SEISMIC STRATIGRAPHIC EVIDENCE FOR THE LAST GLACIAL MAXIMUM AND POST-GLACIAL SEA-LEVEL RISE, RARITAN BAY, N.J.

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A sequence stratigraphic study of the Late Pleistocene (~20 Ka) to Holocene sedimentary record from Raritan Bay yields important information on sea-level changes and provides insight into the recent geologic history of the region. An understanding of the stratigraphy of Raritan Bay and the relationship between more modern estuarine and underlying coastal plain deposits also may provide information necessary to address salt water intrusion problems in areas surrounding Raritan Bay. As development of the shoreline continues, contamination of the Potomac-Raritan-Magothy aquifer in Monmouth County, N.J. will have major implications for groundwater use in areas pumping from the aquifer (Pucci, 1987). Coarse-grained buried channel deposits and fine-grained estuarine muds beneath the bay are adjacent to the Cretaceous coastal plain stratigraphy (Fig. 1). The relationship of the "recent" sediments and the older coastal plain deposits based on the stratigraphy of the Raritan Bay (especially the Potomac-Raritan-Magothy aquifer) is crucial in determining the degree of hydraulic interconnection and creating groundwater flow models for the Raritan Bay vicinity. The creation of a stratigraphic model for the Raritan Bay will also provide answers to the 3-dimensional variability of the most recent interglacial and glacial deposits.

Raritan Bay provides an uncomplicated record of late Pleistocene glacial encroachment, subsequent valley incision, and later infilling during Holocene sea-level rise (Goss, Ashley, & Sheridan, 1995). Thus, it is an ideal location to study the most recent interglacial and glacial deposits and sea-level changes. The lithologically distinct, unconformity bounded units record sedimentation during the late Wisconsinan glacial maximum (~20 ka) while sea-level was near the edge of the continental shelf, and subsequent sea-level rise during the Holocene.

Prior to oxygen isotope stage 2 (late Wisconsinan glaciation), the Raritan River flowed northeastward along the northern margin of present-day Staten Island into the Hudson River. The Laurentide Ice Sheet advanced into the Raritan watershed disrupting drainage during the last glacial maximum (LGM) (~20 ka). Deposition of the terminal moraine and proglacial outwash, as well as the drainage of several proglacial lakes diverted the Raritan River southeastward, cutting a new channel and re-routing the river into the present-day Raritan Bay (Stanford, 1993). Meandering incised valleys trending NW to SE were cut into outwash during falling sea-level as the continental shelf was subaerially exposed.

One-hundred and seventy kilometers of shallow, high-resolution seismic profiles from a 400 km^2 area and thirteen Vibracores™ ranging from three to five meters in length were collected in 1994 (Fig. 2). Reflection data were collected with an Ore Geopulse™ seismic system (peak frequency ~1.0 kHz). Seismic tracks form a coarse-grid pattern with 100 m spacing and are concentrated in the "high-priority" southern region of Raritan Bay. Core locations were predetermined using seismic reflection survey data and spaced to facilitate correlation with primary reflections and unconformities.

Sediment analysis procedures included sieving and pipetting techniques to determine sand-silt-clay ratios. Mineralogical and organic carbon content analyses were also performed. Three-dimensional seismic profiling was accomplished using Arcview, a Geographic Information System (GIS) program.

High-resolution seismic reflection data reveal the incised channels and a package of three seismic sequence tracts overlying Cretaceous "basement" (shallowly southeast dipping sands and clays). Thirteen Vibracores documented three lithologically distinct units separated by unconformities. The lowest unit (≤ 31.74 ka; Beta Analytic Inc., sample RBS 8 A3 C-034) of reddish-orange, coarse to medium sand and gravel derived from the Raritan River watershed represents fluvial, glacial and paraglacial deposits. This outwash is unconformably overlain by dense gray mud, fine sand, and silt with a transition to black organic-rich "industrial" sludge. Shells are present in the dense gray mud, which is correlated with an early Holocene (9.48 ka; USGS, sample W-1633) mud underlying Sandy Hook (Minard, 1969).

Paleochannels incised into Cretaceous sands and clays and glaciofluvial deposits that filled in the channels (while sea-level was lowered) and are identified in the seismic reflection profiles. Two paleochannels are documented: a west to east incised channel originating from the modern Raritan River drainage and second one that is oriented NW to SE carrying discharge from the vicinity of Staten Island. The two channels are likely tributaries of the same river system. They merged in the center of the Bay and continued to flow to the SE, eventually connecting with the Hudson River drainage channel.

Unconformities between lithologic units are the sequence boundary and transgressive (ravinement) surfaces reflecting sea-level fluctuations and associated change in depositional environment. The stratigraphy represents the transition from a lowstand systems tract during the LGM sea-level low to a transgressive systems tract deposited during rising sea-level, and a highstand systems tract of modern "industrial" sludge.

The recognition of an incised channel filled with glacial outwash (sands and gravels) in close proximity to the southern shoreline of Raritan Bay (and the Potomac-Raritan-Magothy aquifer) is significant for future studies of hydraulic interconnection. Information from this study will help identify the high-conductivity conduits for pollutant migration which are commonly associated with fluvial and tidal inlet channels. This knowledge may provide the means to locate the source of existing salt-water intrusion pathways and alleviate future groundwater contamination problems as population growth continues in New Jersey.

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