

FITTING NEWLY DISCOVERED NORTH-SHORE GILBERT-TYPE LACUSTRINE DELTAS INTO A
REVISED PLEISTOCENE CHRONOLOGY OF LONG ISLAND

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During the Quaternary deglaciation(s) of Long Island and vicinity, meltwater lakes formed in the low areas lying between the wasting ice to the north and Long Island and/or a terminal-moraine ridge on the south (Fig. 1). Newly exposed foreset beds of Gilbert-type deltas (Sanders, Merguerian, and Mills, 1993) are part of an extensive pro-glacial lake formation whose island-wide extent has not been previously recognized. We infer that the age of this large lake, which we propose to call "Long Island Lake" (or "Lake Long Island"), is mid- or even early Pleistocene and that it was enclosed on the S by the high parts of Long Island to the W and by a now-eroded pre-Ronkonkoma terminal moraine that extended S and E of Montauk and possibly also encircled what is now Cape Cod (Fig. 2). We fit the deposits of Long Island Lake into the new stratigraphic framework we are developing for the local Pleistocene deposits (Sanders and Merguerian, 1991a, b; 1992) as follows: they are younger than the oldest of the tills deposited by a glacier that flowed from the NNE to the SSW (Early Pleistocene?) and older than at least one of the tills deposited by a glacier that flowed from NNW to SSE, the older of which we think deposited the Ronkonkoma moraine and the younger of which, the Harbor Hill moraine. We think that deposits of the youngest Wisconsinan glacier, the Woodfordian, are not present on most of Long Island (they are restricted to parts of Queens).

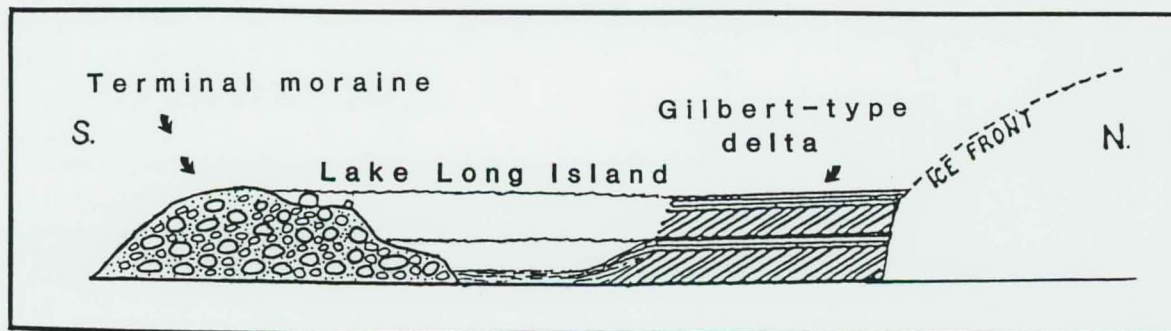


Figure 1. Schematic profile-section showing Gilbert-type deltas on N side of Lake Long Island, which formed in the lowland between the ice front on the N and the terminal-moraine ridge on the S. Two levels are shown: the lower at +40 feet and the upper at +80 feet (referenced to modern sea level). Highlands of Long Island, underlain by Cretaceous strata, could also serve as a dam for the lake on the S side. (Adapted from a figure in Woodworth, 1901.)

Numerous papers have been published about the varved clays, deposited in Late Wisconsinan proglacial lakes, which are present in every major lowland area in the New York metropolitan area (Long Island Sound, Hudson Valley, Hackensack Valley) and in central Connecticut-Massachusetts. (See references by Antevs; Reeds; Newman; Schaffel; Ashley; Shove; Frankel and Thomas; Bertoni, Dowling, and Frankel; and Lewis and Stone.) Such proglacial-lake deposits formed during the meltdown phase of the last Wisconsinan glacier (the Woodfordian). Their ages lie in the range of 13 to 11 ka.

