GRAIN-SIZE ANALYSIS OF CRETACEOUS AND PLEISTOCENE SEDIMENTARY FACIES EXPOSED AT CAUMSETT STATE PARK, LLOYD NECK, NEW YORK

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INTRODUCTION

Sediment samples collected from glacial and non-glacial facies exposed in the beach cliffs at Caumsett State Park were characterized by cumulative weight percent plots of the sand- and gravel-sized grain populations. These plots provide easily interpreted quantitative summaries of the grain size and sorting parameters of individual beds and allow comparison between stratigraphic levels and localities. A total of eleven samples were analyzed from a variety of accessible strata, including poorly sorted glacial sediments (till and outwash), Cretaceous sands, and sands of uncertain origin.

The Cliffs and Caumsett

Located on Lloyd Neck, Long Island (USGS Lloyd Harbor 7.5' quadrangle), Caumsett State Park includes almost two kilometers of north-facing coastline (Fig. 1) along which a prominent vertical cliff face is eroding, revealing as much as 30 meters of sedimentary deposits. These deposits encompass a complex mix of Pleistocene strata, including loess, glacial tills, and glacial outwash, as well as an extensive block of ice-thrusted Cretaceous sediment consisting of light-colored sands interbedded with clay layers (Sirkin, 1996). A number of general field descriptions of the deposits at Caumsett have been published over the years (e.g. Fuller, 1914; Sirkin, 1996; Merguerian and Sanders, 1996) and recently, a more detailed attempt at a stratigraphic description has appeared (Mandell, 1999). Here, we augment these previous descriptions with a detailed sedimentological analysis of several of the major stratigraphic units exposed at Caumsett.

METHODS

The cliff exposures at Caumsett State Park were photographed using a digital camera to create a continuous record of the stratigraphy from west at the fishing access eastward to the end of the cliff line (Fig. 1). Samples were collected from prominent facies exposed at accessible levels near the beach to avoid climbing on the cliffs, which is not allowed by the Parks Department. In one case, samples were collected from a slump block that had moved an intact and clearly identifiable section of the upper cliffs down to beach level. Sediment samples of approximately one liter volume were collected from shallow excavations using a hand trowel. Although the surface of the outcrop was cleaned prior to taking each sample, digging was kept to a minimum to avoid any undermining of the slope of the cliffs.

Sediment samples were wet-sieved to remove all silt- and clay-sized sediment and then dried. The sand and gravel fractions of each sample were then sieved into half-phi size fractions using standard ATM sieves in a sequence from gravel (-2 phi) to very fine sand (4 phi). Each half-phi fraction of the total sample was weighed to calculate weight percent and graphs of cumulative weight percent were plotted on a probability scale for comparison between samples. This type of plot is useful for identifying populations of grains within a sample that derive from different processes active in the environment during deposition (Friedman, et al., 1992).

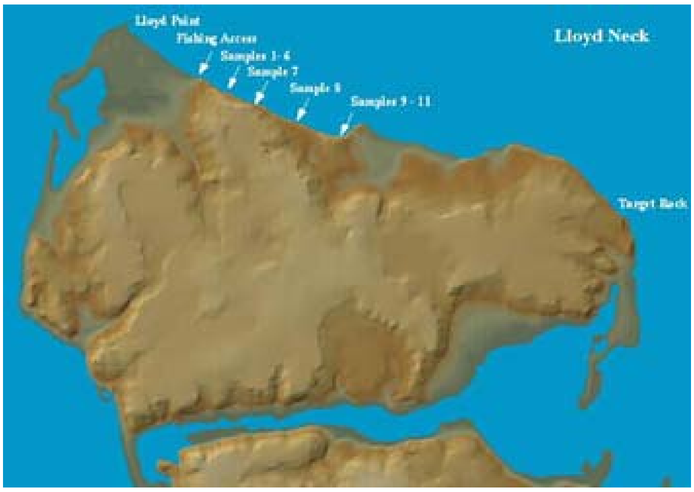

Figure 1. DEM topographic map of Lloyd Neck showing sampling locations. V.E.=2

RESULTS

Sample Locations

The eleven sediment samples analyzed in this study were collected to form a representative west to east transect of the major facies exposed at Caumsett and described in previous studies. Eastward of the fishing access at the northwest end of the park, the cliffs expose a sequence of south-dipping, gravelly sand layers that have been described as outwash with intermixed flow till (Sirkin, 1996) and as the foreset beds of a Gilbert-delta that prograded from the ice front out into a glacial lake (Merguerian and Sanders, 1996). Where not covered by slumping, these layers rest above light-colored Cretaceous sands and the contact is marked by a prominent, thin, orange-weathering sand layer. Sample 1 was collected 10 cm below the contact in the Cretaceous sands, sample 2 was collected from the contact bed, and sample 3 was collected from the pebbly sands 10 cm above the contact bed (Fig. 2).

