the time of his death and were never recovered." These reports were not published but the materials were doubtless incorporated in Jackson's report of 1849-50. (Senate Documents, 31st Congress, 1st Session. Vol. 3, No. 1.)

Just how much had been accomplished is not known, but it is evident from the fragmental reports in the documents of the House and Senate of the Michigan Legislature that Houghton had attained a fairly clear understanding of the succession and structure of the Paleozoic (secondary) rocks, had blocked out the Michigan Coal Basin, understood in a measure the later history of the Great Lakes and had traced the position of some of their former shore lines, had called attention to the importance of the deposits of natural brines,¹² gypsum, coal, peat, marl, clay, limestone, iron ore, and copper, and had discovered gold. The influence of his report on the copper bearing rocks was a factor in not only attracting capital to the copper country and exercising a wise guidance on early prospecting and financial operations, but in hastening the construction of the first canal and locks around the falls of St. Mary's River.

Little more than a year after the suspension of the Survey under Dr. Houghton Congress passed an act, approved March 1, 1847, embracing provisions for the geological exploration of the Lake Superior Land District, organized by the same act. Under this act Dr. C. T. Jackson was appointed by the Secretary of the Treasury to execute the required survey.

After having spent two seasons in the prosecution of this work he presented a report of 801 pages¹³ and resigned his commission. In the meantime the survey was continued and subsequently completed by Messrs. Foster and Whitney.”¹⁴

Some of the assistants of Dr. Houghton were employed by Jackson, Foster and Whitney and Houghton’s results were made use of in other ways to such an extent that a large part of the credit rightfully belongs to him although no proper acknowledgment of it is made by these geologists.

¹²The United States Government ceded to Michigan 76 sections of land for the development of salt springs. Houghton was placed in charge of the borings begun by the State. Wells were sunk at Grand Rapids and on the Tittabawassee River in Midland County.

¹³Senate Documents, 1st Session, 31st Congress. Vol. 3, 1840-50.

¹⁴Report on the Geology and Topography, the Lake Superior land district: part 1, Copper Lands by J. W. Foster and J. D. Whitney, Executive Documents, 1st Session, 31st Congress, 1849-50, Vol. 9. No. 69. Report on the geology and topography of the Lake Superior land district, part 2, The Iron Region by J. W. Foster and J. D. Whitney, Senate Documents, Special Session, 3rd Congress, 1801, Vol. 3, No. 4.

SECOND GEOLOGICAL SURVEY 1859-1863

The second geological survey was inaugurated in 1859, during the administration of Governor Wisner.¹⁵ It was suspended in 1863 from failure of the Legislature to make an appropriation for its continuance.¹⁶ The act is almost identical with the original act of 1837. It authorized the Governor to appoint a competent person and other necessary assistants to finish the geological survey of the State and furnish “a full scientific description of its rocks, soils, and minerals and of its botanical and other natural productions.”

Dr. Alexander Winchell, who was then professor of geology in the University, was appointed State Geologist March 9, 1859. On December 31, 1860, he made a report to the Governor which was printed in 1861 under the title “First Biennial Report of the Progress of the Geological Survey of Michigan.” This is the only publication of the second geological survey. It is unaccompanied by maps, sketches, or other illustrations which rendered it less useful than it would otherwise have been.¹⁷ Dr. Winchell sketches the history of previous geological work in Michigan and gives a full account of his activities and those of his assistants. He gives the only orderly and connected general account of the geology of the State which had ever been made. The non-fossiliferous rocks, which include those of the Northern Peninsula west of a line connecting Marquette and Menominee, are, however, dismissed with a brief statement based on the work of other geologists but the fossiliferous rocks underlying the remainder of the State are described in considerable detail and compared with similar formations in other States but more especially with those of New York where the work of James Hall

and others had developed a succession which had become and still remains in some degree, a standard of reference. Dr. Winchell made large collections of fossils most of which were deposited in the University museum. The chapter devoted to economic geology is interesting,—although it is lacking in statistical matter,—in that it indicates the progress of the non-metallic mineral industry in the Southern Peninsula since Houghton’s time. Part II contains a catalog of the plants, mammals, birds, reptiles, and molluscs of the Southern Peninsula.

¹⁵Public Acts of 1859. No. 206.

¹⁶The total appropriations for the second geological survey. 1859-63, were \$9,000.00 of which only \$6,000.00 was drawn from the treasury.

¹⁷The Legislature apparently disapproved the emphasis laid on the botanical and zoological investigations which were accounted for in this report for in 1861 is directed the state geologist to “restrict his labors to the geological department exclusively.” Act No. 64. Public Acts of 1861.

The second geological survey made a long stride in the study of the geology of the Southern Peninsula. When it is considered that the work was practically abandoned a little more than two years after it was started, that the appropriations were small, and that the time which Dr. Winchell was able to devote to it was limited by his professional duties in the University, it is not surprising that the published results are not more voluminous.

The second geological survey was definitely terminated by joint resolution of the Senate and House approved March 7, 1863,¹⁸ directing Professor Winchell, “the late State Geologist, to transfer to the Board of State Auditors all of the property of the Survey including the specimens not already distributed to the educational institutions as provided by law and to deliver to the Auditor General a schedule of all instruments, property and materials used in the survey belonging to the State.”

¹⁸Joint Resolution No. 10; Session of 1863.

THE THIRD GEOLOGICAL SURVEY, 1869—.

By the year 1869 a strong public demand had arisen for a resumption of the geological survey and Governor Baldwin made the following recommendation in his message to the Legislature:

“I submit to you the importance of providing a thorough and complete geological survey of the State. Many years ago, in our early history, this work was partially prosecuted by the late Dr. Douglass Houghton, whose sudden death put a stop to this important work. Small appropriations were subsequently made, but no general survey has been effected. The developments made by the very partial work hitherto done, have many times repaid the comparatively small expenditure. But what is needed, is a thorough and comprehensive examination of the whole State.

“Great and varied as are its present resources, we know as yet but little of the hidden mysteries which lie developed within its borders.”

In due course a bill was introduced in the House by Mr. Yawkey after which the matter was taken under advice by a joint committee of the House and Senate.¹⁹ The report of this committee reviewed the previous geological work in Michigan and the legislation concerning it including references to other States and made the following recommendation:

“A period of twenty-eight years of general growth, prosperity and development has been allowed to pass, and the richest mineral territory in iron and copper in the world has been left wholly unaided by State appropriations in the development of its gigantic possibilities. Is it any wonder that the enterprising people of that far away region, who have accomplished so much with such little means, grow restless in a connection that brings them no share of the public money derived from a common taxation, that has been profusely scattered over the lower half of the State, in the shape of Prisons, Reform Schools, Insane, Deaf, Dumb, and Blind Asylums, Normal School, Agricultural College, University, geological surveys and internal improvements, and all the thousand and one ways that those nearest to the public treasury reach for its contents?

¹⁹Lyman D. Norris, Chairman Senate Committee; John Q. McKernan, Chairman House Committee.

“In the meanwhile, those hardy pioneers have labored and waited, until now, with a population of near 35,000, a capital invested in 112 companies for developing copper of \$16,250,500, upon which has been paid dividends of \$5,880,000, and an iron interest which, in the twelfth year of its commercial life, produced over one-fifth of all the iron mined in the United States, they have rights, and the State has duties—long neglected duties—toward them, which it were wise to no longer neglect.

“Your committee are of opinion that the State is fully able, and ought to be willing, to enter now upon an enlarged and liberal geological survey of both peninsulas; that if but one can be undertaken, the Lake Superior country is entitled to the preference; and that the survey there, in addition to the duties usually assigned to such officials, should also include the statistics and history of the mineral, mining, smelting, manufacturing, and transportation interests; the compilation of accurate maps, showing the topography, geology and timber, and the position of all mines, furnaces and roads of the iron and copper region. Your committee would further note the fact that within the limits of the proposed survey the State owns a large amount of swamp and school land, reserved from market on account of its supposed mineral value, the determination of which value is a matter of common interest to all the people, while the United States are also holders of large tracts of supposed mineral land,

whose value is wholly unknown, as much of the data given by Foster and Whitney, near twenty years ago, is shown by private examination to have been erroneous and imperfect.

“The Legislature have had their attention called by Prof. Winchell in his address, among other matters, to the history of neighboring state legislation, and asking your earnest and thoughtful attention to that address, they content themselves by presenting to you the accompanying bill and joint resolution, unanimously recommending their passage, and ask to be discharged from the further consideration of this interesting subject.”

The bill embodying the recommendations of the committee was promptly passed and was approved by the Governor on March 26, 1869.²⁰ It created the Board of Geological Survey, an ex-officio body consisting of the Governor, Superintendent of Public Instruction, and President of the State Board of Education. The Board was authorized to appoint “a suitable person possessed of the requisite knowledge of the science of geology who shall be the Director of the Survey” and at the nomination of the Director such assistants as were necessary, to fix the salaries of the Director and his assistants, and in general to “regulate all expenses incident to the Survey.”

²⁰Act No. 66, Public Acts of 1869.

The Director was charged with all of the responsibility for the scientific and administrative work of “a thorough geological and mineralogical survey of the State, embracing a determination of the succession, arrangement, thickness, and position of all strata and rocks; the mineral character and contents, and their economical uses; an investigation and determination of the organic remains of the State; a general examination of the topography, hydrography, and physical geography of the State; an investigation of the soils and subsoils, and the determination of their character and agricultural adaptation; the investigation of all deposits of brine, coal, marl, clay, gypsum, lime, petroleum, metals, and metallic ores, building stone, marble, grit stone, materials for mortar and cement, mineral paint, and all other productions of the geological world capable of being converted into the uses of man.”

The act provided a continuing annual appropriation of \$8,000, and directed that one-half of the expenditure be devoted to work in the Northern Peninsula including “the collection of statistics and history of the mineral, manufacturing, and transportation interests; to the preparation and compilation of accurate maps, showing the topography, geology, and timber, and also the position of mines, roads, and improvements; to the determination of the position and structure of the minerals and mineral rocks; to compiling and collecting all useful knowledge that would be of practical value in finding and extracting ores, and mining and smelting in those districts of the Upper Peninsula known as the iron and copper regions.”

A joint resolution²¹ of the House and Senate was passed instructing the Michigan Senators and Representatives to ask Congress to appropriate annually for three years \$8,000, to assist in making the survey, but the request proved futile and no appropriation was made by Congress.

It is worthy of note that the act of 1869 made no provision for zoological and botanical investigations as did those of 1837 and 1859.

²¹Joint Resolution No. 27. Public Acts of 1869.

DR. ALEXANDER WINCHELL—APRIL 24, 1869-APRIL 17, 1871

The act of 1869 became effective on March 26 and on April 24 Dr. Alexander Winchell was for the second time appointed Director of the Survey at a meeting of the Board held in the offices of the Governor at Detroit.²²

During the eight years that had elapsed since the termination of the second Survey, Dr. Winchell had been “mainly engaged, so far as strictly geological work was concerned, in elaborating its paleontological results and in special surveys of the limited districts with special reference to their economic resources. Thus he became familiar with the geological conditions of the salt and petroleum rocks of Michigan, Ohio, and Canada, on which he made special studies. In respect to the salt-bearing strata of Michigan he established the basin-shaped form of the strata, and defined not only the principles but also the geographic area in which brine might be found. His chief geological problem, however, during this interim was the establishment and defense of the “Marshall Group”.....²³

²²The first Board of Geological Survey were H. P. Baldwin, Governor. Oramel Hosford. Supt. of Public Instruction, and Witter I, Bascher. Pres. of the State Board of Education.

²³Memorial sketch of Alexander Winchell. Nathaniel Winchell—Bull. Geol. Soc. Am., Vol. 3. 1891.

