

# THE FIRST APPEARANCE IN OHIO OF THE THEORY OF CONTINENTAL GLACIATION<sup>1</sup>

GEORGE W. WHITE

*Department of Geology, University of Illinois, Urbana 61801*

## ABSTRACT

Louis Agassiz published his "glacial theory" in *Etudes sur les glaciers* in October, 1840. Edward Hitchcock wrote approvingly of the theory in 1841 and reproduced some of the Agassiz plates. Professor Samuel St. John of Western Reserve College reproduced one of the Hitchcock glacier plates and wrote favorably of the theory and described glacial drift in general in the first geology textbook published in Ohio, in 1851 at Hudson. St. John's influence was particularly important in the career of his student, John Strong Newberry, the famous geologist. Newberry's interest in glacial deposits, and especially in the origin of kames, may be traced to St. John, his geology teacher.

The first statement in Ohio of the hypothesis that "drift" had been deposited by an ice sheet was presented by Samuel St. John in what is probably the first Ohio textbook on geology. It was published at Hudson, Ohio, in 1851 (fig. 1). This book and St. John's classroom discussions contributed to the early interest in glacial phenomena so well exhibited in Ohio and soon to be so extensively described in publications by J. S. Newberry and other geologists of the Second Geological Survey of Ohio. This early Ohio explanation of the glacial theory was not derived from Louis Agassiz directly, but through the works of Edward Hitchcock of Amherst College.

St. John's pleasant and important book appears to have been the first Ohio textbook dealing exclusively with geology. Hamilton L. Smith, A. M., wrote on geology in 1848, but his book, published in Cleveland and illustrated by J. Brainerd, was on both astronomy and geology. And, although Smith's book shows reasonable acquaintance with the English writers on geology, especially Lyell, it pays little attention to American geology and geologists and says nothing about glaciers. Wm. W. Mather, first state geologist of Ohio, published a little textbook of geology in 1833, but it was not published in Ohio and Mather had not come to Ohio at that time.

Glaciers had been described in more or less detail and their relation to certain deposits noted long before 1840, but it was the exposition of the theory of continental glaciation in the book and atlas of Louis Agassiz in 1840, *Etudes sur les glaciers*, that immediately caught the attention, both favorable and unfavorable, of geologists and other scientists. The development of this theory and the events leading up to the 1840 publication have been recently reported by Carozzi (1967). The impact of the theory in Great Britain has been described by North (1943). The development of the glacial hypothesis in America has been treated at length by Merrill (1924, 1964, p. 615-642), but he did not include treatment of the critical year 1841 and the reproduction of any of the Agassiz plates in America. It was the copying of these plates by Hitchcock that was so important in the evolution of the Ohio text.

On December 1, 1839, Edward Hitchcock, who had been appointed state geologist of Massachusetts in 1830, presented to the governor of that state the "Final Report" of the geological survey (Hitchcock, 1841a, p. iv, vii). The printing of the work progressed slowly and the report did not appear until after April 1, 1841. Hitchcock took advantage of the delay to ". . . discover many facts since it was first presented to the Government. These I have not hesitated

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to incorporate into the work . . ." These "many facts" were presented in a "Postscript," which preceded the regular text. The "Postscript" is devoted mainly to "Glacio-aqueous Action between the Tertiary and Historic Period, denominated in my Report, Diluvial Action" (pp. 3a-11a).

The progress of American recognition of glacial deposits and their origin is well illustrated by the publications of Edward Hitchcock. As he had a keen eye for physiographic forms and was always cognizant of relation of surface form

**ELEMENTS**  
OF  
**GEOLOGY,**  
INTENDED FOR THE USE OF STUDENTS.

BY  
**SAMUEL ST. JOHN,**  
PROFESSOR OF CHEMISTRY AND GEOLOGY IN  
WESTERN RESERVE COLLEGE.



Chimborazo.

"Geology, in the magnitude and sublimity of the objects of which it treats,  
undoubtedly ranks next to Astronomy in the scale of the Sciences."

