THE QUATERNARY GEOLOGY OF NEWARK BAY AND KILL VAN KULL CHANNEL, NEW YORK AND NEW JERSEY

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Never-before-known details of the Quaternary geology and its antecedent topography in the New York Harbor waterways west of Upper New York Bay are being revealed by our geologic and geophysical surveys.These surveys are enhancing the engineering for the Port of New York and New Jersey channel-deepening project.To date, the three-dimensional distribution of Quaternary sediment and the underlying rock down to 70 feet below mean low water (MLW) has been mapped in portions of Newark Bay, Kill van Kull, Elizabeth, South Elizabeth, Port Jersey, northeastern Arthur Kill channels and adjoining banks (Figure 1).

This mapping reveals the high variability of these sediments.Although a single stratigraphic model and a single seismic model are useful in mapping these facies throughout the harbor, such models cannot predict the natural complexity in the details on the scale of engineering projects.Mapping and imaging is required.The facies variability is partially a result of the variability in the sub-Quaternary bedrock topography.

Figure 1. Map of study area in the Port of New York and New Jersey.

Mapping is based on 1) direct observation and measurement of rock and sediments from 150+ borings and near-shore outcrops, 2) over 900 boring records from previous work, and 3) surface and subsurface geophysical surveys.Sonar imaging, chirp sonar, and shallow seismic are used to map and image surface and subsurface features.All geophysical measurements are calibrated with measurements on sediment and core borings.All measurements are located with differential GPS. These techniques have produced geological cross sections and sediment-distribution and top-of-rock maps.

Most of the channels are dredged down to bedrock or Pleistocene glacial sediments (Figure 2). Locally the channel floor has a veneer of relatively recent black silt or sand waves of coarse sand and fine gravel.Outside of the channels, Holocene estuarine sediments overlie Pleistocene glacial sediments.

Figure 2. Sonar image of channel floor showing rock outcrops in Newark Bay.

Bedrock ranges from above sea level on the shores to deeper than 120 feet below MLW in the Hudson River channel and varies from deeply weathered (> 20ft) to relatively pristine. These rocks include schist, gneiss and serpentinite just west of the Upper New York Bay and the Triassic-Jurassic Newark Group sandstones and shales intruded by the Palisades diabase sill and associated basaltic sills in western Kill van Kull and Newark Bay.In most places Pleistocene glacial sediments overlie the bedrock. However, locally bedrock is exposed or is overlain by Holocene sediments.

The Palisades diabase was a paleohigh with eroded lows on each side and a channel cut into the top of the diabase. The channel in the Palisades diabase deepens at the approximate position of the easily eroded olivine zone (Figures 3 and 4). Basaltic sills intruded and metamorphosedsandstones and shales above the Palisades diabase sill.These resistantbasalticsills and meta-sediments weathered in relief and are preserved as strike-parallel highs in the sub-Quaternary topography (Figure 5).

