

Postglacial Lakes Minong and Nipissing:
Their effect on the sedimentary stratigraphy
of several lake basins on Isle Royale National
Park, Michigan

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Abstract

During July, 1973, one sediment core was obtained from each of twelve different lake sites on Isle Royale National Park. These sites may be categorized with respect to their relationship with postglacial Lakes Minong and Nipissing:

a) those never submerged by the high water levels of either Minong or Nipissing, b) those covered by Minong waters, but not Nipissing c) those inland lakes covered by both Lakes Minong and Nipissing. Of the twelve sediment cores collected, nine were stratigraphically complete. These lake sediment cores, 1.60m to 7.85m in length, all begin (bottom) in reddish-brown silty clay, which places the origin of all the lake basin deposits during Valders age. The major stratigraphic feature of several of the cores is the homogenous gray clay which overlies the reddish-brown clay in several of the basins. This gray clay is indicative of the incursion of Lake Minong into these basins. Comparisons of the sediment sequences with the maps showing the shoreline of Isle Royale at Minong and Nipissing time aid in separating those basins affected by only Lake Minong from those affected by both Lake Minong and Nipissing. Variation that occurred in the sediments of the lakes sampled did not permit the prediction of sedimentation rates for the Minong and Nipissing gray clays. There is an indication that the low water lake stage, Lake Houghton, may have had some effect on at least two of the basins sampled.

Acknowledgments

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Introduction

Various aspects of the glacial and geologic history of Isle Royale National Park have been studied since the first geologic report was made to Congress in 1850 by Foster and Whitney (Huber, 1973). In general, these reports have dealt with surface features that have been modified by the advances and retreats of the glacial ice, the effects of higher water stages associated with the postglacial lakes on these surface features, and the modifications that have occurred in the bedrock formation of Isle Royale. The purpose of this paper is to describe and interpret the sedimentary stratigraphy of several lake basins on Isle Royale National Park. The report includes a discussion of the relationship of various sediment types common to several of the lakes sampled, and examination of the evidence for postglacial lake incursions into particular basins, and a discussion of the effect of postglacial lake covering on the sediments in these lakes.

Sample Sites

Twelve lake sites were sampled. The surface elevations of these lakes range from 300m (987 ft.) to 187m (614 ft.) above sea level, including the highest and lowest lakes on the island. The present day elevation of Lake Superior is 183m (602.5 ft.). The sites were selected to give as complete a sampling of Isle Royale as possible. These lakes may be

categorized with respect to their relationship with postglacial Lakes Monong and Nipissing: a) those never submerged by the high water levels of either Minong or Nipissing, b) those covered by Monong waters, but not Nipissing, c) those inland lakes covered by both Lakes Minong and Nipissing.

Inland lakes not submerged by Lakes Minong and Nipissing

Lily Lake Bog (Sec. 26, T 64 N R 38 W) is located 4.5 kilometers east of the Washington Creek Campground. The surface elevation of this bog lake is 300m (987 ft.). This is the highest lake on the island and was the first inland lake on Isle Royale to be uncovered after glacial retreat (Fig. 1). The core site was located in the SW corner, SE $\frac{1}{4}$, Sec. 26, on the south-southwest edge of the bog mat 6m from open water.

Fedltman Lake (Sec. 17, T 63 N R 38 W) is located 1.5 kilometers northeast of Rainbow Cover (Fig. 2). The surface elevation of this lake is 201m (660 ft.). It is bordered immediately to the southwest by a 207m (680 ft.) elevation ridge which has been described by Huber (1974) as being a beachline (or barrier bar) formation of postglacial Lake Minong. The core sites for this lake were located in the NW corner, SE $\frac{1}{4}$, Sec. 17, first, 600m southwest of the northeast shore, 300m north of the south shore, and second, 400m southwest of the northeast shore, 250m north of the south shore.

Figure 1. The location of Lily Lake Bog at the time of the glacial ice sheet pause; reconstructed from ice margin deposits present on Isle Royale. (after Huber, 1973)

SHORELINE OF ISLE ROYALE
LAKE LEVEL 200 FEET HIGHER
THAN PRESENT

1. LILY LAKE BOG

PRESENT SHORELINE

GLACIAL ICE SHEET

GLACIAL LAKE

(SUBSEQUENT TO GLACIAL LAKE-BEAVER BAY)