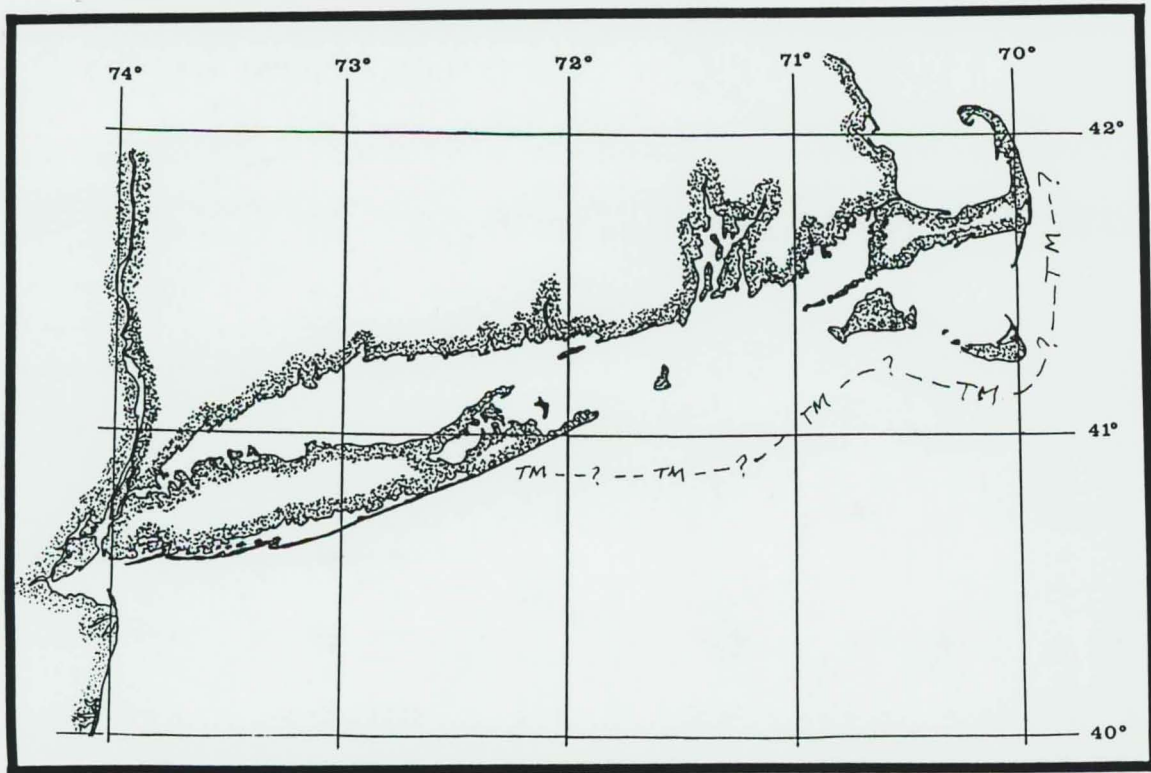


Figure 2. Outline map of southern New England and Long Island showing speculative position of a now-vanished terminal moraine marked by TM - - ? - - TM - - ? that we infer must have existed to serve as a dam for the lake in which the lacustrine strata in the coastal cliff at Montauk Point was deposited.

Described here are the results of our studies (1) of exposures at a few localities along the north-shore cliffs of Long Island that became visible after the severe storms of the winter of 1992-93 had undercut the lower parts of the cliffs and (2) of the cliffs at Montauk Point (Fig. 3) made before the sediments there were mostly covered by shore-protection structures. After the storms had "pulled back the drapes" formed by the ubiquitous slopewash from the top parts of the cliff to reveal the long-hidden strata lurking below, we found significant new pieces to the complex puzzle of the Quaternary history of Long Island that numerous geologists have been trying to fit together for many years.

Mather's sketch (1843) of a section at Lloyd's Neck exposed after storms had eroded the north-shore cliffs, published 42 years before G. K. Gilbert (1885) presented his analysis of the topographic features of lake shores in which he proposed the terms *topset*, *foreset*, and *bottomset* as the three kinds of lacustrine deltaic strata formed along the shores of ancient Lake Bonneville, Utah (and 47 years before Gilbert's Lake Bonneville monograph was published in 1890), shows series of dipping strata that had been truncated and are overlain by horizontal strata (Fig. 4).