Dr. Winchell's second administration of the Geological Survey was destined to be, like the first, short lived. What were the exact causes which led to his resignation is not known. His brother states that they were of a political nature. But whatever they may have been it is evident from the minutes of the meetings of the Board that in 1871, during the meeting of the Legislature, serious disagreements arose concerning the scope and management of the Survey and that Dr. Winchell could not be reconciled to the decisions of the Board. Dr. Winchell had presented a report of progress in November 1870²⁴ together with a plan for the completion and publication of the results of the survey to which the Board apparently dissented. The history of the work during the next two decades is the demonstration of the unwisdom of the failure to carry out the Director's plans which were very comprehensive and complete. The turning away of Dr. Winchell from a work on which he had set his heart and mind was not only unfair to him but a very great loss to the State. The accomplishments of

Winchell's second administration of the Survey are well told in his own words:

“It was understood to be clearly the intention of the law, that the moiety assigned to the Upper Peninsula should be expended in the development of the iron and copper interests of that portion of the State. The adoption of an equitable and judicious plan for the prosecution of this portion of the work was felt by the Board and by the Director to involve a serious responsibility, and very full and candid consideration was given to the subject. Finally, in view of the magnitude of the work which ought to be performed in each of the metalliferous regions of the Upper Peninsula, and in view of the limited amount of means at the disposal of the Board, it was decided not to extend the work in each region over the entire two years which should intervene before another session of the Legislature, but to devote the entire annual moiety to the iron interest in 1869, and to the copper interest in 1870.

²⁴Report of Progress of the Geological Survey. Alexander Winchell, 1871. 64 pp. 8 vo.

“Accordingly, a contract was signed with Major T. B. Brooks, by which he was required to complete a survey and report of the ‘Marquette Iron District,’ in accordance with a ‘Letter of Instructions’ from the Director (hereto appended, marked A), and for which he was to receive, in installments, the sum of \$4,000. A similar contract was signed the following year, with Prof. R. J. Pumpelly, by which he was required to conclude such portion of the survey of the Copper Region as could be accomplished with the desired degree of unity and completeness for the other \$4,000. The work of Major Brooks began June 4, 1869; and such has been his laudable ambition to produce a result not only adequate to the requirements of the contract, but as complete and creditable as possible to all concerned, that he has actually continued his labors to this date, and intends to prolong them into the next year. He has been assisted by John N. Armstrong, draftsman, C. M. Ross, mining engineer, and S. M. Walker, engineer. He makes acknowledgments also to sundry engineers and others, for valuable assistance which will be mentioned in detail in the final report. The work of Prof. Pumpelly began June 1, 1870, and will be continued until brought to a conclusion which can be guaranteed as satisfactory. He has been assisted by A. R. Marvin, mining engineer, and by L. G. Emerson. He acknowledges also the cordial cooperation of the inhabitants of the Upper Peninsula.

“Both of the gentlemen placed in charge of the work in the Upper Peninsula, besides possessing the advantages of a thorough scientific education, had had extensive experience in geological investigations in the United States (and Prof. Pumpelly also in foreign countries), and had already expended three or more years in the geological investigations of the metalliferous regions of the Upper Peninsula.

“Under these arrangements, the entire expense of the general direction of the work, and of the general

investigations, was devolved upon the moiety of the appropriation assigned to the Lower Peninsula. The same fund has also borne the expense of all field work in the Upper Peninsula which has not properly belonged to the survey of the Iron and Copper districts, as already specified. Under the appropriation for the Lower Peninsula, Prof. N. H. Winchell was appointed a permanent assistant; and Prof. M. W. Harrington of the University, Prof. E. A. Strong of Grand Rapids, Mr. A. S. Wadsworth of Traverse City, C. B. Headley of East Saginaw, A. O. Currier of Grand Rapids, and J. H. Emerton of Salem, Mass., have been under engagement for specific periods. Henry S. Cluff of Grand Haven has generously acted as a volunteer in an important work for which we have not found means to guarantee a compensation; and in other voluntary labors not strictly provided for by the intent of the law, we have been favored by Prof. M. W. Harrington, J. B. Steere of Ionia county, and Prof. W. J. Beal of the Agricultural College. *

"The portions of the State actually subjected to examination during 1869-70 are:

- (1) The Copper district of Portage Lake.
- (2) The Marquette Iron District including what is now known as the Gwinn Iron District of Marquette county.
- (3) St. Mary's Peninsula, by which is meant that portion of the Northern Peninsula extending from St. Mary's river west to the Whitefish river of Little Bay De Nocquet.
- (4) The Green Bay Region.
- (5) The Cheboygan Region.
- (6) The Little Traverse Bay Region.
- (7) The Thunder Bay Region.
- (8) The AuSable river Region.
- (9) The valley of the Manistee River.
- (10) The valley of the Pere Marquette River.
- (11) The valley of the Muskegon River.
- (12) Kent County.
- (13) Lapeer County.
- (14) Many other localities in the Southern Peninsula.

Investigations of a most general nature were made on the following subjects:

East Shore statistics of Forest, Lumber and Fisheries.
 West Shore statistics of Forest, Lumber and Fisheries.
 Fruit statistics of the west shore of the Southern Peninsula.
 Meteorological Investigations."

Dr. Winchell had planned and in great degree assembled the material for a series of publications which

would have been of the utmost value in the development of the State. The comprehensiveness of this plan may be inferred from the following outline:

Part I, Physiographic Features of the State.

Book 1. *Geographical Position and Area* in 6 chapters including (1) general geographic relations of Michigan to North America, (2) form and boundaries of the two peninsulas and treaties and laws establishing the State boundaries, (3) list of latitudes and longitudes established by astronomical observations and differences in time between Detroit and other principal points in the State, (4) dimensions of the different degrees of latitude and longitude in Michigan, air line distance between principal points and a list of all islands exceeding 1/100 of a square mile in area, (5) an exposition of the public land surveys and the inaccuracies incident to them, and (6) a record of the areas of all of the townships and islands.

Book 2. *Lakes and Streams* in seven chapters including (1) sketch of the Great Lakes, dimensions, areas, coast lines, harbors, soundings, profiles, annual and secular fluctuations, tides, seiches, currents, storms, climatic effects, and relations of discharge to precipitation and evaporation, (2) navigation and commerce of the Great Lakes, (3) fisheries of the Great Lakes, (4) the inland lakes, (5) the rivers, (6) navigation of the rivers, and (7) water powers.

Book 3. *Topography* in six chapters including (1) relation between topography and geological structure, (2) description of prominent land forms, (3) catalog of elevations and profiles, (4) marshes, alluviums, prairies, and sand dunes, (5) erosions and depositions along the lake shores and river valleys, (6) and scenery.

Book 4. *Climatology* in six chapters including (1) Elements of climate, i. e. temperature, winds, humidity, atmospheric pressure, (2) meteorological tables, (3) discussion of meteorological data of Michigan, (4) special climatic phenomena, (5) general description of the climate throughout the year, and (6) climate in relation to agriculture.

Book 5. *Magnetography* in two chapters including (1) nature and phenomena of magnetic force and (2) uses and properties of the magnetic needle.

Book 6. *Vegetation* in two divisions including (1) duration and succession of forest growths, reciprocal influences of forest and climate, character and distribution of Michigan forests, lumber and other forest products, and (2) herbaceous vegetation including medicinal and edible herbs.

Book 7. *Sanitary Characteristics* of the State in two chapters including (1) natural sanitary districts and their climatic and terrestrial characteristics, and (2) mortuary and sanitary statistics.

Book 8. *Population and Improvements* including settlements and trend of populations and state of internal communications.

Book 9. *Fruit Production* with special reference to the fruit belt of western Michigan.

Book 10. *Agriculture* including chapters on cereals, root crops, hay and grass, nurseries for fruit trees, stock, general farm crops and difficulties encountered by the Michigan farmer.

The other 9 parts to which Part I is introductory had not been so minutely outlined but it was the intention of Winchell to treat them with equal thoroughness.

Part II. *General Geology of the State*. A description of the succession, distribution, and structure of the rock formations.

Part III. *Economic Geology*. A description of all of the natural products of the rocks excluding copper and iron.

Part IV. *The Iron Resources of the State*.

Part V. *The Copper Resources of the State*.

Part VI. *Detailed Geology*. A discussion of the geology of each county in detail.

Part VII. *Paleontology*. A description of the organic remains or fossils in the rocks.

Part VIII. *Zoology*. A description of the animal life of Michigan.

Part IX. *Botany*. A complete account of the plant life of Michigan.

Part X. *Antiquities*. A study of relics and works of Indians, prehistoric peoples in Michigan.

The plan of the Survey and publications had doubtless already met with opposition. Winchell had asked for an appropriation of \$61,300 for a completion of the work he had planned and in publishing his report of progress and outline of work for future accomplishment which only a short time previous had been orally discussed with the Board, he introduces a defense of his plans and at the same time pleads for adequate support in executing them. He says:

"I am deeply interested in this work, in every way. I am in a condition to urge it forward as rapidly as it is practicable to do it. I am in possession of the accumulated notes and observations of a seventeen years' period of residence and study. I have access to the original notes of Dr. Houghton; to a folio volume of notes of my own survey in 1859-60; to several scrap-books filled with items and documents bearing upon the material resources of the State; all the materials of former surveys gathered together in the Museum of the University; all my original notes of investigation upon these materials, besides the two or three folio volumes of notes accumulated during the past two years. I feel therefore, not only interested in the work but prepared to prosecute it. I have no purpose however, of protracting the work beyond such period as the legislation which may be had shall necessitate. I would like to complete it within the next two years. It can be done, and should be done. I should feel impatient over a lingering labor

prolonged through the interference of parsimonious or illiberal views on the part of the State government. It would be injustice to myself, as well as damage to the State. I have other enterprises lying before me in the future. I have no disposition to sacrifice them, and cannot. When this work is concluded I desire to visit foreign lands. When this work is concluded I have another work which has the pledge of my undivided attention. I have no motive therefore, to protract this survey. Its pecuniary recompense to me is but a pittance; though I am content. I confess that I labor rather to be remembered with gratitude and respect, than to leave an inheritance to unknown heirs. * * *

"Sixty thousand dollars is not a large sum of money for the great State of Michigan to expend upon a work which is destined to complete the State itself to the eyes and apprehension of the world. It is too large a sum to squander. Not a cent of it should be misapplied or yielded to a spirit of greed. This work accomplished, Michigan will be read and known of all men. She has nothing to conceal. Her highest endowment is the fullest truth. This exposition of her mineral resources and physical characteristics will proffer irresistible invitations to immigration, to manufacture, to wealth, culture, education, and all that constitutes a great and glorious commonwealth.

"It is not an expenditure for the benefit of a single class of our citizens. It is not an appropriation for the insane, nor the idiotic, nor the deaf and dumb. It is not exclusively for the farmer, nor the mechanic, nor the professional class. It is not for the improvement of a river, nor a harbor, nor for the construction of a canal or railroad which would benefit but one portion of the State. It is not for education alone—either primary, higher, normal, or professional. It is for all these classes, for all these objects, and for all sections at once. It is an expenditure of 5 cents and one mill by each individual of our population to add millions to the valuation of our real estate, millions to the value of our public lands, and thousands to our population. * * * * *

"It is through making the world acquainted with the facts respecting our States, instead of leaving them in ignorance and consequent suspicion; through the disclosure of positively attractive characteristics—through the consequent influx of immigration, not only of the indigent foreign class, but of the native, enterprising, competent, Americanized classes; through the consequent establishment of manufactures and the proper diversification of our industries; through the opening of roads of every description to supply the wants and conveniences of widening and thickening population; through the enhancement, by such means of the aggregate valuation of real estate, and the correlative reduction of the rate of taxation; by these means, and others, will the Survey swell the aggregate of wealth and comfort and civilization within the limits of our State. * * * * *

"I cannot help believing that our Legislature will take such action in this case as shall illustrate and fairly

represent the intelligence and breadth of view which characterize the population of our State.”

But the plans and hopes of Dr. Winchell were destined to fail. During the months of February and March 1871, there were frequent meetings of the Board of Geological Survey and from the brief minutes which are preserved it is evident that the Board was dissatisfied with the direction of the Survey and sought to persuade Dr. Winchell to alter his course in accordance with their views. Thus on February 23 “it was resolved to give the survey a more practical direction and to secure more direct and immediate benefits” and on March 13 “The Board after mature reflection and consultation advised the Director to a course of action, to which, however, the Director was unwilling to consent.” The discussions between the Director and the Board were continued on March 14 and again on the 21st when the differences remaining unsurmountable Dr. Winchell tendered his resignation which was laid on the table, discussed on the following day, and not finally accepted until April 17.