*Sir J. F. W. Herschel.*

**HUDSON, OHIO:**  

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**1851.**

FIGURE 1. Title page of St. John's textbook.

to internal composition and structure, he wrote accurate and extensive descriptions of glacial features long before he realized their glacial origin. It is instructive to compare his early description and assumed flood origin of "Diluvial" features in his Massachusetts reports of 1832 (p. 6), 1833 (p. 141-172), 1835 (p. 148-178), and in the first edition of his textbook of 1840, with his sudden recognition

in early 1841 that Agassiz' glacial theory "explains satisfactorily" so many hitherto puzzling features.

Very late in 1840, or very early in 1841, Hitchcock (1841a, p. 3a) had "been favoured, through the kindness of Professor Silliman of Yale College, with the perusal of a recent work by Professor Agassiz on Glaciers and Glacial action, entitled *Etudes sur les Glaciers*." He also had abstracts of three papers "read last autumn before the London Geological Society, by Agassiz, Buckland, and Lyell . . . The whole subject of diluvium has been made to assume an aspect so new and interesting, that I am unwilling my Report should go out of my hands unaccompanied by a brief review of the facts and inferences concerning it." He did this by means of ". . . an extract from an Address recently published, [given] before the Association of American Geologists at Philadelphia in April, 1841." It is the "Postscript", rather than the "Address" (Hitchcock, 1841b), which is important in the present connection, because the former included illustrations and was even more positive about glacial action than was the "Address."

After describing the appearance, advance, and retreat of glaciers, Hitchcock (1841a, p. 4) asserted that the theory "explains satisfactorily" the origin of deposits of gravel and boulders "which we meet with almost everywhere in the northern parts of our country." He now favored a glacial origin for "lateral moraines [kame terraces] . . . the terminal and medial moraines; . . . smoothing, polishing, and furrowing of the rocks; . . . transportation of boulders; . . . clay and sand above the drift;" and especially for "furrows" which pass over mountains without losing their parallelism.

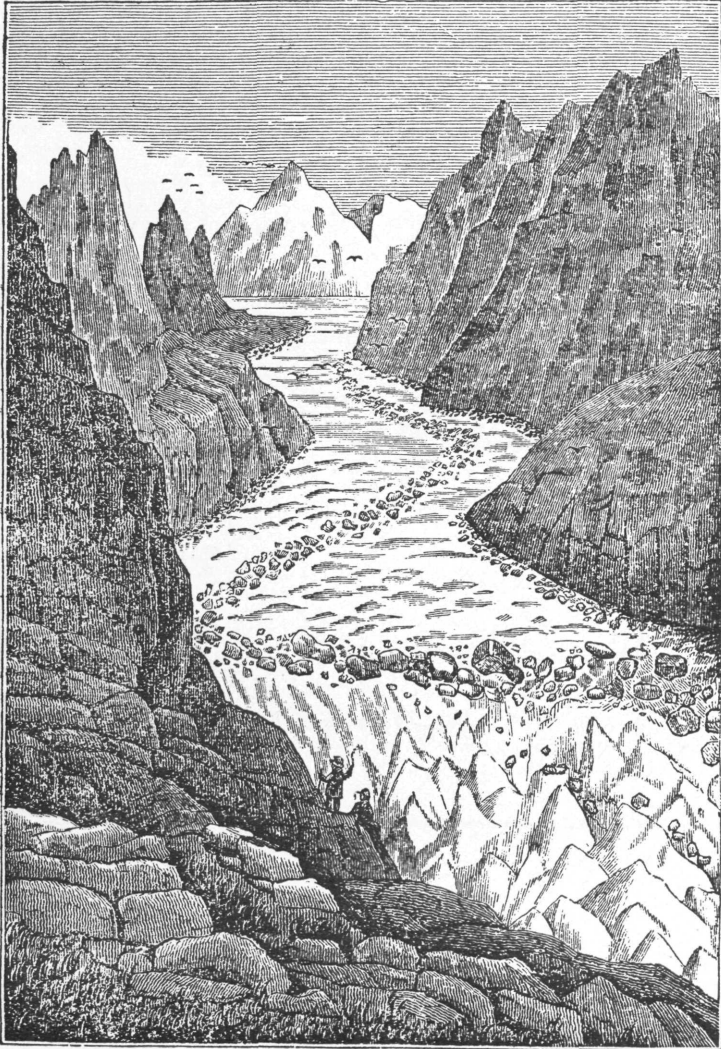
In this "Postscript" are reproduced (at a little less than half original size) ". . . a few cuts, copied on a reduced scale from the splendid drawings accompanying the *Etudes sur les Glaciers* by Agassiz." He actually reproduced Agassiz' plates 9, 10, 12, and a part of Plate 18, of the total of 18 plates and 14 overlays making up the atlas accompanying Agassiz' text. Figure 2 is a reproduction of Hitchcock's Fig. 277, a very faithful copy of Agassiz' Plate 10, "Glacier de Viesch." (It is interesting to note that these same illustrations, in even better impressions, are included in the 31st edition of Hitchcock's textbook (1860). The frontispiece of this edition of the text is of the "Humboldt Glacier, Greenland." A study of the 31 editions of that text, that appeared throughout a 20-year interval, would give much insight into the development and progress in America of the glacial theory).

