

Seismic stratigraphy in Southern Long Island Sound:
the role of lateral transport in clinoform development

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Seismic profiles allow us to image sedimentary horizons within the earth, and the patterns seismic profiles reveal can provide important information about the development of sedimentary sequences in modern environments. New high-resolution seismic profiles from the south shore of central Long Island Sound (off Wading River) show the presence of a 20 m thick, wedge-shaped, layered sedimentary deposit lying 3 to 6 km offshore that is elongated parallel to the shoreline (Figures 1 and 2). The layering within this sedimentary deposit dips offshore, and the layers build offshore to form a clinoform pattern (Figures 2a and 2b). Samples show this to be a zone of muddy sediments. The clinoform layers are deposited on top of older sediments that are interpreted to be deformed because of their contorted nature (*L* on Figure 2b; Lewis and Stone, 1991). To the north, the clinoform layers build out on top of these apparently flat-lying deformed layers. To the south, notches have been cut in the older sediments at several positions (*N* on Figure 2b). Ridges have deposited on top of some of these notches before being buried by the layered sediment deposit (*S₁*, *S₂* and *S₃* on Figure 2b). Gayes and Bokuniewicz (1991) have interpreted these notches and ridges to be wave-cut terraces and sand spits, respectively, formed during the most recent post-glacial (Holocene) sea-level rise (Figure 3). These terraces and sand spits have been covered by the layered sedimentary deposit.

Of particular interest is the origin and depositional history of the layered sediment deposit. Shallow-water sedimentary deposits with prograding seaward-dipping reflections (clinoforms) are often interpreted as deposits formed by the offshore transport of land-derived sediment, in particular fine-grained sediments deposited in front of a delta (prodelta muds; Vail et al., 1991). There are several possible sources of fine-grained sediments to this site in Long Island Sound during sea-level rise. The few Long Island rivers that flow north into Long Island Sound are small and do not appear to have formed deltas. Thus these layered sediments are probably not prodelta muds. Many rivers flow into northern Long Island Sound along the Connecticut shoreline. The largest rivers are the Housatonic River northwest of the study area and the Connecticut River northeast of the study area. Fine-grained sediment may also enter Long Island Sound from the Hudson River through the East River. One additional possible source of the fine-grained sediments deposited here is the erosion of glacial and pre-glacial sediments along the northern shore of Long Island, especially the erosion of the Cretaceous clays exposed in headlands to the west. Eroding glacial deposits may also contribute fine-grained sediments. In order to reach the study site from sources to the west or north, sediments need to be transported around the end of Long Island Sound, most likely the western end as available seismic profiles and morphological evidence suggests that this layered deposit is not present far to the east of the study area. This transport is probably associated with surface circulation patterns in Long Island Sound.

The age of the sediment deposit can be estimated through reference to previous studies of sea-level change during the post-glacial sea-level rise (Figure 3). The oldest sediments in the layered wedge deposit at about 45 meters below sea level appear to have been deposited more recently than 10,000 to 11,000 years before present. A reflection within the layered wedge deposit (*I* on Figure 2b) can be traced to beneath the deepest sand-spit deposit at 30 meters below sea level, suggesting an age of about 7,000 to 9,000 years before present. This reflection is now buried by up to 12 m of sediment, suggesting a maximum accumulation rate of 1.7 to 1.3 mm/year. Using this rate, we calculate that the uppermost 45 to 60 cm of the sediment at this site has been deposited since European settlement in the 1600's. These sediments may thus contain an important record of natural and man-induced environmental and climate variability that should be further investigated.

References Cited:

Gayes, P.T. and Bokuniewicz, H.J., 1991. Estuarine paleoshorelines in Long Island Sound. *Journal of Coastal Research*, SI #11, pp. 39-54.

Lewis, R.S. and Stone, J.R., 1991. Late Quaternary stratigraphy and depositional history of the Long Island Sound Basin: Connecticut and New York. *Journal of Coastal Research*, SI #11, pp. 1-23.

Vail, P.R., Audemard, F., Bowman, S.A., Eisner, P.N. and Perez-Cruz, C., 1991. The stratigraphic signatures of tectonics, eustacy and sedimentology -- an overview. In: Einsele, G., Ricken, W. and Seilacher, A., eds., *Cycles and Events in Stratigraphy*. Springer-Verlag, New York, 617-659 + refs.