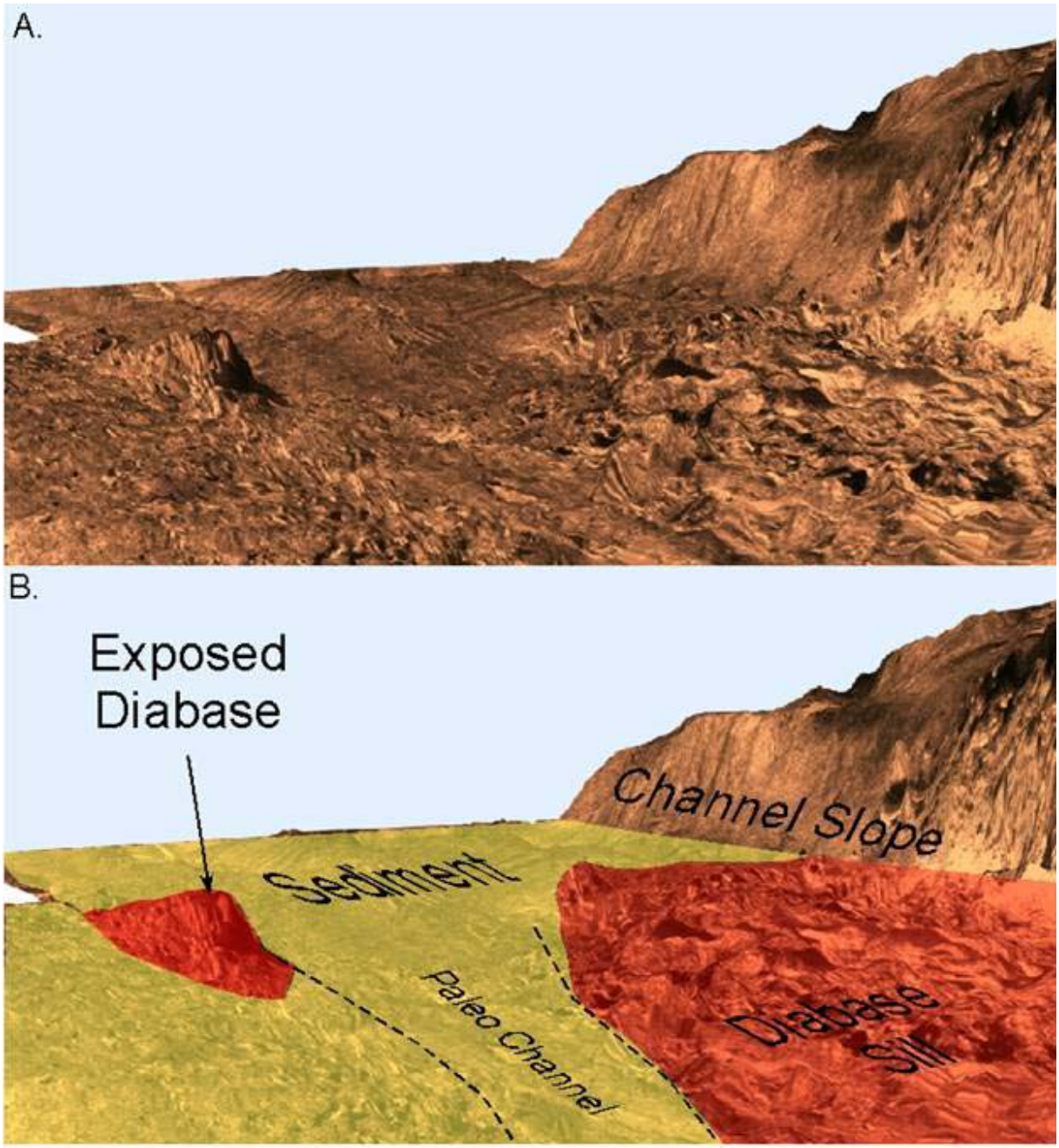


Figure 3. Eastward looking view across 3-D image of Kill van Kull channel near eastern end (stratigraphic base) of Palisades Sill. (A) Sonar image of channel bottom draped on bathymetry and (B) interpretation.The eastern end of the cross section in Figure 4 crosses this area.