Hitchcock's reports were widely disseminated and were well known to Samuel St. John, professor of chemistry, mineralogy, and geology in Western Reserve College, then located at Hudson, Ohio. Dr. St. John, who was born in New Canaan, Connecticut, on March 29, 1813, graduated from Yale College in 1834 as valedictorian. He studied law, chemistry, and medicine for five years more, partly in Paris and London, but mainly at New Haven with Benjamin Silliman. He may have known Hitchcock personally. St. John was admitted to the bar, but never practiced. He was elected professor of chemistry, mineralogy, and geology at Western Reserve in 1838, one year after this post had been established. For part of the following year, he was an assistant on the New York Geological Survey. From 1844 to 1856 he was also professor in the Medical Department in Cleveland (Waite, 1946, p. 94-97). He was prominent in the northern Ohio scientific community, and was the first corresponding secretary of the Cleveland Academy of Natural Science, which was founded in 1845 (Meisel, 1926, vol. 2, p. 564; 1929, vol. 3, p. 7). In 1856 St. John was elected professor in the College of Physicians and Surgeons in New York (later affiliated with Columbia), a post he occupied until his death in 1876. (I am indebted to Mrs. D. E. Helmuth, Archivist of Western Reserve University, for information about St. John and for a copy of the biographical reference in Waite).

St. John soon brought the new ideas about glaciers and glacial deposits to his

students, among whom was John Strong Newberry, who lived in nearby Cuyahoga Falls and whose family owned mines in adjacent Tallmadge. It is recorded that St. John was the instructor who most impressed the young Newberry and who influenced him to take up a career in science (Stevenson, 1893). Newberry received the degrees of A.B. from Western Reserve in 1846 and M.D. from Cleve-

