# BOULDERS AND THE 2 TILL PROBLEM ON LONG ISLAND

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## Introduction

This paper examines 2 till sheets on Long Island, NY and uses an obvious difference between them to derive an estimated age for the older till.

### Description

Many geological studies have recognized and described two drift sheets on western Long Island each composed of till and outwash. The youngest till is found at, or near, the surface throughout most of the area north of the Harbor Hill Moraine. It consists of lodgment till that was deposited as ground moraine when the glacier advanced, and ablation deposits that melted out of the ice during the final recession of the Laurentide ice sheet during the Late Wisconsinan, Woodfordian Substage. The maximum advance occurred about 22,000 years before present (YBP) when drift was deposited at a stationary margin forming the Harbor Hill Moraine. Recession of the glacier on western Long Island began prior to 20,000 YBP and Long Island was ice-free by 18,000 YBP. Numerous C-14 dates on Long Island, in Connecticut and up the Hudson Valley provide a chronology of this advance and retreat. (Connally & Sirkin, 1973)

The older till is also widespread but not widely exposed due to its subsurface position beneath the thick Woodfordian drift. In various locations, it may be absent due to erosion, non-deposition, lateral facies changes to stratified drift, or pinching and swelling caused by glacial tectonics. Also, it may be recognized by perched water in wells where it is often recorded in driller's logs as "hardpan".

The lower till is readily distinguished from the upper till on western Long Island by its light-gray/gray-brown color, dense nature, characteristic badlands erosion pattern, and lack of large boulders. Outcrops fitting this description are scattered across Long Island from the Montauk Peninsula, from whence it gets its name "Montauk Till" (Fuller, 1914), to Port Washington where it is widely exposed in a former sand mine on the west shore of Hempstead Harbor. It was briefly exposed in Roslyn Heights (1967) and Glen Cove (1970) during road-widening projects, and is found in Port Jefferson (Stokes & Sirkin, 1995) and in sea cliffs on Lloyd Neck, and the North Fork. It is 15 meters or more in thickness near Montauk but, more typically, is only 2-3 meters at other outcrops.

After years of investigation and debate, the age of this till is still undetermined since it pre-dates the C-14 dating range. Fuller placed the till in the Illinoian Glacial Stage and said it was

followed on Long Island by the deposition of the marine Gardiner's Clay during the warm Sangamon Interglacial Stage (ca. 120,000 YBP). Most, but not all, later investigators (MacClintock & Richards, 1936, de Laguna & Perlmutter, 1949, etc.) assigned the Montauk Till to the Early Wisconsinan, Altonian Substage (ca. 70,000 YBP). The problem remains that since the limits of C-14 dating are exceeded in both these cases no indisputable absolute dates have been possible despite attempts using high-tech methods including uranium/thorium radioactive decay, amino acid racemization, and optical stimulated luminescence.

Proposed here, is a low-tech approach that uses a prominent difference between the two tills to distinguish between an Illinoian or Wisconsinan age. We know that the lower till is more compacted and it shows signs of moderate weathering in the upper meter (+ or -) of some outcrops. Far more obvious is the low number of boulders over one meter in length that are found in the lower till compared to the abundance of meter-plus boulders in the upper till. Even more striking is the relative abundance of very large (7m+) and giant (10m+) boulders that are imbedded in, or resting on, the surface of the upper till. What might cause this dramatic difference and how might it relate to the ages of the two tills?

Discussion

Glacial advances (of whatever age) had to travel the same distance across the same ancient bedrock to reach Long Island. So why did the earlier advance primarily collect erratics of cobble to small boulder size while the Woodfordian advance removed and transported numerous huge boulders? The answer should be directly related to the condition of the land surface to the north of Long Island. If a long warm interval, such as the Sangamon Interglacial, preceded a glacial advance, the land surface (in this case New England and eastern New York) would have been covered by deep regolith formed during 50,000 years, or more, of weathering of the bedrock. The first ice sheet to advance over this weathered surface would have stripped away the loose rocks and soil, but the solid bedrock below would have been protected from major excavation by the regolith buffer.

Upon retreat of the glacier, if the region remained relatively cool, with long intervals of winter freezing and summer thawing, water would have penetrated deep into the joint surfaces of the tough metamorphic and igneous rocks that dominate southern New England and the Manhattan Prong in New York. During the Woodfordian, a powerful glacial advance, evidenced by large-scale ice-thrusting on Long Island (Mills & Wells, 1974), quarried large blocks of bedrock from the mainland and transported these intact boulders some 10 to 20 miles south to the north shore of the island. A sizeable percentage of these massive boulders show that they were plucked along joint surfaces. If this scenario is correct, which sequence of events best describes the age of the lower (Montauk) till?

The Illinoian was a long, cold glacial stage that began almost 300,000 YBP and lasted with only one significant break until the Sangamon Interglacial began at 128,000 YBP. The Sangamon warming trend lasted over 50,000 years during oxygen isotope stage 5 (OIS 5), until the onset of Altonian glaciation during OIS 4 (Martini, Brookfield & Sagura, 2001). The stage 5 warming would have provided an adequate length of time for a significant buildup of regolith due to weathering of the bedrock surface.

It is proposed that during the Altonian, a glacial advance that peaked around 70,000 YBP removed this loose material and deposited it as the Montauk Till on Long Island. The mid-Wisconsinan OIS 3 was a time of less extensive glacial advances and retreats with evidence of glacial margins in the vicinity of the Canadian border. During this interval southern New England and New York were mainly ice-free but subjected to harsh winter conditions more like that found in northern Canada today. Under such conditions the bedrock would have been exposed to ice-wedging in joints and other fractures; perfect conditions for quarrying and transport of large boulders to Long Island during the OIS stage 2 maximum about 22,000 YBP.

Conclusion

Applying this model to an Illinoian age for the Montauk Till is more problematic. It would require that regolith from a mid-Illinoian OIS 7 warm period over 200,000 YBP was removed during a late- Illinoian, OIS 6 advance to produce the Montauk till. Furthermore, in this scenario, over 100,000 years of Sangamon and post-Sangamon weathering of the bedrock would not have produced enough regolith to mitigate deep plucking of large joint-faced boulders during the Woodfordian glaciation. The model also assumes that an Altonian advance never reached Long Island and that any till from that glaciation was left on the mainland.

Given the choice between an Illinoian or Altonian date, the evidence provided by the large boulders is simpler and more plausible* when applied to an Altonian age for the lower till on Long Island.

[*Principle of Occum's Razor: Among competing hypotheses, until proven, the one with the fewest assumptions should be selected.]

Addendum

The occurrence of a "Montauk-like" lower till 100 miles to the west of Montauk Point in Nassau County or 100 miles to the east in Martha's Vineyard or Nantucket does not necessarily imply that these tills all were deposited at the same time. In fact, at least five major ice lobes controlled the direction and timing of the ice flow over the 200 miles between New York City and Cape Cod. Therefore, dates measured in one region may not provide accurate dates for similar looking deposits in adjacent lobes of the glacial margin. But, irrespective of its age, the

characteristics of a till should reflect its source and whether it mainly consisted of regolith or bare rock.

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