REGIONAL GEOLOGIC FRAMEWORK OF THE INNER-CONTINENTAL SHELF OFF NEW YORK: BASELINE INFORMATION FOR ENVIRONMENTAL AND RESOURCE MANAGEMENT

William C. Schwab, E. Robert Thieler, Bradford Butman, and Marilyn R. Buchholtz ten Brink

(U.S. Geological Survey, 384 Woods Hole Road, Woods Hole, MA 02543-2310)

A focus for the U.S. Geological Survey (USGS) Coastal and Marine Geology Program is mapping of the shallow Exclusive Economic Zone (EEZ), with an emphasis on the heavily utilized areas of the sea floor offshore of major metropolitan centers. Our objective is to develop a regional synthesis of the sea-floor geology that will provide information for a wide range of management decisions and form a basis for further process-oriented investigations. In 1995, the USGS began a program, in cooperation with the U.S. Army Corps of Engineers (USACE), to generate geologic maps of the sea floor and shallow subsurface for coastal waters offshore of the New York — New Jersey metropolitan area and along the south shore of Long Island (Figure 1).

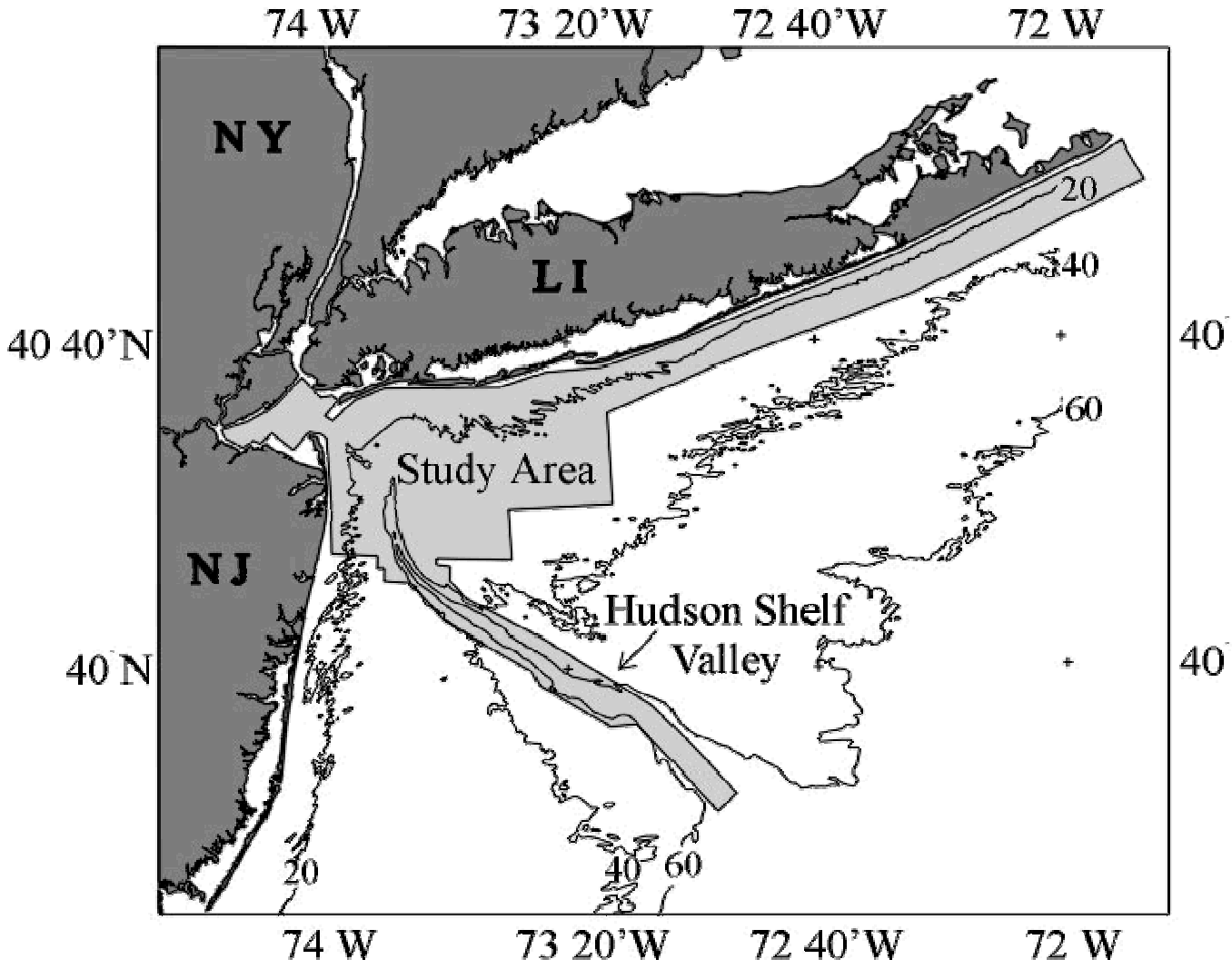

Figure 1: Map showing location of the study area. Bathymetric contours are in meters. Boxed area shows extent of geophysical and geologic survey.

