Geophysical and Geological Reconnaissance for the ONR Geoclutter Program

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LONG-TERM GOALS

The primary goal of the Geoclutter program is to assess geologic clutter/reverberation issues in a seismically and geologically well-characterized shallow-water environment. The mid-outer continental shelf off New Jersey provides such an opportunity, because both bathymetry (a known and prominent cause of backscatter) and portions of the shallow subsurface have been mapped in detail as a result of STRATAFORM. The Geoclutter program consists of three field program phases: (I) an acoustic reconnaissance survey utilizing Navy gray ships and assets to identify potential geoclutter hot spots; (II) a full bistatic acoustic experiment focusing on the chosen areas, and (III), the focus of the work described here, detailed geologic and geophysical surveys of the hot spots identified in Phases I and II.

OBJECTIVES

Our primary objectives for Geoclutter work in 2002 were to (1) continue interpretation of the 2001 and 2002 chirp seismic data, (2) complete analysis of seafloor sample and geotechnical data, and (3) collect and analyze long cores during a test cruise of the AHC-800 drilling system. In the short term, we seek to transition our geologic and geophysical products into reasonable geoacoustic models for use in future acoustic modeling work.

APPROACH

We have employed a variety of approaches in our work. Stratal horizons are interpreted from chirp seismic data using commercial seismic interpretation software. Seafloor measurements, including grain size, porosity, in situ velocity and attenuation, backscatter strength, and acoustic impedance, are compared with each other using correlation analyses Cores have been both logged for geoacoustic properties, providing ground truth, and sampled, to corroborate geologic interpretation and provide age dating of the sedimentary strata evident in the chirp data.

WORK COMPLETED

Interpretation of the chirp data has continued with significant progress. The analysis of seafloor properties based on in situ acoustic data, grab samples, short cores and remote sensing data (chirp and backscatter) is complete and has been submitted to a peer-reviewed journal (Goff et al., 2003). Three long cores, ranging in length from 4 to 13 m, were collected in 2002 aboard the R/V Knorr using the

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AHC-800 system supplied by DOSECC (Fig. 1). These cores are the longest high-quality cores collected from this part of the margin and represent a unique sample set to provide temporal, stratigraphic and environmental context both for seismic stratigraphic interpretation and future sampling efforts. Geotechnical measurements from these cores were logged at sea, and samples have recently been collected which are currently undergoing detailed analyses for time stratigraphy, sediment texture and paleoenvironmental conditions.