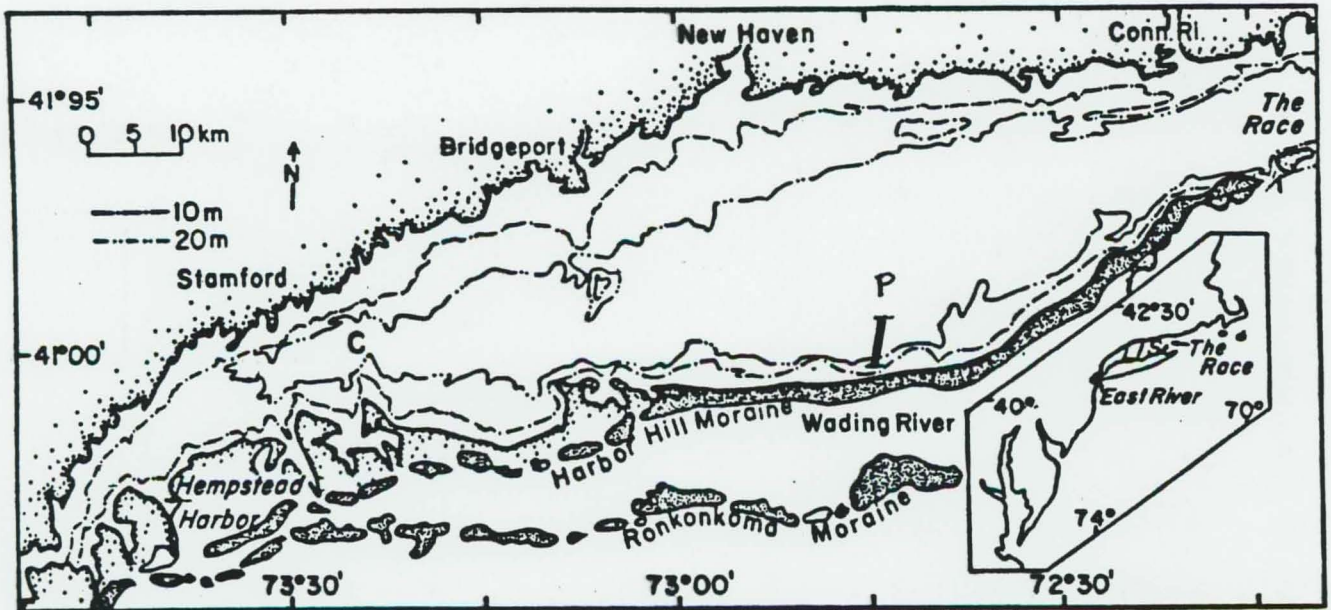


Figure 1: Map of Long Island Sound showing the location of the seismic line shown in Figure 2 (marked as *P*). Also shown are the locations of moraines on Long Island. The prominent headlands in western Long Island Sound (south of the *C* in Western Long Island Sound) are developed in generally fine-grained sediments of Cretaceous age (after Gayes and Bokuniewicz, 1991).

Figure 2 (overleaf): A high-resolution seismic profile collected of Wading River on the south-central shore of Long Island Sound. This profile was collected using the Geopulse profiling system and was replayed from tape-recorded data. A laminated wedge-shape deposit has filled in along the southern margin of Long Island Sound. Similar seismic units are often thought to form in deeper water off sediment sources such as deltas. However, only small rivers exist on the northern shore of Long Island. These sediments have probably been transported to this area by currents flowing westward along the south shore of Long Island Sound. Upper: original seismic record. Lower: line drawing of key reflecting horizons. *L* is top of underlying deformed layer, *N* marks wave-cut notches, *S₁-S₃* are sand spits formed during sea-level rise, *I* is an important internal reflector within the clinof orm sequence. *M* indicates a multiple reflection, this is an artifact caused by the sound bouncing two or more times in the water column, it does not represent a subbottom horizon.

