Sedimentology of a Morphologically Complex Seafloor Environment, New Jersey Continental Shelf

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LONG-TERM GOAL

The overarching goal of this research is to advance our understanding of "geologic clutter", acoustic anomalies created by natural sub-seafloor features such as infilled paleochannels, using the continental shelf off New Jersey as a natural laboratory.

OBJECTIVES

As part of the ONR Geoclutter initiative, the objectives of this project are as follows: (1) to identify modern–Holocene sedimentary processes responsible for the morphology and sedimentological heterogeneity of the seafloor; and (2) to determine the physical basis for seismic discontinuities and associated stratigraphic surfaces in the shallow subbottom. To meet these objectives, coordinated geophysical and geological studies have been performed to characterize the sedimentology and stratigraphy at priority Geoclutter sites on the continental shelf.

APPROACH

The research approach involved geological groundtruthing of two sonar datasets previously generated for the Geoclutter study area: (1) multibeam acoustic backscatter derived from Simrad EM1000 (95 kHz) multibeam bathymetry (Goff et al., 1999); and (2) chirp seismic stratigraphy using a system developed by Florida Atlantic University (1.5−15 kHz pulse bandwidth). To correlate acoustic backscatter and seabed sediment type, the sedimentology of short cores collected aboard the RV *Cape Henlopen* in 2001 (cruise CH01−17) was characterized by the PI (UDel Task 1/2). To determine the physical basis for subbottom seismic reflectors at selected Geoclutter sites, AHC-800 drillcores were recovered aboard the RV *Knorr* in 2002 (cruise KN-168) by a team of scientists from DOSECC, University of Texas Institute of Geophysics (UTIG), Skidaway Institute of Oceanography (SKIO), University of Delaware (UDel), and Georgia State University (GSU). Specifically, the PI conducted aboard-ship measurements of sediment physical properties on the drillcores using a GeoTek multi-sensor core logger (UDel Task 2/2).

WORK COMPLETED

Task 1 has been completed, and portion of the data have been incorporated in a manuscript submitted for publication (Goff et al., 2003). Task 2 has also been completed; sediment physical properties data for three drillcores (4−13 m length) have been analyzed and used to develop synthetic seismograms for the cored sections. Details of the drilling effort are provided in a cruise report authored by C. Alexander and J. Austin. Preliminary results of the ongoing drillcore studies, which will continue during FY03−04, will be presented at the Fall 2003 AGU meeting in a series of papers coauthored by the collaborating investigators (see Publications).

RESULTS

Seabed Studies

In the Geoclutter study area the seabed is a heterogenous mosaic of late Pleistocene fluvio-deltaic muds and medium-grained sands deposited subsequently during the Holocene. The Holocene sand sheet, continuous throughout the greater middle shelf, wedges-out at ~110 m leaving the Pleistocene muds exposed at the seafloor. These muds are over-consolidated (stiff), having been exposed throughout the Holocene. Acoustic backscatter in the area is negatively correlated with seabed porosity, and though this was expected, the broad range of porosities measured (0.35−0.55) was not. The spatial variation in porosity is largely due to the coexistence of sand and stiff mud; sand porosities ranged from 0.55 to 0.45, whereas the stiff muds were less porous at 0.35−0.45 (Goff et al., 2003). Another cause for spatial variability is internal sedimentary structures such as shell deposits and rip-up clasts, evidence of post-depositional erosion and resedimentation during the Holocene transgression (Duncan et al., 2000).

Correlation of seismic profiles and lithostratigraphy

Significant progress has been made in relating chirp seismic reflectors and sediment lithology via physical properties analysis of AHC-800 drillcores; seismic discontinuities within the channel fills have been convincingly correlated with sedimentary units at decimeter length scales. One important finding is that pronounced changes in acoustic impedance downsection are associated with depositional *and* erosional surfaces, contacts of strata with disparate sediment types and (or) consolidation states (Figure 1). The majority of these surfaces were created by shallow-marine processes as the channels backfilled during the Holocene transgression, the details of which are being investigated via C-14 geochronology (C. Alexander) and microfossil analysis (B. Christensen). Some of these surfaces span the channel cross-section, whereas others are discontinuous and of variable reflectivity. Intervals of high and extremely variable acoustic impedance are produced by thick beds of shell fragments, material originally transported within the channel environment. Other changes in impedance occur across surfaces separating strata of nearly identical sediment type, yet differing in consolidation state. Such boundaries were most likely produced by a hiatus or erosion in the paleoenvironment. In sum, these results reveal that the small-scale seismic reflectors (decimeters to several meters thick) are produced by highly heterogeneous sedimentary strata with physical characteristics related to the depositional and post-depositional processes.

IMPACT/APPLICATIONS

The goal of the Geoclutter Phase II was to characterize seafloor geology at a number of selected sites through analysis of multibeam and chirp sonar datasets, sediment sampling, and studies of sediment physical properties from drillcores. When modeled by acousticians, the geological data will be used to design signal-processing algorithms that distinguish natural features and man-made targets present at (and just below) the seafloor. In addition, new insights on the nature of infilled paleochannels on the continental shelf have resulted from this work, knowledge with potential applications to shallow-marine environments worldwide.

TRANSITIONS

No specific products have stemmed from this research to date.

