Geological and Geophysical Reconnaissance for the ONR Geoclutter Program

James A. Austin, Jr., John A. Goff
The University of Texas at Austin, Institute for Geophysics (UTIG)
4412 Spicewood Springs Road, Bldg. 600, Austin, TX 78759-8500
Ph: (512) 471-0450; Fax: (512) 471-8844; E-Mail: jamie@utig.ig.utexas.edu

Grant Number: N00014-00-1-0844
http://www.ig.utexas.edu/

LONG-TERM GOALS

The common goals are to: 1) understand the acoustic scattering process in shallow water, with the objective of designing physics-based signal processing algorithms to distinguish naturally-occurring features (e.g., iceberg scours, shallow gas accumulations, outcrops of high-amplitude shallow subsurface reflectors, shallowly-buried meandering channels) which are ubiquitous on the world's continental shelves, so-called “geoclutter”, from man-made targets of similar dimensions (e.g., submarines), and 2) to predict the distribution and properties of geoclutter at a chosen U.S. continental margin test site, with eventual application to other continental shelves of Navy interest globally.

OBJECTIVES

To plan and conduct an integrated, interdisciplinary, multi-year initiative, involving both geologists/geophysicists and acousticians, and including geologic and ocean acoustics/signal processing field and analysis components, in order: 1) to understand, characterize, and predict lateral and vertical, naturally-occurring heterogeneities (geoclutter) both at the seafloor and in the shallow sub-bottom of a U.S. continental margin test region, and 2) to identify, understand, characterize, and mitigate the geoclutter, specifically the heterogeneities that may produce discrete acoustic returns at low grazing angles, by carrying out precise acoustic reverberation experiments in the same region, so that such false alarms, or detects, of tactical sonar systems can be put in a proper context.

APPROACH

The underlying premise for geoclutter research is that both seafloor and shallow sub-seafloor geologic elements contribute to acoustic reverberation in shelfal water depths, in such a way as to affect tactical ASW sonar systems adversely. A comprehensive suite of reverberation measurements on a continental shelf, chosen because that shelf is also extremely well-characterized geologically, should result in improved characterization of the linkages between “clutter” and the ambient geologic environment. As part of ONR’s recently completed STRATAFORM (Stratal Formation on Margins) Initiative, a "natural laboratory" to study source-to-sink sediment dispersal and preservation was established on the mid- and outer continental shelf off New Jersey. Throughout this region, seismic interpretation and mapping and limited sampling have been combined with digital compilations of multibeam bathymetry and seafloor backscatter. As a result, this shelf has been chosen as the test site for both geoclutter acoustic reconnaissance (Phase I) and detailed geological and geophysical reconnaissance in support of Phase I (Phase II).

Report Documentation Page

Form Approved
OMB No. 0704-0188

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1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
30 SEP 2001		**00-00-2001 to 00-00-2001**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Geological and Geophysical Reconnaissance for the ONR Geoclutter Program	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **The University of Texas at Austin, Institute for Geophysics (UTIG),,4412 Spicewood Springs Road, Bldg. 600,,Austin,,TX, 78759**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

The common goals are to: 1) understand the acoustic scattering process in shallow water, with the objective of designing physics-based signal processing algorithms to distinguish naturally-occurring features (e.g., iceberg scours, shallow gas accumulations, outcrops of high-amplitude shallow subsurface reflectors, shallowly-buried meandering channels) which are ubiquitous on the world's continental shelves, so-called geoclutter, from man-made targets of similar dimensions (e.g., submarines), and 2) to predict the distribution and properties of geoclutter at a chosen U.S. continental margin test site, with eventual application to other continental shelves of Navy interest globally.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a REPORT	b ABSTRACT	c THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**6**	

The key individuals involved at UTIG, other than the Principal Investigators listed above, include one post-doctoral appointee (Gulick) and one Ph.D. student (Nordfjord). All will be part of Phase II data analysis and interpretation. Collaborations exist with the acousticians in the Geoclutter initiative through Dr. N. Makris, MIT; he is in charge of Phase I and follow-up interpretations. Other Phase II collaborators include Drs. L. Mayer, UNH, C. Sommerfield, UDEL, and S. Schock, FAU.

