Surface and Near-Surface Sediments in the Northern Part of Seneca Lake, NY

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The purpose of this field trip is to examine data bearing on the origin of the sediments found in the northern part of Seneca Lake. These sediments are apparently typical of those found in the other Finger Lakes of New York so that learning about the processes which formed them gives insight into the general problem of the origin of sediments in these lakes and similar lakes elsewhere.

The valley in which the lake is situated has been cut into the South-dipping Devonian shales and sandstones of the Appalachian Plateau (Figure 1). Apparently, a north-flowing stream occupied the valley during the late Tertiary and then during the Pleistocene glaciers eroded and otherwise sculpted the Tertiary landscape mantling the resulting surface with a wide variety of ice-laid and water-laid sediments. Glacial processes and their effects on local geography have attracted the attention of workers since early in the nineteenth century. A current summary of investigations is given by Muller (1965).

Deglaciation took place locally between 14,000 and 12,500 years BP. During ice retreat several moraines were draped across the land surface as well as across the floor the lakes which preceded Seneca (Figure 1). Many of the moraines formed at the northern boundary of a pro-glacial lake either as shoreline features or at the ice edge beneath a lake surface. Those moraines emplaced the floor of what was later to be Seneca Lake were subsequently buried by lake sediments.

On this trip we will examine directly and by subbottom profile the sediment on the lake floor as well as those in the immediate subbottom available to a light dredge or piston corer.

Seneca Lake's drainage basin boundary, the lake's major tributaries, the local bedrock geology and the location of moraines are given in Figure 1.

THE TRIP

Our route carries us from the dock at the northeast corner of the lake south to the various sampling locations and back again, a total of about 10 km. (See Figure 2). While underway, we will examine the subbottom where possible. At the various locations we will look at bottom sediments collected by Ponar dredge and at the last stop we will examine a sediment core. Since shoreline sediments form such a small fraction of the sediments in the lake basin we will not be concerned with them on this trip.

