

A Brief History of the Ohio Geological Survey

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A BRIEF HISTORY OF THE OHIO GEOLOGICAL SURVEY^{1, 2}

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Abstract. Since its inception in 1837, the Ohio Geological Survey has been the principal source of geologic information in and about Ohio. These data, gathered during a 141-year period under the direction of ten state geologists, constitute more than 30,000 printed pages and numerous maps describing and illustrating Ohio's geology and mineral resources. This information has, perhaps more than any other factor, been responsible for the development within the state of important industries that rely upon mineral commodities derived from Ohio's bedrock and glacial sediments.

The Ohio Division of Geological Survey is the oldest natural resources agency in the state. During the 19th century the Survey was responsible for investigation of the flora, fauna, soils, and agriculture of Ohio in addition to the primary function of geologic studies. Investigative activities of the Survey were sporadic in the 19th century; major periods of activity were 1837-1838, 1869-1874, and 1882-1893. Since 1900 the Survey has been maintained on a continuous basis, although funding and staff size have remained characteristically modest. In 1949 the Ohio Geological Survey became one of the seven originally chartered divisions of the Ohio Department of Natural Resources.

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The Ohio Geological Survey is the oldest legislatively authorized natural resources agency in the state and has served as the principal source of geologic information pertaining to Ohio since 1837. The Survey has therefore been inextricably linked to the development of geological investigations in Ohio. During its 141-year existence, funding for the Survey has been characteristically modest and, upon occasion, controversy and criticism have plagued Survey progress and activities. In spite of these obstacles, the Ohio Geological Survey has furnished the necessary geologic data base upon which the state's important mineral industries have developed and, at times, has been the focal point for solution of stratigraphic and other geologic problems of regional, national, or worldwide significance. These data constitute more than 30,000 printed pages and numerous separate maps and charts, in addition to

many unpublished reports, maps, and field observations.

There have been four separate surveys or organizations: First organization, 1837-1838, William W. Mather, State Geologist; Second organization, 1869-1888, John S. Newberry (1869-1882), and Edward Orton, Sr. (1882-1888), State Geologists; Third organization, 1888-1900, Edward Orton, Sr., State Geologist; Fourth organization, 1900-present, Edward Orton, Jr. (1900-1906), John A. Bownocker (1906-1928), Wilbur E. Stout (1928-1946), George W. White (1946-1947), John H. Melvin (1947-1957), Ralph J. Bernhagen (1957-1968), and Horace R. Collins (1968-present), State Geologists (figure 1). Many individuals have served the Ohio Geological Survey with distinction as full-time staff members or as unsalaried authors of important research studies. Indeed, a cursory perusal of authors of the many Survey reports yields a long list of prominent geologists.

The present paper is by no means an exhaustive analysis of the history of the Ohio Geological Survey. Our treatment deals with administrative and organiza-

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tional aspects of Survey history primarily during the 19th century and early 20th century. Sturgeon (1979) traces development of mineral industries and stratigraphic classification in the Upper Paleozoic of Ohio in relation to the Survey. We have been forced to brevity both by limitations of space and limitations of time available for compilation. In addition, unpublished reference materials such as letters, manuscripts, photographs, and other data are widely scattered and, apparently, rather incomplete, necessitating a time-consuming and tedious search before a comprehensive treatise of the history of the Ohio Geological Survey can be compiled.

Almost nothing survives in the files of the Survey from administrations prior to that of Wilbur Stout (1929-1946). These missing documents, *in toto*, probably do not survive in any repository; they most likely were disposed of because they were not old enough to be of historical significance but were too old to be of contemporary value. Such pertinent historical materials that we have located in this continuing investigation include: S. P. Hildreth Collection and E. B. Andrews Papers, Marietta College Library, Marietta, Ohio; Whittlesey Papers, Western Reserve Historical Society, Cleveland, Ohio; Klippart Papers and Lapham Papers, The Ohio Historical Society, Columbus, Ohio; James Hall Papers, New York State Library, Albany, New York. Notably conspicuous by their absence from this list are the Mather, Newberry, and Orton, Sr., papers. Should these collections be located, if extant, they would prove of much importance to the history of Ohio geology and particularly the history of the Ohio Geological Survey.