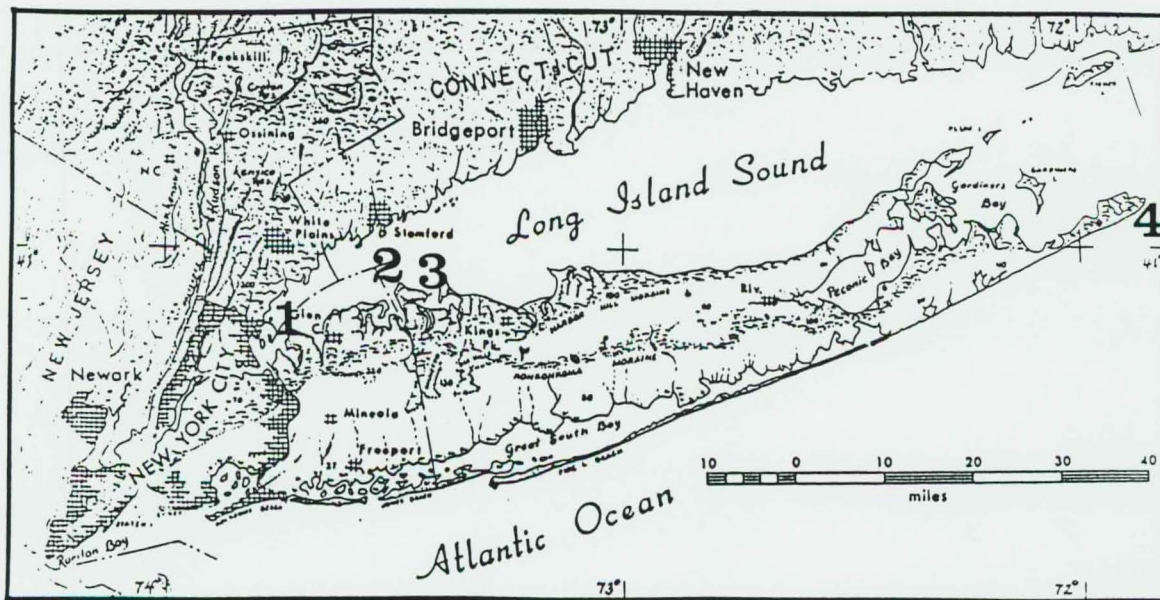


Figure 3. Physiographic index map of Long Island. Numbers show localities: 1, Sands Point; 2, Caumsett State Park; 3, Target Rock National Wildlife Preserve; 4, Montauk Point. (Base from J. A. Bier, 1964.)

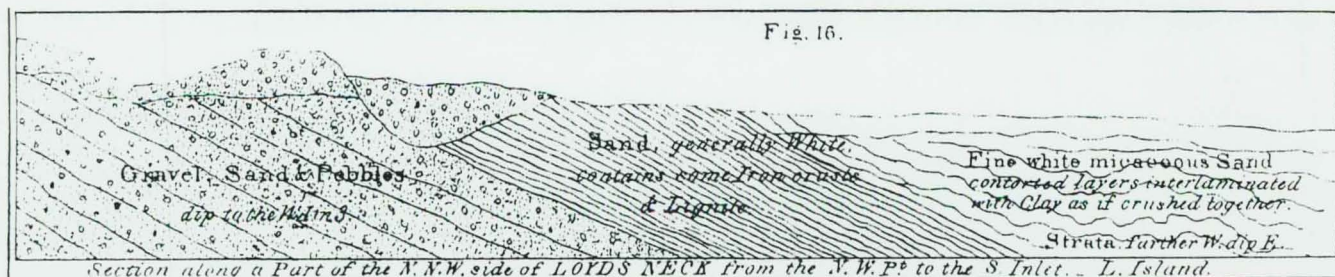


Figure 4. Sketch of foreset beds, with component of W dip (to R), that are discordantly overlain by till. Lloyd's Neck (now Caumsett State Park). (Mather, 1843, Plate 4, figure 16.)

