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Publisher's version / Version de l'éditeur:

Bulletin of the Geological Society of America, 71, pp. 93-94, 1 plate, 1960-03-01

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BOULDER IN VARVED CLAY AT
STEEP ROCK LAKE, ONTARIO, CANADA

BY

R. M. HARDY AND R. F. LEGGET

REPRINTED FROM
BULLETIN OF THE GEOLOGICAL SOCIETY OF AMERICA
VOL. 71, JANUARY 1960, P. 93 - 94

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BOULDER IN VARVED CLAY AT STEEP ROCK LAKE, ONTARIO, CANADA

By R. M. HARDY AND R. F. LEGGET

Varved glacial clays of unusual extent have been revealed by the unwatering of Steep Rock Lake, in western Ontario, an operation carried out in order to gain access to the high-grade iron ore beneath the bed of the lake. Samuel (1945) and Legget (1958) have described the initial development and methods of operation. Pearson (1957) has published an account of the final phase of the unwatering operation with which the first author has been associated as a consultant. A detailed study of typical exposures of the varved clay was made by Antevs (1951). Laboratory studies have been carried out primarily for engineering purposes (Legget and Bartley, 1953). Details of more detailed laboratory studies of these varved soils have been given by Eden (1955).

Legget and Bartley (1953) and Eden (1955) have raised questions about the process of sedimentation that resulted in the varves as now exposed by the excavation. Similar questions are raised by the appearance of the sediments adjacent to a small boulder exposed during dredging operations and photographed by Hardy (Pl. 1). The boulder was found near the center of Falls Bay, which is in the northeast corner of the lake and includes about 7 square miles of water surface. Its location was approximately 2000 feet from the northerly shore line, at an elevation of about 912 feet. When dewatering started in 1944 the lake level was 1263 feet, the lake-bed clay surface near the boulder was about 1000, and the bedrock elevation was about 825. Antevs (1951) suggests that the water level of "Lake Johnston", the glacial stage of the modern lake, stood at 1363 feet.

The freshly dredged clay surfaces are treacherous, and it was not, therefore, possible to recover the boulder for examination. It was, however, about 8 inches in equivalent diameter, and the photograph shows it to be partially rounded. It is the only deposition of its kind which either of the authors has seen or heard of during the course of their many visits to Steep Rock Lake.

It may be assumed that the boulder was dropped from floating ice in the lake waters

above. If the maximum level suggested by Antevs be assumed, the boulder fell through a depth of some 450 feet of water before coming to rest on the clay lake bed, but its velocity of descent is indeterminate because ice may have been adhering to it. Careful examination of the photograph, however, shows that it landed on a dark layer and pierced this layer as well as the immediately underlying light-colored layer, but was held by the second dark layer which was only about 2 inches below the lake-bed surface. This is confirmed by the "curling" of the two layers to the lower right of the boulder. It follows, therefore, that the surface layers of the clay onto which the boulder fell, even though then so recently deposited, must have possessed appreciable shearing strength. Correspondingly, this gain in shear strength must have been rapid, much more so than is usually encountered in normally deposited soils.

The weight of the boulder compressed or consolidated the soil for several inches below the surface upon which it came to rest. It is therefore surprising to note that any subsequent consolidation of these same layers because of the weight of about 100 feet of overburden was not so great as that produced locally by the submerged weight of this relatively small boulder. It follows that there must have been a substantial increase in particle bond strength, and therefore a reduction in compressibility, in the interval between the time of the fall of the boulder and the completion of the process of sedimentation up to the final level of the bottom of the lake.

This suggestion is confirmed by the clearly defined steep slope of the first varve to be deposited on top of the boulder. The maximum slope of this exceeds 45° so that it is in striking contrast to the degree of slope normally encountered in such subaqueous deposits. Such a rapid build up of thixotropic forces between soil particles could account for other phenomena of the Steep Rock soils, already reported, such as the natural moisture contents higher than the liquid limits, and a high degree of sensitivity.

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- MANUSCRIPT RECEIVED BY THE SECRETARY OF THE SOCIETY, JUNE 22, 1959

BOULDER EMBEDDED IN VARVED CLAY IN THE BED
OF STEEP ROCK LAKE, ONTARIO, CANADA