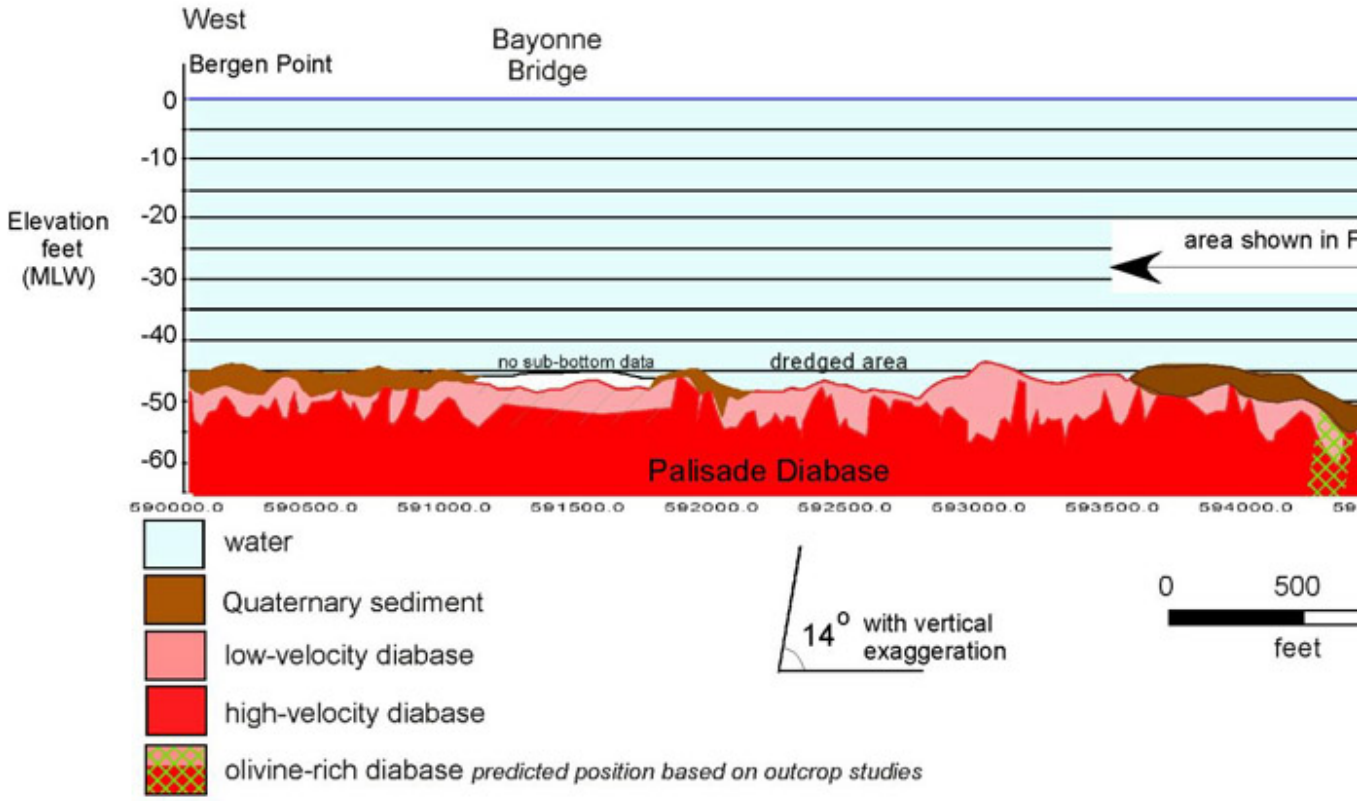


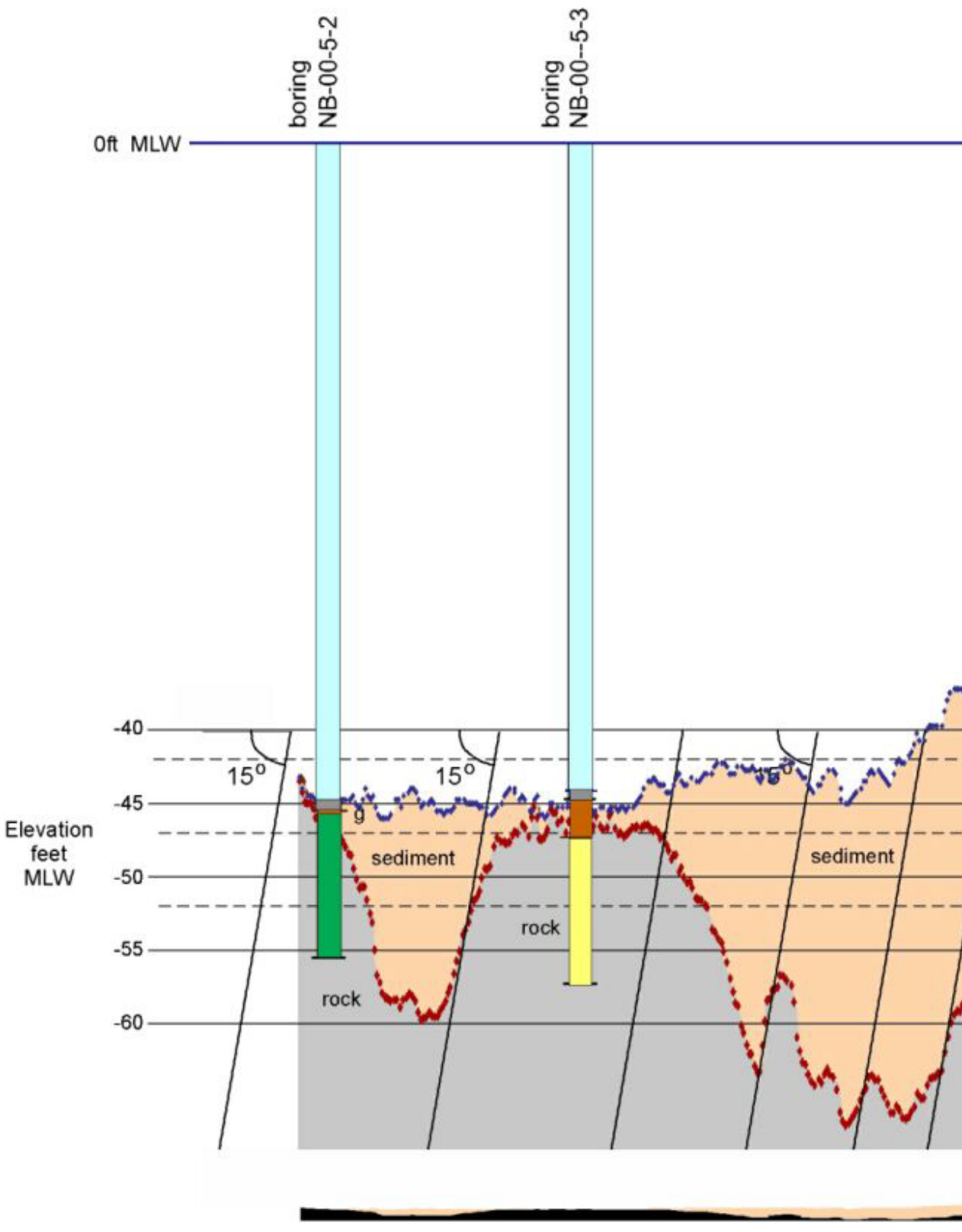
Figure 4. East-west geological cross section through the Palisades Diabase Sill in western Kill van Kull.This section was based on chirp sonar sub-bottom surveys and borings. The low-velocity diabase ranges from blasted to naturally weathered rock.The sediment on the eastern end fills a channel in the diabase.

The Pleistocene sediments are glacial moraine till deposits, glacial lake deposits of finely laminated to varved clayey silts and outwash sands.The tills covered the topography and formed irregular mounded highs.The finely laminated to varved clayey silts filled in the lows and onlap the mounded paleo-topography of the tills (Figure 6).

The deepest Holocene sediments in the boring records are gray silts and sands that extend down to at least 120 feet below MLW in the Hudson River channel in Upper New York Bay. The oldest Holocene sediments imaged by seismic and chirp sonar are a clayey silts unit at 65 ft below MLW.The clayey silts onlap the escarpment on thewestern side oftheHudson River channel in Upper New York Bay (Figure 7).These clayey silts are overlain by gray sands and silts. The gray silts and sands also cover shallower Pleistocene sediments.Along the Hudson River escarpment there are channels incised into the Pleistocene sediments and serpentinite (Figure 8).Holocene gray coarse sands and shell-fragment-rich fine gravels fill one of these channels down to at least 57 feet below MLW at the easternmost Kill Van Kull.

Holocene sediments and features in Newark Bay include a fossil oyster reef on diabase, finely laminated tidal deposits overlying Pleistocene varved silty clays, peat, organic silts and gray silts. Gray silts and sands occur throughout the area.Locally these are overlain by the relatively recent black silts.