WORK COMPLETED

Field experiments in support of both phases have now been completed. As a result of Geoclutter Phase I, conducted in April-May 2001, preliminary maps of prospective geoclutter targets were supplied to UTIG investigators for two primary areas (Figure 1). The detailed geophysical characterization of those areas, Geoclutter Phase II, has just been completed, in two parts. Part 1 was a cruise by the *Cape Henlopen*, CH01-17 (July 31-August 6, 2001), during which UTIG, UNH, and UDEL investigators collected suites of shallow subsurface compressional wave velocity measurements, grab samples, and short cores. Part 2 was a cruise by the *Endeavor*, EN359 (August 12-September 10, 2001), during which UTIG and FAU investigators used a deep-towed chirp sonar supplied by FAU to image the upper ~30 m of the geologic section, at frequencies of 1-4 kHz and at profile separations ranging from 0.5 nmi to ~50 m (Figure 1). Secondary acquisition using a hull-mounted Edgetech chirp sonar system was also conducted in Area 2.

RESULTS

Hardware and software capabilities put aboard *Endeavor* by UTIG for EN359 allowed chirp sonar data and precision navigation to be merged at sea. Preliminary mapping of important dendritic drainage patterns (Figure 2) and outcrops of important reflectors (i.e., "R") was carried out aboard ship. These maps both confirm and amplify geophysical interpretations of high-resolution MCS and Huntec profiles made during STRATAFORM. Some of these features appear to correlate spatially with geoclutter targets identified during Phase I. More precise correlations between geophysical (i.e., chirp-sonar) characterizations of geologic features and geoclutter targets identified during Phase I will await further Phase I and Phase II data analysis.

IMPACT/APPLICATIONS

The maps completed during Phase II shipboard data acquisition (Figure 2) will be refined and transmitted to Phase I investigators in various forms before the end of FY2002, so that prospective geoclutter targets identified as a result of Phase I operations in Areas 1 and 2 (Figure 1) can be tied to a detailed geophysical characterization of important geologic features. Over the next ~5 years, the Geoclutter initiative will 1) understand, characterize, and predict lateral and vertical, naturally-occurring heterogeneities both at the seafloor and in the shallow sub-bottom of the mid- and outer continental shelf off New Jersey, and 2) identify, understand, characterize, and mitigate that geoclutter, specifically the heterogeneities that may produce discrete acoustic returns at low grazing angles, so that such false alarms, or detects, of tactical sonar systems can be put in a proper context.

TRANSITIONS

DURIP funding has been secured to equip the DOSECC GLAD800 lake-drilling system with active heave compensation. A test of that system will be conducted offshore the U.S. east coast aboard the WHOI research vessel *Knorr* in November 2001. If that test is successful, present plans call for the

GLAD800, mounted on the *Knorr*, to conduct sampling operations off New Jersey in September 2002 to confirm the geologic identity of mapped Phase II geophysical targets.

RELATED PROJECTS

STRATAFORM and ODP (an international program funded through NSF) have both played prominent roles in ongoing New Jersey research over the past decade. STRATAFORM/Geoclutter sampling envisioned for 2001 (and beyond) should proceed in tandem with additional acoustic reconnaissance, including perhaps additional 2D and 3D chirp sonar imaging, as part of Geoclutter.

PUBLICATIONS

Austin, J. A., Jr., 1999, An analysis of geologic clutter in shallow water, a workshop. ONR rept., unpub, 11 p.

Austin, J. A., Jr., J. Goff, S. Gulick, C. Fulthorpe, S. Nordfjord, M. Wiederspahn, S Saustrup, S. Schock, J. Wulf, K. Gjerding, L. Mayer, and C. Sommerfield, in press, Assessing the "geo" in geoclutter: new chirp sonar, sampling, and compressional wave velocity results from the New Jersey shelf (abs). *Eos*.

Fulthorpe, C. S., J. A. Austin, Jr., and G. S. Mountain, 2000, Morphology and distribution of Miocene slope incisions off New Jersey: Are they diagnostic of sequence boundaries? *Geological Society of America Bulletin*, v. 112, p. 817-828.

Goff, J. A., H. C. Olson, and C. S. Duncan, 2000, Correlation of side-scan backscatter intensity with grain-size distribution of shelf sediments, New Jersey margin. *Geo-Marine Letters*, v. 20, p. 43-49.

Goff, J. A., L. Mayer, and C. Sommerfield, 2001, CH01-17 cruise report, unpub.