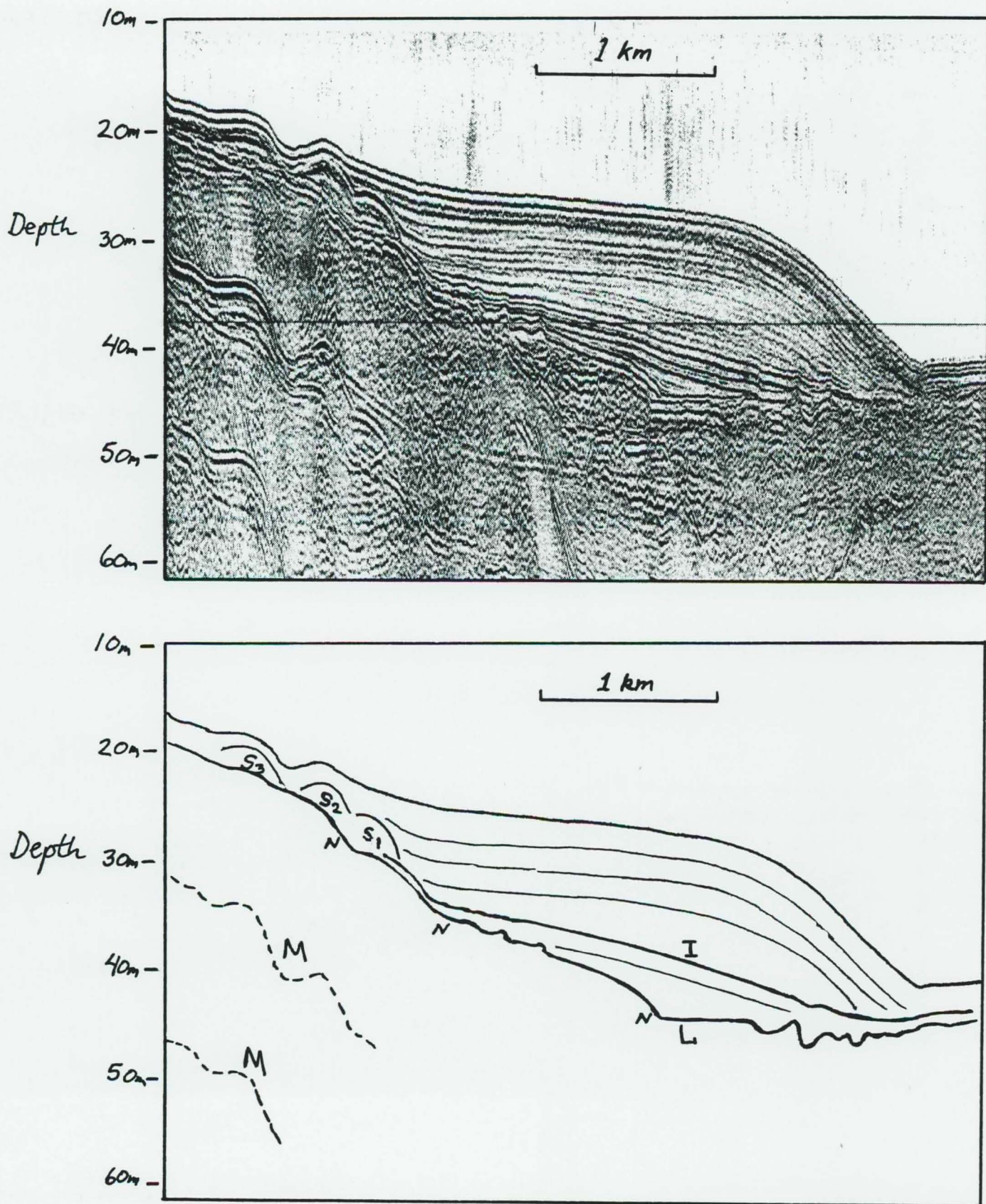


Figure 2

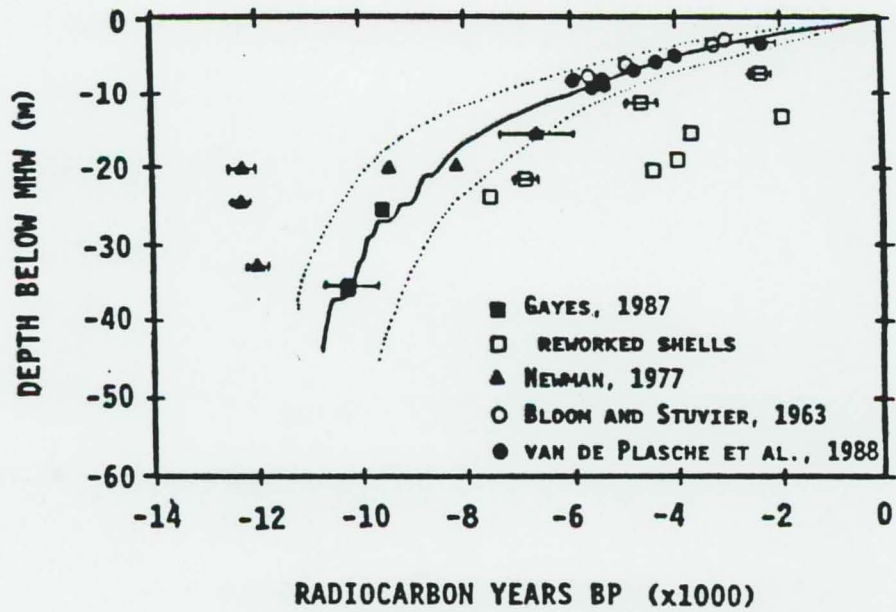


Figure 3: Plot of post-glacial sea-level history for Long Island Sound determined by radiocarbon dating of deposits thought to have formed near sea level (from Gayes and Bokuniewicz, 1991). Sea level rose at a high average rate (about 10-15 cm per year) to about 8,000 years before present. The average rate of sea-level rise since then has been relatively constant at about 1.5 mm per year.