The late Holocene transgressive succession records the Hudson River estuary flooding over the banks westward into western Upper New York Bay, Kill van Kull and over the Palisades sill into Newark Bay.


boring NB-00-5-2
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-40
-45
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15°
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sediment
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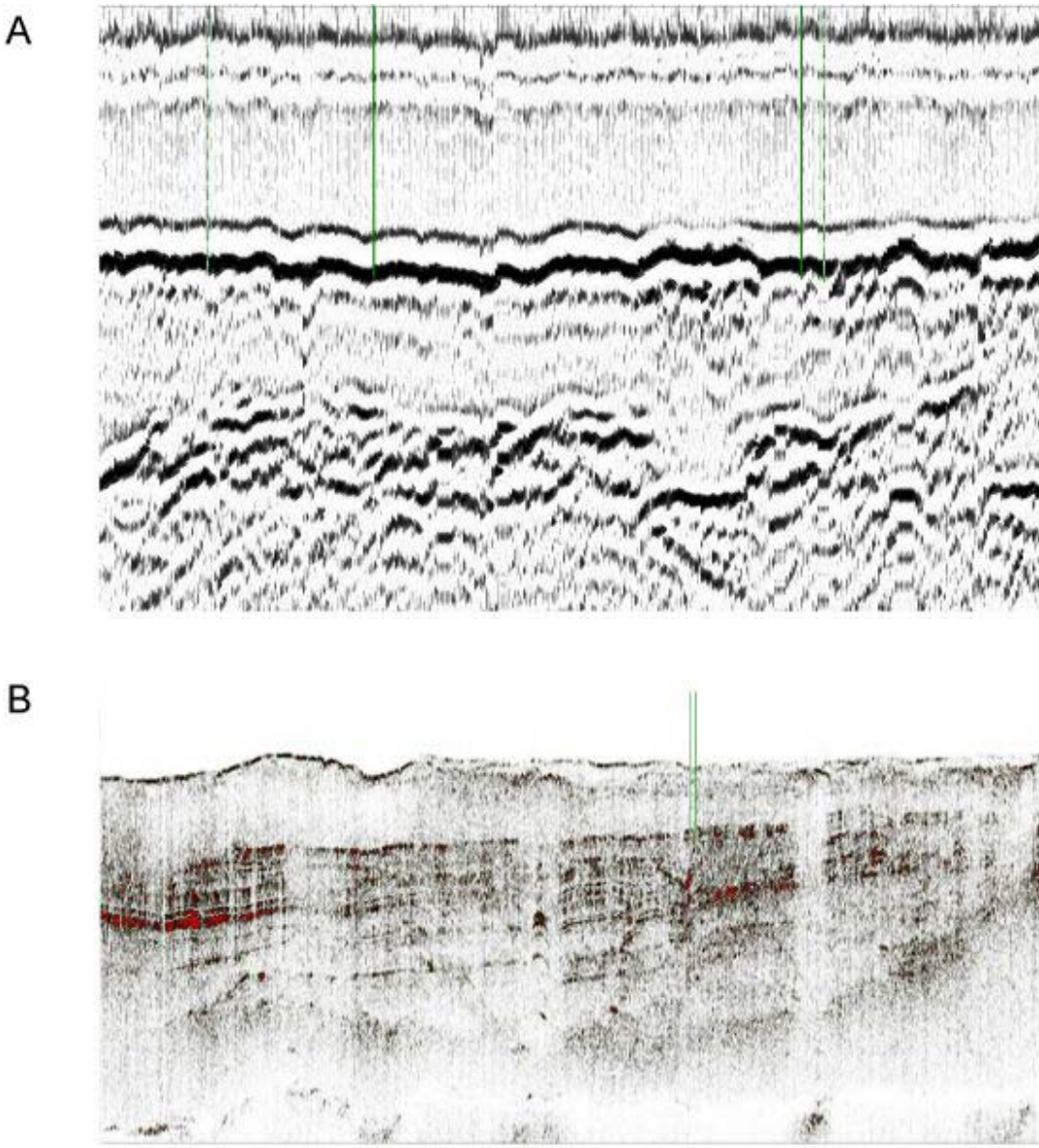
Figure 5. Interpreted cross section along a chirp sonar sub-bottom profile in southern Newark Bay just west of the Palisades sill.The borings were plotted independently of the sonar interface.The Regional dip is about 15^{o} to the northwest.Many of the northwest dipping surfaces can be interpreted as dip slopes dipping.