Fuller (1914) showed many examples of cliff sections exposed by storms. A few of his sketches from Montauk Point and vicinity show what he referred to as "Montauk till" with interstratified gravel, sands, and clays in dipping layers (Figs. 5 and 6). Fuller inferred that such dips had resulted from the effects of glacier-flow ("ice-push") deformation of initially horizontal strata. Although we have not seen the exact localities shown in these two Fuller sketches near Montauk, we have seen dipping diamictons (Flint, Sanders, and Rodgers, 1960b) near Montauk Lighthouse that closely resemble dipping deposits that Fuller assigned to the "Montauk till." (What we consider to be the Montauk Till in the exposures near the Montauk Lighthouse displays no discernible dip. We infer that the dipping diamictons are foreset layers of a Gilbert-type delta complex consisting of the products of sublacustrine debris flows.)

Mather used the name "Long Island Formation" informally for the sediments that he thought underlie most of the island; he assigned this formation to the Tertiary. Mather's term has been abandoned, but we are considering the feasibility of reviving it for the pre-Wisconsinan, extensive suite of sediments deposited in Long Island Lake.

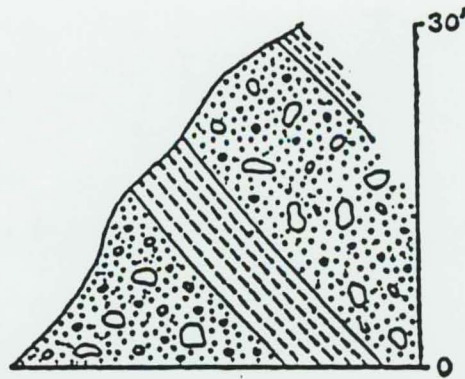


FIGURE 156.—Section 1 mile west of Rocky Point, Montauk, showing intercalated bed of gravel in Montauk till member.

Figure 5. Fuller's sketch of exposure 1 mi W of Rocky Point, Montauk showing dipping diamictons and intercalated well-bedded strata. Based on what is exposed at Caumsett State Park, we infer that all these dipping layers are deltaic strata, the diamictons being products of subaqueous debris flows, not tills. (M. L. Fuller, 1914, fig. 156.)

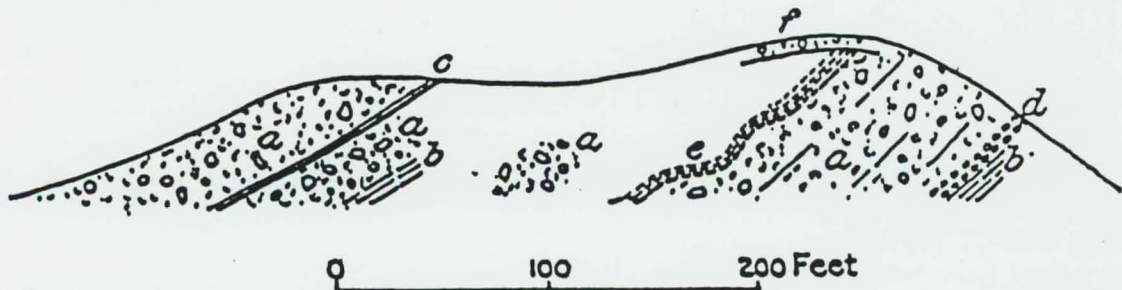


FIGURE 157.—Section half a mile south of Cullodan Point, Montauk, showing intercalated sand and clays in Montauk till member. *a*, Montauk till member; *b*, clayey sand; *c*, clay; *d*, gravel; *e*, sand; *f*, Wisconsin till.

Figure 6. Fuller's sketch of exposure 0.5 mi S of Cullodan Point, Montauk, showing a dipping succession of diamictons and well-bedded strata and overlain by a horizontal till (*f*, at top; "Wisconsin till" in Fuller's caption. Other letter notations, after Fuller, are: *a*, "Montauk till member"; *b*, clayey sand; *c*, clay; *d*, gravel, and *e*, sand. (M. L. Fuller, 1914, fig. 157).