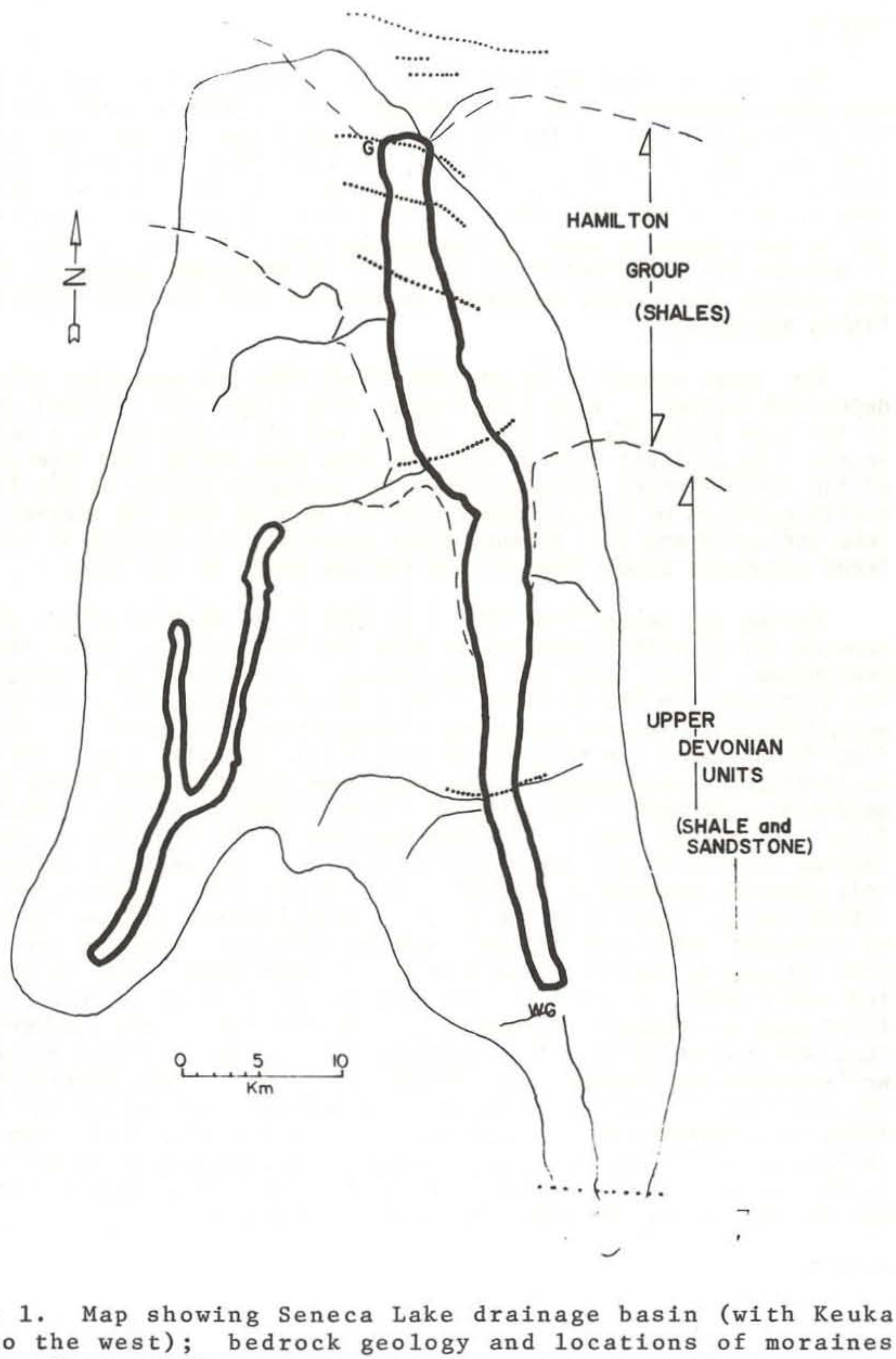

Figure 1. Map showing Seneca Lake drainage basin (with Keuka Lake to the west); bedrock geology and locations of moraines crossing Seneca Lake.

STOP 1

At this location the lake bottom is covered with a sheet of fine sand the exact thickness of which is unknown. The coarsest sands are found at the northeast corner of the lake while toward the southern edge of the sand sheet the silt--and clay-sized fractions become appreciable. Shell debris and whole shells make up a minor part of this sediment mass and at some localities tubules made up of agglutinated sand grains are concentrated in the ripple troughs. Although the exact thickness of this sand sheet is unknown its distribution is broken up by irregular exposures of what are thought to be older sediments suggesting that the sand thickness is highly variable.

The sands appear to be derived mainly from the reworking of previously deposited sediment. Very little other than clay-sized sediment is brought to the lake bottom by the local streams and cliff erosion is a negligible source. So at least part of the sand mass must be derived from winnowing of the moraine which extends across the northeast corner of the lake. An additional part of the sand mass must be derived from the erosion of older lake sediments and till because these materials are exposed in small scattered exposures across much of the shallow parts of the lake.

During the cruise from STOP 1 to STOP 2 the masking effect of the sand on the subbottom profiles is lost and the profiles reveal the sediment below. Three types are illustrated, each defined by a unique acoustic signature, in the profiles. One kind of sediment is characterized by well defined reflectors which are closely spaced and parallel. The reflecting surfaces are taken to be proglacial lake strata and their varying inclinations with respect to the lake floor indicate that either the strata have been deformed or that they have been draped across an irregular surface. The second type of sediment revealed by the profiles is characterized by weak, diffuse, non-planar reflectors. The sediment represented by this acoustic pattern is thought to be glacial till. Support for this interpretation comes from the vertical relationships between the two types of sediment: that with the well defined reflectors rests on the sediment with the poorly defined reflectors at all localities. This is the expected relationship if the interpretation of the profiles is correct. A third type of sediment is recorded by the profiles at the sediment interface and just below it. This sediment mass is characterized either by well defined but discontinuous reflectors or by its near transparency to the sonic pulse from the profiler. The sediment responsible for these acoustic signatures must be complex and dredge samples have shown it to include silts, silty muds and carbonates. Rocks surfaces do not occur, as far as its presently known, within the penetration range of the subbottom profiler anywhere at the north end of the lake.