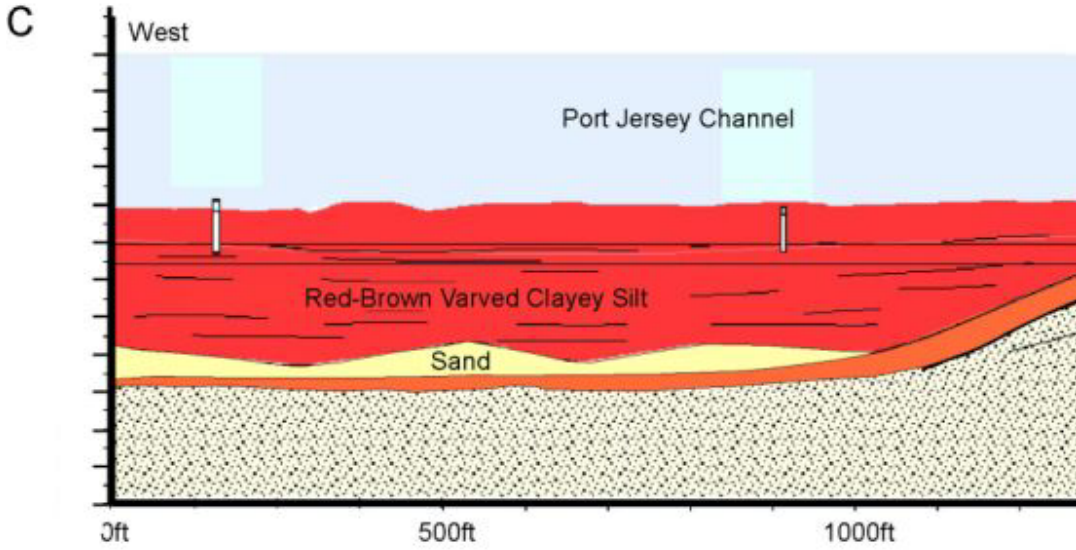


Figure 6. The Pleistocene glacial-lake deposits of varved clayey silt onlapglacial till.**A)** Seismic profile,**B**) Chirp sonar sub-bottom profile and **C**) geological interpretation of the subsurface in the western end of Port Jersey Channel.The till is following the underlying sandstone topography.

