EARLY DISCOVERERS

XIX

EARLY DESCRIPTION AND EXPLANATION OF KETTLE HOLES

CHARLES WHITTLESEY (1808-1886)

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CHARLES WHITTLESEY was a graduate of West Point, an army officer, engineer, geologist, lawyer, historian, archeologist, member of state and national geological surveys and a voluminous writer on a variety of subjects. During his own lifetime he felt that his geological talents and contributions were not sufficiently recognized—an opinion in which he was probably correct. The purpose of the present note is to call attention to his descriptions of kettle holes and his analysis of their origin, which appear to be the earliest in America.

Whittlesey was one of the first in North America to perceive the difference between ice-laid unsorted, unstratified material, stratified outwash and lacustrine material and to recognize that all of these originated from ice action. As early as 1838, Whittlesey (1838, pl., p. 56) had noticed several stratigraphic units of the drift near Cleveland, Ohio, and understood that the drift covering the bedrock in northeastern Ohio varied markedly in thickness. All of Whittlesey's many reports after 1838 stress stratigraphic division of the drift, a general recognition of which came many decades later. He even noted that the gravel and sand "diluvial hills" (kames) in northeastern Ohio have "an external coating of clay to the depth of 10, 20, or 30 feet [3–9 m.]" (1838, p. 56), an observation that was lost sight of for over 100 years (White, 1953, p. 36).

In an early description of drift in Wisconsin, Whittlesey (1852) described in detail stratigraphic sections, with diagrams, of interbedded boulder clay, sand and gravel, and lacustrine clay. In his sections of stratigraphy and structure he showed the relation of the irregular and discontinuous overlying drift to the bedrock.

Whittlesey's first speculations about the origin of kettle holes were in a report before the American Association for the Advancement of Science in 1859 (Whittlesey, 1860), in which he stated that in Wisconsin "there are numberless crater-like depressions in the drift material which are called by the people 'potash kettles'". He traced the area of kettles for 150 miles (240 km.) and thus early recognized the "kettle moraine" of Wisconsin. He had noticed these kettle holes ten years before—"while exploring in 1849 it occurred to me that these cavities could not be explained by the usual and well-known examples of aqueous deposits". His description and discussion (Whittlesey, 1860) is as follows:

> "Along the summits or dividing ridge between the waters of Rock river and those of Lake Michigan, there are numberless crater-like depressions in the drift materials, which are called by the people 'potash kettles'.
>
> "They are in the form of cavities, sunk below the general surface, ten, fifteen, and even one hundred feet, their outline rudely circular, and their sides as steep as the earth will stand. . . .
>
> "The materials in which they are found are the coarse drift, such as everywhere in the west occupies the summit of the country. . . .
>
> "To get an idea of the appearance of the 'potash kettle' country, imagine a region of drift moraines inverted. Instead of a surface thickly set with rounded hillocks, suppose it to be occupied by cavities of irregular size and depth.

"If the grinder of a mastodon is reversed and impressed upon a piece of wax, the depressions which result, will represent the drift cavities as contrasted with drift elevations. In travelling through such a region the explorer frequently finds them so near together, that he no sooner rises out of one than he is obliged immediately to descend into another, the diameter of which may not be more than twice or thrice its depth.

"There is very seldom any water in the bottom, owing to the loose and porous character of the gravel drift. Boulders are seen at the bottom, on the sides, and on the surface around them.

"When they are thickly set, as at the source of the Oconto river, and no hillocks between, the rim or edge between them is sometimes so narrow that large boulders have not base enough to rest upon, and tumble down the sides.

"The internal slope is frequently straight like a funnel or inverted cone, but more often cup-shaped or curved in a manner correctly expressed by the form of a kettle. . . .

"At the foot of the Alps, moraines are formed mechanically by the movements of glaciers, carrying forward earth and stones, that are finally left in rounded heaps on the more level country. Masses of ice become entangled with the loose materials which in due time melt away and disappear.

"Without entering at large into a discussion of the drift force, I assume for the present purpose that, in the early periods of the drift epoch, it was *glacier ice*. Nothing else seems to be equal in energy to the results we observe. A strong objection to this view has been removed by the observations of Dr. H. H. [I. I.] Hayes, of the Kane Arctic Expedition.

"On the north-west coast of Greenland, which is a vast glacier, the ice was found to be progressing toward the coast over a country that was comparatively level. It had a movement not only down inclined surfaces, such as the slopes of mountains, but along flat land, and even *up* inclinations that were opposed to its progress. If the temperature of Greenland or the Arctic Circle was brought down to latitude 40° north, glaciers would exist. Regarding the explanations of Agassiz and Desor as to the cause of the motion of glaciers to be correct, that it is not wholly due to gravity, there is nothing improbable in such a movement over a level country. . . .