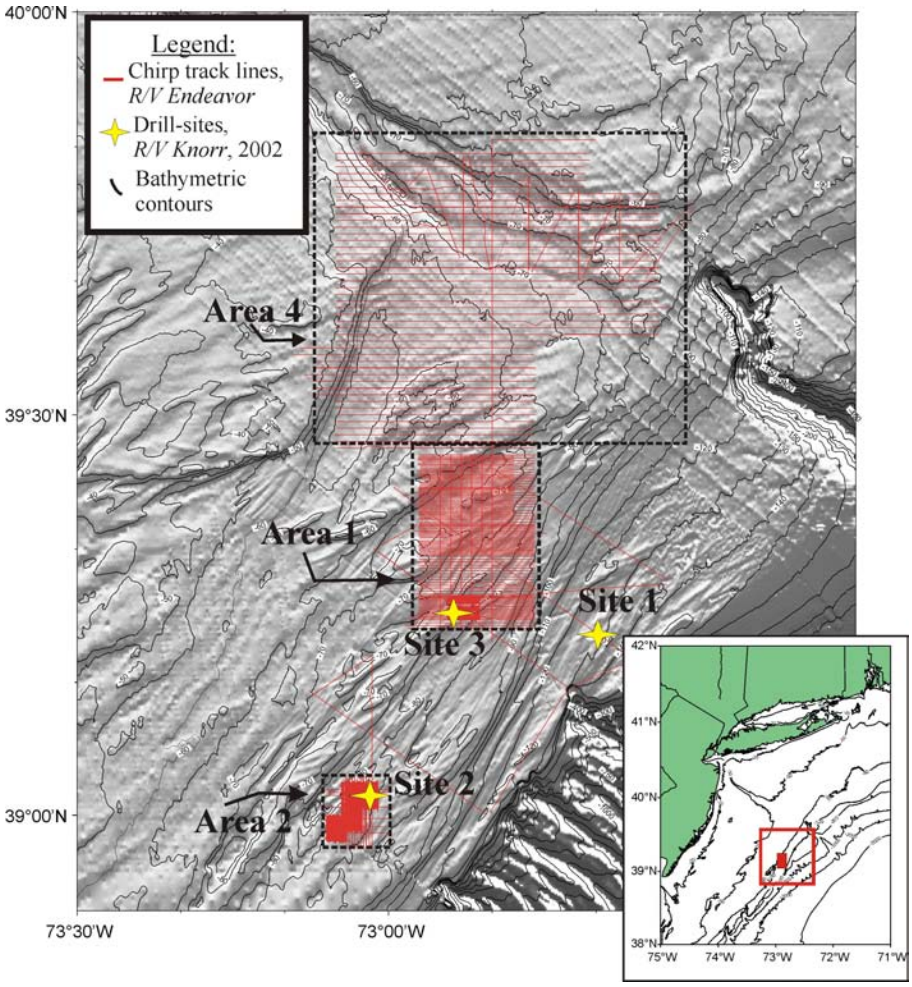

Figure 1. Location of deep-towed chirp-sonar tracklines collected aboard R/V Endeavor (EN359 and EN370), superimposed on NOAA's bathymetry of the New Jersey middle and outer continental shelf. The small inset locates our study area regionally. Drill sites 1-3 cored with the AHC-800 system aboard R/V Knorr in fall 2002 are marked as yellow stars.

RESULTS

Characterization of seafloor samples and *in situ* geotechnical measurements (Goff et al., 2003) illuminate the physical processes of erosion and sediment reworking on the outer shelf that are either active or have been strong seabed modifiers in the recent geologic past. We have also established the relationship between seafloor sedimentology and acoustic backscatter on the New Jersey shelf, and have provided ground-truth for the chirp acoustic impedance measurements with *in situ* velocity measurements (Figure 2).

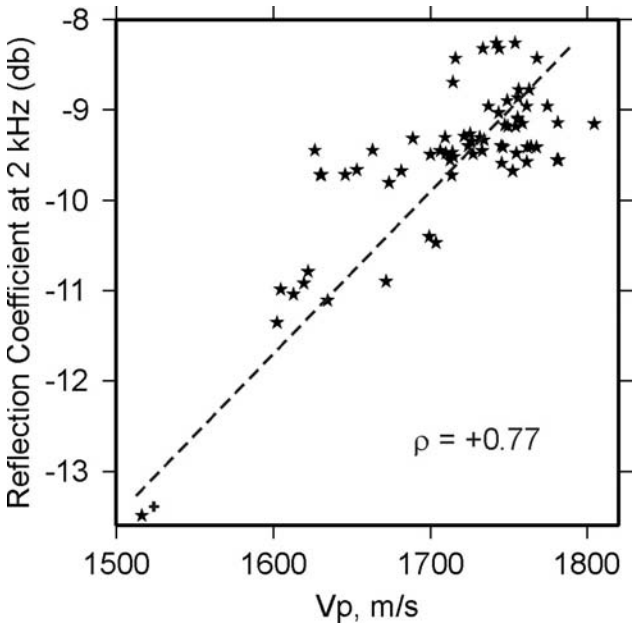

Figure 2. Vertical incidence reflection coefficient at 2 kHz versus in situ compressional velocity measurements at 65 kHz.

