Geological and Geophysical Support for the "Geoclutter" Acoustic Reconnaissance Field Program (Phase I)

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LONG-TERM GOALS

Identify and characterize, sufficient for acoustic modeling purposes, seafloor and subseafloor structures that may give rise to signal-like returns ("geoclutter") on long-range active sonar systems.

OBJECTIVES

The primary objective of this work is to provide geologic and geophysical support for the planned Geoclutter acoustic reconnaissance experiment (Phase I. A. of the overall program; see below), to be conducted on the New Jersey shelf south of the Hudson Shelf Valley (Figure 1). This will involve: (1) preparing an environmental assessment; (2) identifying likely geoclutter targets based on existing bathymetry, seismic reflection, and sampling data; (3) making available digital maps and seismic interpretation profiles for use in acoustic modeling and cruise preparation; (4) participation in the acoustic reconnaissance cruise; and (5) initial preparations for a forthcoming geophysical survey of acoustic "hotspots" that are identified in the reconnaissance.

APPROACH

The premise for this work is that, in any littoral area, buried geologic features can contribute significantly to acoustic reverberation, which affects tactical ASW sonar systems. Proper acoustic processing, coupled with quantitative geologic models, can be used to distinguish these buried features from real (man-made) targets. Complexity arises from STRATAFORM studies on the continental shelf off New Jersey that have shown the general lack of predictability of the shallow subsurface using seafloor imagery, even with 100% coverage.

The primary goal of the Geoclutter program will be to assess geologic clutter/reverberation issues in a well-characterized shallow-water environment. The mid-outer continental shelf off New Jersey provides an opportunity, because both bathymetry (a known and prominent cause of backscatter) and the shallow subsurface have been mapped in detail as a result of STRATAFORM. The Geoclutter program will consists of three field program phases: (I) a monostatic acoustic reconnaissance of the New Jersey shelf region to identify acoustic "hot spots" for further study; (II) detailed geologic and geophysical survey of the hot spots identified

in Phase I; and (III) a full bistatic acoustic experiment focusing on the chosen areas. The focus of our present work is primarily on the Phase I experiment. Dr. N. Makris of MIT is the PI in charge of the Phase I experiment and preliminary acoustic modeling.

Our initial efforts have been aimed at identifying potential geoclutter target sites for the purpose of planning the Phase I experiment, and providing to Dr. Makris profiles of seafloor and shallow stratigraphic morphology. There are a number of candidate clutter targets that can be identified in bathymetry, sidescan and seismic reflection data that presently exist in the proposed survey area. These include: buried channels with highly reflective channel walls and thalwegs from 2D and 3D Huntec profiling; iceberg scour marks, erosion pits, large sand ridges, surface or near-surface outcroppings of seismically reflective subsurface horizons, and areas of highly reflective, probably gravelly, seafloor identified from the sidescan.

WORK COMPLETED

We have completed a preliminary map of potential geoclutter target sites within the STRATAFORM New Jersey natural laboratory (Figure 2) and provided to Dr. Makris a profile of bathymetry and subsurface stratigraphy for use in his preliminary modeling work (Figure 3).

Originally, an acoustic reconnaissance experiment using a Navy destroyer was intended for the summer of 2000. Goff and Austin were to participate on that as part of this grant. However, for a variety of reasons that cruise has been postponed to the first quarter of 2001. We will therefore participate on that cruise using funds from our grant for the Geoclutter geophysical field program.

RESULTS

The results of this work thus far are principally contained in Makris' progress report. One of the more salient impacts of the acoustic modeling work based on our profiles has been to recognize the critical importance of accurate measurement of seafloor sediment properties, especially sound velocity. Given the extremely low grazing angles associated with the operation of long range active sonar systems in shallow water, small changes in the sound velocity of seafloor sediments can have a dramatic impact on the level of acoustic energy that is transmitted into the subsurface.