The New York Bight Apex is one of the most heavily populated impacted coastal regions of the United States. Major issues in the New York — New Jersey area include: the long-term fate and effect of contaminated sediments; identification of acceptable sites for disposal of dredged material; identification of offshore sand and gravel resources; coastal erosion; and alterations of the benthic habitat caused by bottom trawling. A regional synthesis of the sea floor geology is needed to provide the information necessary to address these issues from a system-wide perspective. The USGS mapping program includes a description of sedimentary environments, sediment texture and chemistry, sea-floor morphology, geologic history, and the geometry and structure of the Quaternary strata. The descriptions and maps provide: 1) a detailed view of the sea floor; 2) a framework for understanding the evolution of the Holocene sedimentary deposits on the inner-continental shelf; 3) an understanding of the evolution of Long Island's barrier-island system; 4) a framework for understanding the regional sediment transport system

of the inner-continental shelf; and 4) a framework for assessment of the impact of historic and ongoing waste-disposal operations.

The mapping was conducted using high-resolution sidescan-sonar, seismic-reflection, multibeam swath bathymetry, and bottom sampling techniques. This mapping effort differs from previous regional studies of this area (e.g.,Williams, 1976; Freeland and Swift, 1978) in that it provides: 1) digital, sidescan-sonar images that cover 100 percent of the sea floor; 2) seismic-reflection profiles of near-surface strata that were previously unresolvable; and 3) integrated chemical and geological measurements of modern sedimentary deposits. The sidescan-sonar imagery, in particular, identifies a range of features and sea-floor environments in the study area and provides insight into the processes controlling the distribution of sediments and associated contaminants on the sea floor (Schwab and others, 1997a, 1997b, 1999, 2000; Butman and others, 1998; Foster and others, 1999; Lotto, 2000). Major results of the mapping program thus far include:

(1) Anthropogenic impact is clearly observable on the sidescan imagery. Over the past 80 years, the New York Bight Apex has received about 250 million cubic meters of dredged material and construction waste. The imagery reveals that historical dumping was not contained within designated disposal sites. The mapping of disposal areas are of interest to Federal, State, and local agencies that are charged with evaluation of both the impact of past disposal practices a plan reclamation strategy. Local benthic disturbance from recent bottom trawling is also evident on the sidescan imagery.

(2) The Holocene sedimentary deposit is thin or absent over much of the inner-continental shelf. The Holocene sedimentary deposit originated primarily from erosion of exposed Pleistocene glaciofluvial deposits and Cretaceous/Tertiary coastal-plain strata during the Holocene marine transgression. Maps clearly define the Pleistocene fluvial drainage system and modern sediment depositional patterns. The general morphology of the nearshore segment of the continental shelf (water depths less than about 25 m) is a result of active formation and modification of a ravinement surface. Here, the Holocene sediments are absent or extremely thin. Fine-grained sands and silts winnowed from the innermost shelf and from bathymetric highs are, in general, deposited in water deeper than about 25 m. These mapping results are being used by the USACOE to guide sea-floor-coring investigations to identify sites where disposal pits may be excavated and used for containment of contaminated dredge spoils. They are also being used by the USGS and National Marine Fisheries Service to investigate fisheries habitats.

(3) Transport paths of previously disposed contaminated sediment have been identified. Approximately 125 million cubic meters of sewage sludge from the New York — New Jersey metropolitan area was disposed at a site 20 km offshore of New York City between 1923-1987. The Hudson Shelf Valley (the drowned portion of the ancestral Hudson River) cuts across the continental shelf, terminating near this disposal site. The shelf valley provides a long-term sink and/or conduit for cross-shelf transport of this material. Mapping results show that some sewage sludge material (along with natural silty sediment) has been transported up to 150 km south from the original disposal site

down the axis of the Hudson Shelf Valley where it has accumulated in isolated depressions. In addition, sewage sludge, which remained in the original disposal site, has been reworked and, in places, partially buried by fine-grained sand. This information produces a framework for development of an environmentally sound plan for future disposal of dredged material.

(4) Aggregate resources can be developed from the Quaternary sedimentary deposit off southern Long Island. Our maps provide critical location and volume information necessary for assessment of offshore sand resources, which can be used in planned beach nourishment projects. The USACE and National Park Service are currently using these maps to develop plans for extraction of sand and to evaluate the possible environmental impacts of exploiting this resource.