A rather large assemblage of publications relates directly to the history of the Survey. An exhaustive list can be derived from the Bibliography of Ohio Geology (Watkins 1953, Smyth 1963, 1969, 1972). Much important information is contained in the prefacing remarks of Annual Reports (Mather 1838a, 1838b; Orton 1890), Reports of Progress (Newberry 1871a, 1871b), and Volumes (Newberry 1873a, 1874, 1875, 1878, 1882; Orton, 1884, 1888, 1893; Orton, Jr., 1906a). Papers by Aumann (1953),

Melvin (1950, 1952), Merrill (1906, 1920, 1924), Orton (1894), Stoddard (1928), G. W. White (1976), and Whittlesey (1885) are of direct importance to Survey history. Merrill's (1920, pp. 387-427) work is the most complete summary of the Ohio Geological Survey through 1900. Biographies of individuals associated with the Survey frequently furnish pertinent information. Of particular interest are those of Mather (Hitchcock 1897, Newvahnner 1931), Whittlesey (A. Winchell 1889), Hildreth (Waller 1944), Locke (N. H. Winchell 1894; Waller, 1946), Newberry (Stevenson 1893, Kemp 1893, Waller 1943), Orton, Sr. (Stevenson 1900; I. C. White 1900, Swinnerton 1939), Orton, Jr. (Magruder *et al* 1932), Bownocker (Stauffer 1929), and Stout (Bernhagen 1961).

MATHER SURVEY (1837-1838)

Geological investigations in Ohio prior to the establishment of a geological survey in 1837 were of a sometimes cursory and generally localized nature, carried out by individuals on a purely part-time basis at their own expense. Predictably, the overall geological framework of Ohio was poorly understood, and private exploration of and investment in mineral resources was frequently shadowed by trickery, deceit, and certainly speculation brought about by this ignorance (Mather 1838b, p. 6; Merrill 1920, p. 387-388).

The beginning of the industrial revolution and the demands of an increasing population in Ohio for mineral commodities, in particular salt, coal, iron ore, and clay, prompted Governor Robert Lucas to recommend the establishment of a geological survey of the state in his annual message to the legislature in 1835 (Stoddard 1928, p. 108). Undoubtedly Governor Lucas' motivation was, in part, due to his desire to keep Ohio competitive with the surrounding states, many of which had established or were in the process of establishing geological surveys. It is obvious also from correspondence of Increase A. Lapham (Lapham Papers, Ohio Historical Society) that many Ohio scientists were strongly in favor of a geological survey and conveyed their sentiments to political figures, including the governor. The legislature, acting