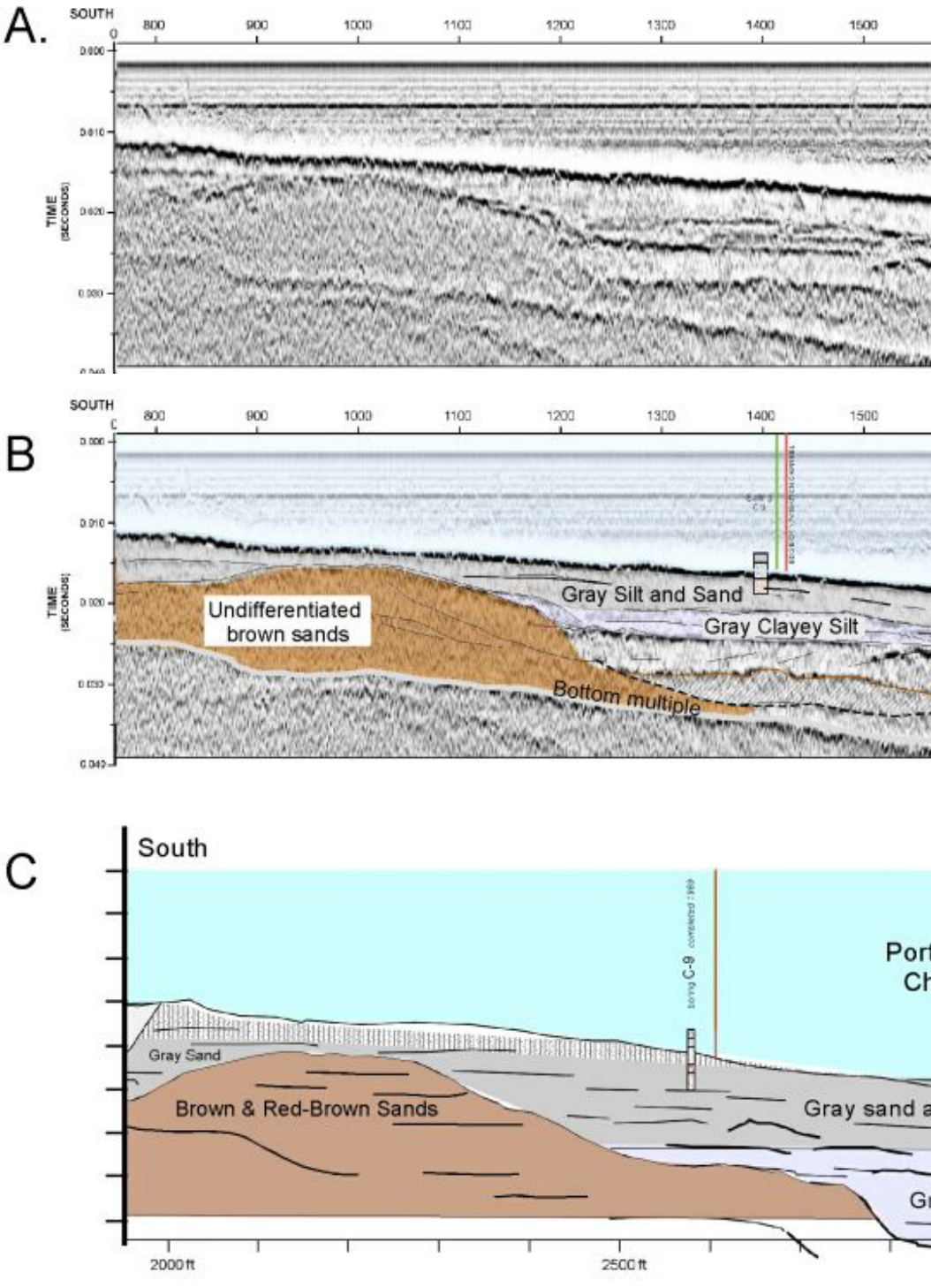
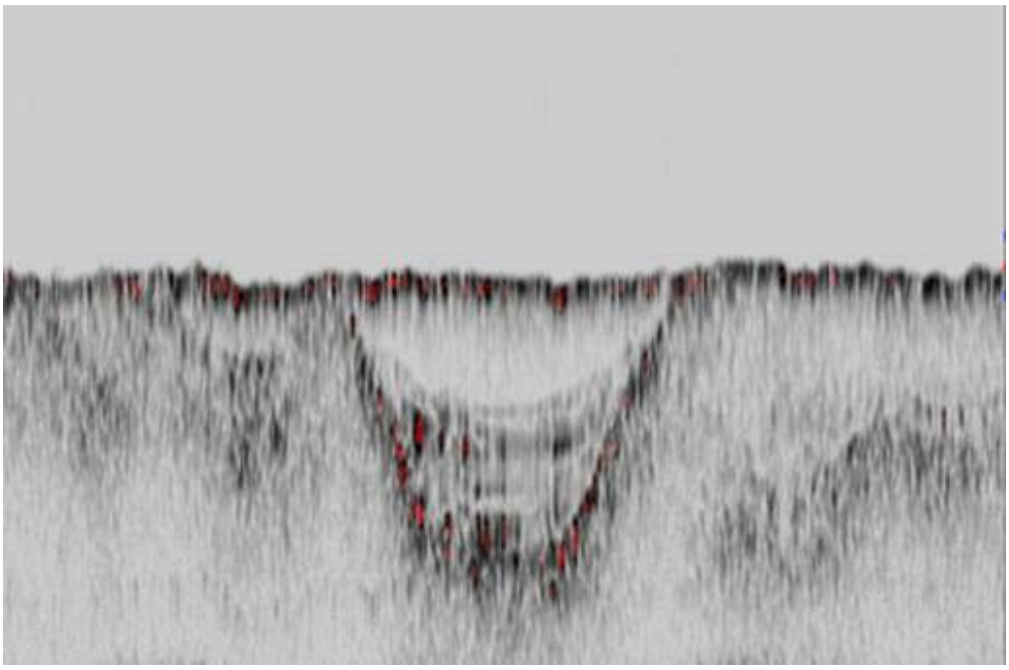