"Admitting the probability of such a state of things, it follows that along the southern edge of this all-pervading glacier, fragments and masses of ice would be enclosed in and buried beneath the drift materials. . . .

"It is reported that in Patagonia huge piles of stones and ice are seen mingled together for years.

"My first impression on viewing the cavities at the head of the Oconto, was that they are due to *subsidence*. In the cases just cited, if the mixed mass consisted more of ice than of earth and stones, the surface should be one of pits and depressions. Hillocks or moraines could only occur in such materials where the earthy and imperishable parts are in excess. When the proportions are about equal, there would be both cavities and moraines.

"In the southerly part of Wisconsin both forms are combined, but as we proceed northerly the sunken species increase, and the hillocks and ozars diminish.

"As we proceed northerly there is in them less of stratification and a closer approach to the true glacial moraines. . . ."

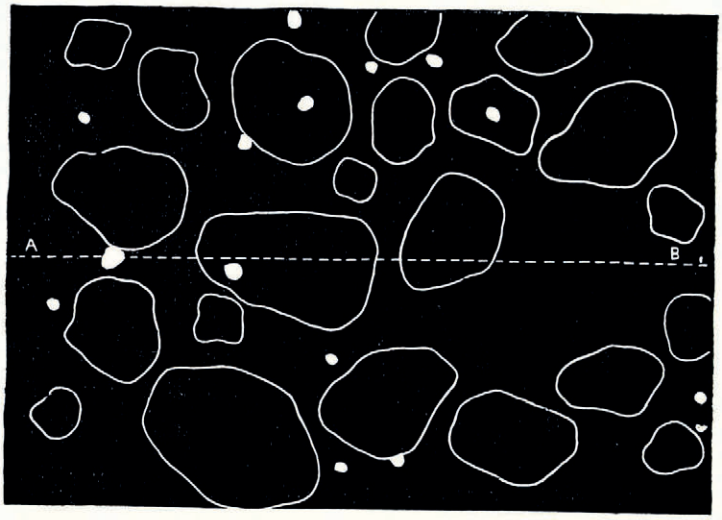
Figures to illustrate the kettle holes did not accompany the 1860 report but were included in a report a few years later in which Whittlesey (1866) summarized his observations of over 25 years on the glacial drift of the Great Lakes states and included a map and many sections, some of them in color. His illustrations of kettle holes reproduced here as Figures 1 and 2, with their original captions, are from that report.

Whittlesey was one of the first observers in America to compare the deposits reported around the Greenland Ice Sheet with those of the United States. He recognized the entire role played by glacier ice at a time when the origin of the drift in America was still usually ascribed to icebergs and water. Whittlesey did not fall into the trap—which would have been readily excusable—of burying icebergs to make kettle holes. He unequivocally buried glacial ice. Some of his other observations and explanations of drift sequences, glacial boundaries, raised beaches, and engineering effects of different drift deposits are equally important and deserve to be included in a book-length biographical study.

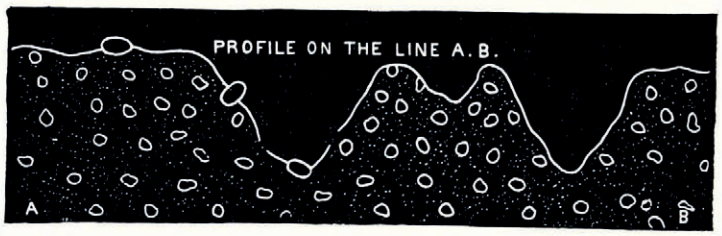
Fig. 1.

DRIFT CAVITIES, OR "POTASH KETTLES," near Greenbush, Wisconsin. Range of drift hills looking west.
○ ○ ○ Boulders of Northern rocks—base 150 feet above Lake Michigan.

Fig. 2.



HORIZONTAL PROJECTION of drift cavities 15 to 60 feet deep, head waters of Oconto river, Wisconsin.
○ ○ ○ Large Boulders of Sienite—350 feet above Lake Michigan.



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[*It is known* (*Flint, R. F.* [*1957.*] Glacial and Pleistocene geology. *New York, John Wiley and Sons, Inc.; London, Chapman and Hall Ltd., p. 140, 149, 151, 152*) *that kettle holes may originate in one of several ways: by the partial burial of the stagnant remnants of a glacier, by the complete burial of the remnants of a glacier, or by the burial of "floated-in or dropped-in ice masses". The first method produces the largest and deepest kettle holes, whereas the "thinner, buried ice masses create shallow kettles". The prominent steep-sided kettle holes which caught Whittlesey's attention appear to belong to the first kind.* Ed.]

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