(5) A net onshore flux of fine- to medium-grained sand, from the inner-continental shelf to the nearshore zone, is a significant component of the overall sediment budget. If existing sediment budgets along southern Long Island are accurate, an onshore sediment flux from the inner shelf to the nearshore zone is necessary to explain the evolution of the barrier-island system. Although a sediment budget is an important element in the development of coastal erosion mitigation strategy, budgets are rarely accurate because necessary temporal and spatial data are sparse. This paucity of data leads to numerous assumptions about sediment transport processes in the complex nearshore environment. The mapping results on the inner-shelf off southern Long Island clearly establish the relation between the evolution of this barrier-island system and the framework geology and the relation between the inner-continental shelf sand supply and coastal behavior. Sediment supply on the inner-continental shelf is created by erosion of former headlands (Quaternary sediments underlain by semi-lithified Cretaceous sedimentary strata). Onshore sediment flux from offshore shelf areas of relatively thick Holocene sediments also increase the sediment available for maintenance of island stability. Thus, the complexity of the nearshore sedimentary system arises from the interplay of antecedent geology and modern oceanographic processes.

Acknowledgements

We thank the captains and crews of the Research Vessels *Argo Maine*, *Diane G*, *Meagan Miller*, *Alpha & Omega*, *Seaward Explorer*, and *Creed*. Technical support at sea was provided by Thomas O'Brien, David Nichols, Kenneth Parolski, and Barry Irwin. Data processing and map production was provided by Jane Denny, David Foster, Ann Swift, William Danforth, Mead Allison, and Linda Lotto. This project was greatly aided by the cooperation and support of Steven Couch and Leonard Houston, U.S. Army Corps of Engineers, New York District. Any use of trade names or company names does not imply endorsement by the U.S. Geological Survey.

References

Butman, B., Danforth, W.W., Schwab, W.C., and Buchholtz ten Brink, M., 1998, Multibeam echo sounder bathymetry and backscatter maps of the upper Hudson Shelf Valley and adjacent shelf, offshore of New York: U.S. Geological Survey Open-File Report 98-616, 4 sheets.

Foster, D.S., Swift, B.A., and Schwab, W.C., 1999, Stratigraphic framework maps of the nearshore area of southern Long Island from Fire Island to Montauk Point, New York: U.S. Geological Survey Open-File Report 99-559, 3 sheets, scale 1:125,000

Freeland, G.L., and Swift, D.J.P., 1978, Surficial sediments: Marine EcoSystems Analysis (MESA) Program, MESA New York Bight Atlas Monograph 10, New York Sea Grant Institute, Albany, New York, 93 p.

Lotto, L.L., 2000, Seismic stratigraphy and Quaternary evolution of the New York Bight Apex inner-continental shelf: Texas A&M University, unpublished M.S. thesis, 85 p and 18 sheets.

Schwab, W.C., Corso, W., Allison, M.A., Butman, B., Denny, J.F., Lotto, L.L., Danforth, W.W., Foster, D.S., O'Brien, T.F., Nichols, D., Irwin, B.J., and Parolski, K., 1997a, Mapping the sea floor geology offshore of the New York – New Jersey metropolitan area using sidescan sonar: preliminary report: U.S. Geological Survey Open-File Report 97-61, 3 sheets.

Schwab, W.C., Allison, M.A., Corso, W., Butman, B., Buchholtz ten Brink, Denny, J.F., Danforth, W.W., and Foster, D.S., 1997b, Initial results of high-resolution sea-floor mapping offshore of the New York-New Jersey metropolitan area using sidescan sonar: Northeastern Geology and Environmental Sciences, v. 19, no. 4, p. 243-262.

Schwab, W.C., Thieler, E.R., Allen, J.R., Foster, D.S., Swift, B.A., and Denny, J.F., 2000, Influence of inner-continental shelf geologic framework on the evolution and behavior of the barrier-island system between Fire Island Inlet and Shinnecock Inlet, Long Island, New York: Journal of Coastal Research, 41 p. (in press)

Schwab, W.C., Thieler, E.R., Allen, J.R., Foster, D.S., Swift, B.A., Denny, J.F., and Danforth, W.W., 1999, Geologic mapping of the nearshore area offshore Fire Island, New York, in Kraus, N.C., and McDougal, W.G., eds., Coastal Sediments '99: vol. 2, p. 1552-1567.

Williams, S.J., 1976, Geomorphology, shallow subbottom structure and sediments of the Atlantic inner continental shelf off Long Island, New York: U.S. Army Corps of Engineers Coastal Engineering Research Center, Technical Paper No. 76-2, 123 p.