STOP 2

At this position most of the surficial sediments are made up of finely-ground carbonate debris as well as whole shells. Most of the shells and shell debris are provided by gastropods with a minor contribution from bivales. Micritic sediments of this type are typical of that found at many localities along the west side of the lake in water depths less than

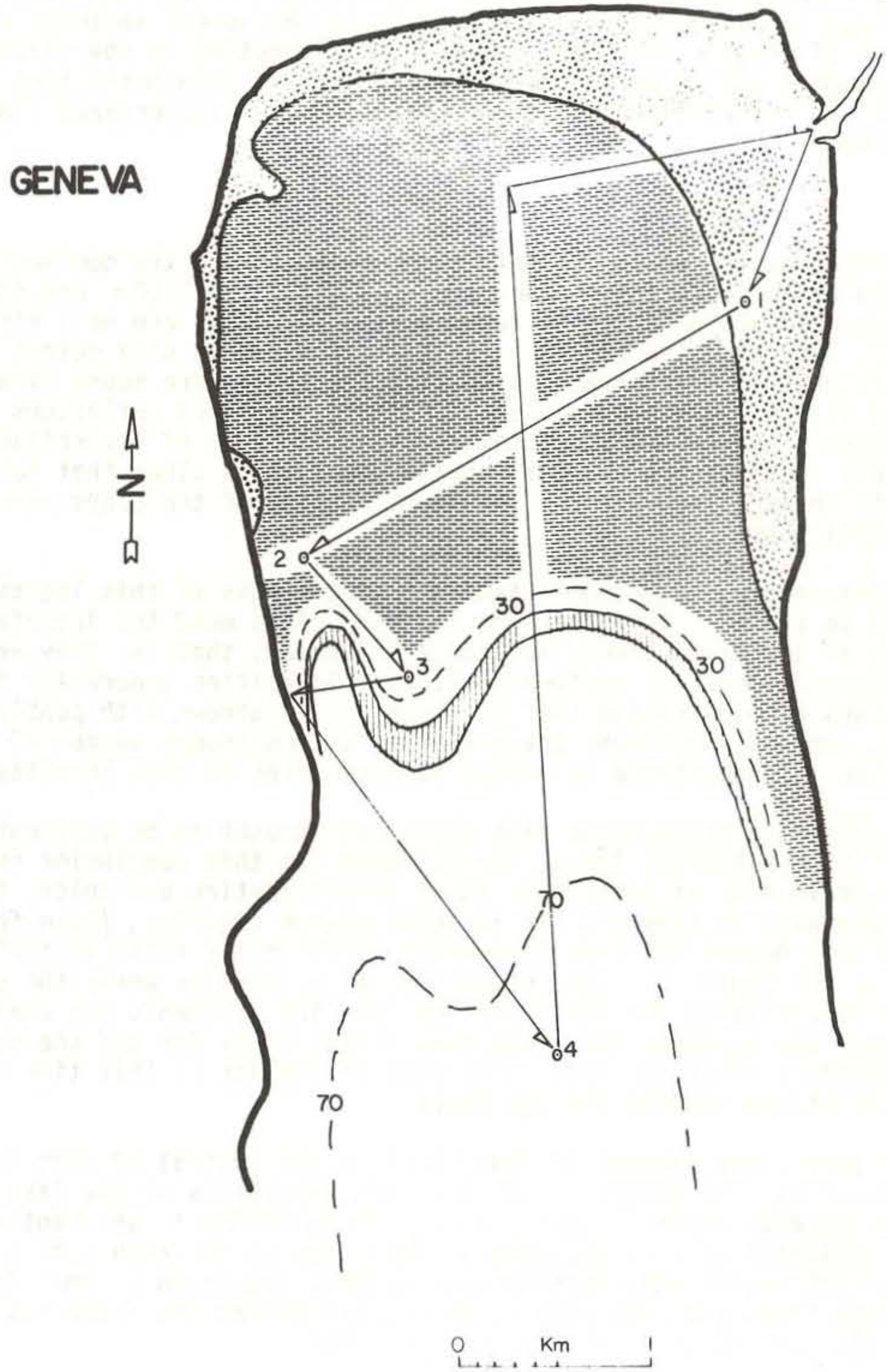

Figure 2. Map showing cruise tracks, sample sites, bathymetry in meters, and sediment facies: stipple - sand, dashes - silts and carbonates, vertical ruling - pink clays and open area to south - black muds.