RELATED PROJECTS

The geological/geophysical component of the ONR Geoclutter program is composed of several coordinated subprojects, each with a particular emphasis. UTIG is the lead group on multibeam backscatter groundtruthing (Goff), as well as the analysis of chirp stratigraphy (Austin, Fulthorpe, Goff, and Gulick). J. Austin (UTIG) and C. Alexander (SKIO) were the co-chief scientists on the drilling cruise, and D. Nielson (DOSECC) coordinated the drilling operation itself. The PI was responsible for operating the GeoTek logger aboard ship and subsequently for reducing the physical properties data. Detailed sedimentological and chronological studies of the drillcores by C. Alexander and B. Christensen (GSU) are underway.

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PUBLICATIONS

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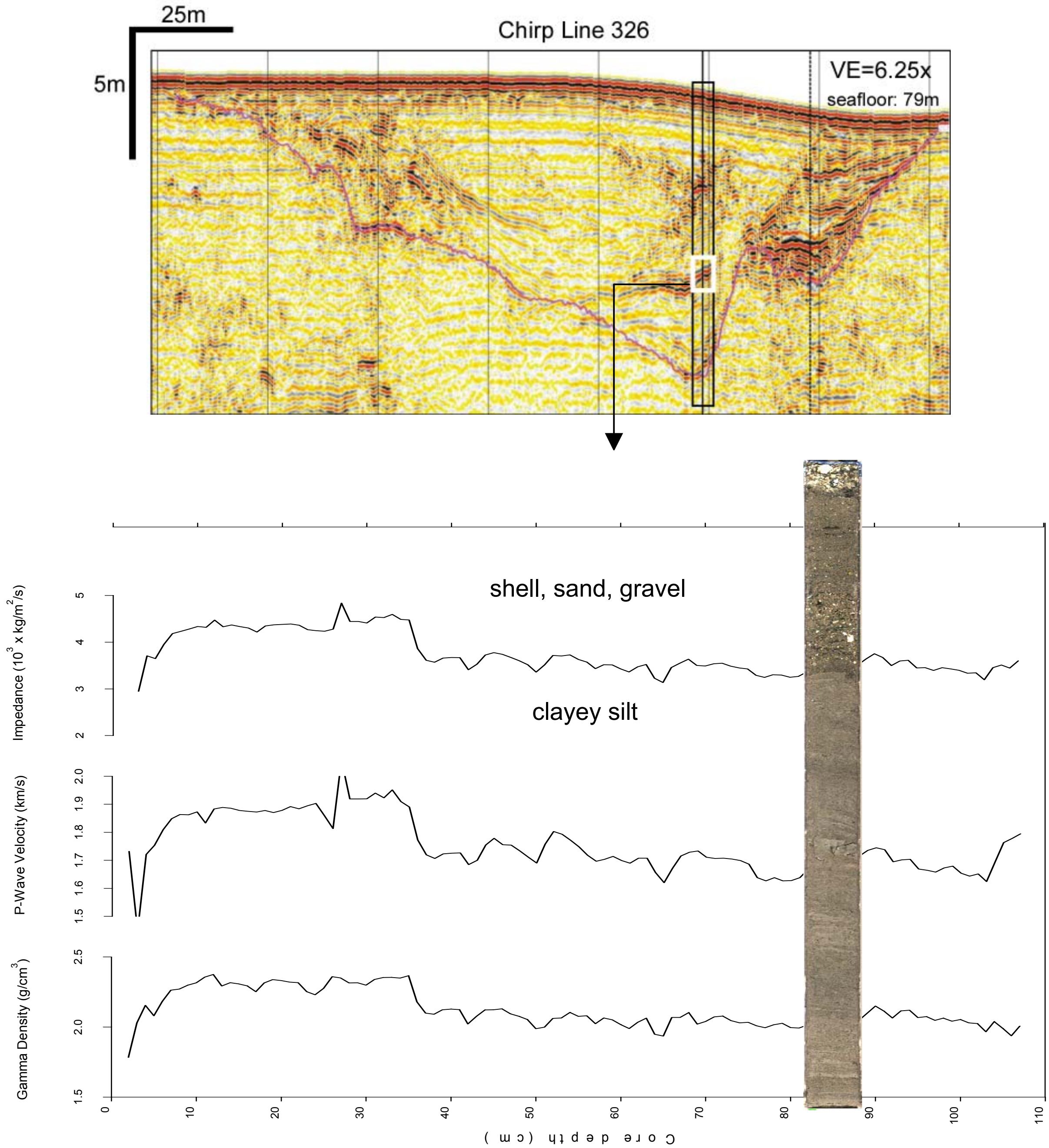

Figure 1. Example of correlated seismic and sediment physical properties data for Geoclutter drillcore Site 2. (Top) Chirp profile showing a buried channel with internal seismic reflectors of variable amplitude. The 13-m section cored during cruise KN-168 is shown (black rectangle). (Bottom) Downcore physical properties and photograph for the core section corresponding to a prominent seismic discontinuity near the channel base (white rectangle). The discontinuity is created by a contrast in acoustic impedance (density x velocity) across a stratal surface formed by the contact of shell-gravel-sand (high impedance) and clayey silt (low impedance). Seismic profile courtesy of UTIG.