MARGIN

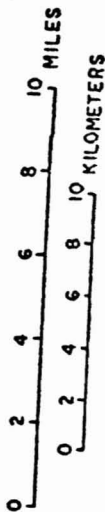
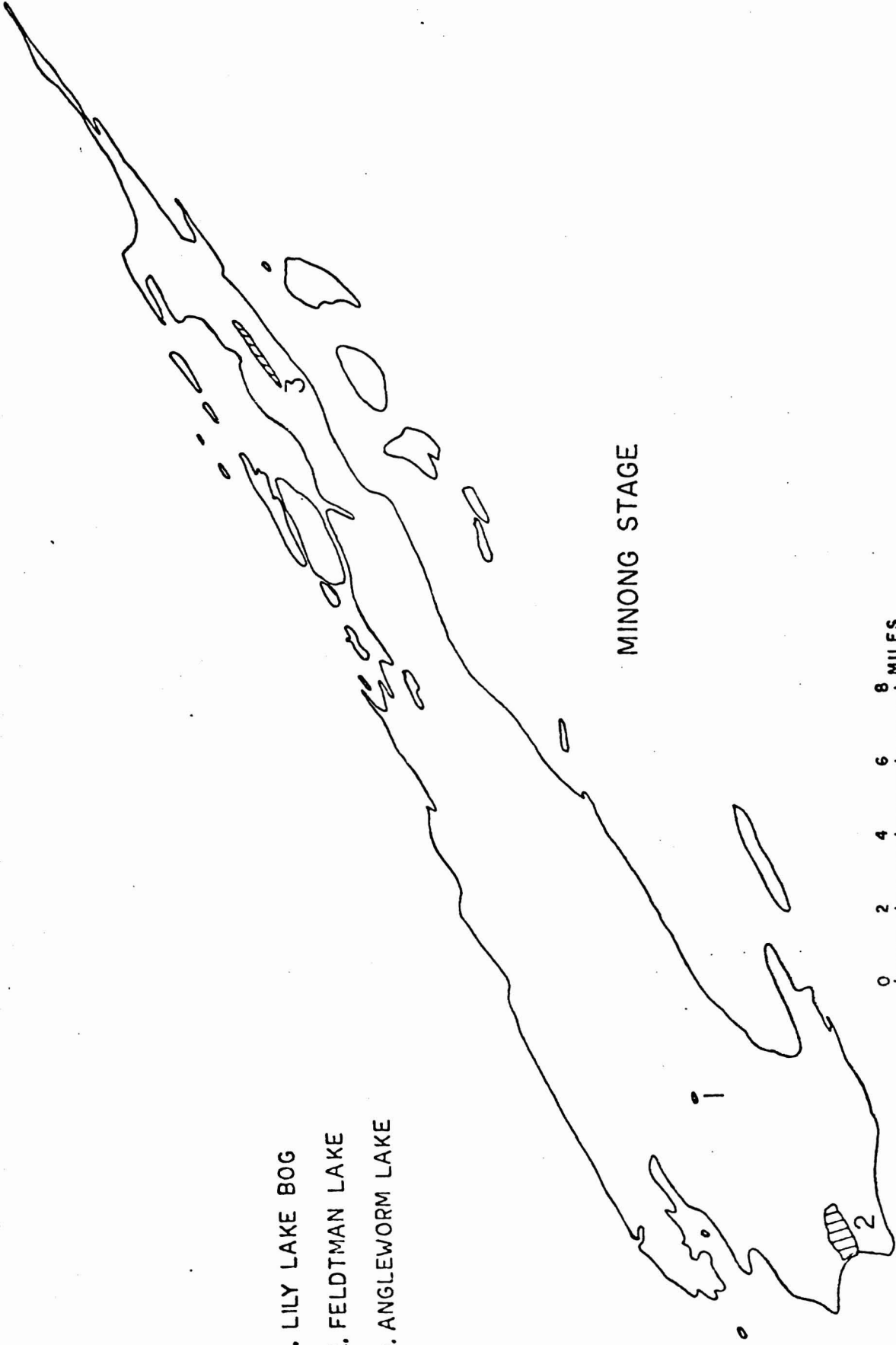
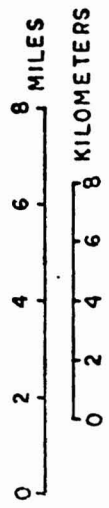


Figure 2. Location of the lake basins exposed at the time of the Minong high water stage (after Stanley, 1932). Included is the barrier bar formation proposed for the SW end of Feldtman Lake (after Huber, 1974).

- 1. LILY LAKE BOG
- 2. FELDTMAN LAKE
- 3. ANGLEWORM LAKE

MINONG STAGE



Angleworm Lake (Sec. 29, T 66 N R 34 W) is located 4.3 kilometers west of the Daisy Farm Campground (Fig. 2). The surface elevation of Angleworm Lake is 240m (789 ft.) above sea level. The core site was located approximately 12m from the northern shore in the SE corner, NE $\frac{1}{4}$, Sec. 29, off the end of the foot trail leading down to the lake from the Greenstone Ridge.