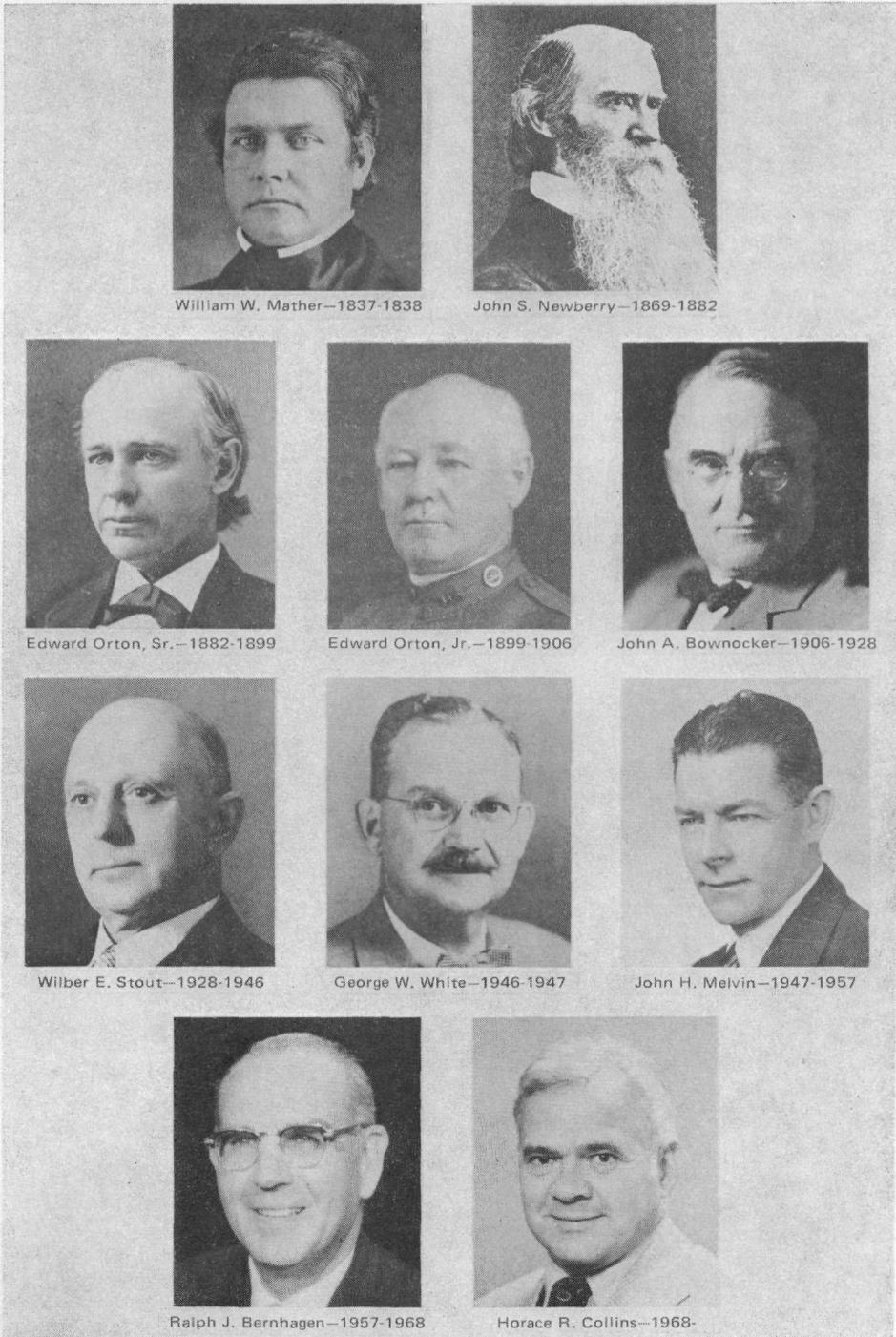


FIGURE 1. State Geologists of Ohio.

upon Governor Lucas' suggestion, passed a resolution on March 14, 1836, establishing a committee "to report to the next legislature the best methods of obtaining a complete geological survey of the state, and an estimate of the probable cost of the same" (Hildreth 1836, p. 65).

The committee appointed by the legislature consisted of John L. Riddell, John Locke, Increase A. Lapham, and Samuel P. Hildreth, chairman. Hildreth's report (1836) to the legislature represented a summary of the geological information then known about Ohio. The reports of Riddell and Lapham (1837) were not included with Hildreth's report but were presented to the legislature somewhat later. These individuals conducted field work during the summer of 1836 so that a more precise direction could be given to the Survey. Hildreth's committee (1836) recommended that the geological survey consist of a principal geologist and five assistant geologists, one draftsman, and one naturalist, to be funded for salaries and travel expenses at a sum of \$12,000 per year for four years.

The Geological Survey of Ohio was authorized by legislative action on March 27, 1837, and was organized along lines similar to those suggested by Hildreth's committee. William Williams Mather was appointed Principal Geologist with Samuel P. Hildreth, John Locke, Caleb Briggs, Jr., Jared P. Kirtland, and Charles Whittlesey as assistants. J. W. Foster was added to the corps to replace Locke, who was in Europe during 1837, and after Hildreth's resignation was made a permanent member (Stoddard 1928, p. 116). Kirtland was to report on the topography and serve as draftsman. The other assistant geologists were to report on the geology of various parts of the state and other topics to which they were assigned.

Hildreth was by reputation and deed the most experienced geological observer in Ohio; however, he either did not secure or did not accept the appointment as principal geologist. Merrill (1920, p. 394) indicated that Governor Vance offered the Principal Geologist position to Hildreth, then to Kirtland. Both reportedly declined the position and recommended Mather's appointment. In a

letter to I. A. Lapham (Jan. 11, 1836, Lapham Papers) Hildreth responded: "In answer to whom amongst our geologists would be most competent, I answer without hesitation Mr. E. [Edward] Hitchcock of Massachusetts." Mather, who was with the Natural History Survey of New York at the time of the appointment, was 33 years of age and had little firsthand experience and familiarity with the geology of Ohio. Perhaps Hildreth's (1836, p. 77) comment in the committee report to the legislature, strongly recommending establishment of a survey in Ohio, gives some insight on Mather's appointment: "That great and public spirited state, New York, ever amongst the foremost in the march of improvement, has taken up the subject with a zeal and an outlay, commensurate with so noble an object." It might be surmised, in the absence of other information, that political figures in Ohio considered it a coup to lure one of New York's own geologists away to become principal geologist of Ohio. Orton (1894, p. 504) gave credence to this idea, indicating that Mather's work with the New York Survey gave him considerable prestige in Ohio.

Hildreth resigned his appointment as first assistant geologist after the 1837 field season, owing, according to Mather (1838a, p. 20), to inferior health. Waller (1944, p. 336) cast considerable doubt on the inferiority of Hildreth's health as he related numerous activities and travels undertaken by Hildreth during this period. Hildreth (Waller 1944, p. 336) indicated that he resigned from the Survey to donate more time to his medical practice and the financial support of his family.