30 meters especially where only small or intermittent streams enter the lake. These carbonate sediments appear to be the normal sediment where the influx of clastic sediment is low. It is tempting to speculate that if the sediment influx were reduced throughout the lake basin then carbonates would be the dominant sediment instead of the fine-grained clastics normally seen.

STOP 3

Cruising south it appears that the carbonates are the dominant sediment type at least as far as the site of STOP 3. At STOP 3 one finds clay exposed on south-facing bottom slopes. The clays are well stratified (varved?), very cohesive and they exhibit light red to pink colors. Single pebble--or granule-sized grains and ostracode shells are found widely scattered in the clay sequence. Well defined, parallel reflectors characterize these clays in the subbottom profiles and many of the reflectors are steeply inclined. Along this cruise track it is clear that most of the strata inclinations are the result of draping of the clays across a complex till mass.

Sediments exposed on south-facing bottom slopes at this location appear to be eroded. The strata in the pink clays meet the interface at a variety of angles and their exposures are clean, that is, they are free of any younger, covering sediment. At many localities underwater television scans have disclosed that this surface is strewn with pebbles and granules, some with sediment shadows. The discontinuous veneer of co rse clasts also is encountered in dredge samples taken at this locality.

As indicated above these pink clays are thought to be sediments deposited in a proglacial lake. The evidence for this conclusion includes the fine-grain size of the clays, their stratification and color, the lack of organics in them and the included coarse clastics. These features indicate both deposition from suspension sufficiently rapid to inhibit reduction of the ferric iron and deposition at a location where the quantity of organics available for incorporation into the sediments was minimal. The coarser clasts might well have been rafted in by ice and the ostracodes were probably surface dwellers. The edge of the ice at this time most likely was at the moraine through Geneva.

The pink clays exposed at this locality are typical of what is found at depths of 10 - 40 meters in the northern two-thirds of the lake. At lesser or greater depths it appears that these sediments are mantled by younger sediments so that exposure of the clays is the result of a bottom process which selectively removes any sediment deposited at that depth. At the same time, the pink clay is eroded presenting the fresh clay surface seen on the lake floor at the depths specified.

Our work indicates that the internal waves are the only likely sediment transport agent capable of erosion at specific depths in the lake. Internal waves are a dynamic feature of thermoclines in most bodies of water and their existence in Seneca Lake is well documented (Hunkins and Fliegel, 1973; Ahrnsbrak, 1978). They apparently move from south to north in the lake and on striking the south-facing slopes at location 3 they break and erode the bottom sediment. A likely analogy would be that of waves striking a shoreline and carrying away the fine-grained sediment exposed there.

STOP 4

From STOP 3 the ship will pass over a canyon-like feature on the floor and then move south across steep bottom slopes to the flatter floor typical of the deeper parts of the lake. At this location the sediments are very fine-grained, black to very dark gray, stratified and rich in organics. The subbottom profiles indicate that the black muds often overlie older sediments which have the acoustic characterics of the pink clays. These black muds are found over most of the deep floor of the lake. They contain no shell material, few grains coarser than fine silt and much sulfide. South of Geneva the black muds often are as much as eight meters thick. Near large deltas these muds contain turbidite sands and at the base of the steeper slopes subaqueous slide beds as part of the sequence (Woodrow, Blackburn and Monahan, 1969). The deep lake muds are deposited mainly from suspension the fine material having been carried into the lake by streams and by erosion of older, bottom sediments by internal waves.

Our return cruise will carry us back across the bottom facies and varied bottom topography at the north end of the lake.

SUMMARY

The glacially-carved Seneca Lake valley is partly filled with proglacial lake sediments which were laid down on still older Pleistocene sediments. The proglacial lake sediments were subsequently buried by organic-rich sediments. Carbonates are presently accumulating in shallow water parts of the lake where sediment influx is low and sands are accumulating where wave-generated bottom currents sweep the bottom. The deep lake is floored by organic-rich, black muds. At intermediate depths proglacial lake clays are being eroded by internal waves which move the eroded material to the deeper parts of the lake.

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