Inland lakes submerged by Lake Minong

Siskiwit Lake (Sec. 36, T 65 N R 36 W) is located 500m northwest of the Malone Bay Ranger station (Fig. 3). Siskiwit Lake has a surface elevation of 200m (659 ft.). The core site was located in the middle of the NE $\frac{1}{4}$, Sec. 36, approximately 25m south of the northern shore of Eagle Point Cove.

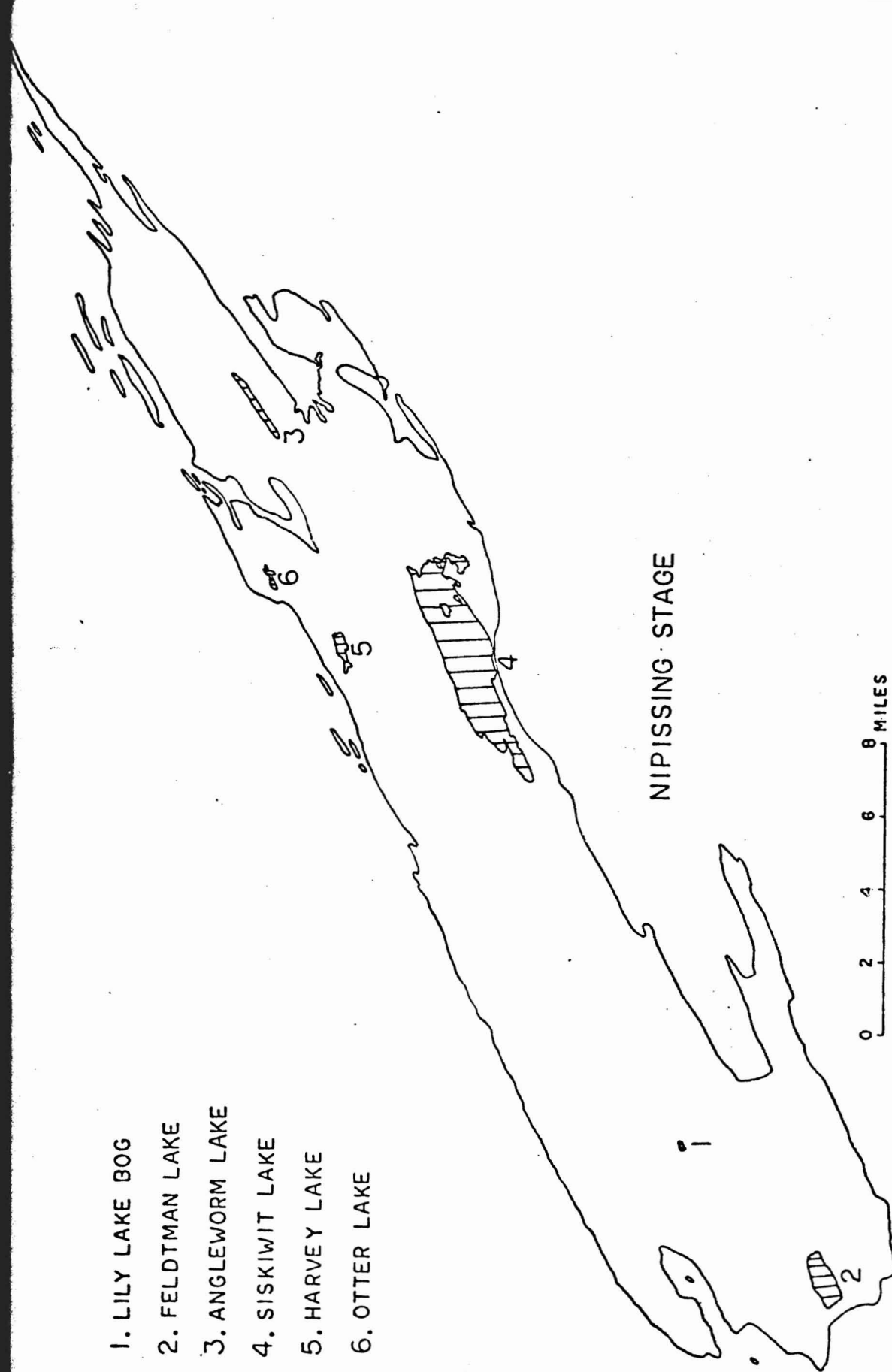
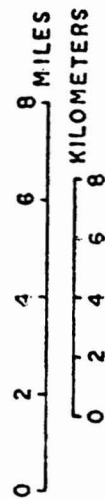
Harvey Lake (Sec. 6, T 65 N R 35 W) is located 2.0 kilometers east of the Todd Harbor Campground (Fig. 3). The surface elevation of this lake is not charted; however, based upon examination of a 6m (20 ft.) contour map, the elevation of this lake can be estimated between 219m (720 ft.) and 225m (740 ft.). The core site was located on the section line at the quarter section corner between Sec. 6 and 7, 300m northeast of the outlet stream, 85m from the northern shore.