The Mather Survey conducted field work for the seasons of 1837 and 1838 and published results of these endeavors in two annual reports both bearing the publication date of 1838. Legislative appropriations for the Survey were discontinued (except for \$300 to catalog the mineral specimens) after publication of the 2nd Annual Report despite repeated attempts at passage of legislation to renew the appropriation of the Survey (Stoddard 1928, p. 121-125). Hildreth noted (Waller 1944, p. 336) that the

paucity of funds in the state treasury, caused by over-expenditures on the state canal system and other works, was the primary reason for discontinuing the survey. Orton (1894, p. 507) intimated that the demise of the Mather Survey may have been additionally precipitated by a certain air of disillusionment among legislators with the results obtained, because of the great expectations of wealth and fortune fostered during the necessary but perhaps overdone initial promoting of the potential wealth to be generated by the Survey. Stoddard (1928, p. 128-129) listed the financial panic of 1837, local jealousies brought about by the impression that only the coal-bearing portion of the state would benefit from a geological survey, party politics, and accusations by certain legislators that members of the geological corps had used information derived from Survey activities to speculate on land and mineral-resource purchases. This latter charge was denied by Mather (Merrill 1920, p. 395). Perhaps all of these factors were involved in the demise of the Mather Survey. Repeated attempts to restore the Survey appropriation to the state budget met with no success (Stoddard 1928, p. 121-125). A total of \$16,700 was expended for the first Survey (Merrill 1920, p. 423).

ACCOMPLISHMENTS OF THE MATHER SURVEY

The 1st Annual Report (Mather 1838a) is, in its entirety, little more than a brief but surprisingly accurate reconnaissance sketch of Ohio's geology; it contains numerous astute insights from several of the assistants. This report is brief because field work did not commence until late June 1837, after a portion of the field season had passed.

Among the noteworthy comments in the 1st Annual Report are those of Mather concerning the problems of erosion of the Lake Erie shore—a problem that is still a great concern and area of investigation for the Survey. Hildreth's report furnished a detailed summary of the salt industry in Ohio. The reports of Kirtland, Briggs, Whittlesey, and Foster are brief summaries of the mineral resources and stratigraphy or other responsibilities in their respective districts.

The 2nd Annual Report (Mather

1838b) contains considerable information gathered primarily during the field season of 1838. The future importance of mineral industries founded upon the state's abundant supplies of coal, limestone, clay, sandstone, and iron ore was foreseen. Mather predicted that coal would become the most important mineral industry of the state. Kirtland's report on the Recent Fauna of Ohio is a highly significant record of distribution of many animals extirpated from Ohio since pioneer days.

The report by John Locke on the southwestern district is the most extensive and is replete with abundant original observations, geological and otherwise. Locke was interested in elevations and dip of strata and was the first to recognize the existence of the Cincinnati Arch. Locke's report contains numerous diagrams depicting the stratigraphy of southwestern Ohio, a map of Fort Ancient, and perhaps most significantly a colored geologic map of Adams County. Although this map, which included a cross section, is primitive by today's standards, it was a notable accomplishment for its day. It must be borne in mind that no base maps depicting topography were available.

Whittlesey (1838) published a planimetric map of the state that has been referred to by Smith (1977, p. 173) as the most accurate map of Ohio compiled in the 19th century. The detailed topographic map of the state suggested by Mather (1838a, p. 21) was not finished before cessation of the Survey.

Perhaps the most significant accomplishment of the first Geological Survey of Ohio was the delineation of the general stratigraphic sequence in the state and the basic geological structure. From these data more accurate assessment of the state's mineral resources was possible, and prevailing notions, such as the occurrence of coal in western Ohio, could be dispelled on the basis of firm information. Merrill (1920, p. 400) noted that the value of taxable lands in the eight counties most intensively examined by the Survey increased in value from \$5.5 million in 1835 to \$11.3 million in 1841. Ostensibly this increase was due in part to the revelation of the mineral wealth by the Survey.

The accomplishments of the Mather

Survey must be regarded highly on their own merits; however, when the several factors below are kept in mind, these accomplishments assume greater significance:

- 1) the geology of Ohio was essentially unknown;
- 2) the Survey only lasted for a year and a half;
- 3) no adequate base maps were in existence and few known elevations were tabulated;
- 4) travel was difficult, roads were poor, and members of the Survey were regarded suspiciously by many residents (see Locke 1838, p. 201-274, for anecdotes in this regard).

NEWBERRY SURVEY (1869-1882)

After termination of the first Survey as a viable organization in 1838, numerous attempts were made to reactivate the Geological Survey (Newberry 1871a, p. 6), including an unpublished plea by Mather in 1853 before the State Board of Agriculture (Hitchcock 1897, p. 14). Merrill (1920, p. 398-400) presents a detailed summary of these efforts. These attempts failed, however, and 31 years passed before a geological survey again became a reality in Ohio.