In the meantime the Board had proceeded to have the law changed in such a way as to abolish not only the power and duties of the Director but the office itself and to center the full responsibility as well as authority in the Board. The Legislature acted promptly and amended the law in accordance with the desires of the Board, at the same time repealing the provision requiring an equal division of the work and expenditure between the Northern and the Southern Peninsulas.²⁶ In other respects the law remains unaltered.

²⁶Act No. 179. Public Acts of 1871. Approved April 17, 1871.

Dr. Winchell's resignation was accepted on the day the amendments became effective and on this same day Dr. Carl Rominger was appointed to continue the survey of that part of the State not included in the investigations of Major Brooks on the iron ranges, and of Prof. Pumpelly in the copper country.

DR. CARL ROMINGER, 1872-1885

THE SURVEY OF THE NORTHERN PENINSULA UNDER BROOKS, PUMPELLY, AND ROMINGER, 1871-2

In 1871-2 Dr. Rominger completed a survey of the Paleozoic rocks which cover the east end of the Northern Peninsula from Marquette to St. Mary's river while the studies of Brooks and Pumpelly on the iron and copper districts were brought to a close. Near the end of 1872 the manuscripts and illustrations were practically finished and were transmitted by the Board to Julius Bien, publisher, of New York. In 1874 an edition of 2,500 copies were delivered to the Board consisting of Vol. I (12 vo.) in three parts, viz.: Part I, 319 pp., Iron-bearing Rocks by Major T. B. Brooks; Part II, 143 pp., Copper District by Raphael Pumpelly assisted by A. R. Marvine, L. G. Emerson, and L. B. Ladd; Part III, 105 pp., Paleozoic Rocks by Carl Rominger, accompanied

by an atlas of geological maps, sections and statistical data; and Vol. II (12 vo. 298 pp.), Appendices to Part I of Vol. I, containing a lithological description of specimens of rocks by Alexis A. Julien, Major Brooks, and Chas. E. Wright.²⁶

²⁶The total cost of the edition was \$22,208.00 or \$8.88 per set.

The appearance of this report marks an epoch in the study of the geology of the Northern Peninsula. Twenty-one years had passed since the reports of the Jackson-Foster-Whitney surveys had been given to the public. In the interim a few articles by various writers on various subjects of the geology of the Northern Peninsula had appeared in certain periodicals but no considerable advance in understanding of the general geology had been made. Previous accounts had been based on explorations more or less widely extended but the studies of Pumpelly, particularly on the copper bearing rocks, and Brooks on the Marquette range were based on those minute observations which have characterized nearly all subsequent work in this region. Pumpelly's "Paragenesis of the Minerals Associated with Copper" is one of the classics of geology, and Marvine's "Detailed Structure and Stratigraphic Sections" remains even today the standard for comparison and correlation of the formation members of the vast thickness of sedimentary beds and lava flows of the copper bearing series on Keweenaw Point. Brooks' report on the Marquette Range is devoted mainly to the economic aspect of iron mining and smelting but nevertheless a great advance was made in his studies of the structure and succession of the Huronian system in this range. Brooks was the first to perceive that the Marquette range is a great synclinal trough forty miles in length pitching westward from the vicinity of Marquette. He also, in company with Pumpelly, made reconnaissance examinations of the Gogebic range from Penokee Gap in Wisconsin eastward to Lake Gogebic in Michigan and determined correctly the relations of the Laurentian, Huronian, and Keweenawan systems in this range. Numerous details of the geology of the Menominee and Felch Mountain ranges are also given.

Rominger's report on the Paleozoic rocks is the first comprehensive description of the geology of "St. Mary's Peninsula" and maintains the high standard set by Pumpelly and Brooks.

During the four years 1872-1876 Dr. Rominger was engaged practically alone in the work of the Survey. The results of his researches are embodied in Volume III of the Survey reports—a discussion of the geological structure of the Southern Peninsula, confirming and carrying further the views and researches of the earlier geologists, Houghton and Winchell, as to the "basin structure" of the Michigan area. Included as an appendix to Vol. III, is a report on the salt wells by Dr. S. S. Garrigues, the State Salt Inspector. But by far the most important part of this publication is Part III, a carefully elaborated monograph on the indigenous fossil corals of the State, which was the first treatise of a state Survey devoted wholly to corals, and which remains

today the classic treatise of fossil corals of the Michigan Basin.

In the spring of 1887, the Board of Geological Survey, although comprehending the valuable work of earlier geologists, realized that much exploration of a geological nature remained to be done in the Northern Peninsula, and that despite the arduous labors of Houghton and Winchell, investigations were only commenced and should be continued "Not alone in the appreciation of the economical importance of a thorough knowledge of the geology of this part of the State, which by its mineral wealth belongs to the most favored spots of the continent, but they thought also that the pride and duty of the citizens of the commonwealth required it to contribute to the promotion of science in general with the same liberality as many other States have done and are still doing, and to have so interesting a part of its territory fully examined." Therefore the Board accepted the report of Dr. Rominger and approved his plan "to examine with careful accuracy certain small circumscribed districts, so related as to embrace the most important rock formations developed in the region." For the successful execution of such a plan accurate topographic maps were indispensable, but here Dr. Rominger, like earlier and later geologists, found his work hampered and delayed by the lack of such maps, having to depend upon the government maps of the linear survey of the United States, upon which the topography was often either omitted or inaccurately recorded. However, the need for careful topographic work as well as a general geologic reconnaissance resulted in the discovery of many "instructive" outcrops which would have been overlooked in less careful and painstaking work. Three summer seasons were spent in a detailed investigation, and in the construction of a special geologic and topographic map (scale 2 in. : 1 mi.) of the district about Marquette, Negaunee and Ishpeming—an area of over 200 square miles. Also Dr. Rominger examined the then important mining locations—Washington, Champion, Republic, Spurr, Michigamme. The season of 1880 was spent in a similar careful examination of the Menominee region, the carefully written report of the work appearing as Vol. IV of the Survey Reports. "Part II, on the Menominee Iron Region was especially valuable in guiding explorations for iron ore in Iron and Dickinson Counties, a region at that time almost an unbroken wilderness."

During 1884, continuing his plan of careful examination of small areas, the State Geologist continued work in the Northern Peninsula in the copper and iron country. Although the report of the season's work on the copper, gold and iron regions of the Northern Peninsula would have been of great value to mining companies, it would make so small a volume that the Board deemed it advisable to delay its publication, therefore a report pertinent to the mining problems of the day was not placed before the public until ten years later, when it appeared as part of Volume V, 1895.

Dr. Rominger continued as State Geologist until May, 1885, when he was succeeded by Mr. Charles E. Wright of Marquette, who had been Commissioner of Mineral Statistics since 1878, and a member of the Board of Control of the Mining School at Houghton.

CHARLES E. WRIGHT 1885-1888

DR. M. E. WADSWORTH 1888-1893

Mr. Wright remained State Geologist until his death, March, 1888. During the field season he was engaged in making maps of the topography and sketches to illustrate geologic phenomena of the Northern Peninsula, and in the collection of 3,300 specimens of rocks to be the nuclei of the rock collections of the University and various colleges of the State. In the Southern Peninsula, he visited the salt wells and from information there obtained prepared sixty sections of deep borings. At the time of Wright's death, however, in spite of his zealous labors to fit himself for the position of State Geologist, by years of research and study, and although he had planned and laid out work on a large scale, nothing was available for publication, and many facts and conclusions reached by him were lost to the public.

Following the death of Mr. Wright, pressure was brought to bear upon the Board of Geological Survey to appoint someone as State Geologist who could take up the work where Mr. Wright had left it, the choice falling upon Dr. M. E. Wadsworth, Director of the State Mining School, who had been for many years an associate of Mr. Wright. An arrangement was made with the Mining School whereby Dr. Wadsworth was permitted to manage that institution and at the same time act as State Geologist. That such a union of offices was unwise was brought to the attention of the Board, but "the inadequacy of the means provided for carrying on the Survey²⁷ rendering it impossible for the Board to employ men, furnish rooms, and equip a suitable laboratory, caused the argument that the interests of the School and Survey were, in a measure, identical and that each would aid the other in the objects sought, to prevail."

²⁷\$8,000 a year, any part of which remaining at the end of the fiscal year must be returned to the State treasury.

With the appointment of Dr. Wadsworth, the Survey at last secured offices of its own. Up to that time the Survey had had no habitation other than the private offices or homes of the various geologists, a condition which makes it not surprising that much Survey property had been lost. In May, 1889, the Mining School gave a room, rent free, about twenty-five by thirty feet in size, in which all indoor work of the Survey could be performed, and in which was stored all the property of the Survey, except manuscript and published volumes. The School also allowed the Survey unrestricted access to and use of all its departments and laboratories, thus providing a means of more rapid indoor work, preparation of

specimens, thin sections, analyses, and map work, which should have hastened publication of reports.

Dr. Wadsworth continued Wright's plan of detailed surveys in the Iron Districts, exploring the territory between Iron River and Gogebic Lake, and between the State boundary and township 46 on the north, and in mapping unsurveyed districts near the Marquette district in 1888; in 1889 extending the exploration westward from Lake Gogebic to the State boundary and in exploring the eastern boundary of the copper bearing rocks.

In 1889 arrangements were made for the cooperation of the State Survey with the United States Survey, enabling the State Survey to devote most of its time and resources to the economic geology of the State, leaving the more purely scientific studies, particularly in paleontology, to the United States Survey. The Board at that time upon the recommendation of Dr. Wadsworth, voted to correspond with Prof. Mendenhall, Superintendent of the Coast and Geodetic Survey, asking him to undertake the triangulation of the State, the making of a topographic map, and the running of a line of levels in the State, but apparently nothing further was done to aid the inauguration and progress of the much needed topographic survey.

The Board of Geological Survey of 1890-92²⁸ seems to have taken a very lively personal interest in the work of the Survey. They accepted Dr. Wadsworth's very ambitious plans of organization of and work for the Survey²⁹ but from the minutes of the meetings it is evident that they were "dissatisfied and disappointed" with the slow output of material for publication and "dissatisfied that the rock specimens and thin sections were not being prepared and sent to the various schools and colleges with greater rapidity." The Board visited the offices of the Survey at Houghton and at a joint meeting with the Board of Control of the Mining School, it was decided that Dr. Wadsworth should be released from his duties as Director of the school until May 1, 1892 (from August, 1891), "to such an extent as was necessary to enable him to complete the work to date." Also the State Geologist was requested to supply the Board with "data for their annual report by January 1, 1891." In this request the Board was disappointed and the somewhat acrimonious correspondence ensuing led Dr. Wadsworth to tender his resignation March 3, 1891, which resignation was not however accepted, but a sharp communication was sent him "that unless the material required for the annual report of the board is forwarded to the Board by the first of April next, the Board will take steps forthwith to transfer its property to Lansing, discharge its present employees and employ such others as it sees fit." Also a committee, Messrs. Babcock and Fitch, was appointed to visit the State Geologist to ascertain what progress was made in preparation of the report. This investigation and a letter to the Board (see footnote²⁹) giving in detail the State Geologist's plan and the statement that "suspension of its operations or any change in the Survey now would

result either in putting back the publication for many years, or more probably would cause the entire loss to the State of the past ten years' work already done since no one can take up the work of another, in its partial development, and carry it on as fully and as rapidly as the originator himself," resulted in continuing Dr. Wadsworth as State Geologist and writing him that "the differences between him and the Board had arisen from a misunderstanding of the amount of work to be completed," and in the report of the Board is written "Dr. Wadsworth has the survey thoroughly organized, and has surrounded himself with intelligent assistants, and so far as *the time given the Survey* will permit, is making considerable progress."

²⁸Winans. Babcock, Fitch.

²⁹1st.—History of the former geological work done in Michigan with the results obtained.

2d.—A general index of all past publications that relate to the general and economic geology of Michigan, giving ranges, townships and sections as an aid to the explorer, miner, quarryman, and others.

3d.—Republication of the reports of Dr. Douglass Houghton.

4th.—Unpublished report of Dr. Rominger.

5th.—Sketch of the life of Chas. E. Wright, M.E., late State Geologist, containing his annual report.

6th.—Township or district maps of the distribution of the rocks and geological formations, for the use of the explorer and others, covering the chief parts of the counties of Baraga, Marquette, Iron, Menominee, and Gogebic, with some portions of Ontonagon, Houghton and Keeweenaw counties.