Otter Lake (Sec. 33, T 66 N R 33 W) is located 3.0 Kilometers west of the McCargo Cove Campground (Fig. 3). The surface elevation of this lake is also uncharted, but is estimated from the 6m contour map at between 213 m (700 ft.)

Figure 3. Location of the lake basins exposed
at the time of the Nipissing high water stage
(after Stanley, 1932).

1. LILY LAKE BOG
2. FELDTMAN LAKE
3. ANGLEWORM LAKE
4. SISKIWIT LAKE
5. HARVEY LAKE
6. OTTER LAKE

NIPISSING STAGE



and 219 (720 ft.). The core site was located in the NW corner, NE $\frac{1}{4}$, Sec. 33, 8m from the northern shore in the middle of the lake.

Inland lakes submerged by Lakes Minong and Nipissing

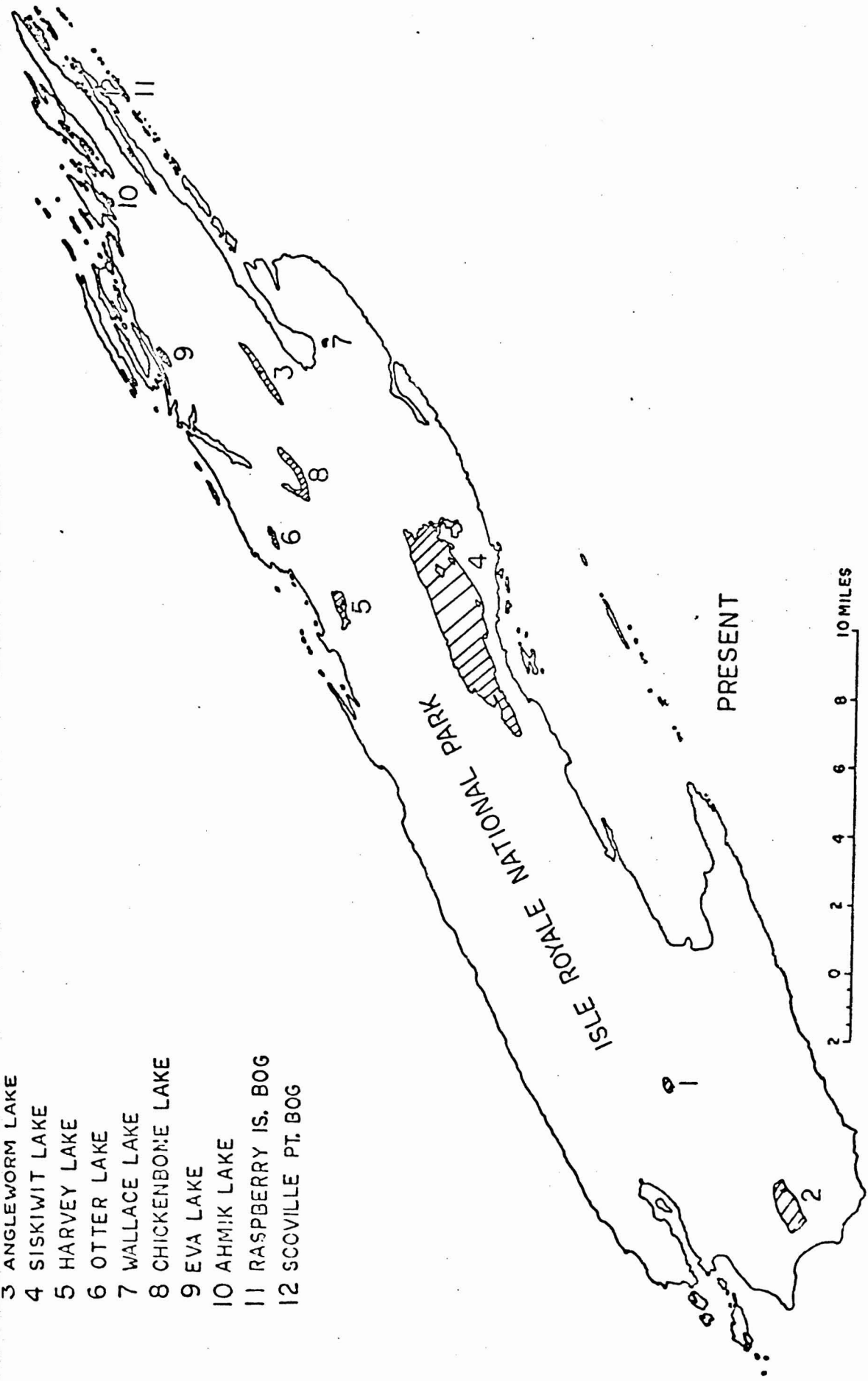
Wallace Lake (Sec. 4, T 65 N R 35 W) is located 800m south of the south edge of Moskey Basin (Fig. 4). The actual surface elevation of this lake is not chartered. By examination of the 6m contour map, the surface elevation of Wallace Lake can be estimated between 188m (620 ft.) and 195m (640 ft.). The core site was located in the SE corner, NW $\frac{1}{4}$, Sec. 4, 18m north of the south shore in the northeastern one-third of the basin.