At the encouragement of Governor Rutherford B. Hayes and others, Captain Alfred Lee of Delaware County introduced into the legislature in 1879 a bill calling for the establishment of a Geological Survey of Ohio (Newberry 1871a, p. 7). This bill was passed in March 1869.

Nearly every prominent geologist in Ohio was consulted in the preparation of this bill; however, it is apparent that the General Assembly began with a naive opinion as to the cost, time, and results of a geological survey (Merrill 1920, p. 403). The bill called for appointment of a principal geologist and three assistants, one of whom was to be responsible for an agricultural survey of the state. The survey was to be completed in three years, with reports furnished on economic geology, general geology, botany, archeology, zoology, and agriculture. Appropriations were to be \$13,900 per year for three years.

John Strong Newberry, Charles Whit-

tlesey, Edward Orton, and E. B. Andrews were the principal candidates for the chief position, and many thought that Whittlesey was the likely choice. Indeed, Whittlesey had many supporters in the legislature. He met with Governor Hayes soon before the selection was to be made and was led to believe he would become the second state geologist of Ohio. However, the next day Newberry's appointment was announced (Ohio General Assembly 1870). Political "deals" were part of this selection process and some details on this subject were made known in February 1870 in the report (Ohio General Assembly 1870) of hearings by the House Retrenchment Committee on investigation of Survey activities. The principal details of this report are summarized below.

Whittlesey was informed by one of his legislative supporters that Newberry received the appointment primarily because his (Newberry's) principal supporters, particularly Lieutenant Governor Lee and John Klippart, Secretary of the State Board of Agriculture, were close to the governor. Whittlesey also stated that Newberry gained Klippart's support by promising to recommend him for the position of agricultural assistant. Whittlesey had been reluctant to make such a deal. However, Newberry's letter of acceptance (April 30, 1869, R. B. Hayes Papers, Hayes Memorial Library, Fremont, Ohio), in which he made recommendations for assistants to Governor Hayes, does not support this allegation. Newberry wrote "In regard to the Agricultural Assistant, you are fully competent to decide without my help. His duties are not strictly geological and the Agriculturists should have a voice in his appointment.

"I suggested a name to you in our conversation, but from your judgment the interests of the state would suffer by such an appointment. I hope you will follow your convictions, not mine.

"The gentleman whose name you mentioned in this connection would honor any survey, and would be entirely acceptable—I shall accept your decision and take my share of the responsibility." We are uncertain of the identity of the respective candidates supported by the

Governor and by Newberry; however, the above quote certainly does not suggest any strong lobbying by Newberry in Klippart's behalf.

It is of interest to note that Newberry wrote Whittlesey a letter dated April 6, 1869 (Ohio General Assembly 1870, p. 18), after unsuccessfully trying to contact Whittlesey personally, offering to make a deal. The terms were that if Newberry were to receive the appointment of principal geologist Whittlesey would be first assistant. If Whittlesey were to receive the appointment then Newberry requested he be appointed in charge of paleontology. Whittlesey's response, if any, is unknown.

Newberry and his selected assistants, Edward Orton, E. B. Andrews, and John Klippart, were confirmed by the Senate and field work began on June 1, 1869. Eleven local assistants also were chosen.

Whittlesey was obviously distressed over his failure to receive the appointment of chief geologist and apparently spent most of the time Newberry and his assistants were in the field in 1869 building a case against Newberry's appointment. The principal charge against Newberry was the retention of his professorship at Columbia College (New York) at \$3,000 per year while serving as principal geologist of Ohio at \$3,000 per year. Newberry, however, had informed Governor Hayes and members of the legislature of this arrangement before his confirmation. The majority party of the committee strongly deplored Newberry's appointment while retaining the position at Columbia and stated that this circumstance was "a humiliation to the state of Ohio".

The evidence presented at the hearings conducted by the House Committee on Retrenchment consisted of several letters and oral testimony intended to be damaging to Newberry. Such topics as Newberry's legal residence (Cleveland or New York) and place of voting were discussed. Newberry's dual appointments were portrayed in the light of fraud against the state, and aspersions were cast on the political nature of Newberry's appointment. Among those giving testimony, in addition to Whittlesey, were E. B.

Andrews and Leo Lesquereux. Andrews' testimony is remarkably lacking in vociferous defense of one side or the other (no doubt he wished to be a survivor no matter what the outcome). Newberry remarked to Klippart in a confidential letter (November 26, 1869, Klippart Papers) that Andrews "has evidently damned by faint praise."