Woodworth (1901) reported on the Pleistocene geology of Queens County. His illustrations of delta foresets and -topsets came from the large sand pit in Port Washington during the early days of its active phase (Fig. 7). (This pit is no longer operating.)

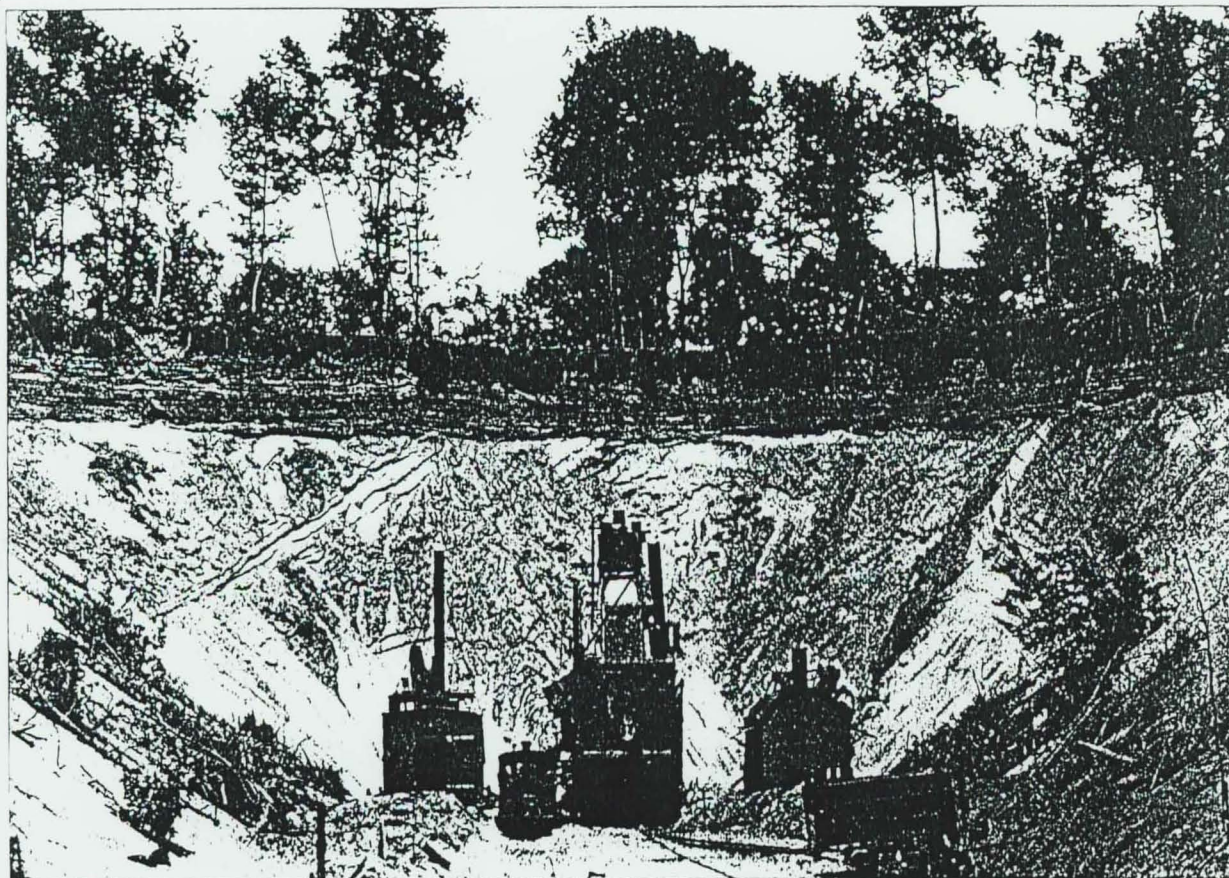


Figure 7. Photo (by H. Ries) of horizontal topsets (top, beneath trees, and inclined foresets of a Gilbert-type delta exposed in 1901 in a Port Washington sand pit. (J. B. Woodworth, 1901.)