Chickenbone Lake (Sec. 35, T 66 N R 35 W) is located 1.5 kilometers southwest of the McCargo Cove Campground (Fig. 4). The surface elevation of this lake is 202m (644 ft.) above sea level. The core site was located in the SW corner, NE $\frac{1}{4}$, Sec. 35, 800m southwest of the northeast end of the lake approximately 200m north of the south shore.

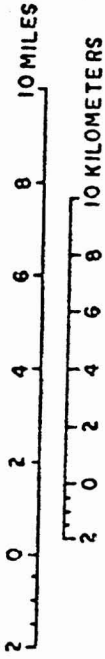
Lake Eva (Sec. 8, T 66 N R 34 W) is located 5.3 kilometers northeast of the McCargo Cove Campground (Fig. 4). This is the lowest lake on the island with a surface elevation of 187m (614 ft.) The core site was located in the NW corner, SW $\frac{1}{4}$, SE $\frac{1}{4}$, Sec 8, 15m from the northern shore near the middle of the lake.

Figure 4. Spatial distribution and location of the lake basins cored in this study with respect to the present day shoreline of Isle Royale National Park.

- 3 ANGLEWORM LAKE
- 4 SISKIWIT LAKE
- 5 HARVEY LAKE
- 6 OTTER LAKE
- 7 WALLACE LAKE
- 8 CHICKENBONE LAKE
- 9 EVA LAKE
- 10 AHMIK LAKE
- 11 RASPBERRY IS. BOG
- 12 SCOVILLE PT. BOG



PRESENT



Ahmik Lake (Sec. 31, T 67 N R 33 W) is located 800m west of the northwest end of Duncan Bay (Fig. 4). Ahmik Lake has a surface elevation of 192m (631 ft.). The core site was located in the NE corner SE $\frac{1}{4}$, SW $\frac{1}{4}$, Sec. 31, 12m from the southern shore, 15m from the southwest end of a small island in the northeastern one-third of the lake.

Raspberry Island Bog (Sec. 3, T 66 N R 33 W) is located 400m east of the Rock Harbor Lodge area (Fig. 4). The surface elevation of this closed bog is 194m (639 ft.). The core site was located in the SW corner, SW $\frac{1}{4}$, NE $\frac{1}{4}$, Sec. 3, 4m north of the boardwalk trail.

Scoville Point Bog (Sec. 34, T 67 N R 33 W) is located 3.0 kilometers northeast of the Rock Harbor Lodge area (Fig. 4). The surface elevation of this closed bog is 193m (635 ft.). The core site was located in the middle of the NE $\frac{1}{4}$, SE $\frac{1}{4}$, Sec. 34, in the center of this small basin.

Sediment Collection

During July, 1973, a sediment core was collected from each of the twelve sites described on Isle Royale National Park. A Livingston sampler, with a 5cm diameter sleeve, was used to sample in three locations, Wallace Lake, Anglemorm Lake and Ahmik Lake. The other nine locations were sampled using a Hiller sampler, with a 1.25cm diameter core. The cores were measured and the color and texture changes described. At the time of measurement and stratigraphic description, the

cores were sampled at 5cm intervals for pollen and charcoal analysis in an attempt to relate them to postglacial forest history and the presettlement forest and fire history of Isle Royale National Park.