The minority party on the committee came to the defense of Newberry and the attempt at removal was thwarted, although Whittlesey continued his attacks in letters to newspapers. Newberry finally responded to Whittlesey's accusations in a lengthy letter to the *Cincinnati Commercial* (March 28, 1870). All of Whittlesey's charges were reduced to the trivial and often false nature that they were. Newberry went on to examine Whittlesey's motives for these attacks (his loss of the principal geologist position) and took the opportunity to severely criticize Whittlesey's abilities as a geologist. These accusative exchanges between Whittlesey and Newberry and their respective supporters soon faded from the public forum, but the controversial beginnings of the Newberry Survey apparently generated significant polarization among influential political figures in the state. Throughout Newberry's tenure as State Geologist of Ohio petty criticism and political bickering were constant.

Newberry's plan for the Survey was to publish four volumes; the first two were to consist of two parts, geology and paleontology, the third volume was to report on economic geology, and the fourth to consider agriculture, botany, and zoology. From the beginning the investigations and publications of the Newberry Survey were criticized for the length of time necessary to complete work, the expense, and, most importantly, the "impractical" nature of the stratigraphic and paleontologic work. In his annual reports to the legislature for 1869 and 1870 Newberry steadfastly defended the need for such basic work before a comprehensive analysis of the economic geology could be completed. Illustrative of Newberry's replies to the criticism befalling him was this statement (p. 8) in the Report of Progress for 1870:

"There are, however, yet some intelligent men, even editors and members of legislature, who cherish the notion that there is nothing which has any value in this world but that thing which has a dollar in it, and that so plainly visible as to be seen by them. Such men, to quote the language of one of them, 'don't care a row of pins for your clams and salamanders, but want something practical.'" Rather unprophetically, and perhaps wishfully, Newberry further states "Happily the class to which they belong is rapidly passing away."

The expense of publication of the paleontology reports was great, about \$69,000 per volume, but Newberry cannot fairly be blamed for this circumstance. Newberry (1873b, p. 13) recommended printing only 5,000 copies each of these volumes; however, the legislature insisted upon printing 20,000 copies each, which were distributed *pro rata* among the legislators (Orton 1893, p. xv).

The Newberry Survey continued as a viable organization until June 1, 1874, although salaries were paid only until February 15, 1874 (Newberry 1874, p. xiv). The total expenditure of the Survey from June 1, 1869, to June 1, 1874, was about \$256,000, of which \$87,000 was for expenses and \$169,000 was for publication costs (Newberry 1874, p. xiv). It has been stated (Orton 1894, p. 511) that the financial condition of the country and the state at the close of 1873 was the principal reason for discontinuing the Survey, but certainly the constant criticism and petty bickering must have been influential factors in ending the Survey.

There was no formal organization of the Survey after 1874 and indeed no funding except small amounts to cover some field expenses and printing costs for volumes previously prepared (see Merrill 1920, p. 923-926 for summary of these expenditures). Only Newberry and Edward Orton remained as *de facto* members of the geological corps. Newberry, without compensation from the state, assembled Volume III, *Geology*, published in 1878, and Volume IV, *Zoology*, published in 1882. Newberry stated (1882) that these volumes were finished at a cost of several hundred dollars of his own money. With publication of Volume IV

Newberry's tenure as State Geologist of Ohio ended. Work begun under Newberry's direction was continued by Edward Orton, and through the efforts of Orton the manuscripts on paleontology prepared originally for a proposed second part of Volume III were finally published in Volume VII (Orton, 1893).

ACCOMPLISHMENTS OF THE NEWBERRY SURVEY

The geological work done in Ohio under Newberry's direction was the foundation for most later geologic studies, including studies of mineral resources, stratigraphy, and paleontology. Although Newberry's organization was intensely criticized, the work must be considered representative of one of the most significant eras of Ohio geology.

The principal accomplishments of the Newberry Survey were:

- 1) development of a stratigraphic classification for Ohio from which our modern classification has developed;
- 2) establishment of the age and correlations of many stratigraphic units;
- 3) first statewide analysis of Ohio geology on a county basis;
- 4) first official geologic map of the state;
- 5) first comprehensive analysis of Ohio fossils; these studies formed, in part, the basis for development of the stratigraphic classification;
- 6) first systematic investigations of the glacial geology of the state;
- 7) presentation of important aspects of economic geology, particularly coal.

THE ORTON (EDWARD ORTON AND EDWARD ORTON, JR.) SURVEY (1882-1906)

In 1882, with publication of Volume IV and the end of Newberry's tenure, his chief assistant, Edward Orton, became State Geologist. Orton received an appropriation of \$5,000 to complete the long-awaited volume on economic geology on which he and others had been laboring for so many years. The volume (Volume V) appeared in 1884 and presented, in more than 1,000 pages, detailed descriptions of the coal-bearing strata of Ohio and summaries of the iron, clay, and coke industries in the state. Also included were discourses on the building stones of Ohio and the glacial boundary.