Extensive, shallowly buried fluvial/fluvio-deltaic/marginal marine dendritic drainage systems have been mapped in Area 1 (Figures 1, 3) using very high resolution (1-4 kHz and 1-15 kHz) geophysical (deep-towed chirp sonar) data. These data record a broad spectrum of channel shapes, depths (from a few to 10's of meters) and widths (~100's to 1000's of meters). We believe that the observed range of channel types is likely influenced by variations in both the magnitude of discharge and the character of the flow regime. A comparison of these mapped systems with a representative group of modern fluvial and marginal marine systems will help us understand the genesis of these shallow subsurface drainage systems.

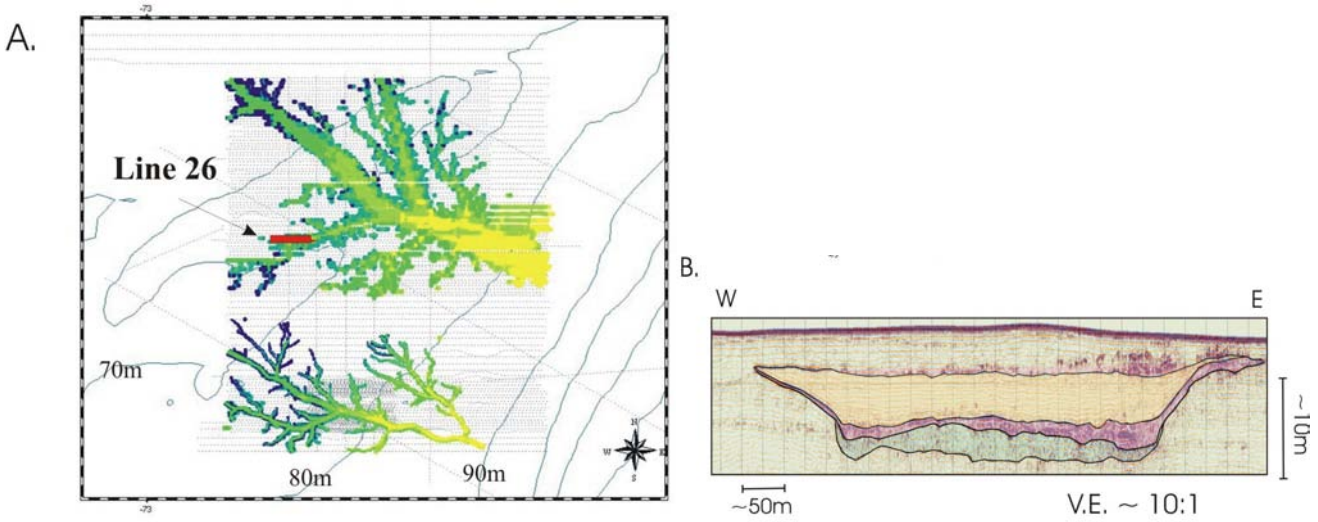

Figure 3. A. Interpretation of the dendritic drainage network observed in the Area 1 chirp data. B. Interpreted section of seismic line 26, showing channel fill stratificatio.

Preliminary results from the 2001 acoustic reconnaissance experiment have identified Area 2 as a site of interest because of the well-resolved and repeatable clutter targets that were observed there. The Area 2 EN359 chirp data were subsequently augmented during the 2002 EN370 cruise (collected by G.S. Mountain, LDEO and S. Schock, FAU) with ~50 m spacing, for a total of ~750 line km. Interpretations reveal three buried, dendritic and meandering channel systems, ~2-4 km apart and oriented E to NE (Fulthorpe et al., 2002). Channel-fill seismic stratigraphy indicates multiple stages of incision and filling. The northernmost channel system is of primary geoclutter interest. It is mainly V-shaped, up to 350 m wide and 12 m deep, and among the smallest in the Geoclutter survey area. It has been drilled at Site 2, revealing a predominantly sandy fill with, at its base, a burrowed contact with underlying mud that correlates well with the seismic interpretation. A prominent, vertical, seismic facies change, absent from Area 1, occurs throughout Area 2 (Figure 4): stratified material is overlain by up to ~20 m of seismically transparent material separated by a highly irregular boundary, older than the mapped dendritic channel systems. In places, the boundary resembles incisions, which truncate underlying reflections and have flanks that are steeper than even the steepest interpreted channel flanks being mapped in Areas 1 and 2. Partially completed mapping of this facies boundary, using the dense Area 2 profiles, reveals that its irregularities are not entirely random, but the causal mechanism(s) for these features is/are as yet unknown.