7th.—Descriptive text to accompany above maps containing an account of the geological structure so far as known, and a description of the observed rocks and minerals.

8th.—A classification and description of the minerals of Michigan, their distribution, methods of determination, etc., to assist the explorer and others.

9th.—A general classification and description of rocks, with special relation to Michigan rocks, for general use.

10th.—A general classification and description of ore deposits in general, with special reference to the Michigan ore deposits, as an assistance to explorers, miners, and others.

11th.—The iron ore deposits of Michigan, their origin and relations, with sections, maps, etc., together with a discussion of the comparative relations of other iron ore deposits.

12th.—The gold and silver deposits of Michigan, with maps, etc., together with a comparison of the mode of occurrence of related deposits.

13th.—The copper deposits of Michigan and related districts.

14th.—The gas and salt wells of Michigan, with sections and a general discussion of the occurrence of gas, petroleum and salt.

15th.—The building stones, their properties, mode of occurrence, etc.

16th.—Gypsum, coal, limes, clays, marls, and the minor mineral products of Michigan.

17th.—Methods of mining, timbering, hoisting, etc., particularly those employed in Michigan.

18th.—Methods of ore dressing used in Michigan, and elsewhere if adapted to Michigan products.

19th.—Metallurgical processes suitable for use in Michigan.

20th.—Rectification of the boundary line between the copper bearing rocks and the Eastern sandstone, with a discussion of their relations and the probable extension of the copper belt.

Although the papers comprising Vol. V of the Survey publication, excepting the manuscript relating to salt, gas and petroleum wells, were in the hands of the Board in June, 1892, and in spite of the fact that it was the lack of published results of the progress of the survey that stirred this Board to its singular activity, the Board retired with the volume unpublished, publishing only "The Report of The State Board of Geological Survey for the

years 1891 and 1892," to which are appended Exhibits setting forth the expenses of the Survey from its inception to November 1892, the reports of Dr. Carl Rominger for the years 1881 and 1882-3; of Mr. Charles E. Wright for the years 1885-8, of Dr. M. E. Wadsworth for the years 1887, 1890, 1891, 1892; also a provisional report by Dr. Wadsworth upon the geology of the iron, gold, and copper districts of Michigan. This provisional report of Dr. Wadsworth's is the only contribution of the Wright and Wadsworth administration. It was published without maps and is for that reason of less value than it otherwise would be.

This is the first and only report by a Board of Geological Survey of Michigan, as such; although the law provides that such a report shall be made, it makes no provision as to the official or body to whom the report is to be presented. In this report it was observed that the members of the Board are such ex-officio (the Governor, Superintendent of Public Instruction, and Secretary of the State Board of Education) and that if the law intended the annual report to be made to the governor, it would in effect require the governor to make a report to himself. The Board of 1891-2 made its report to the Legislature, and suggested that the law be amended to specify the official body to whom the report shall be made. Among the recommendations for remedial legislation made by this very active and interested Board were some which were significant of future changes to be made in the conduct of the Survey: one was, that "a room in the Capitol be set aside for the Geological Survey * * * * *" thus foreshadowing the time when the Survey would be severed from Mining School or University and be an independent institution with offices in Lansing; another asked an increased appropriation so as to secure the *entire time* of competent geologists, so paving the way for the time when the Director of the Survey should also be independent of Mining School or University or other institution, paving the way for the time when the finances of the Survey should be on a plain business basis, and the work of the Survey should no longer be hindered by the divided interests of the Director (Dr. Winchell and Dr. Rominger were professors in the University, Mr. Wright was a practicing mining engineer, and Dr. Wadsworth was President of the College of Mines), but the compensation of the Director be such that he could devote his entire time to the Survey; a third recommendation brought about some immediate though partial result, but was partially carried out nearly twenty years later. The Board said: "We are unable to see any reason for the existence of a Commissioner of Mineral Statistics independent of the Geological Survey. The work of the officer naturally falls under the supervision of the Survey, and could better be done by it than by such commissioner. Should that office, therefore, be united with the Survey, and an additional officer be added to the Board of Geological Survey, whose duties should be to discharge the functions now performed by that officer, great good would accrue to the State. The Geological Survey would be properly looked after, and equally valuable results

obtained relative to mineral statistics, with but little if any additional expense to the State."

The Legislature took no action at this time, but eventually the recommendations were partly carried out and the successors of Dr. Wadsworth have devoted their undivided efforts to the Survey.

The succeeding Board, Gov. John T. Rich, Hon. Perry Powers, and Hon. H. R. Pattengill, acted upon the recommendations of their predecessors to the extent of considering legislation to incorporate the office of Mineral Statistics with the Survey, and to appoint a State Geologist independent of the College of Mines. When informed of the intentions of the Board, Dr. Wadsworth offered to resign as President of the Mining School and devote his entire time to the directorship of the Survey, if his compensation would be placed at \$4,000 a year. The Board did not accept Dr. Wadsworth's proposal, however, and on July 1, 1893, appointed Dr. Lucius L. Hubbard of the Board of Directors of the Mining School to the office of State Geologist, and Dr. A. C. Lane, Assistant State Geologist.

DR. LUCIUS L. HUBBARD, 1893-1899

With the appointment of Dr. Hubbard the Survey entered upon a period of thorough reorganization—it was severed from Mining School and University, the efforts of the Director were not henceforth to be divided with other interests, the Survey was no longer to be an appendage to the University or the College of Mines, a condition considered by the Board to be beneficial to those institutions, but detrimental to the Survey.

On October 6, 1893, the Board of Control of the Mining School passed a resolution giving the Survey permission to erect "a suitable building on the east side of the Michigan Mining School property * * * * *" on a piece of ground to be designated by the Executive Committee of the Board of Control, and to occupy the same rent free for the purposes of carrying on the work of the Survey, but for no other purpose; said ground occupied by said building to be under the general management of the Board of Control of the Mining School; the Board of Control reserving the right, if at any time the ground occupied by said building should in their judgment be needed for the use of the Mining School, to remove the said structure to some other part of its grounds; the said Geological Survey to occupy said ground on which said building shall be erected as tenants at the will of the Board of Control of the Michigan Mining School." The offer of the Board of Control was accepted, and through the efforts of Dr. Hubbard the citizens of Houghton contributed \$1,100 to which the Survey added \$1,500 and a small one and a half story building equipped with a fire-proof vault was erected, and at last after an existence of over half a century, the first department of the State to be created secured housing of its own, partly equipped with apparatus most necessary for its work.

Up to this time the history of the achievements of the Third Survey is mainly a record of exploration and progress in the Northern Peninsula, aside from the brief, interrupted work of Prof. Winchell, 1859-1863 and the lonely work of Prof. Rominger, and some records and statistics collected by Mr. Wright on the salt and gas wells of the Southern Peninsula. But since the United States Geological Survey was at this time completing the Monograph on the Lake Superior District³⁰ and further work by the Michigan Survey in the Iron District would lead to duplication, Dr. Hubbard made an agreement with the Federal Survey to do no work in the Iron District, continuing, however, work on Keweenaw Point and Isle Royale. However, exploration was extended to the Southern Peninsula under the direction of Dr. Lane, Assistant State Geologist. Dr. Lane had been engaged for some time past in making microscopical studies of the thin sections of Michigan rocks collected by Mr. Wright; he had also carefully worked over the notes on and the records of gas and salt well sections left by Mr. Wright and from these prepared the first important contribution since that of Prof. Rominger to the literature of the Geology of the Southern Peninsula—"The Geology of the Lower Peninsula with Reference to Deep Borings." This work "was particularly valuable, both scientifically and economically because it enabled correlations to be made between the strata in one part of the Southern Peninsula with similar strata in all other parts, and thus not only clarified the geologic history of the Paleozoic Era in Michigan, but furnished a valuable guide for the prospector in search of any of the products of these rocks, such as gypsum, coal, building stone, cement materials and especially salt and bromine." It developed from these studies of Dr. Lane, that there are four horizons that yield commercial salt and brines. This report with an introduction by Dr. Hubbard on "The Origin of Salt, Gypsum and Petroleum" was published in 1895 as Part II of Volume V, Part I being the long delayed report of Dr. Rominger on the Geology of the Upper Peninsula.

³⁰Monograph 52 U. S. G. S. Van Hise and Leith.

During the years 1895-96, Dr. Hubbard was engaged in intensive field study of the copper bearing rocks,³¹ the Keweenaw Series, on Keweenaw Point, and at the same time, Dr. Lane was engaged in a similar study of the same series of rocks which compose the unique Isle Royale. Dr. Hubbard made particular study of problems untouched or unconsidered by other geologists, particularly in connection with the acid intrusives in the lower part of the series; he obtained much data enabling him to elucidate many valuable details of structure, and interpret results of explorations, particularly near Portage Lake.

Dr. Lane's studies on Isle Royale were similar in scope to Dr. Hubbard's for Keweenaw Point, but Dr. Lane included minute studies of the copper bearing rocks, or Keweenaw Series forming the island, their origin, present composition, structural and topographic relations and the geologic processes by which they have been

metamorphosed to their present condition. Dr. Lane reported also on the prehistoric copper mining on Isle Royale, and described modern attempts to locate and mine copper from all of which he was enabled to give valuable advice concerning future exploration.

³¹A direct result of the geological studies made by Dr. Hubbard in the copper district was his discovery of the Champion Mine, which is now (1921) Michigan's most valuable copper mine. "The Champion Mine is valued at \$11,000,000, has produced 341,660.308 pounds of copper and paid \$25,860,260 in dividends. For the eight year period 1012-1010 the Champion paid to the State \$903,888.89 in taxes." nearly twice the total cost of the Michigan Geological Survey since 1869.

The reports of these two surveys embody the highest type of geological work; they were accompanied by valuable maps and were complete and ready for publication in December, 1896. But they also were fated to delay in publication. For some reason the Board of Auditors refused to publish reports of the Geological Survey unless authorized to do so by the legislature. This caused a delay of two years in publication and resulted in the passing of Act No. 78 of the Laws of 1899, by which the Board of Geological Survey was authorized "to order the publication of reports which it is by aforesaid act³² authorized to require." "By publication is understood to include printing, and at their discretion electrotyping, of the reports above mentioned, and the preparation of illustrations and maps thereto appertaining; * *

Sec. 2. Bills for the expenses incurred under the provisions of Section 1 of this Act shall after approval by the Board be presented to the State Board of Auditors and after allowance of them audited by the Auditor General and paid for from the general fund * * * * *". Following the passage of this Act, the two reports appeared as Vol. VI of the Survey Reports published by Dr. Hubbard's successor, though properly belonging to Dr. Hubbard's administration.

³²Act No. 65. Laws of 1869.

Many inquiries from people within and without Michigan relative to the economic mineral deposits of the State came to the office of the Survey, and because the absence of knowledge as to the exact location of such deposits was a serious drawback to possible exploitation by would-be investors, and therefore to the development of the State, the Survey planned the accumulation of knowledge of such nature, and Dr. Hubbard laid out a plan for work in the Southern Peninsula, a plan which was determined by the geological structure of the Southern Peninsula. "As is well known, the geological structure of the Lower Peninsula can be compared to a series of bowls placed one within another, the center is occupied by the coal measures and from the center outwards the different formations may be expected to occur more or less regularly in all directions in sequence. Consequently the geology of any given segment of the bowl-aggregate or basin will be likely to match approximately any other segment. The geology of Monroe County will correspond to the area about Cheboygan and St. Ignace. Sanilac and the greater part

of Huron and Tuscola being without the coal basin, will represent the geological conditions that prevail in Iosco, Missaukee, Newaygo, Kent, Barry, Washtenaw, Lapeer and other counties contiguous to the coal basin. * * *

The plan of the survey was to begin simultaneously on different parts of the formations, in counties where the rock outcrops were supposed to be most abundant and where these outcrops supplemented by data from artesian and other wells, would enable us to construct maps showing the surface contour and other maps showing the rock contours—that is, the calculated depth from the surface to rock at any point. The detailed enumeration of these reports of the different economic products encountered during the progress of the work, not only would be an aid to the investment of capital at the point or points specified, but would serve an even more important purpose. The citizens of Cheboygan, knowing that they are on the same belt that passes under Monroe County, would know that unless geologic conditions had changed much to the north, they might find in their neighborhood both pure and hydraulic limestone, glass-sand and salt; * * * Thus the publication of one county report would have significance and interest for the citizens of many counties, and might stimulate exploration at many points. It would be for the Survey to determine later with more precision the exact boundaries of the different belts as its systematic work was extended to other counties. * * **³³

In the consummation of this plan field work was carried on in Huron County by Dr. Lane, in Sanilac County by Dr. C. H. Gordon and in Monroe County by Prof. W. H. Sherzer. The work was begun most auspiciously, the manuscripts on Huron and Sanilac counties being submitted in January and September 1897, and the field work on Monroe County being completed early in 1898, but the facts did not reach the people of the State for whom they were intended due to the refusal of the Board of Auditors to order printing of plates for the county bulletins. Pending legislation on the question Dr. Lane addressed a number of Farmers' Institutes on the subject "The Best Farm Water Supply," "this," quoting Dr. Hubbard, "appeared to be the best medium available to bring before the people a part, at least, of the results of the Survey work."