**Fig. 277.**



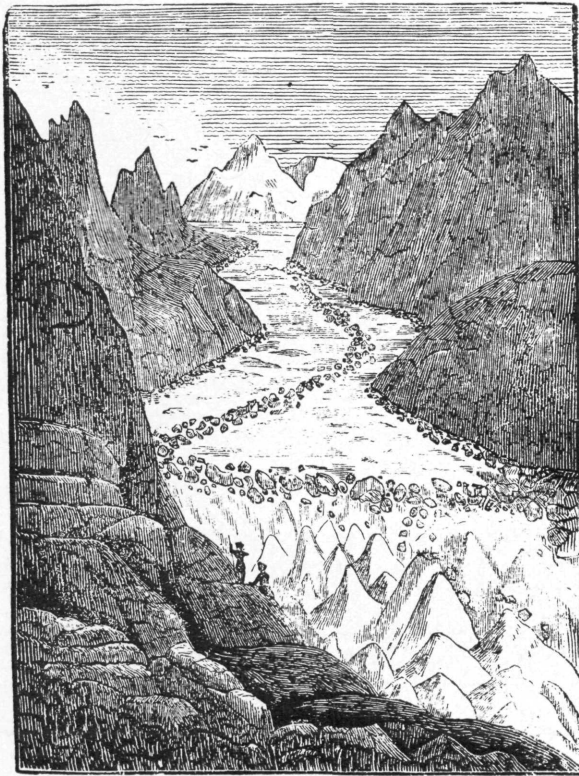
*Glacier of Viesch in the Alps.*

FIGURE 2. Hitchcock's Fig. 277, a copy of Agassiz' plate. Original size 95 x 139 mm.

land Medical School in 1848. After three years study of medicine, botany, and zoology in France, he returned to northern Ohio to practice medicine, but soon gave more and more of his attention to science, and especially to geology, and became one of the outstanding geologists of the nineteenth century. Newberry's

writings, almost from the outset, showed a keen discernment for physiography, and especially for morphology and composition of glacial deposits. It was from Professor Samuel St. John that Newberry learned of the glacial theory, only two or three years after Agassiz had published his explanation in 1840 and Hitchcock had given it such an approving promulgation in 1841. No doubt professor and student saw together the morainic knolls and the till and gravel deposits in the Cuyahoga Falls-Tallmadge-Hudson region, and looked at the striations on the ledges of Sharon Conglomerate in Boston, just west of Hudson, and in Twinsburg to the north (Newberry, 1873, p. 206; Leverett, 1902, pl. 13 and p. 422-425; White, 1953, pl. 6).

Fig. 12.



Glacier of Viesch, with medial und lateral moraines.

FIGURE 3. St. John's Fig. 12, a copy engraved by J. Brainerd from Hitchcock's figure. Original size 75 x 103 mm.

St. John must have been engaged for some time, probably several years, in the writing of his book (fig. 1). It therefore provides a summary of what he had been teaching for the several years before 1851. The material in his book was in part derived from ". . . Lyell, Murchison, Buckland, Ansted, Agassiz, Hitchcock, Dana, and the State Geological Surveys, particularly that of Professor Hall of New York." The book contains 175 figures and a final folding plate of a "jaw of a fossil fish found at Delaware, Ohio." These were ". . . executed by Professor Brainerd, and in some instances subjects were sketched from nature by him." Although it is not the present purpose to analyze St. John's whole book, it may

be noted that its organization is quite similar to any modern general elementary text that includes both physical and historical geology. The stratigraphy is modern in terminology. A long chapter on "Practical Geology" includes material on what today is called "environmental geology." The brief chapter on "History of Geology" is an early American summary of the subject. The concluding chapter is on regional geology of the world.

St. John described and discussed the work of glaciers (p. 25-28) and included illustrations of a glacier, striations, and an iceberg. The "Glacier of Viesch with medial and lateral moraines," shown here as figure 3, is a three-quarter-size copy of Hitchcock's copy (fig. 2) of Agassiz' original plate 10. A comparison of figure 3 with figure 2 will show how faithfully the engraver Brainerd copied Hitchcock's cut. Agassiz' original text and atlas are now rare, and possessed by only a few fortunate libraries, but excellent photographic reproductions of the plates are now available in the new critical translation of the *Etudes* (Carozzi, 1967).

St. John's figure 13, "Striae of Glaciers," was probably taken from an actual Ohio specimen by Brainerd, as it does not correspond to any of the striated rocks illustrated by Hitchcock.

The application of the glacial theory to the explanation of drift is both implicit and explicit in the long Chapter IX (pp. 223-251), "Rocks of the Quaternary Period." This chapter is divided into "The Drift Period" (pp. 223-240) and "The Alluvium" (pp. 240-251). The running head for the "Drift Period" is "The Drift or Pleistocene Period," surely a very early use of this time term in America. In this section the author discussed the limit of drift; direction of drift movement; large boulders; grooves and striations; *roches moutonnees*; "altered drift" (stratified drift); marine terraces, with an illustration of the "Parallel Roads and River Terraces of Glen Roy"; caves with fossils; and large vertebrate fossils, especially mastodons and particularly those from Big Bone Lick.

