B33A-03

Spatial and Temporal Variability of Sedimentary Environments in the Hudson River Estuary

Angela L. Slagle*, S.M. Carbotte, F.O. Nitsche, W.B. Ryan, R. Bell

Lamont-Doherty Earth Observatory, 61 Route 9W, Palisades, NY 10964, USA * contact: aslagle@ldeo.columbia.edu

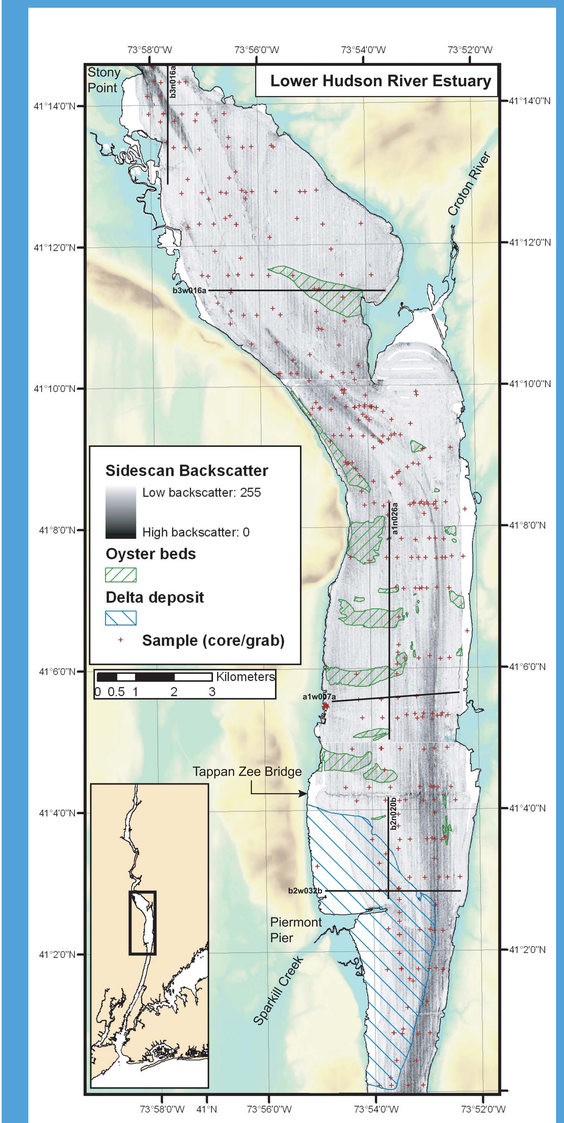

Figure 1 - Basemap of the Lower Hudson River Estuary, showing 100kHz sidescan sonar data. Key seismic lines are shown in black (see details in Fig. 2 - Fig. 9). Mapped oyster beds are shown in green and delta deposit is outlined in blue. Red crosses indicate samples, either grabs or sediment cores.

HAVERSTRAW BAY

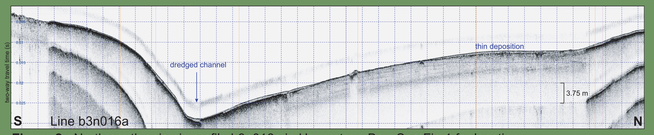

Figure 2 - North-south seismic profile b3n016a in Haverstraw Bay. See Fig.1 for location.

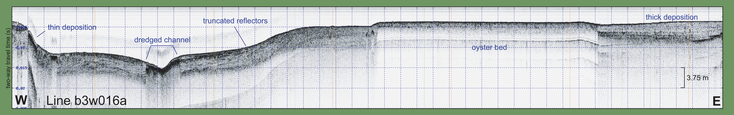

Figure 3 - East-west seismic profile b3w016a in Haverstraw Bay. See Fig.1 for location.

Haverstraw Bay is an area dominated by deposition, both thin (<0.5m) and thick (>0.5m) (Fig. 11). The broad channel has been frequently dredged and is characterized by a lack of seismic penetration (Fig. 2,3). This may be due to a rough surface that scatters sound or it may be an acoustically-impenetrable gas layer associated with the high organic content of post-dredging deposition.

Figure 4 - Stony Point (bedrock) is an area of dynamic scour.

Relic oyster beds are imaged on the shallow, wide flats on the east side of Haverstraw Bay (Fig. 1,3). More beds may be buried beneath thick sediment in this area, but sampling has not yet confirmed their identification.