A similar sequence of samples was collected approximately one hundred meters to the east where a slump block has carried the same stratigraphic contact from higher up the cliff down to beach level. Here the contact is also marked by a thin, sandy layer, but it is thinner and less distinct from the sediments below than observed to the west. Sample 4 was taken from the white sands below the contact, sample 5 from the bed at the contact, and sample 6 from the pebbly sands above the contact (Fig. 3).

Figure 2. Outcrop at west end of cliffs with sample locations.

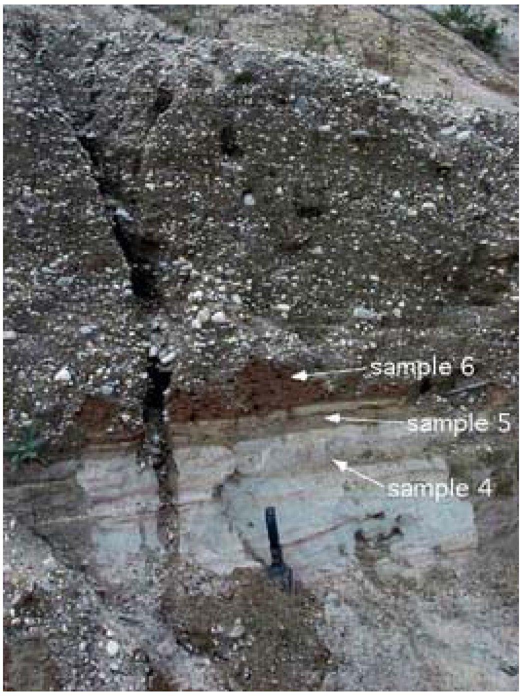

Figure 3. View of contact between Cretaceous and Pleistocene sediments with sample locations.

Approximately 500 meters east of the fishing access the cliffs are dominated by outcrops of white sands interbedded with clay. This area exposes the core of what has been described as a large block of Cretaceous sediments thrust up by the advance of glacial ice and incorporated into the outwash deposits of the moraine (Sirkin, 1996). Sample 7 was taken from the lower part of the white sand interval.

Figure 4. View of Cretaceous sands and clays and sample location.

Approximately 750 meters east of the fishing access the cliff line descends until it is less than 7 meters above the beach. Here the Cretaceous sediments are absent and the exposure reveals beige-weathering sands and till. Sample 8 is from a prominent sand layer near the top of the exposure (Fig. 5).

Figure 5. View of outwash sand unit and sample location.

Approximately 1200 meters east of the fishing access the cliff line rises again to reveal a sequence of strata dominated by what appear to be glacial tills with prominent boulders imbedded in the cliff face. Sample 9 was collected from midway up the cliff face near two prominent boulders in the process of weathering out of the till (Fig. 6). Farther to the east the cliff line descends again and pebbly sands are exposed near beach level. Here there is a prominent color change in the till bed that marks a boundary separating indurated sediment below and loose, unconsolidated sediment above, near the base of the soil horizon. The soil itself appears to be developed in a layer of loess that caps the deposits across much of the cliff line. Sample 10 was collected from the unconsolidated sediments above the color change and sample 11 was collected from the indurated sediments below the color change (Fig. 7).

Figure 6. Till exposed at east end of cliff line with sample location.

Figure 7. View of contact between loose and indurated till.

Grain Size Analysis
Cumulative weight percent plots for all samples are shown in Figure 8. Three distinct clusters of plots are apparent. Cluster 1 includes samples 3, 6, 9, 10, and 11. These samples are from facies previously described as glacial till and outwash and are characterized by a high proportion of pebbles (between 15% and 60% of the total sample)

and poorly sorted sands (indicated by a shallow slope in the cumulative weight percent curve). Cluster 2 includes samples 1, 4, and 7, which are from non-glacial facies attributed to coastal deposition in the Cretaceous. These samples include a lesser component of poorly sorted granules and coarse sands mixed with well-sorted medium and fine sands. Sample 5 is also a member of Cluster 2, although it occurs at the contact between the Cretaceous sands and Pleistocene outwash and could be associated with either. Cluster 3 is made up of samples 2 and 8, which are distinctly different from the other samples in that they are predominantly well-sorted, fine sands. Like sample 5, sample 2 is also found at the contact between the Cretaceous sands and Pleistocene outwash. Sample 8 is from the eastern extent of the cliff face beyond the limit of Cretaceous outcrop where several units of Pleistocene outwash are exposed.