Results

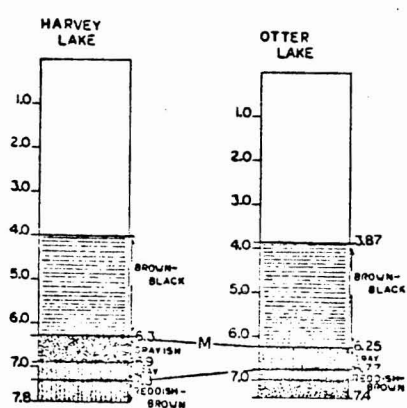
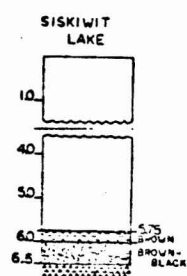
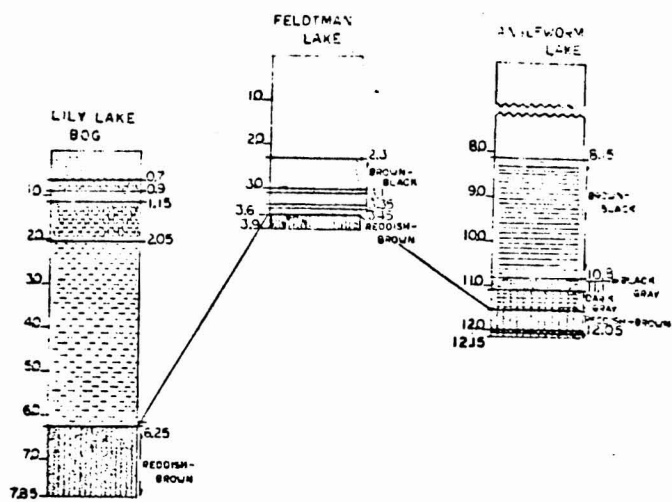
The average length of sediment core obtained from the sites sampled on Isle Royale was 3.72m (0.75-7.85m). In all instances, except Siskiwit Lake, the length of sediment core obtained represents the maximum amount of obtainable core using either the Livingston or Hiller sampler. In the Siskiwit Lake basin the sample prematurely ended on a rock ledge; therefore, a complete stratigraphic core was not obtained.

All of the lake sediment cores begin (bottom) in a reddish-brown silty clay (10 R 5/4) (Fig. 5). In general, these cores can be divided into three categories based upon the sedimentary sequences. The first group, Lily Lake Bog, Feldtman Lake, and Anglemorm Lake, ended in unvarved reddish-brown silty clay that passes upward to organic gyttja (brown-black, 5 YR 2/1) with little or no grayish colored material encountered.

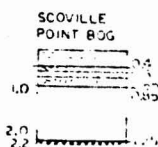
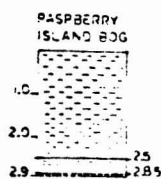
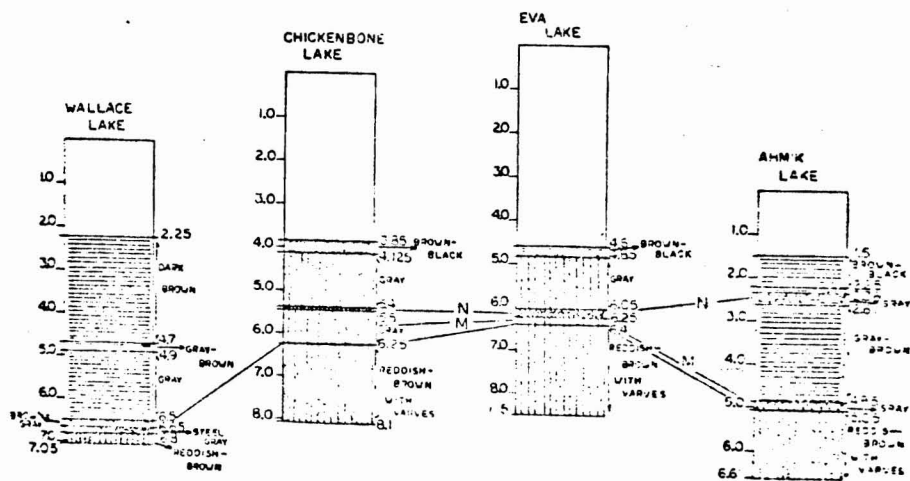
In the second category, Harvey and Otter Lakes, the reddish-brown silty clay passes upward to a homogenous gray clay (5 Y 3-5/1-2) and in Harvey upward to gray silty sand, before ending (top) in organic gyttja.

The third group, Chickenbone Lake, Eva Lake, and Ahmik Lake, contained a different sediment sequence. The reddish-brown silty clay in these basins is distinctly varved. The

Figure 5. Comparisons of the sedimentary stratigraphy of the lakes core in this study during July, 1973.



M—MINONG
N—NIPISSING



laminations alternated between coarser grained gray clays and finer grained red clays. From the varved reddish-brown silty clay, the sediments pass upward to homogenous gray clay or gray-brown (5 YR 5/1) clayey gyttja that is bisected or contains distinct layers of sand. These cores then pass upward to organic gyttja.

Those lakes not mentioned in the general categories, Siskiwit and Wallace Lake, do not lend themselves to this type of generalization. The incompleteness of the Siskiwit Lake core makes it impossible to classify it at the present time. The Wallace Lake sediment core can be assigned to the third category. However, because of the location of Wallace Lake and the probable connection it had with the Nipissing waters, the stratigraphy is slightly different although the accumulation of gray material is comparable to the sediments of those lakes in the third category.