TAPPAN ZEE

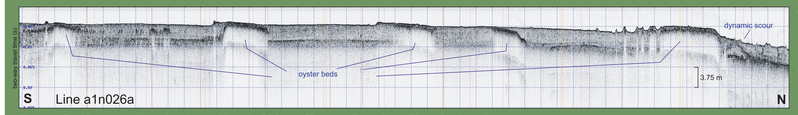

Figure 5 - North-south seismic profile a1n026a in Tappan Zee. See Fig.1 for location.

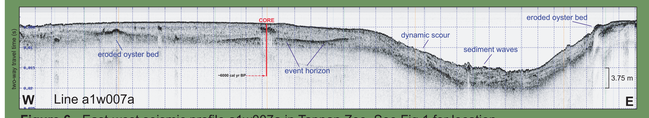

Figure 6 - East-west seismic profile a1w007a in Tappan Zee. See Fig.1 for location.

The **Tappan Zee** area has wide, shallow flats west of the channel which experience mainly erosion or non-deposition (Fig. 11). The channel is dominated by dynamic scour, a process involving both deposition and erosion (Fig. 5,6,11). Dynamic sediment waves occur in the channel in the southern Tappan Zee (Fig. 6,11).

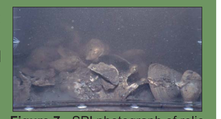

Figure 7 - SPI photograph of relic oyster beds in Tappan Zee.

Relic oyster beds have also been imaged in this area of the estuary. Their organization in map view suggests that these beds may once have stretched from bank to bank (Fig. 1). The oysters appear as outcropping beds (Fig. 3,5), eroded remnants (Fig. 6,9) and sediment-covered beds (Fig. 8). ^{14}C dates indicate that oysters grew during distinct periods in the past, but disappeared 500-800 cal yr B.P. Environmental factors such as the Little Ice Age and increased storminess may have factored in their disappearance.

PIERMONT

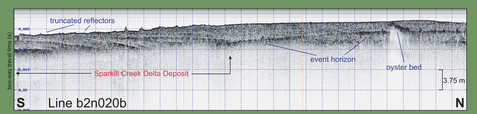

Figure 8 - North-south seismic profile b2n020b in Piermont. See Fig.1 for location.

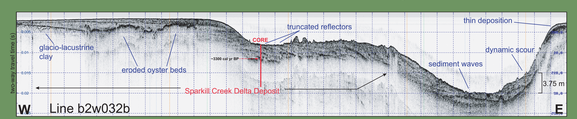

Figure 9 - East-west seismic profile b2w032b in Piermont. See Fig.1 for location.

Anthropogenic structures influence the sedimentary environment in the **Piermont** area, which is dominated by erosion and dynamic processes (Fig. 11). Dynamic drifts develop on either side of the Tappan Zee Bridge supports. Erosion occurs off the Piermont Pier and deposition occurs behind it. The channel is a region of dynamic scour, sediment waves and erosion (Fig. 9,11).

A delta deposit, characterized by dipping reflectors and coarser sediment, dominates the sedimentary record in Piermont (Fig. 8,9,10). Most likely sourced from Sparkill Creek to the west, the deposit is 3-km wide, 7-km long and approx. 3.5-m thick. The modern surface of the deposit is eroded, with no evidence of recent deltaic deposition. ^{14}C dates indicate that the delta was active between 3370 and 2520 cal yr B.P., but the reasons for the onset and termination of this deposit are not yet clear.

Figure 10 - Photograph of sediment core in Piermont area. Note sandy layers in this deltaic deposit.