³³Sixth Annual Report of State Geologist, L. L. Hubbard. Jan. 1899.

During the early history of the salt industry in the Saginaw Valley, the refuse from the lumber mills had furnished readily available fuel, but this "inexhaustible supply of pine" became exhausted, and if the salt industry was to flourish, a cheap fuel must be found within the State since lacking competition, the cost of imported coal from Ohio and Pennsylvania was almost prohibitive. This caused in 1895 a rapid development in the coal areas which had been known for over fifty years. In 1898, Dr. Lane had prepared a report on the Coal Basin to help development and "to give the land owner of Lower Michigan that amount of geological information which would enable him to form an intelligent estimate of the value of his land for coal mining

purposes, and to plan intelligently for the economical development thereof,³⁴ and to make the report available and of value, it was printed serially in the Michigan Miner (Saginaw). It may be said here that later these reports were all issued by the Survey.³⁵ But the delay in printing having made the work of the Survey temporarily useless, Dr. Hubbard declined to continue the county survey on the same scale as in the three counties already surveyed, so that during the season of 1898 the county survey was carried on only in Tuscola County, by Prof. C. A. Davis working almost alone.

January 10, 1899, Dr. Hubbard tendered his resignation from the directorship of the Survey. His administration had been most efficient; he had thoroughly reorganized the Survey, perfected a plan for its development, which still remains in effect to some extent, surrounded himself with competent assistants, and though sadly embarrassed by the unaccountable opposition of the Board of Auditors, had secured results of benefit to the State.

³⁴Vol. VIII.

³⁵Vol. VII.—1900, and Vol. VIII.—1903.

DR. A. C. LANE, 1899-1909

In April, 1899, the Board of Geological Survey elected Dr. Lane as State Geologist. Dr. Lane had been connected with the Survey during Dr. Wadsworth's administration, and had served as Assistant State Geologist with Dr. Hubbard. He was thoroughly conversant with the plans of Dr. Hubbard for the development of the Survey and continued to put them into execution.

The main office of the Survey was now transferred to Lansing and quarters for it secured in the old Hollister block and later in the Old State Building. Mr. Savicki, working under the direction of Dr. Hubbard, was left in charge of the Houghton office. The building which this office occupied was later moved from the grounds of the College of Mines to a lot on East Street which was later purchased by the Survey, although it was always the dream of Dr. Lane that the State might build a substantial, preferably stone, building in which valuable drill cores (costing \$2.00 to \$5.00 per foot) might be kept—"a stone library for a library of stone."

Hitherto the interests of the Survey had been devoted mainly to the Northern Peninsula and to structural geology. The geology of the Southern Peninsula is far less complex than that of the Northern, and the economic minerals and deposits at or near the surface are more numerous and varied, though even in the aggregate not so valuable as the minerals of the Northern Peninsula. This fact coupled with the numerous requests for data on such deposits, on artesian water supplies, on coal, etc., make it not at all surprising that the Survey publications began to assume a more diverse character as to subject matter. Investigations of the economic geology continued—

particularly investigations of coal, clay, shales, and marls.³⁶ At the suggestion of Prof. Russell of the University of Michigan, Mr. J. H. Cole in 1902 was engaged in a field study of the St. Clair Delta, a formation unique among deltas since it is being formed by a short river which serves as the outlet of a great lake.³⁷ During the same season Mr. G. P. Grimsley of the Kansas Survey was investigating the gypsum industry of the State.³⁷ The activities of the Survey were widely distributed throughout the State as well as being diversified in character. For the division of geology in the Northern Peninsula, Prof. I. C. Russell was engaged in exploration and reconnaissance along the northern shores of Lake Michigan and Lake Huron³⁸ and in a study of the surface geology of Menominee, Dickinson and Iron Counties.³⁹ Mr. W. C. Gordon, then in charge of the Houghton office, explored, examined and made a geologic section of the copper bearing rocks of the Keweenaw Series between Bessemer and Lake Superior down Black River, a work designed to call attention to a then little known area of copper bearing rocks.⁴⁰ Dr. Hubbard had continued without salary, to direct work in the Northern Peninsula, but about 1903 found it impossible to devote time to the Survey and Dr. Frederic E. Wright "a highly trained man from the College of Mines was engaged as Assistant State Geologist." Dr. Wright brought to his study of the Porcupine Mountains⁴¹ and Mt. Bohemia⁴² the same painstaking care which later made him an expert in the field of petrography. Towards the close of Dr. Lane's administration, Mr. R. C. Allen began a study of the Iron River District.

³⁶Vol. VIII. Part I. Clays and Shales, Dr. H. Ries, Cornell; Part II, Coal, Dr. Lane; Part III, Marl, Dr. D. J. Hill.

³⁷Part I, Vol. IX. Part II, Vol. IX.

³⁸Ann. Rept. 1904.

³⁹Ann. Rept. 1906.

⁴⁰Ann. Rept. 1906.

⁴¹Ann. Rept. 1903.

⁴²Ann. Rept. 1908.

Preparation of a report on the Surface Geology of the Northern Peninsula was in charge of Mr. Leverett of the United States Geological Survey. From the numerous requests reaching the Director's office Dr. Lane had become interested in the water supply of the State and besides his interest in the correlation of copper drilling from data furnished from the mines, Dr. Lane made a study and analysis of the potable waters of the Peninsula. The published reports of these last three investigations did not appear till some time after Dr. Lane's resignation from the Survey.

In the Southern Peninsula following the plan of Dr. Hubbard to secure data on the economic deposits of the State, examinations were made of salt shafts, peat deposits, the Port Huron oil field and of foundry sands. Most of the Michigan foundries secured the needed molding sands from Ohio, and as these deposits approached exhaustion it seemed advisable to

determine whether Michigan's many factories could not be supplied by Michigan sand. Accordingly Prof. H. Ries was engaged to examine and report on the deposits of molding sands in the State. The report⁴³ shows that Michigan has many deposits of sand although much of it is too coarse for molding purposes and many of the deposits are limited in area. Reports of counties—Lapeer,⁴⁴ Muskegon,⁴⁴ Bay,⁴⁵ contiguous to the Coal Basin were continued, the reports on Arenac County⁴⁴ completed and that for Wayne County begun. The Board of Supervisors of Alcona petitioned for a survey of that county, but the funds at the disposal of the Survey did not permit the survey of that county without dropping work of equal importance begun elsewhere. Therefore with a public spiritedness worthy of emulation, Mr. J. H. Killmaster of Alcona County gave the free use of his team of horses and the supervisors of Alcona County voted to expend \$200 on the survey under the direction of Dr. Lane.

⁴³Ann. Report. 1907.

⁴⁴Ann. Rept. 1901.

⁴⁵Ann. Rept. 1905.

Perhaps the most important contribution to the literature on the geology of the Southern Peninsula during Dr. Lane's incumbency is that contained in the Annual Report for 1908—The Geological Section of Michigan, by Dr. Lane and Prof. A. E. Seaman. The section was made from a careful examination and correlation of well records⁴⁶ by Dr. Lane for the Southern Peninsula and for the Northern Peninsula from drill records and the observations made by Dr. Seaman. The section was published in 1909—a fitting close to Dr. Lane's long active connection with the Survey. It is in the main tentative, but nevertheless its chief correlations remain substantially as worked out by the authors.

In securing legislation and appropriations for the Survey, Dr. Lane was not so successful as in securing aid in the scientific field. From the amount of work done in the State, and the very meager appropriations (\$8,000 a year) one is constrained to believe that much of the work was a "labor of love," perhaps fittingly repaid by indorsement of the scientific world but most unsubstantially rewarded by the chief beneficiary—the State of Michigan. However some very needed and long asked for legislation was secured—the establishment of the divisions of topographic and biologic surveys.

⁴⁶Vol. V. Geol. Surv.

From the time of Douglass Houghton, every State Geologist had urged the need of a topographic survey of the State, every legislature, after the first four, had failed to heed that need and meet it with a proper appropriation. In 1891, Dr. Wadsworth reported that "plans are being formulated for a complete topographical map of Michigan in part at least by the aid of the United States Coast Survey and the United States Geological Survey." In 1892, he writes that "some correspondence has been had with the United States Geological Survey" in an effort to obtain the needed survey, and he urged

that the Board press the needed legislation and secure the proper appropriation, but with no result. Ten years later, Dr. Lane found that because of the removal of the Houghton office, plans for summer field work in the Northern Peninsula were delayed and the sum of money for such work rendered available for work in the Southern Peninsula. This sum was used with the consent of the Board, "in preparing a sample sheet of a topographic map such as the United States is prepared to execute in cooperation with the State." Accordingly August 17, 1901, a contract⁴⁷ was signed by C. D. Walcott, Director of the United States Geological Survey, and Dr. Lane, State Geologist of Michigan, for the execution of a cooperative topographic survey of one thirty minute quadrangle between latitudes 40° and 40° 30' and longitude 83° 30' and 84°—nearly covering Washtenaw County and portions of adjacent counties on the north, east and south. Thus, following repeated but futile appeals to the Legislature by nearly all the former State Geologists, by the Michigan Academy of Science, Engineering Society, the faculty of the University, Prof. Russell and others, was inaugurated with the very meager funds at the disposal of the State Geologist, a survey which benefits a greater variety of man's pursuits than any other single department of the Geological Survey, a survey which had been needed from the establishment of the Survey in 1837, earnestly desired by Douglass Houghton,⁴⁸ and all succeeding geologists and whose value had been demonstrated by the use made of the Menominee sheets prepared by the Federal Survey. According to the agreement between the Director of the Federal Survey and the State Geologist, \$4,000 was to be expended from the Federal Survey and \$2,000 appropriated from the meager general fund of the State Survey. This sum, however, was not sufficient to complete the mapping and the quadrangle was completed at Federal expense.

The satisfactory execution of this map, the repeated urgings of Prof. Russell, endorsements of scientific men and Michigan's representatives in Congress, the earnest solicitations of the members of the University faculties, and the indefatigable efforts of the State Geologist, convinced the Legislature of 1903 of the need of such topographic work, and it therefore appropriated the sum of \$1,000 (!) to continue the work.⁴⁹ This act was a step in the right direction but it did not go far enough—it merely appropriated a small sum to further the work, but the Legislature of 1905 by Act 251 authorized the Board of Geological Survey "to confer with the director or representative of the United States Geological Survey and to accept its cooperation with this State in the preparation and completion of a contour topographic map of this State, which is hereby authorized to be made."⁵⁰

The division of topographic survey has since grown steadily but the State Legislatures during Dr. Lane's administration did not see fit to appropriate sufficient funds to carry the work to the speedy completion in which the Federal Government was willing to cooperate.

⁴⁷Ann Report. 1901. p. 261.

⁴⁸Witness that Act No. 49, 1838 did provide for a topographical department and Act No. 02. 1844 provided a salary for a State Topographer, but the reorganization of 1860 and 1860 made no provision for further topographic work.

⁴⁹Act 178. 1903.

⁵⁰Act 251. Public Acts 1905.