Figure 7. The Holocene gray clayey silts and gray sands and silts onlap the Hudson

River escarpment. **A.** North-South Chirp sonar sub-bottom profile crossing the eastern end of Port Jersey Channel. Vertical scale is in time.**B.** Geological interpretation of sub-bottom line in A. Vertical scale is in time.**C.**Geological cross section based on sub-bottom profiles and core.Vertical scale is in feet.

A.



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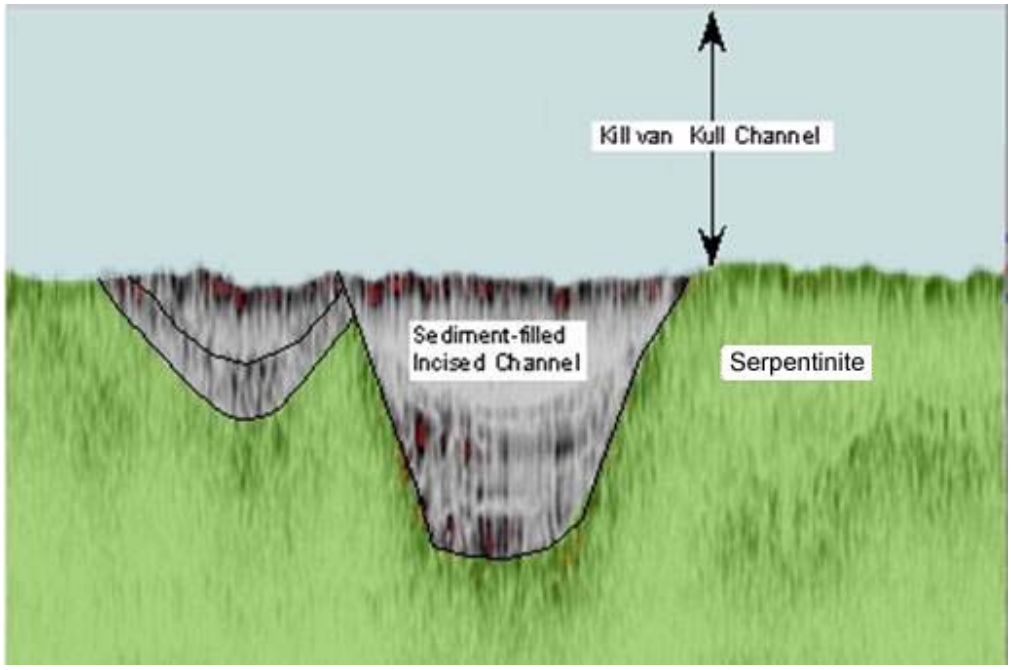

Figure 8. Chirp sonar sub-bottom profile image and interpretation of sediment-filled paleo-channel in the serpentinite in eastern Kill van Kull Channel.Sediment is interpreted to be Holocene sands and silts. The vertical dimension is in time. The channel bottom is approximately 42 feet below MLW.

Acknowledgments

Most of the data presented in this study was collected for projects contracted by the U.S. Army Corps of Engineers (USACE) and the Port Authority of New York and New Jersey (PANYNJ).Earthworks compiled and interpreted the boring records, which are primarily from the USACE and the PANYNJ.This study was guided by maps and cross sections from an earlier compilation of the pre-1999 boring data presented in the USACE New York District's 1999 *Feasibility Report for New York and New Jersey Harbor Navigation Study*.