The Raspberry Island and Scoville Point Bog samples did not include any characteristic clays. This is attributed to the shallowness of these basins. At the time of their gradual exposure, these basins were probably subject to wave washing action that virtually scoured these basins of glacial or lake sediments. These sites do not show any characteristic minerological stratigraphy and will not be further compared with the other cores.

Discussion

The lake sediment cores all begin in reddish-brown silty clay which places the origin of all the lake basin deposits at Valders age or possibly younger. Examination of the reddish-brown silty clay by Dr. Stephan C. Nordeng, of the Geology Department at Michigan Technological University, verified the Valderan origin.

The major stratigraphic feature of the cores is the gray clay which overlies the reddish-brown clays at many sites. The actual origin of the gray clay has been the subject of considerable debate. While Hough (1958) contends that the gray clays overlying the red clays (reddish-brown) in the Lake Michigan basin are simply the reduced equivalents of the red clays, Nussman (1965), based upon various chemical and physical properties similar to both gray and red clays, concludes that the red and gray clays found in the Lake Superior basin are different sediment types.

Farrand (1969a, p. 40) states, "that the transition from red to gray clay marks a changing province of sediment being introduced into the lake (Lake Superior)." He based this statement on the fact that there are two rather distinct sediment provinces surrounding the Lake Superior basin (Farrand, 1969a and 1969b). South and west of a line from Sault Ste. Marie to Thunderbay, Ontario nearly all of the late and postglacial sediments from the Lake Superior basin are red or reddish-brown, representative of the ferruginous rocks of the iron ranges. North and east of the line, the sediments are predominately

gray, derived from the granitic colored rocks of the Canadian Shield. Farrand (1969a, p.40) further states that in his samples of Lake Superior sediment cores, "the transition from red to gray clay takes place within the varved sediments, which implies that the ice sheet was present in the Lake Superior basin at the time of transition." Since the varves in this transition period consisted of fine grained red clay layers (winter settling) and coarser grained gray clay layers (summer settling), Farrand (1969a and 1969b) concluded that the two different sediments were mechanically mixed during the deposition of the transition portion and represent introduction of new sediments into the Lake Superior basin. Farrand places the origin of this red clay-gray clay transition at early Lake Minong time.

Based upon Farrand's (1969a and 1969b) interpretation of the stratigraphy of the sediments in the cores in his samples of Lake Superior it is possible to delineate the incursion of postglacial Lake Minong into several of the basins in the samples taken on Isle Royale. The presence of the gray clay that overlies the reddish-brown clay in these sediment samples will be used as the indicator of the postglacial Lake Minong incursion. By coupling the sediment sequences (Fig. 5) with the maps that illustrate the exposure of the various basins to the Lake Minong and Lake Nipissing stages on Isle Royale (Fig. 2, 3, and 4) it is possible to separate those lakes affected by only Lake Minong from those affected by both Lakes Minong and Nipissing. The absence of gray clay overlying the reddish-brown clay indicates that a particular basin was not affected by either Lakes Minong or Nipissing.

The sedimentary stratigraphy of Lily Lake Bog, Feldtman Lake, and Angleworm Lake passes upward from the deposits of reddish-brown silty clay to accumulations of organic gyttja (or peat). This signifies that these lakes, at a very early stage, became independant inland lakes and began the eutrophication process. The actual deposition of the reddish-brown clay probably resulted from the direct sedimentary deposit during glacial retreat. Bedrock was not contacted in the boring of any of these basins; therefore, it is not possible at this time to estimate the approximate total amounts of glacial deposition present in these basins.

In Siskiwit Lake (which will not be discussed), Harvey Lake, and Otter Lake, the first indications of postglacial lake inundation is evidenced in the sedimentary sequence. Comparison of these sediment cores (Fig. 5) and the probable mapped shoreline of Isle Royale at the postglacial Lake Minong stage by Stanley (1932) (Fig. 3), suggests that the gray clay can be used as an indicator of postglacial lake covering. The sediment sequence changes from the basal reddish-brown silty clay to gray clay and thence to the shallower organic material, which signifies the independence of these inland lake basins. Due to the differences that exist in location and elevation of these basins, it is not possible to explain the exact causes that result in the presence of the gray sand in the Harvey Lake basin.

The sediments of the Wallace, Chickenbone, Eva, and Ahmik Lakes have the same origin with respect to postglacial lake covering. Differences that exist in location and

elevation of these sites probably account for the variations in the texture and color of the sediments.

The Wallace Lake sediment core begins in reddish-brown silty clay, which passes upward to an accumulation of steel gray clay (N 4) and then brown-gray clay (5 YR 4/1). Above is an accumulation of gray clayey gyttja with the sediment sequence ending in the accumulation of organic gyttja, indicative of an independant inland lake.