The original acts creating the Geological Survey provided also for a zoological and biological Survey of the State⁵¹ but with the reorganization of the Survey in 1869, with lack of that vision which actuated the organizers of the first Survey, and failing to appreciate the economic as well as purely scientific value of a thorough survey of the fauna and flora of the State, the Legislature made no provision for carrying on the biological work; so for thirty-six years a most important field was neglected. The Michigan Academy of Science endeavored to remedy matters and from 1900 brief references are made in the minutes of the Board of Geological Survey to the attempts to reestablish the biological division. Dr. Lane asked for an appropriation of \$1,000 "until we can see what the work needs." In 1903 the Board authorized Dr. Lane to confer with the heads of departments of Zoology and Botany of the University and Agricultural College, Experiment Station and Board of Forestry and submit a plan for the conduct of the Biological Survey. As a result of these activities the Legislature realized that the work of the biological survey would "provide information which if used in legislation will save the State literally millions of dollars in augmented crops and actually return to the people of Michigan hundreds of thousands of dollars in animal food and fur alone. * * that the wild life is a valuable resource and that an inventory and appraisal are necessary to an intelligent administering of this resource," therefore the Legislature enacted⁵² "that the Board of Geological Survey is hereby authorized and required to make under the 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."

⁵¹Acts No. 30, Public Acts 1887. and No. 49, Public Acts 1838.

⁵²Act No. 250, Public Acts 1905.

The Biological Survey did not lack material for early publication. During the summer of 1904 an ecological study of the Porcupine Mountains, Ontonagon County, and of Isle Royale had been made by an expedition sent out by the University Museum of the University of Michigan under the direction of Dr. C. C. Adams then curator of the museum, with Mr. A. G. Ruthven as chief naturalist of the party. The region of the Porcupines had been prospected over during the early days of mining activity but a half century had elapsed since the sinking of shafts so that the region had reverted practically to its primeval condition. Since the encroachment of civilization had so destroyed habitats and exterminated plant and animal species in the Southern Peninsula it

was desirable that collections be made from these primitive regions of the Northern Peninsula before the approach of civilization made it too late.⁵³ Only a few weeks could be devoted during 1904 to the work on Isle Royale but the work was completed in the 1905 season.⁵⁴ These surveys were made at no expense to the State but were made possible through the generosity of public spirited friends of the University Museum, Mr. H. M. Kauffman and Hon. Peter White of Marquette and Dr. Bryant Walker of Detroit.

⁵⁴The reports of this survey by Mr. Ruthven, Otto McCrary and Dr. Bryant Walker appear in the Annual Report for 1905.

⁵⁵Biological Survey of Michigan 1908. C. C. Adams.

The prolonged strike of the hard coal miners in 1902-3 followed by scarcity and high prices of all sorts of fuel led to consideration of all possible sources of available fuel supply, among them peat, since about one-seventh of the area of Michigan was estimated swamp or muck land. Dr. Lane prepared a brief report on peat in 1902, and later assigned to Prof. Davis the task of making extended investigations into the method and accumulation of peat, causes for its variation, in structure and appearance, and its distribution within the State. From these investigations one of the most valuable papers of the biological survey was prepared for publication in 1906.⁵⁵ The demand for this publication proved the wisdom of the establishment of the biological survey, and of presenting to the people of the State accounts of the biologic resources, if there were any doubt of such wisdom.

A biologic survey was made of Walnut Lake in Oakland County by Mr. T. L. Hankinson and associates.⁵⁶ The main object of this survey was to determine why whitefish, which the Michigan Fish Commission had planted in a number of lakes, should thrive in this particular lake when unable to maintain themselves elsewhere—to determine what factors of the Walnut Lake habitat cause the whitefish to flourish there. A knowledge of these conditions makes it possible to determine in what other lakes of the State this valuable food fish may be planted and raised. Other papers of scientific and economic interest were well under preparation by 1909 to appear in future publications, i. e. on the Crataegus (the Thornapple) of Michigan (Ann. Rept. 1907), crawfish, insect galls, sites of aboriginal remains, etc.

⁵⁶Annual Rept. 1906.

⁵⁶Ann. Rept. 1907.

An outcome of the organization of the biological Survey as a division of the Geological Survey was the recognition by Dr. Lane and the Board of Geological Survey of the wisdom of having an advisory committee, an extra-legal body, of scientific men as a Board of Advisors for the Survey. Accordingly in 1905 Dr. Lane was authorized to appoint such a board consisting of two geologists, two botanists and two zoologists, and chose Dr. L. L. Hubbard and Prof. I. C. Russell, geologists, Prof. Jacob Reighard and Prof. Barrows, zoologists and

Mr. W. J. Beal and Prof. F. C. Newcombe, botanists as the first advisory board of the Survey. In 1908 Dr. A. G. Ruthven of the University of Michigan was appointed Chief Naturalist of the Survey.

In 1909 Dr. Lane resigned from the Survey to accept a position in Tufts College. Dr. Lane had been associated with the Survey for more than twenty years, and had watched and fostered its growth from a State department which as an adjunct to the College of Mines had employed the partial services of a State Geologist and a few assistants in work in the Northern Peninsula, to an independent department employing the expert services of a large body of trained scientists in investigations in both Peninsulas, a department not of geology alone, but with the added divisions of topography and biology, thus complying with the wise provisions due to the genius of Douglass Houghton and embodied in the Act 20, 1837, by which the first survey was organized. Though hampered always in his plans by insufficient appropriations and the apathy, lack of foresight, or utter indifference of the Legislature, Dr. Lane had so firmly established the Third Survey that it was ready to enter that wider scope brought about by his successor. In accepting his resignation the Board of Geological Survey passed the following resolution:

“Whereas, Dr. Alfred C. Lane, for twenty years State Geologist for the State of Michigan, has resigned his position in this capacity, Therefore Be it Resolved by the State Board of Geological Survey that Dr. Lane’s resignation is greatly regretted by this Board. His administration has been unprecedented in length of time and unparalleled by amount of publication and marked by uninterruptedly harmonious relations with other Boards and the great schools of the State. Geological work has been fairly distributed in all parts of the State, and without neglecting pure science, economic results have been attained. Among the results obtained have been copper lodes located; the coal production has increased from 50,000 tons to 1,500,000 tons; rock salt is now to be mined; soda, salt, mineral water, limestone, cement and clay industries have been fostered and valuable advice on water supply given. In view of these well known facts be it further

Resolved, that the severing of Dr. Lane’s official relations with the work is a distinct loss to the State and that another State is to be congratulated on securing the services of a man who has for so long done valuable work for Michigan, and be it further

Resolved, that a copy of these resolutions be spread on the minutes of the Board of Geological Survey.”

MR. R. C. ALLEN, 1909-1919

Dr. Lane's resignation took effect in September, 1909, and he was immediately succeeded by Mr. R. C. Allen as State Geologist.

With the foundation laid by Dr. Lane, the Survey under his successor has been able to build and expand, to take its place as one of the extremely vital forces in the development of the State. With a dynamic director unfettered by academic traditions and ties, the Survey became the dynamic force in Michigan welfare that Douglass Houghton visioned, of "practical and immediate application in the administration and development of State policies and laws bearing upon the development, use, exploitation, and taxation of the natural resources of the State."

A review of the new series of publications is a review of the purely geological work undertaken. A perusal of these publications will show that geology as a pure science has nowhere overshadowed geology as an economic science of daily value to all the citizens of the State. Some of the geological work was undertaken before the present regime but completed and published since 1909, Prof. A. W. Grabau and Prof. W. H. Sherzer completed a study of the Monroe formation.⁵⁷ It may be stated here that from this study and subsequent studies based upon it knowledge was obtained of the valuable glass sand deposits of Monroe County. This was a knowledge of extreme value during the War, since cut off from German sources of optical glass supply, America seemed on the verge of impotence in those researches using optical instruments. An available supply of pure, iron-free glass sand would relieve that condition. Michigan has such glass sand and supplied it and continues to supply it in quantities sufficient for all government uses for high grade optical glass.

⁵⁷Pub. 2, Geol. Ser. 1, 1910.

"The Monroe Formation of Michigan and Adjoining Regions" is the first of a series of monographs on the Paleozoic formations of Michigan. Four others are still in preparation—the Devonian formations by Professor Grabau, the Marshall and the Coldwater formations by Professor G. H. Girty, and the Niagaran limestones by Mr. George M. Ehlers. These monographs when completed will give an exhaustive history of the Paleozoic geology of the Michigan province and will be a repository of valuable information on the mineral resources and groundwater supplies of the Southern Peninsula and the eastern half of the Northern Peninsula.

Of Dr. Hubbard's proposed county reports two have been completed. Arenac County⁵⁸ by Professor W. M. Gregory, and Wayne County by Prof. Sherzer.⁵⁹ The Wayne County report is written in such a careful and admirable style that it is used as a textbook by teachers of geography in Detroit. This use of the Wayne County report shows that the Survey publications are not written only for pure science and to fill library shelves; more

teachers of the State could greatly increase their personal efficiency as well as add to the interest of their classes by a greater use of Survey publications—many of which are prepared by teachers having other teachers in consideration.

⁵⁸Pub. 11, Geol. Ser. 8, 1911.

⁵⁹Pub. 12, Geol. Ser. 9, 1911.

Reports on Sanilac, Monroe and Huron counties. Vol. VII, 1900. The reports on Bay and Tuscola Counties were published in the Annual Reports of 1906 and 1908 respectively during Dr. Lane's administration.

Two other publications show the wide application to State problems—The Surface Geology of the Northern Peninsula⁶⁰ and the Surface Geology of the Southern Peninsula⁶¹ by Frank Leverett. So great was the demand for these publications that the editions were exhausted but were later revised and republished as one volume—Surface Geology of Michigan.⁶² Since Michigan lies within the area of continental glaciation of the Pleistocene ("Great Ice Age") its surface geology is simple in main features but very complex in detail. The surface of the State is covered by "drift" varying from zero to more than a thousand feet in thickness. As the ice front retreated ground moraines and till plains were developed from the debris gathered during the ice advance. Some of this material was sorted by water action, some not, adding to soil complexities. At times a readvance of the ice equalled its retreat, i. e. melting equalled forward movement. At such times and places the debris was piled in tumulated ridges of heterogeneous rocky materials—the "moraines," which, because of the lobate character of the ice-front in the Southern Peninsula form festoons about the Lake Erie and Saginaw Bay depressions. Part of these ridges of hummocky hills, the kames, are water laid or their material water sorted; between the moraines are till plains, back of them the ancient lake beds of Algonquin and Nipissing time when the northeasterly ice-impounded waters extended farther to the south and west than at present. Along glacial and present river valleys are river laid deposits; swamps and lakes of the Ice Age and subsequent time have disappeared leaving palustrine and lacustrine deposits varying from peat and muck to clay. Such facts account for the complexity in detail of the surface geology of the State, the soils are of great variety and of varying productivity, the surface is of varying slope and elevation, hence complicating the problem of drainage. Only incidental study of these surface conditions had been made until 1904 when Professor I. C. Russell began a series of studies of the glacial (surface) formations of the Northern Peninsula⁶³ and Professor C. A. Davis of peat deposits.⁶³ For the Southern Peninsula Dr. Lane in 1907 published a large scale map of the surface (soil) formations with an explanatory text setting forth also an easily comprehended history of the ice advance and retreat in Michigan. In August, 1905, Mr. Frank Leverett of the United States Geological Survey began studies of the glacial geology in Michigan. In 1910 these studies were made possible and available for Michigan through the