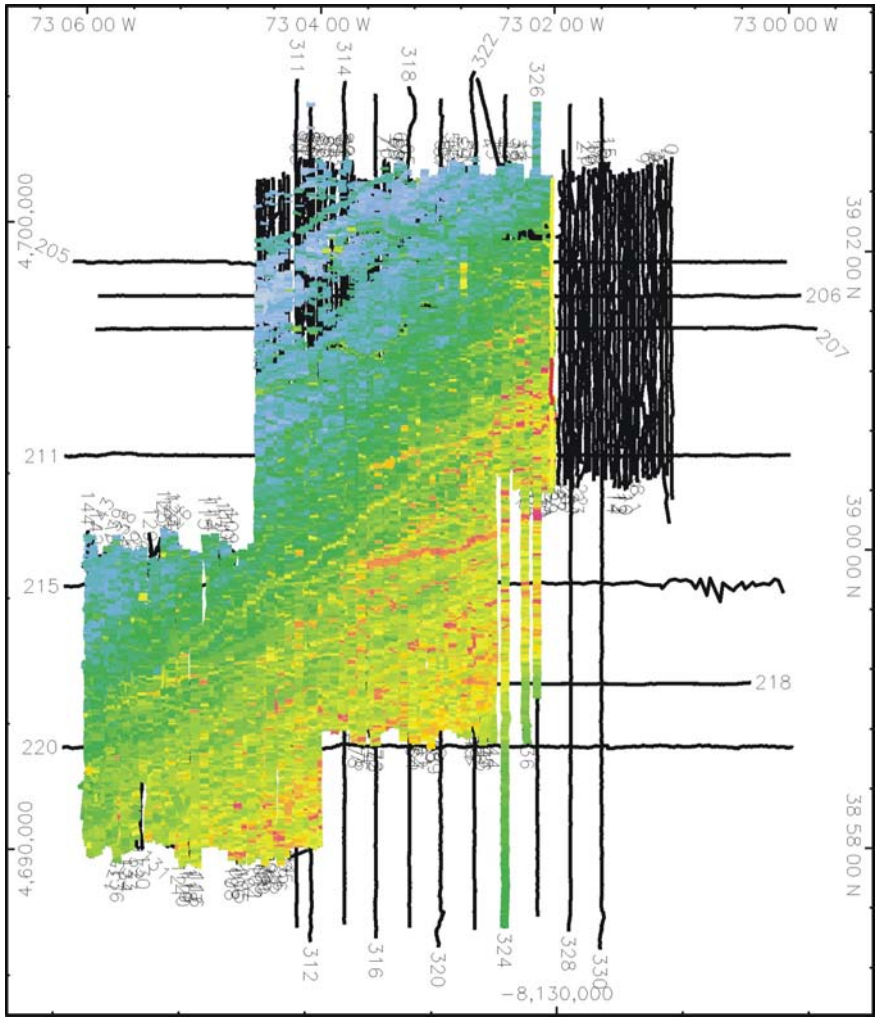

Figure 4. Underway interpretation of the facies change horizon being mapped in Area 2.

Examination of the geologic and climatic history of a continental margin using seismic reflection data is dependent on identifying key horizons that mark geologically and climatically significant episodes. On the New Jersey margin, the "R" horizon has beern postulated to be a key indicator of the climate just prior to the end of the Last Glacial Maximum (LGM), possibly the major erosional event that immediately preceded the deposition of post-LGM sediments. Post-LGM sediments have been subsequently eroded by a series of fluvial channels that appear to correlate in places with acoustic clutter. The suite of ultra-high resolution chirp-sonar reflection data which clearly image "R," and Site 3 of the 2002 drilling cruise on the *R/V Knorr* which penetrated "R", are excellent tools for investigating the geographic distribution and sequence stratigraphic relationship for the "R" reflector. A preliminary interpretation of "R" within the Area 1 and along Area 3 dip lines has been completed (Figure 5).