Volume V was apparently received

with enthusiasm, and perhaps praise, by the citizens of Ohio, for Orton continued as State Geologist. This work was on only a part-time basis, as Orton retained his position as professor of geology and president of Ohio State University.

Orton, however, was unable to include in Volume V the complete information on the coal resources of Ohio, and essentially nothing was included on petroleum and natural gas because of lack of space. The legislature was highly desirous of the report on petroleum and natural gas and therefore appropriated \$4,500 to complete this work, which by legislative action on May 1, 1885, was to be in the hands of the printer by October 1, 1885. The frenzied activity in the oil and gas fields of Ohio, particularly the Findlay field, compelled Orton to go before the legislature in January 1886 to request an extension on this work so that the abundant new data could be included. The legislature extended Orton's deadline for the manuscript on oil and gas to February 1, 1887 (Orton 1888, p. vi). In the interim between January 1886 and February 1887, Orton prepared and had printed a slim preliminary report on oil and gas (Orton 1886).

Volume VI appeared in 1888 and consisted of more than 800 pages, of which nearly 600 pages dealt with petroleum and natural gas. Also included in this volume were chapters on the Pittsburgh coal and the Pomeroy and Federal Creek coal fields, manufacture of salt and bromine, gypsum, lime, and natural and artificial cements, and the glacial drift deposits of the state. The report on petroleum and natural gas by Orton is perhaps his finest achievement. This work represents a summation of the knowledge then extant on the origin, accumulation, and production of these fuels and is widely quoted even today.

Apparently the long-awaited volumes on economic geology met with favor by the legislature, and a need and benefit were seen in maintaining the Geological Survey on a continuous basis. On April 12, 1889, the legislature established the third organization of the Geological Survey, with Edward Orton remaining as State Geologist. In this legislation was a provision to make the appointment of

the state geologist for a term of three years (Orton Jr., 1906b, p. v).

In 1890 the First Annual Report of the Third Organization was published by Orton. The primary emphasis in this report dealt with the new information on oil and gas with comments on stratigraphic revisions. Orton presented his prophetic views on the appalling waste of natural gas in the state and pleaded for curtailment of these practices.

In 1893 Volume 7 appeared and was divided into two parts: part I, economic geology, contained new and additional information on the stratigraphy, clays, and coals of Ohio; part II treated botany, archaeology, and paleontology. In essence, part II was a completion of the work promised but never completed by the Newberry Survey. Chapters by R. P. Whitfield and E. O. Ulrich on paleontology were prepared for volume III, part II, but never published by the Survey. Additional paleontological work was deemed necessary by Orton, and reports by C. L. Herrick, A. F. Foerste, and E. W. Claypole and A. A. Wright appeared. Gerard Fowke treated the archeology of Ohio and W. A. Kellerman and W. C. Werner prepared the botanical report. The botanical report was originally scheduled for Volume IV (1882), prepared by H. C. Beardsley, but the manuscript had been lost (Orton 1893, p. vii).

The publication of Volume 7 marked the end of active Geological Survey work under Orton and the end of an era in Ohio geology. Orton continued to hold the position of State Geologist in an honorary capacity, as no appropriations were made and no active investigations were carried out (Orton, Jr. 1906a, p. 5). Orton died in October 1899, having been incapacitated by a series of strokes, thus ending 30 years of service to the Ohio Geological Survey. In December 1899, Edward Orton, Jr. was appointed State Geologist to fill the unexpired term of his father and was reappointed in 1901 and 1904 (Orton, Jr. 1906a, p. 5).

In 1900 the Survey was reorganized and became known as the Fourth Organization, which continues to the present. This reorganization was not a formal legislative one but was a change in

procedural matters enacted under the direction of Edward Orton, Jr. Prior to the Fourth Organization, the Survey had no office space or equipment; the business of the Survey was carried out in the home or office of Edward Orton, Sr. A permanent office at Ohio State University, stocked with necessary equipment, gave the Survey its first permanent headquarters (Orton, Jr. 1906b, p. xxii).

Edward Orton, Jr. appointed Charles Prosser and John A. Bownocker as assistant geologists. Numerous other individuals, both students and professors, served with the Survey on a part-time basis. Although important stratigraphic revisions appeared, the focus of the Survey was on economic geology, reflecting the interests of Edward Orton, Jr., who is considered the founder of ceramic engineering. Reports were now issued individually, as bulletins, and bound into volumes only when sufficient materials had been published.

BOWNOCKER SURVEY (1906-1928)

Edward Orton, Jr. resigned his position as State Geologist in 1906 and John A. Bownocker was appointed to take his place. During Bownocker's tenure (1906-1928), 25 bulletins appeared dealing with diverse topics including mineral resources such as coal, oil and gas, peat, clay, building stones, and ground water; stratigraphy of the Devonian, Mississippian, Pennsylvanian, and Permian Systems in Ohio; paleontology; and important reports on regional geology, including the first detailed county reports. In addition, the present geologic map of Ohio was compiled by Bownocker.