"Theories of the Drift" are discussed on pages 253 to 256. The "iceberg theory" was examined in a closely reasoned argument and found insufficient. The "elevation theory," so popular at the time (and later), was likewise found wanting. His statement of the "glacier theory" is as follows (pp. 255-256):

322. The *glacier theory* supposes that the climate, which in the Tertiary period had been so warm as to allow the palms to grow within the temperate zones, became much colder, causing enormous sheets of ice—polar glaciers—to advance far beyond their previous limits, moving along the surface by alternate advance and retreat, rounding, polishing and striating the rocks, and afterward when melted depositing their loads of boulders and detritus, where the drift is now found. In Europe the center of expansion is supposed to have been the Scandinavian mountains, and in North America in the polar regions, from which the glaciers advanced southerly.

The advocates of this theory contend that the phenomena of glaciers as witnessed in the Alps (§ 32,) are perfect miniature representations of the drift—its striae, furrows, boulders and moraines; that the elevation of extensive regions in high latitudes, like those of the Cordilleras in Mexico, and the high plains of Central Asia, would produce such a reduction of temperature as to cause immense glaciers, even thousands of feet in thickness. This theory is advocated by Prof. Agassiz.

The principal objection to the glacial theory is that glaciers are at present entirely confined to valleys, and the origin of such an enormous sheet of ice as it contemplates is altogether hypothetical.

323. Neither of these theories is deemed quite satisfactory; the proximate cause of the phenomena is very generally supposed to have been the joint action of ice and currents of water, but their origin and exact modes of operation are not determined.

In 1851 little was known of the Greenland ice cap and practically nothing of the Antarctic ice. Soon afterward, however, information about these ice sheets became known to geologists (Whittlesey, 1860), and thus the glacial theory with the "enormous sheet of ice as it contemplates" became less and less hypothetical.

The relation of ice-laid drift (till) to water-laid drift (outwash) was a puzzle to the early proponents of the glacial theory and they assumed that nonglacial water action was required to explain the stratified deposits. Agassiz himself understood

the marine and lacustrine origin of some stratified drift deposits, but did not understand the intimate relation of till and fluvioglacial material in some deposits, especially those of kames. He never understood the role of glacial meltwater (Agassiz, 1850, p. 410) and his keenly observing one-time associate, Edward Desor, similarly required lakes or seas to explain outwash deposits (Desor, *In* Foster and Whitney, 1850, p. 217). Indeed it was sometime after 1874 that the precise role of meltwater in forming stratified drift became generally understood. It is eminently fitting that a student of Samuel St. John, John Strong Newberry (1874, p. 41-54), contributed greatly to the understanding of the puzzle. His excellent descriptions of Ohio kames and his illustrations of their forms and internal structure contributed the data that were required for final understanding. Although Newberry himself, in 1874 (p. 47), still believed that the Stark County kames required standing water and icebergs for their formation, he put kame deposition closer and closer to an actual glacier front. At any rate, he precisely recorded the data that would soon lead to an ice-front and meltwater origin for kames, and for the meltwater-stream origin of valley trains.

Samuel St. John enters the history of glacial geology in 1851. He plays an important part through the first book published west of the mountains to record a clear statement of the theory of continental glaciation. He published nothing else on glacial geology. No other geological books or regular journal articles of his are recorded. His single book must have influenced many students and his influence passed on through the prestigious Newberry was great. As yet we do not know the extent of his influence on others, especially on the "Cleveland group" of Charles Whittlesey (White, 1964) and others, but it almost certainly was significant with them also. Professor Samuel St. John has a clear claim to the title of the first expositor of the theory of continental glaciation in Ohio.

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