courtesy of the Director of the United States Geological Survey in granting the State Geologist's request for Mr. Leverett's services. In the early days, people of the East were dissuaded from settlement in Michigan by reports that most of Michigan was an area of swamps, muskegs and lakes, unfit for habitation of anything but huckleberries and Indians. Most of these falsehoods had been nailed for the Southern Peninsula, but agriculturists were still kept from the Northern Peninsula by the belief (encouraged by the lumberman who wished to preserve his timber) that it is mountainous, barren,—inhospitable to any but the miner and lumberman. But when the forest cover is removed from a region, agriculture develops there. So it is in the Northern Peninsula; the Upper Peninsula Development Company was organized late in 1910 and thus the issue of the Surface Geology of the Northern Peninsula with new maps was most opportune. The Southern Peninsula suffered less from long believed tales of its inhospitability to the farmer but there are areas still undeveloped. To meet the demand for information on this territory and to prevent and offset fraudulent land deals by unscrupulous promoters, the Surface Geology of the Southern Peninsula was prepared (with a new 1:1,000,000 map and a chapter on climate). The edition was exhausted, and, as before stated revised and combined with the earlier Northern Peninsula publication and issued in 1918 as the Surface Geology of Michigan. This last publication is in a sense a stop-gap to meet the present needs of a growing and insistent demand for a complete soil survey of the State. The farmer now applies scientific principles to farm management and crop cultivation. He has become an agriculturist. When buying new land, and for land he already owns, he demands more detailed information as to soil and subsoil conditions, ground water level and control, soil composition, texture, structure, and absorptive properties, the type of fertilizer needed and its source of supply, and types of crops suitable to the land. The State Geologist and the Board of the Geological Survey recognized this demand and in the minutes of the meetings of the Board we find references to a soil survey from 1910. In 1912 we find in the Director's report "The law of 1869 * * * authorizes and directs you to investigate soils and subsoils in their relation to agriculture and to publish and disseminate this information among the people. * * * The State Geologist has had prepared and issued general soil maps of the State * * * these maps still constitute the basis of accurate and reliable information regarding the soils of Michigan * * . A private edition of 65,000 copies of this map of the Northern Peninsula was authorized and issued and the Board of State Auditors have had printed 20,000 of the Southern Peninsula maps for the use of the Commissioner of Immigration. These maps are extensively used by the College of Agriculture and large numbers are being distributed by the State Geologist on requests from all parts of the country. The maps are general in scope and scale and do not permit of detail * * ". The Director then discussed plans of cooperation with the Federal Bureau of Soils and suggested legislation for

a soil survey. Gov. W. N. Ferris devoted a considerable part of his inaugural message to the need of a soil survey and the Legislature of 1915 discussed the plan but the matter was held in abeyance until the 1917 session of the Legislature when Representative M. H. Wiley introduced a bill providing for a soil and economic survey of the State. This bill became a law upon the affixing of the Governor's signature May 11, 1917, to No. 373 Public Acts 1917. Though Michigan has a law authorizing the making of a soil and land survey the exigencies of war time and the number of soil geologists withdrawn from civilian pursuits to the military establishment made it inadvisable to initiate the soil survey at that time.

⁶⁰Pub. 7, Geol. Ser. 6, 1911.

⁶¹Pub. 9, Geol. Ser. 7, 1911.

⁶²Pub. 26, Geol. Ser. 31, 1918.

⁶³Ann. Repts. 1904, 1906.

The demands for Publication 7, 9 and 25 because of the information, although meager, which they contain in regard to agricultural drainage, the paucity of accurate and reliable information on drainage problems in Michigan, the acute problem of drainage in the Saginaw Valley, all show the urgent need of a State survey of drainage conditions. Proper study and solution of the drainage problems are however bound up in and partially dependent on the topographic survey. But the topographic survey has progressed slowly due to insufficient funds and the drainage problems are becoming acute. Men of various pursuits became interested and involved in the problem—members of the Michigan Engineering Society, State Highway Department, United States Department of Agriculture, Bureau of Public Roads, the Association of County Drain Commissioners, the courts,⁶⁴—until it became the practically unanimous opinion of engineers, commissioners, drainage experts, judges, that there should be an early and thorough revision of the Michigan Drain Laws "and that in order to afford the Legislature a basis for the most intelligent consideration of this matter, a thorough investigation of the whole drainage system of the State should be made together with a review of the progress and laws of other States in connection with our present needs." Accordingly in October 1917 the Board of Geological Survey authorized cooperation with the United States Department of Agriculture in a drainage investigation of the State. An agreement was entered into between the Board and the Bureau of Public Roads, Department of Agriculture, in pursuance of which during 1918 every county in the State was visited by an engineer representative of Drainage Investigations, Bureau of Public Roads, conferences were held with each county drain commissioner relative to drainage in his county, drain records were examined and data abstracted and compiled, county officials were interviewed, field trips made and drains investigated. The results of these investigations are embodied in a report⁶⁵ which contains also a history of the development of agricultural drainage in Michigan, a discussion of

types of drainage and certain drainage problems, suggestions for improving the drainage conditions, suggested legislation, and abstracts of working drainage laws of Ohio, Wisconsin, Iowa, Missouri and Georgia, States having drainage problems similar to those of Michigan. The report was prepared for the Legislature and the county-drain commissioners, but although a bill to remedy drainage conditions was introduced the Legislature of 1919 adjourned without passing the much needed law.

⁶⁴City of Saginaw et al. vs. Drain Commissioner.

⁶⁵Pub. 28, G. S. 23, 1919.

The Northern Peninsula, especially west of the meridian of Marquette, presents many problems to intrigue the interest of the mining geologist. The once scorned territory that contains Michigan's famed mineral wealth in iron and copper, also, as a part of the Lake Superior District, holds a key to the pre-Cambrian problem.

Naturally from the earliest survey these facts have caused more emphasis to be placed on geological work in the western half of the Peninsula than in the eastern where economic geology is similar to that in the Southern Peninsula and the purely scientific problems are of the less complex Paleozoic type. The investigations and solution of the geological complexities of this region—often made more difficult of solution by the overlying mantle of glacial drift—the study and mapping of pre-Cambrian rocks with particular reference to the determination of the age and correlation of the various formations and the economic uses, if any, to which these formations or any part may be devoted—have been for a number of years and are still the problems of Mr. Allen and his chief assistant, L. P. Barrett.

The results of these investigations which in some instances disprove and set aside the theories advanced by other geologists are set forth in the Survey Publications 3, 16, 18.

The enabling acts of 1869 and 1871 authorize the Director of the Geological Survey "to make a thorough * * * mineralogical survey of the State" but in 1877 by Act No. 9 the Legislature authorized the appointment of a Commissioner of Mineral Statistics whose duties were "to make an annual report to the Governor, setting forth in detail the mineral statistics for the year with the progress and development of the mining and smelting industries; * * * to make such geological surveys and other surveys as are needed for fully carrying out the purposes of this act; to observe and to record by maps and plans when necessary special facts which may be developed in the progress of mining and exploration * * * to collect typical suites of copper, iron and other ores* *and examine them microscopically, to name and classify them, showing by geological sections their stratigraphical positions, * * * " The act was amended in 1879, 1883, 1895 to make appropriations, provide for publication and to limit the term of the commissioner.

It will be noted that the act provides another department whose work and duties by law duplicate those of the Geological Survey. There may have been reason for such an act during the directorate of Dr. Rominger, who rather scorned assistants and with the eccentricities of genius preferred to work alone, therefore, since he had other duties also as a professor in the University, conducting the Survey for twelve years in a somewhat desultory and very leisurely manner. A lover of pure science and a not-to-be-hurried student, it is conceivable that Dr. Rominger would view with distaste the collection of statistics. But why the law was made and why the commissioner of mineral statistics was not made an officer of the Geological Survey is not known. Despite a few excellent reports from some commissioners the office was a failure. Some commissioners made no reports at all—this may have been due to the defect in the law which ordered the commissioner to pay for printing and distribution of reports, office expenses, etc., from the \$2,500 which he drew as salary from the State. That the commissioners recognized the duplication of efforts is shown by Charles D. Lawton writing in 1891, "The duties of the office * * are purely scientific and identical or nearly so with those which pertain to the office of the State Geologist. But in practice it has been found better to make the reports of the Commissioner statistical and economic, avoiding lithology and introducing only economic geology to the descriptions of the mines and mineral formations." In 1892 the Board of Geological Survey said: "We are unable to see any reason for the existence of a Commissioner of Mineral Statistics independent of the Geological Survey. The work of that office naturally falls under the supervision of the Survey and could be better done by it than by such commissioners." In April 1910 at a meeting of the Board of Scientific Advisers Dr. L. L. Hubbard explained "That it is the unanimous opinion of the mining interest of the Northern Peninsula that the State Geologist should be charged with the duties now devolving upon the Commissioner of Mineral Statistics" and a motion was made and carried "that the State Geologist incorporate in his future annual reports, geological descriptions and sections of the various mines of the State and so far as possible a report of the general situation with regard to the mining industry." Accordingly with the consent and approval of the Board of Geological Survey the State Geologist requested the Governor and Legislature to abolish the office of Commissioner of Mineral Statistics, setting forth his reasons in a letter to Governor Osborn, December 6, 1910. As a result the Legislature of 1911 by Act No. 7 repealed Act No. 9 of 1877 and transferred the duties of the Commissioner of Mineral Statistics to the State Board of Geological Survey, "to continue the collection of statistics, the conducting of investigations, the making of reports and all other duties as specified in said Act No. 9 of the public acts of 1877." Since this act went into effect there have been issued eight annual reports⁶⁶ of the mineral resources of the State.⁶⁶ Each publication contains a review of the copper industry in Michigan, a resume and statistical tables of the miscellaneous metallic and non-metallic minerals, and a

directory of mineral producers. Each report contains also a more or less lengthy treatise on some one or two non-metallic industries. To amplify these reports the Survey has published two reports on economic geology "Occurrence of Oil and Gas in Michigan"⁶⁷ by R. A. Smith and "Brine and Salt Deposits of Michigan"⁶⁸ by Charles W. Cook, the latter publication being a treatise presented by Mr. Cook and accepted for the doctor's degree by the faculty of the University of Michigan.

⁶⁶Pub. 8, G. S. 6, Pub. 13, G. S. 10, Pub. 16, G. S. 12, Pub. 19, G. S. 16, Pub. 21, G. S. 17, Pub. 24, G. S. 20, Pub. 27, G. S. 22, Pub. 29, G. S. 24.

⁶⁷Pub. 14, G. S. 11, 1911.

⁶⁸Pub. 15, G. S. 12, 1913.

A very important development from the work of the Survey in collecting mineral statistics is the cooperative work of the Survey with the Board of State Tax Commissioners. The plan of cooperation is an outgrowth of the "Finlay appraisals" of iron mines in 1911. The fact that these appraisals were too high and former tax valuations altogether too low made evident the wisdom of close supervision over the assessment of such property by a central authority—the Board of State Tax Commissioners—the "Tax Commission." The Board of Tax Commissioners decided on an annual reappraisal of the iron mines, and knowing that the Geological Survey has on its files records and information dealing with the geology and mineral resources of the region in question and that the State Geologist, Mr. Allen, by his scientific interest in and special studies of the region and his highly trained technical knowledge is peculiarly fitted to assist in the geological considerations of the appraisal, the Board of Tax Commissioners requested him to assist in the appraisal of the iron mines of Gogebic, Iron and Dickinson Counties. Mr. Allen was requested to submit to the Commission his ideas in regard to the establishment of permanent cooperative relations with the Survey. Accepting the conclusions and tentative plans of Mr. Allen the Board of Tax Commissioners conveyed to the Governor a resolution pointing out the necessity of cooperation with the Board of Geological Survey. The plan⁶⁹ was approved by the Board of Geological Survey and its Board of Scientific Advisors, and was given legal sanction by the Legislature of 1913 through an appropriation of funds to the Geological Survey for the purpose of assisting the Tax Commission.⁷⁰

The system devised by Mr. Allen and the Tax Commission is the first strictly scientific system of mine appraisal for taxation established and maintained by a Board of Tax Commissioners, and the Geological Survey of Michigan is the first survey to adapt itself to the needs of administration of the tax laws. The system has attracted attention throughout the country; it is pronounced by the National Tax Association the most admirable that may be devised; and it is the system recommended in final consideration by Dr. L. E. Young, Economist of the University of Illinois who has made an intensive study of the whole subject of mine taxation in

the United States.⁷¹ The system has now been in operation nine years and has proven fair and equitable to mine owners and the State and has maintained the assessment of mining property at its full cash value.

Cooperation is also extended to the Public Domain Commission. This commission is required by law to reserve all mineral rights in the sale of State lands, and the determination of mineral rights naturally falls to the Geological Survey. In 1916 the attention of the Commission was brought to the fact that various dredging companies were removing sand and gravel from the lake bottoms and shores of Lakes Michigan, Huron, and St. Clair. Residents along Lake St. Clair claimed considerable damage was being done the beaches by the removal of shore sand and gravel. The State Geologist was consulted concerning these cases of trespass by the sand and gravel dredgers and in cases considering royalty rates on sand and gravel dredged from the waters under the control of the State. Perhaps the most important cooperation with the Public Domain Commission has been with the Biological Division of the Survey and will be considered later.

