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VARVES IN SANDUSKY BAY SEDIMENT

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While determining the quantity and distribution of the sediment in Sandusky Bay near the western end of Lake Erie for the Division of Conservation of Ohio, the writer found the deposits to be varved. Since several nearly complete cores of sediment were secured, an estimation of the total number of varves has been possible. Estimates of three cores have been made, two in the Bay proper and one at the edge of the Bay. This last core penetrated 10 feet of deposit that lies above the level of the Bay floor that is not represented in the other two borings. Since it represents as complete a profile as is likely to be found of the lacustrine deposits of the glacial waters that covered northwestern Ohio for a considerable part of post-glacial time, it was thought that the varve count might be of interest to glaciologists.

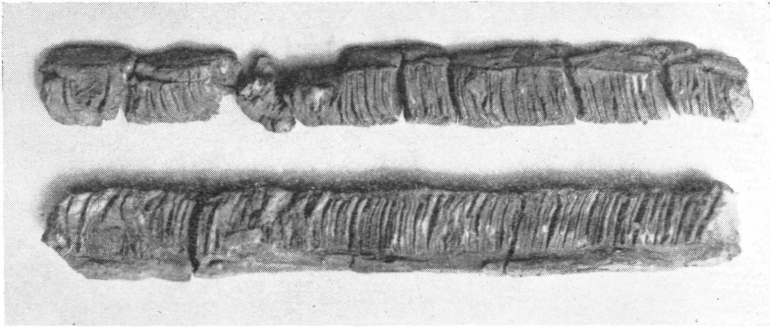


FIG. 1. A piece of core from a boring near the center of Sandusky Bay torn open thus exposing the varved structure of the deposit. After being torn open the core was allowed to dry which caused enough shrinkage to accentuate the gaps between the layers. The visible layers are only one-half of those actually present; they are the thicker winter deposit. The very thin quartz layers, between those that are visible, that make up the summer deposit do not show in the photograph.

The Bay lies inside the shorelines of the glacial lake that existed in front of the Huron-Erie lobe of the Wisconsin ice sheet. As inferred from Taylor's account (Leverett and Taylor, 1915)¹ glacial waters covered the region from the late Maumee stage, through the Arkona, Whittlesey, Wayne, Warren and Elkton stages. After the Elkton stage the melt water of the upper lake (Algonquin) found drainage eastward (Kirkfield outlet) and lowered the lake level in the Erie

¹Leverett, Frank, and Taylor, Frank B., 1915. The Pleistocene of Indiana and Michigan and the history of the Great Lakes. United States Geological Survey. Monograph 53: 316-518.

basin below that of the Bay region, thus ending deposition there. The present Bay is the widened mouth of the Sandusky River which cut its way through the lacustrine deposits of this series of lakes after the Elkton stage. The glacier was retreating from Sandusky Bay to a point near the Niagara gorge during the period of deposition of the sediment referred to here—a distance of approximately 250 miles.

The cores of sediment were secured by driving the sampler ($\frac{3}{4}$ -inch tube) into the sediment approximately one foot at a time in soft sediment and as little as two inches in hard sediment. An attempt was always made to get a sample of the same length as the distance the sampler was driven into the sediment. This procedure avoided compaction of the sediment. The sampling was carried on inside a casing that was always driven to the level of the bottom of the last sample and washed clean before a new sample was taken. This method entailed the loss of about two inches of core between each sample. Cores were torn open lengthwise to reveal the varved structure. Examination of Figure 1 reveals the varved structure of a typical sample.

The technique of estimating the total number of varves consisted first, in dividing the depth of the boring into increments and counting accurately the varves of the available sediment of each increment, and second, determining the average number of varves per inch (in the available sediment) and multiplying this by the number of inches penetrated in securing the samples included in the increment. This method gives an estimate that includes the portions of sediment lost between samples. Finally, the estimates of all the increments were added together to secure the total number of varves in the core. In choosing the increments care was taken to include as uniform thicknesses of varves as was possible, thus keeping the deviation of any of the varves from the average of its increment at a minimum.

Both the winter and summer layers of the varves in the deposits reported here are very distinct, one of them being thin, white and composed almost entirely of fine quartz crystals, whereas, the other is thicker, dark and composed mostly of clay, some carbonates and a slight amount of organic matter. The particles of the white quartz layer of the varve are so poorly cemented that the core easily breaks apart along it, but those of the dark stratum are well cemented together. Frequently the dark stratum of a varve shows eight or ten subdivisions that may represent disturbances of settling caused by individual storms.