IMPACT/APPLICATIONS

The newly formed ONR-sponsored "Geoclutter" program is a ~5-year field and analysis effort: (1) to understand, characterize, and predict lateral and vertical, naturally-occurring heterogeneities that may produce discrete acoustic returns at low grazing angles in a mid-outer shelf test site off the U.S. (New Jersey), and then (2) to conduct precise acoustic reverberation experiments at this site to understand, characterize, and potentially mitigate the geologic clutter, so that the false alarms, or detects, of tactical sonar systems encountered in this marine geologic environment around the world can be characterized properly. The goal of the planned field experiments off the U.S. east coast is to understand the process of acoustic reverberation from the seabed in shallow water, with the objective of designing physics-based signal processing

("detection") algorithms to distinguish these naturally-occurring features on the world's continental shelves (e.g., shallowly-buried meandering channels, surface outcrop of reflective horizons, erosion scars) from man-made targets of similar dimensions (e.g., submarines).

The products that we are generating under this grant will greatly facilitate the planning and operation of the Phase I Geoclutter acoustic reconnaissance field program. This work also constitutes preliminary step for the Phase II work of detailed geological and geophysical survey of the target sites that will ultimately be chosen for intensive acoustic study in Phase III.

TRANSITIONS

The products that we are generating are being used by Dr. Makris for the planning of the Phase I acoustic reconnaissance experiment and for preliminary acoustic modeling work.

RELATED PROJECTS

The New Jersey shelf was chosen as the focus for the Geoclutter work in large part because of the intensive data collection that has already occurred there as part of both the ONR STRATAFORM program and ODP site survey work.

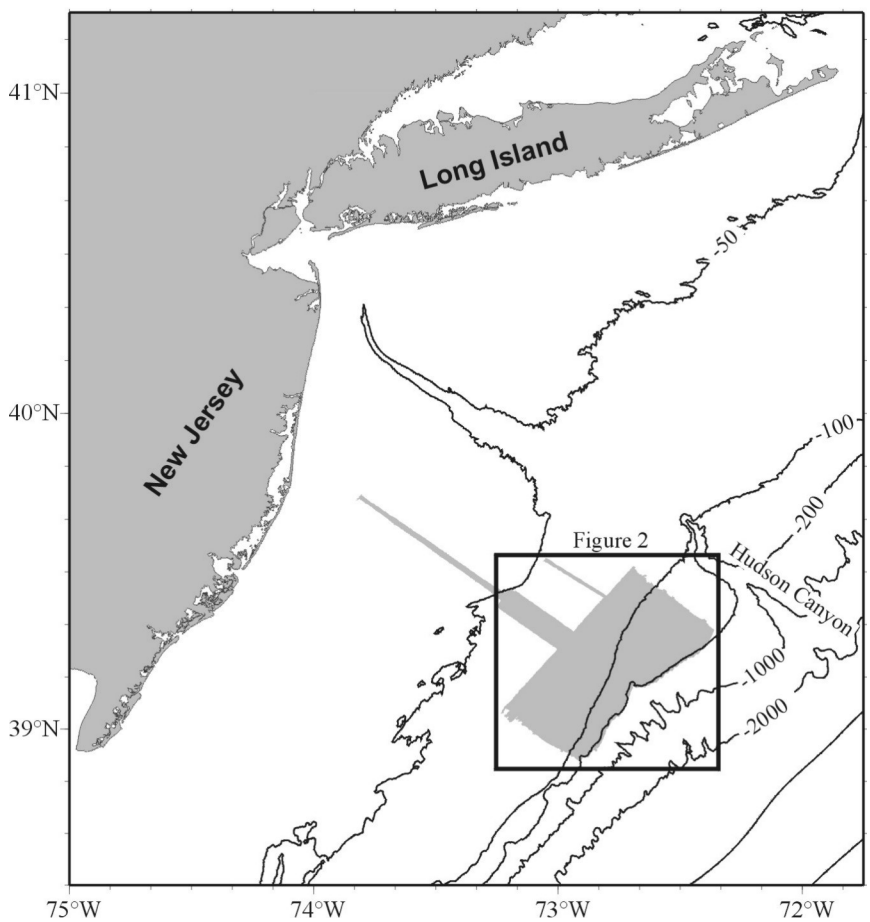

Figure 1. Location figure for Geoclutter experiment. Contour depth in meters. Offshore shaded region is area covered by STRATAFORM New Jersey swath sonar data.