⁶⁹Rept. Board of State Tax Commissioners 1913-14.

⁷⁰Act No. 341. Pub. Acts 1913.

⁷¹Mine Taxation in the United States, Lewis Emmanuel Young, E.M., Ph.D. University of Illinois Studies in Social Service. Volume V. No. 4. 1916.

Interdepartmental cooperation has been maintained since 1913 with the Michigan Securities Commission in administration of the so-called "Blue Sky Law"⁷² which requires the Securities Commission to consider and prevent or allow the sales of stocks, bonds, and securities in Michigan, so protecting the investor from fraudulent or unsafe speculations. The Commission may require and make "a detailed examination of such investment company's property, business and affairs, which examination shall be at the expense of such investment company. It may cause an appraisal to be made . . . including the value of patents, goodwill, promotion and intangible assets . . ." Under this provision of the law examination and valuation of mining, oil, gas, coal and other mineral development companies is undertaken and directed by the Survey. The cooperation requires investigations of mineral lands in many other States as well as in Michigan—of coal in Pennsylvania, Virginia, Illinois, Ohio, of oil in Texas, Oklahoma, Kansas, Wyoming, of copper in Colorado, and so on.

⁷²Act No. 46, Public Acts of 1915.

It will be remembered that by Act No. 251 of the Public Acts of 1905 a topographical survey of the State was authorized to be made in cooperation with the Federal Survey. The plan of the Federal Survey is to make a topographic map of the entire country under a uniform plan to be used in all the States. The Federal Survey with its large corps of trained topographers and ample experience and equipment is able to maintain a high standard of work at the lowest possible cost. It offers to

meet the State dollar for dollar to the extent of \$25,000 a year in order to secure cooperation and expedition in the work. For ten years the Legislatures saw fit to meet this generous offer with a most inadequate sum, and the making of the topographic map of Michigan lagged while in many other States it was hurried to completion. Michigan has entered an era of rapid development and improvement. Agricultural drainage, good roads, local hydrographic and sanitation problems, problems of State and County boundaries, military operations—in fact all public works demand accurate maps of topographic conditions. The city of Jackson has recently completed an elaborate large scale map with a one-foot contour interval, to be used in city sanitary engineering problems. This map was completed at a cost to the city of about \$80,000. Such maps are needed by all other large or rapidly growing cities of the State, for engineering problems in connection with water supply and sanitation if for no other purpose. Recent Legislatures have in a measure recognized the untold value of the topographic map⁷³ and have appropriated much larger sums for the completion of the topographic map of the State. Only 16 per cent. of the State or a little more than 9,600 square miles is as yet adequately mapped. The mapping of certain parts of the State, the Leonidas, Union City, Battle Creek, Galesburg and Kalamazoo quadrangles was hastened by the War,—by the need for topographic maps for military use in and about Camp Custer. The Battle Creek and Galesburg maps are also published on one sheet as the Camp Custer quadrangle.

⁷³The maps are executed on a scale of 1:620,000 in units or quadrangles 15' of latitude by 15' of longitude, and register with adjacent quadrangles making it easy to combine separate sheets to form a map of a larger area—county, drainage district or system, or natural physiographic province.

A most interesting cooperative work of the topographic branch was in the relocation and marking of the Ohio-Michigan boundary line. The historical cartographical blunders which led to the original boundary disputes and the settlement of the dispute by acceptance of Ohio's claims and the gift to Michigan of statehood and the (then considered almost worthless) Upper Peninsula are well known. During the years that had elapsed since the 1836 and 1842 surveys, many of the original boundary marks—stakes, fences, etc.—had been obliterated, the eastern terminus,—the most northerly cape of Maumee Bay had been washed away for many years, and because increasing land values caused disputes it became advisable to permanently settle the long dispute by accurate relocation and permanent monumenting of the boundary. Accordingly upon the passing of laws by the legislatures of Michigan⁷⁴ and Ohio⁷⁵ authorizing the retracement and appropriating funds (\$3,600 by each State) an agreement was entered into with the Federal Survey for the employment of Mr. S. S. Gannett, Chief Geographer of the United States Geological Survey, "to act as engineer in executing the field work under the direction of the commission"—Mr. R. C. Allen, Director of the Michigan Geological Survey and Prof. C. E. Sherman, Inspector Ohio Topographic Survey. The

surveying party under direction of Mr. Gannett took the field July 12, 1915, and on October 26 following had completed all surveying and placed all the monuments. The monuments are enduring granite posts five and one-half feet in length, one foot square, imbedded in concrete to a depth of four feet. The posts are lettered "Michigan" on the north side, "Ohio" on the south, "State Line" on the east and "Post" on the west. The initial or terminal western post, a block of granite replacing the original "niggerhead" boulder, is twelve inches below the surface of the road in Lat. 40°41'46.2", north, and Long. 84°48'21.1" west. The eastern terminal post, Post 71 is set in swampy land a little more than 900 feet from Maumee Bay, therefore Post 70 is the "Monument Post." The completion of the survey and the setting of the Monument Post was appropriately celebrated November 25, 1915. Thus in a very amicable way was forever settled the disputed points in the boundary line between the two States."

⁷⁴Act No. 84. Public Acts 1915.

⁷⁵House Bill 701, Eighty-first General Assembly of Ohio.

⁷⁶The report of the Commissioners is given in detail in the Biennial Reports of the Director of the Michigan Geological Survey. Pub. 22. G. S. 18m 1916.

The biological division of the Survey which was reestablished by Act No. 250 of the Public Acts of 1905 is supervised by Dr. A. G. Ruthven, Chief Naturalist of the Survey. The Biological Survey is both an inventory and an appraisal of the wild life of the State and should be of recognized economic value to the citizens of the State. However the appropriations for so great a work are ridiculously small but the work accomplished has been great since the men engaged have done the work with personal sacrifices and a cost to the State of practically field expenses only. "At present most of the resources are being devoted to the determination of the animal and plant life of the different sections of the State. The main activity is thus the making of an inventory. Men are engaged each year to go to selected areas and list and obtain samples of fauna and flora." The zoological collections are assigned to the University Museum, the botanical to the Michigan Agricultural College. "In the course of this work they make as extensive studies of habits and abundance as is possible in the time available * * * "Some of the results obtained have been published, with the consent of the Chief Naturalist, in scientific journals and Museum Publications—at no cost to the State—in order to be placed before the public in as short a time as possible. Other reports have been published by the Survey.⁷⁷

The Public Domain Commission has sought the aid of the Chief Naturalist in carrying out its chief purpose—the conservation of the wild life of the State, and has cooperated with the Survey to the extent of financing one field season for Prof. Sponslor's work in a survey of the woodlots and timberlands of Michigan.

Nor did the War find the Survey unprepared. The War Minerals Council of the Committee of National Defense

found in the Survey records without special investigations, an adequate source of information concerning those minerals needed. Mr. R. A. Smith was called upon from time to time to furnish such information. Two members of the staff enlisted in active warfare in France, Captain O. R. Hamilton commanded Company B 28th Engineers which he had recruited, and Captain L. P. Barrett served in the 5th Field Artillery. The Director served in Washington as a member of the Board of Tax Reviewers.

⁷⁷Crawfishes of Michigan, Insect Galls, Birds of Schoolgirls' Glen; Preliminary lists of sites of aboriginal remains: Pub. 1, Biol. Ser. 1, 1909.

Biological Survey of the Sand Dune Region on the South Shore of Saginaw Bay: Pub. 4, Biol. Ser. 2, 1911.

Herpetology of Michigan: Pub. 10, Biol. Ser. 3, 1911.

Miscellaneous Papers on the Zoology of Michigan: Pub. 20. B. S. 4, 1915.

Agaricaceae (Gilled Fungi) of Michigan: Pub. 26. B. S. 5, 1918.

Michigan Fishes, and Michigan Wild Plants in preparation.

Following the Armistice the Survey prepared to return to more intensive work in the economic field. The routine work of the War period gave way to more precise geological investigations and to plans for expansion with the return of that portion of the staff engaged in active War work and military operations. Topographic mapping was renewed, and plans were made for appraisals of the copper as well as the iron mines, and for investigations of various economic and geological problems related to the mineral industries.

As a result of increased need for competent geologists in the post-War reconstruction of the industries of the country Mr. R. C. Allen was made numerous flattering overtures by various mining and mineral interests.

October 1, 1919, Mr. Allen resigned as State Geologist of Michigan to become the general manager and vice-president of the Lake Superior Iron Ore Association—a position offering flattering inducements and at the same time allowing Mr. Allen to remain in touch with his especial scientific problem—the solution of the geologic puzzle of the pre-Cambrian area of the Lake Superior District.

The Board of Geological Survey on October 28, 1919, appointed Mr. Richard A. Smith to the office of State Geologist and Director of the Geological Survey of the State. Mr. Smith has been connected with the Survey since 1909 as Assistant State Geologist and was practically acting director during Mr. Allen's absence in Washington.

In brief review the Third Survey organized by law in 1869 to make a mineralogical and geological survey of the State has been expanded by various acts of the Legislature until now it consists of three main departments: Geological, with the divisions of Geology, Appraisals and Mineral Statistics; Topographical; and Biological. The Survey is housed in offices on the fourth floor of the Capitol National Bank Building. It has investigated and is investigating the geology, physiography,⁷⁸ drainage, topography, economic resources in metals and non-metals, fauna and flora of

the State as well as assisting other departments of the State government particularly in the appraisal of mines for taxation purposes. "The Survey as now organized occupies a unique position among the similar organizations of other States because it has led the way in adapting the results of its scientific investigations as well as the technical ability of its staff to the practical needs of the State not only in the development, use and conservation of our natural resources but also in the direct administration of some of the important laws. The Board and its staff have seized on every opportunity for useful service so far as the facilities and funds have permitted."

It has not been possible in this sketch of the history of the Survey to review the work of all the geologists and their assistants, and it has been necessary to neglect entirely the work of many others who have directly or indirectly furthered the work of the Survey. To enumerate them all would be to recall the names of geologists, mineralogists, biologists, topographers, and others connected with the various educational institutions of this and other States, and with the Federal Survey whose studies have enriched the literature and contributed to the present fund of knowledge of the geology and natural history of Michigan as well as those private individuals whose generosity and interest in scientific pursuits have made many of the studies possible. All have believed in and sought to make the world see the truth of the motto on the State coat of arms—"Si quaeris peninsulam amoenam circumspice."

⁷⁸Scott, I. D., The Inland Lakes of Michigan: Pub. 30, G. S. 25. Michigan Geological Survey.

AFTERWORD

As a result of the legislation of 1921 the powers and duties of the Board of Geological Survey were transferred to the Department of Conservation of the State. The Legislature did not see fit to make appropriations for the vitally necessary topographic survey, the soil and land survey, or the biological survey. The work of these divisions is now at a standstill. The interdepartmental relations and cooperations still remain, and the geological work continues. In the summers of 1920, 1921 parties under the direction of Mr. L. P. Barrett and Dr. W. I. Robinson (who joined the staff after the resignation of Mr. O. R. Hamilton and Mr. O. W. Wheelwright) made exploration of the iron formations of the Northern Peninsula; and Mr. R. C. Hussey was engaged in a study of the Ordovician shale group, Mr. Hussey's investigation being carried on in cooperation with the University of Michigan. During 1919 and 1920 Prof. I. D. Scott completed his Studies of the inland lakes of the State. The results of these studies are embodied in an admirable text and a descriptive report, *The Inland Lakes of Michigan*.⁷⁸ An economic survey of the clays and shales of Michigan has been undertaken by Mr. G. G. Brown of the University of Michigan, under the direction of the State Geologist with the cooperation of the Department of Chemical Engineering of the University. Early in 1922 the long proposed and demanded soil and land economic survey and census of natural resources was inaugurated in cooperation with the State Department of Agriculture, the Michigan Agricultural College and the University of Michigan, with Mr. R. A. Smith, State Geologist, acting as Director of the Michigan Land Economic Survey.

⁷⁸Scott, I. D., *The Inland Lakes of Michigan*: Pub. 30, O. S. 26. Michigan Geological Survey.