The sizes of the particles that make up the varved deposit vary from 50% at some levels to 60% at others that are less than 2 microns in diameter. Maximum sizes (found only at the lower levels) vary from 35 to 80 microns.

Table I shows (for the most complete core—it includes 10 feet of sediment above the present Bay level) the depths limiting each increment, the average number of varves per inch, the total number of varves in each increment, and the total number of varves for all the increments, i. e., in the complete core. The total depth of sediment in this case is 37' 7". The sediment of this boring lies on bed rock. It can not be stated definitely that this core includes all of the deposit of the glacial lake under consideration since some may have been lost by erosion or by removal by readvancing ice. Erosion has probably been slight due to the extreme flatness of the region. The varve estimates made in the three cores gave comparable results.

An examination of the column in the table labelled "Av. per inch" shows that the varves vary in thickness somewhat at different levels. Twelve and one-half varves is the minimum number per inch and 38 the maximum. Although there are minor fluctuations from increment to increment in the number of varves, there is in general a decrease in the number per inch from the lower to the higher levels of the deposit, i. e., the varves get thicker the nearer the surface is approached.

This indicates a greater annual deposition in the higher levels. The differences in thickness of varves are due almost entirely to differences in the dark layer. Dr. George M. Stanley (personal communication) suggests that "the increasing thickness of varves towards the top of the section is largely a result of the shallowing lake and nearer shoreline, since this is probably the principal source of sediment."

TABLE I

RECORD OF THE ESTIMATES BY INCREMENTS (SELECTED BECAUSE OF THE UNIFORMITY OF THICKNESS OF THE LAYERS WITHIN IT) OF THE VARVES IN A BORING A FEW FEET BEYOND THE SOUTHERN EDGE OF SANDUSKY BAY ON LAKE ERIE. ESTIMATES ARE NECESSARY BECAUSE A FEW INCHES OF THE CORE BETWEEN EACH SAMPLE TAKEN WERE LOST. THEY WERE MADE BY DETERMINING THE AVERAGE NUMBER OF VARVES IN THE AVAILABLE SEDIMENT (USUALLY ABOUT 75%) OF EACH INCREMENT AND MULTIPLYING THIS NUMBER BY THE TOTAL NUMBER OF INCHES IN THE INCREMENT

Depth of Increments	Average Number of Varves per Inch	Number of Varves in Increments	Depth of Increments	Average Number of Varves per Inch	Number of Varves in Increments
0-1'5"	12.5	212.5	18'-19'3"	31	465
1'5"-2'2"	16	144	19'3"-20'7"	33	528
2'2"-2'11"	21	189	20'7"-21'11"	36	540
2'11"-4'4"	18	306	21'11"-23'5"	32	576
4'4"-4'10"	17	102	23'5"-24'	29	203
4'10"-5'8"	16.5	165	24'-25'	29	348
5'8"-6'4"	22	176	25'-25'6"	28.6	171.6
6'4"-6'11"	17	119	25'6"-26'6"	30	360
6'11"-7'5"	19.5	117	26'6"-27'	33	198
7'5"-8'	16.5	115.5	27'-28'	38	494
8'-9'	19	228	28'1"-28'6"	34	170
9'-9'10"	23	230	28'6"-29'7"	33.5	435.5
9'10"-10'8"	21.5	215	29'7"-30'	36	180
10'8"-11'8"	20	240	30'-31'1"	34	442
11'8"-12'8"	27.5	330	31'1"-32'7"	28	504
12'8"-13'8"	27	314	32'7"-34'1"	28.5	513
13'8"-14'8"	32	384	34'1"-34'10"	29.5	265.5
14'8"-15'8"	32.5	390	34'10"-35'8"	29	290
15'8"-16'8"	28.6	323.2	35'8"-37'2"	30	540
16'8"-18'	34	544	37'2"-37'7"	31	155

Grand Total of Varves, 12,223

The total number of varves in the core, namely, 12,223, certainly represents the minimum number of years that the Sandusky Bay region was covered by cold glacial waters. Since the Erie lobe of the glacier receded approximately 250 miles during this time it must have receded at an average rate of 108 feet per year.

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