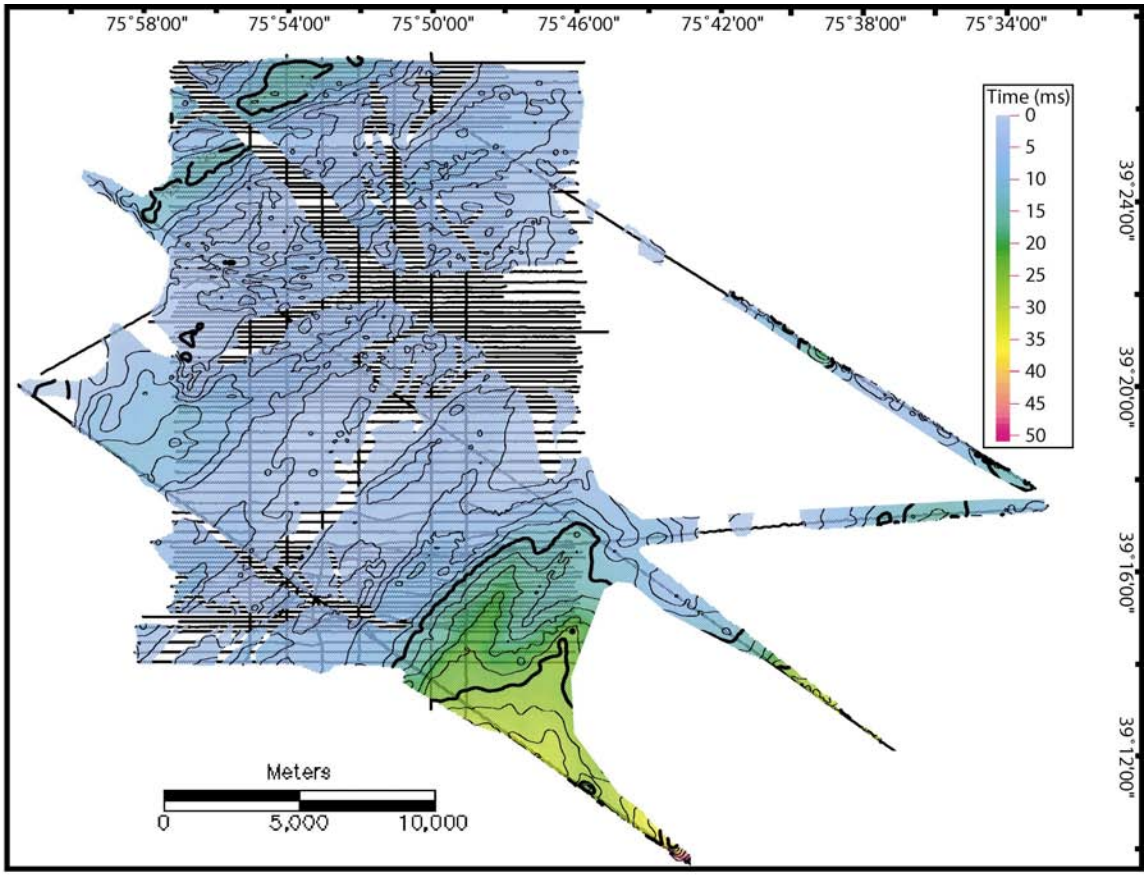

Figure 5. Interpreted and interpolated "R" horizon in Area 1 and along dip profiles.

IMPACT/APPLICATIONS

The primary application of our geological and geophysical characterization is in the establishment of critical paleoenvironmental characteristics for the understanding of acoustic interactions with the seabed.

RELATED PROJECTS

The ONR STRATAFORM program provided initial site characterization for the Geoclutter natural laboratory. The SWAT acoustic experiment was also carried out in this area, and the 2006 Shallow Water Acoustics experiment is now planned for this area.

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