The classification of gray clayey gyttja associated with postglacial lake inundation of this basin might be supported by examination of the map of the extent of the shoreline of Isle Royale at Nipissing time (Fig. 3). The Wallace Lake basin was, at that time, a finger inlet bay off of the south shore of Moskey basin. It is possible that Wallace Lake was accumulating organic material while influxes of gray clay could be brought into this embayment from Moskey basin; therefore, the sediment would acquire the characteristic gray coloration associated with postglacial lake covering.

In Chickenbone Lake, the sedimentary stratigraphy begins in a varved reddish-brown silty clay that passes upward to homogenous gray clay. The gray clay contains a distinct sand layer with more homogenous gray clay lying above this. The sediment sequence ends in a slight accumulation of organic gyttja. The laminations that occur in the reddish-brown silty clay in this basin and those of Eva and Ahmik Lakes appear to be the result of postglacial lake inundation. This seems to represent the period of alternating gray and reddish sediment introduction as disucssed by Farrand (1969a and 1969b).

The sedimentary stratigraphy in the core from Eva Lake is almost identical to that of the core from Chickenbone Lake. This core begins in varved reddish-brown silty clay that passes upward to homogenous gray clay which contains a distinct sand layer. Above the sand layer lies more gray clay that passes upward to organic gyttja.

The variation that occurs in the sediment sequence of Eva Lake when compared to Chickenbone Lake is probably the result of the location and elevational differences that exist in these two basins. Chickenbone Lake is located much further inland and was more protected at Minong time (Fig. 3) than was Eva Lake. Also, the surface elevation of Chickenbone Lake is greater than the surface elevation of Eva Lake. It seems apparent that these two basins were exposed for approximately the same amount of time to the incursion of Lake Minong and Nipissing. Eva Lake was exposed for a slightly longer period as evidenced by the smaller amount of organic gyttja.

The Ahmik Lake sedimentary stratigraphy varies considerably from the stratigraphy of any of the other basins bored. The sediment passes upward from the varved reddish-brown silty clay, identical to that found in Chickenbone and Eva Lakes, to a gray silty sand. The gray silty sand is overlain by gray-brown clayey gyttja which passes upward to another gray silty sand band, finally ending in organic gyttja.

The first gray sand band could be interpreted as the incursion of the Lake Minong high water stage, while the second gray sand band might indicate the waning phases of the Nipissing

high water stage in this basin. However, this type of interpretation does lead to a feeling that there was uniform settling occurring between the Lake Minong and Lake Nipissing high water stages.

Farrand's (1969a and 1969b) assumption of uniform sedimentation for the homogenous gray clays found on the bottom of Lake Superior does not seem applicable to the sediments found in the lake basin borings on Isle Royale National Park. The variations that occur within the sediments of a lake make it impossible to assume this type of sedimentation.

Farrand's (1969b, p. 194) discussion of the various lakes associated with the glacial retreat describes a low water stage, Lake Houghton, which immediately succeeded Lake Minong and was about 20m (75 ft.) lower in elevation. This low water stage would have increased the size of the Isle Royale shoreline beyond the Minong beaches. Consequently several of the lake basins which were deeply covered by Minong waters would have become inland basins; others were only shallowly covered. It appears that this lower lake stage had an effect on the sedimentation of such basins as Chickenbone and Eva Lakes. It is postulated that the gray sand layer in these sediment cores represents near shore, shallow water deposits of the Lake Houghton stage. This supports Farrand's (1969b) conception of the Lake Houghton stage and enables a better understanding of some of the variations that occur in two of the sediment cores.

Conclusion

The reddish-brown silty clay that begins the sedimentary stratigraphy of the nine stratigraphically complete sediment cores places the origin of the lake sediment deposits in these basins at Valders age. The major stratigraphic feature present in several of these cores is the presence of homogenous gray clay which overlies the basal reddish-brown clays. This feature indicates whether or not a particular basin was affected by the high water levels of postglacial Lake Minong. In comparing the sediment sequences and the diagrams of the Isle Royale shoreline at the Minong and Nipissing high water stages it is possible to separate those basins covered by only Lake Minong from those covered by both Lakes Minong and Nipissing. This finding supports Farrand's (1969a and 1969b) interpretation of new sediment introduction into the Lake Superior basin.

The variations that occur in the sediment sequences among the basins makes it impossible at the present time to determine sedimentation rates for the Lake Minong and Lake Nipissing gray clays. The evidence does indicate that the sedimentation rate varies from basin to basin. It appears as though the gray sand band found in the sediment cores from Chickenborn and Eva Lakes could be the result of the Lake Houghton low water stage that Farrand (1969b) suggests existed between postglacial Lakes Minong and Nipissing.

A subsequent analysis of sedimentation rate and associated environmental history, on these and other lake cores, will be possible at a later date with the aid of an array of radiocarbon dates and the results of pollen analysis.

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