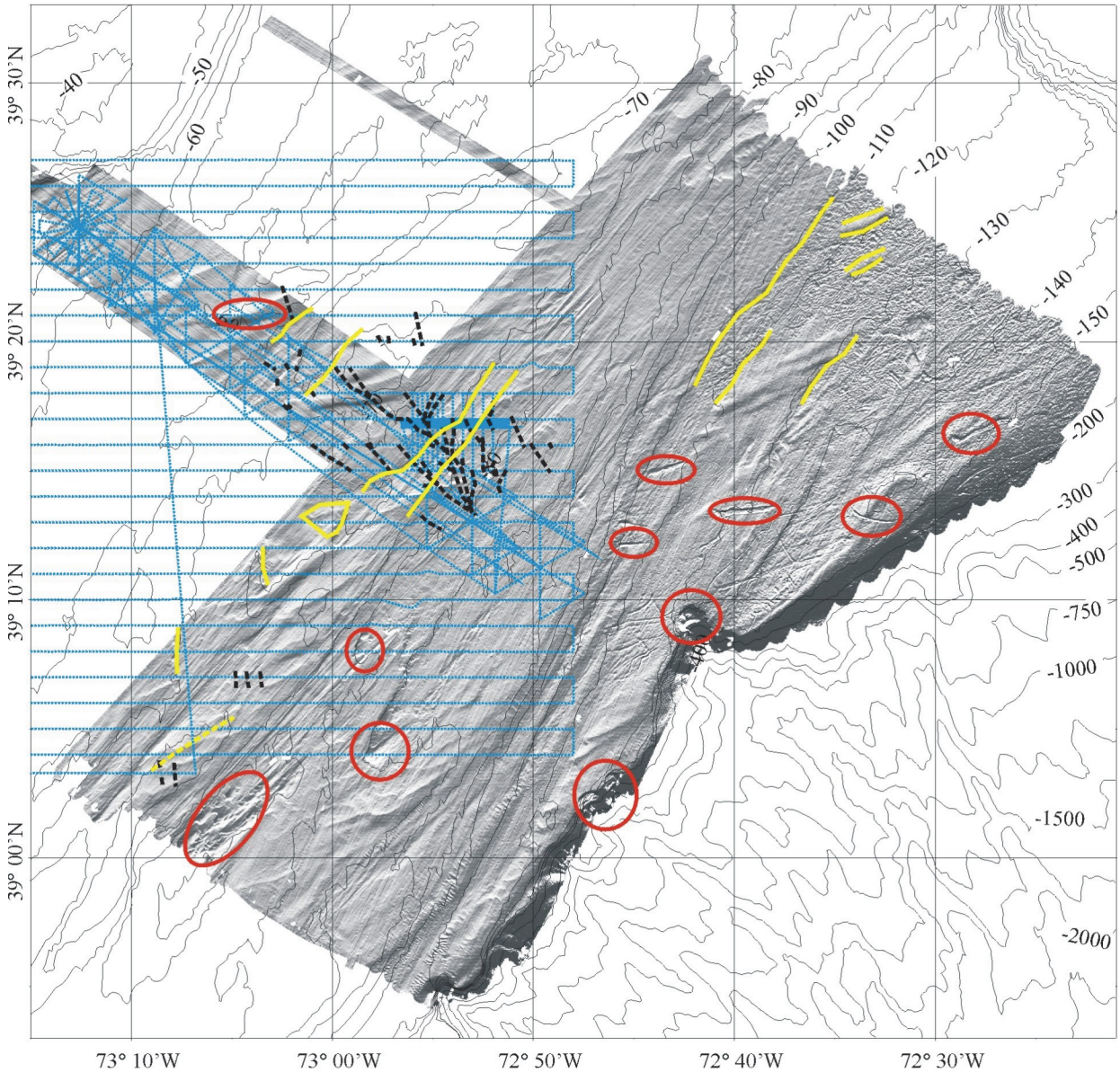

Figure 2. Possible geoclutter targets identified from swath map and ultra-high resolution seismic reflection data. See Figure 1 for location. The STRATAFORM swath bathymetry data are displayed with artificial illumination from the north. Contours in meters are from regional data compiled by NGDC. Light blue lines indicate tracklines for available Huntec ultra-high resolution seismic reflection data. Three different types of possible geoclutter targets are identified: red ovals indicate bathymetric