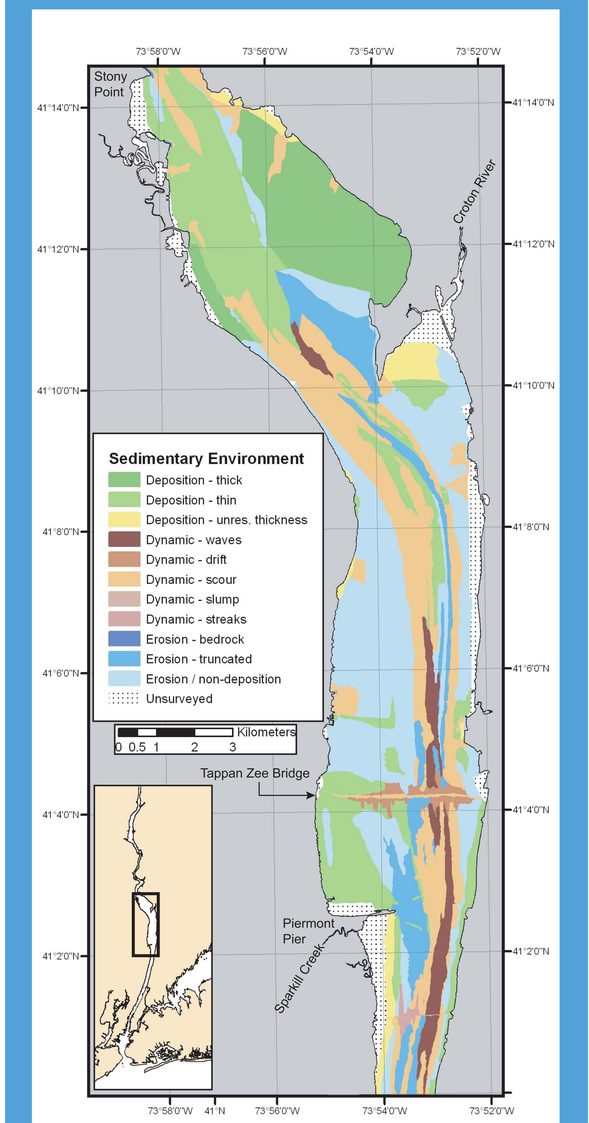

Figure 11 - Integration of high-resolution seismic surveys, side-scan sonar backscatter and multibeam bathymetry with sediment samples for ground truth allows differentiation of distinct environments in the estuary. Green and yellow colors indicate deposition; Blue shades indicate erosion; and brown and gold colors show dynamic environments. Detailed environments are indicated in the legend.

INTRODUCTION

Sitting at the interface between marine and terrestrial systems, estuaries are sensitive to natural climatic, sea-level and tectonic changes as well as to anthropogenic impacts. Research on estuarine systems has led to improved understanding of estuarine processes, but relation of those processes to the long-term evolution of estuaries is still uncertain. A geophysical survey funded by the New York State Dept. of Environmental Conservation resolves details of spatial and temporal variability of sedimentary processes in the Hudson River Estuary. Here we present interpreted sedimentary environments and evidence of past environments for a 30-km stretch of the Lower Hudson River Estuary.

SUMMARY OF KEY RESULTS

Modern Sedimentary Environments

* Deposition occurs mainly in Haverstraw Bay on shallow marginal flats and on the channel floor (see Fig.11).
* South of Haverstraw Bay, deposition is limited to the sharp channel bend and to areas of anthropogenic disturbance (i.e. north of Piermont Pier).
* Erosion dominates the broad, shallow marginal flats in the Tappan Zee and Piermont areas.
* Natural and man-made obstructions to river flow create local erosional areas (see outcropping oyster beds in Haverstraw Bay, Fig. 3; and erosion off Piermont Pier, Fig. 9).
* Dynamic environments (both erosion and deposition) occur where sediment is actively moving through the estuary, as seen by the sediment waves on the channel walls and floor of the Lower Estuary (see Fig.11).
* Dynamic sediment drifts and scouring are also associated with man-made constructions, such as the Tappan Zee Bridge and a buried pipeline south of the bridge (see Fig.11).

Evidence of Temporal Variability

* Relic oyster beds are imaged in the Lower Estuary, buried by sediment and outcropping on the river bottom (see Fig. 1). Existing shell dates suggest that oysters thrived in the past but disappeared 500-800 cal yr B.P.
* A delta deposit (3km x 7km, ave. thickness 3.5m) dominates the marginal flats south of the Tappan Zee Bridge (see Fig. 1). Radiocarbon dates indicate the delta was actively depositing between 3370 and 2520 cal yr B.P.

ACKNOWLEDGEMENTS

The Hudson River Benthic Mapping Project is funded by the New York State Department of Environmental Conservation. Research is also supported by the Estuarine Reserves Division, Office of Ocean and Coastal Resource Management, National Ocean Service, National Oceanic and Atmospheric Administration.