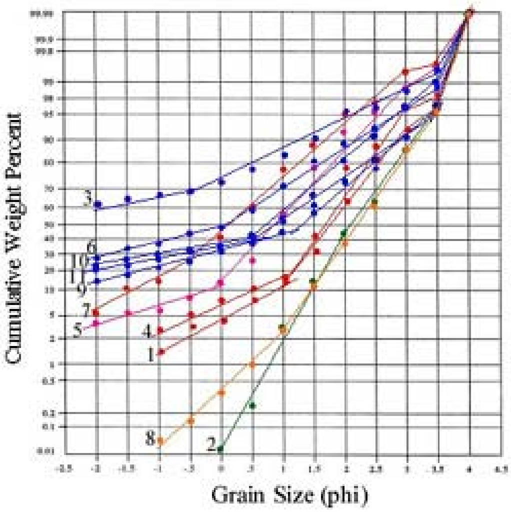

Figure 8. Cumulative weight percent plots for all samples.

DISCUSSION

Several observations emerge from grain size analysis that raise questions for additional research. Pebbly outwash from the western end of the cliff line (samples 3 and 6) are coarsely stratified in outcrop, forming indistinct beds that dip to the south at a shallow angle (Sirkin, 1996). Boulder-bearing tills exposed at the east end of the cliff line are unstratified (samples 9, 10, and 11). However, all of these coarse-grained glacial deposits are very poorly sorted and have very similar cumulative weight percent distributions (Fig. 9). This argues for a similar process of deposition for both unstratified and poorly stratified units at Caumsett suggesting that the poorly stratified layers exposed at the west end of the cliff line may be a type of flow till. Also, there is very little difference in the grain size distribution between the loose till (sample 10) and indurated till (sample 11) in contact at the east end of the cliff line (Fig. 9). This indicates that the upper loose till is not a distinct depositional unit and that its lack of induration is due to weathering and phytoturbation caused by its proximity to the soil horizon and exposure to plant roots.

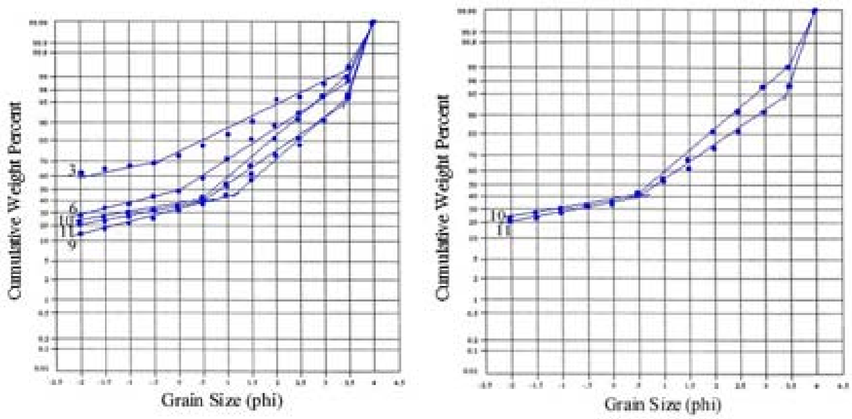

Figure 9. Cumulative weight percent plots for samples from poorly sorted till and outwash.

The samples from Cretaceous sands (1, 4, 7), which can be identified on the basis of their distinctive color and mineral content, also have similar cumulative weight percent distributions (Fig. 10). The overall shape of the curves is similar for individual samples, with some curves displaced upward due to larger amounts of pebbles and coarse sand (compare sample 7 to samples 1 and 4 in Fig. 10). It is interesting to note the significant difference in the two samples taken from the contact between the Cretaceous sands and overlying glacial drift (samples 2 and 5). Sample 2 is a well sorted, medium to fine sand with a cumulative weight percent distribution similar to that of sample 8 (Fig. 8), which must be glacial outwash due to its stratigraphic association with till deposits. The layer from which sample 2 was collected appears to be a good candidate for a bottomset bed, over which the sloping layers of poorly sorted pebbly sands could have prograded as a Gilbert delta (Merguerian and Sanders, 1996). However, the stratigraphically equivalent contact bed farther to the east that produced sample 5 appears to have more in common with the underlying Cretaceous sands, suggesting that bottomset beds are absent. Clearly, more detailed observations and additional samples are needed before the nature of the contact between the Cretaceous sands and Pleistocene drift and the genesis of the glacial deposits can be confidently interpreted.

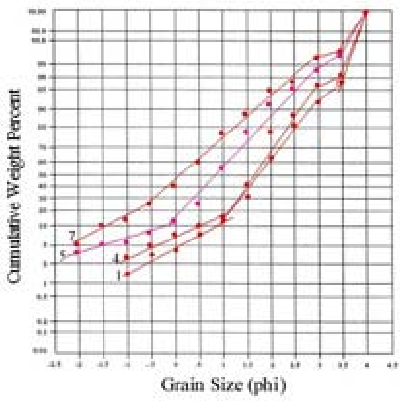

Figure 10. Cumulative weight percent plots for samples from Cretaceous sands.

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