targets; yellow lines indicate important changes in sedimentary properties at or near the seafloor, as inferred from backscatter data or by outcrops of prominent subsurface reflectors; black dashed lines indicate shallowly buried (< 10 m) channels (see Figure 3).

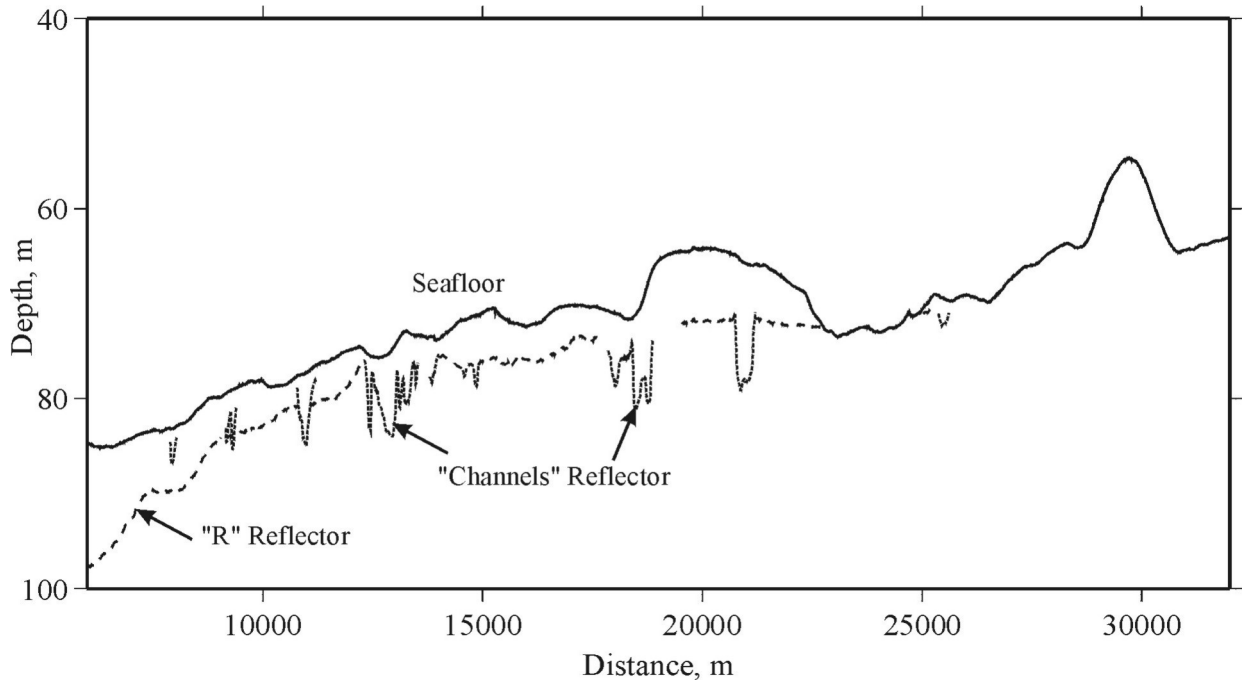

Figure 3. Seismic reflection interpretation profile on the New Jersey shelf indicating both seafloor and subsurface complexities that could give rise to" geoclutter" signals. This profile has been provided to Makris for his preliminary modeling work.