Bownocker was, during this time, professor of geology and chairman of the geology department at Ohio State University. Numerous students, former students, and professors at Ohio State were involved to varying degrees in the work of the Survey, and geologists at other institutions in Ohio contributed reports. During much of Bownocker's tenure Wilber Stout and Raymond E. Lamborn were actively employed by the Survey.

The tenure of John A. Bownocker as State Geologist marks an important time in the history of the Survey, as geological

investigations on many diverse subjects were published and the Survey was maintained continuously, in contrast to the sporadic investigations during the previous century.

THE STOUT SURVEY (1928-1946)

With the death of J. A. Bownocker in 1928 Wilber Stout was appointed State Geologist, becoming the first full-time State Geologist. Unfortunately Stout's appointment coincided with the Great Depression that was to affect activities for more than a decade.

Soon after Stout took over as State Geologist the panic of the burgeoning depression reached the legislature, and budgets were cut wherever possible. Among those appropriations to be entirely eliminated for 1932 was that of the Survey. Many people were alarmed by this action, including Edward Orton, Jr., now near the end of his life. Orton, Jr., whose political influence was great, wrote Governor George White imploring him to maintain the Survey even if it meant that only Stout was retained (letter, July 21, 1931, OSU archives). In addition, the railroads serving Ohio lobbied strongly in the Survey's favor (personal communication from Wilber Stout to M. T. Sturgeon). These pleas were successful in restoring most of the Survey appropriation to the budget. Stout (letter, October 15, 1931, OSU archives) thanked Orton, Jr. for his efforts and indicated that the State Board of Control provided \$11,155 of the \$15,500 appropriated by the legislature to continue the Survey for 1932. Appropriations for the Survey were, however, at a subsistence level throughout the 1930's and into the early 1940's. During this period the Survey staff consisted of Stout and Raymond E. Lamborn with Ethel S. Dean as secretary.

During Stout's tenure as State Geologist bulletins appeared on clay, shale, dolomite and limestone, brine, ground water, iron, flint, coal, and marl. Nearly all of these reports were authored by Stout or Lamborn. Had financial conditions in the state been more favorable, the Survey under Stout's direction would have undoubtedly published considerably more reports.

THE MODERN ERA (1946-PRESENT)

Upon the retirement of Wilber Stout in 1946 George W. White was appointed State Geologist. White remained in office only a year and a half before accepting the position of chairman of the Department of Geology at the University of Illinois. The Survey remained small during White's brief tenure, however, he made a significant and partly successful plea before the legislature to increase appropriations for the Survey (*The Columbus Citizen*, June 15, 1947).

John H. Melvin was appointed State Geologist in 1947 upon the resignation of White and was successful in increasing Survey appropriations more than two-fold in the late 1940's. The report of the Ohio Program Commission (1951, p. 50) summarized the Survey's financial situation by concluding that ". . . the Division of Geological Survey has been one of the most grossly under-supported agencies of the state for many years."

A new system of presentation of publications was introduced under Melvin that included Reports of Investigations and Information Circulars in addition to Bulletins. This new format allowed brief versions of technical reports and more popular topics to be made available quickly.

In 1949 the Survey became one of the seven originally chartered divisions in the newly organized Department of Natural Resources. The Survey offices remained in Orton Hall at Ohio State University, where they had been since 1904. Mineral resources and regional geology continued to be the primary emphasis of the Survey.

In 1957 Ralph J. Bernhagen was appointed State Geologist. Investigations on mineral resources and regional geology continued and the technical staff remained at a level between 15 and 20, as it had since 1948. In 1962 the Survey moved from its cramped quarters in the basement of Orton Hall at Ohio State University to offices at 1207 Grandview Avenue, Columbus.

In 1968 Horace R. Collins was appointed State Geologist, the tenth individual to hold the position in the 141-year history of the Survey. In 1973 the Survey moved to its present location at Fountain Square in north Columbus.

This move brought all divisions of the Department of Natural Resources to a single location.

The need for continuing study of Ohio's geology and mineral resources was perhaps best stated by Edward Orton, Sr. (1893, p. xi):

"As to what remains to be done in Ohio geology, it is difficult to speak. The science of geology is constantly lengthening its cords and strengthening its stakes. Every line of investigation opens up larger questions than those which it directly undertakes to settle. New methods of research are coming into use, and old problems must be reconsidered by their aid. It is only the generalities of our geology that have been thus far attacked. Deeper and more thorough work will be demanded in every subdivision of every field."

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