DESCRIPTIONS OF THE DELTAIC STRATA

Our descriptions are based on four localities, in three of which are found new exposures created by storm erosion. In the fourth locality, Montauk Point, as mentioned, parts of the important exposures are no longer visible.

Sands Point

Except for a thin (1 m or so) till and overlying loess at the crest, the body of the cliffs E of the place where the trail ends at a wooden stairway to the beach at Sands Point is composed of outwash. The top third consists of pebbly, trough-cross-stratified typical coarse outwash, with flow indicated toward the S or SW.

At the E end of the first stretch of beach E of the trail, strata of sands dip steeply (ca. 45°) into the cliff. At first sight from a distance, this dip appears to be the kind of thing that results from rotational tilting

on a slumped block. The proof that these are *true Gilbert-type delta foresets* is that **horizontal sets** of coarse, trough-cross-stratified pebbly outwash overlie the inclined foresets and truncate them along a horizontal surface. Moreover, the composition of the foresets differs from that of the topsets; the foresets are finer grained and regularly bedded.

Just to the W of where the stairway leads to the beach, is exposed a **red-brown till filling a U-shaped valley carved into the delta deposits**. We infer that this means the delta cannot possibly be of Wisconsinan age, but must be older than one of the tills deposited by a glacier that flowed from NW to SE (to deposit the red-brown till).

In an exposure E of where the road leads down to the seawall in distress, a small, shallow boulder-lined U-shaped trough had been cut into the delta topsets and backfilled with till, now totally reworked by outwash streams. (An exactly comparable relationship is shown in Mather's sketch of Fig. 4; and a closely analogous but larger, boulder-lined channel formerly was visible cutting into the lake sediments at Montauk Point that form the bulk of the eroding cliff S of the lighthouse.) By digging, we uncovered the truncated layers in the topset sands and the fact that any boulders containing biotite have decayed considerably.

Caumsett State Park

The relationships found at Sands Point generally prevail also at Caumsett State Park. At Caumsett, however, inclined pebbly beds predominate in the foresets. Based on the increase in gravel in the delta foresets eastward from Sands Point to Caumsett State Park, we think that the vaguely stratified diamictites having displaying prominent dips do not represent deformed till but rather are deltaic deposits, products of sublacustrine debris flows. Among the pebbles are **numerous decomposed mafic metamorphic rocks**. We take these decomposed rocks as evidence that the age of this deltaic deposit is pre-Wisconsinan.

Target Rock

At Target rock, the lower half of the cliff consists of till containing the green porphyritic mafic erratics from the Maltby volcanics W of New Haven, CT, indicating the ice flowed from NNE to SSW. We correlate this till with the oldest till at Croton Point Park (the gray till containing decayed granite stones; Merguerian and Sanders, 1992). Above this till is 1 cm or so of fine gray clay, and then come ripple-laminated silts/fine sands, with splendid examples of climbing ripples (as illustrated by Sirkin and Mills, 1975, description of Stop 3A). These rippled strata display lateral particle-size changes along the ripple profiles from coarser to finer, with superposition of these yielding "pseudo-bedding." We infer that these rippled sediments and the clay are the bottomset beds, if you will, of the delta foresets exposed at Caumsett State Park. Another thin till at the top of the cliff at Target Rock must have come from the NNW; it would have been deposited by a glacier that flowed from NW to SE, to bring the erratics of Inwood Marble and Cortlandt Complex (Sanders and Merguerian, 1991b). If this is correct, then the age of the newly discovered delta deposits must be no younger than mid-Pleistocene (younger than old gray till from NNE and older than a till deposited by a glacier that flowed from the NW).

Montauk Point

The significant relationship about the lake deposits at Montauk is that they are being eroded in a cliff that faces the open Atlantic Ocean. Given the requirement that a terminal moraine is required to serve as a dam along the southern margin of any proglacial lake that now faces the open ocean of extreme eastern Long Island, then the lake sediments near the Montauk lighthouse require us to infer that a terminal moraine, older than and lying south of the Ronkonkama Moraine, formerly existed seaward of the present S shore of eastern Long Island and has been eroded and submerged. (See Figure 2.)

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