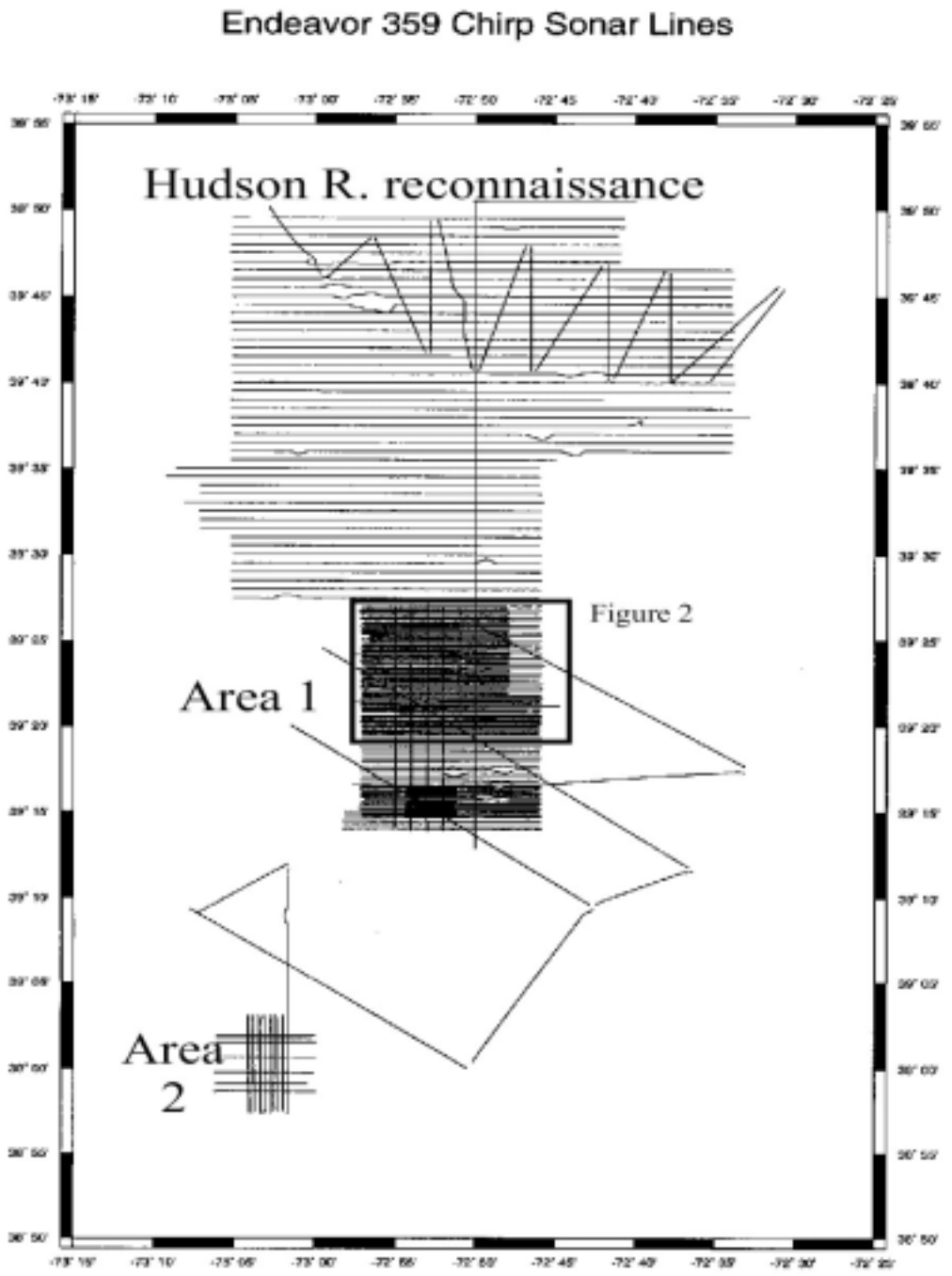

Figure 1: Deep-towed chirp sonar coverage, *Endeavor* cruise #359, August 12-September 10, 2001.

Figure 1: Deep-towed chirp sonar coverage achieved during Endeavor cruise #359, August 1-September 10, 2001, as part of Phase II of the Geoclutter initiative. EN359 concentrated in two areas deemed of high priority during the Phase I acoustic reconnaissance (April-May 2001) - Area 1 (top priority) and Area 2 (secondary priority). This map does not include hull-mounted chirp-sonar profiles collected in Area 2, and additional hull-mounted chirp sonar tie-lines between Areas 1 and 2. Area 1 profile density varies from 400 m to ~50 m.

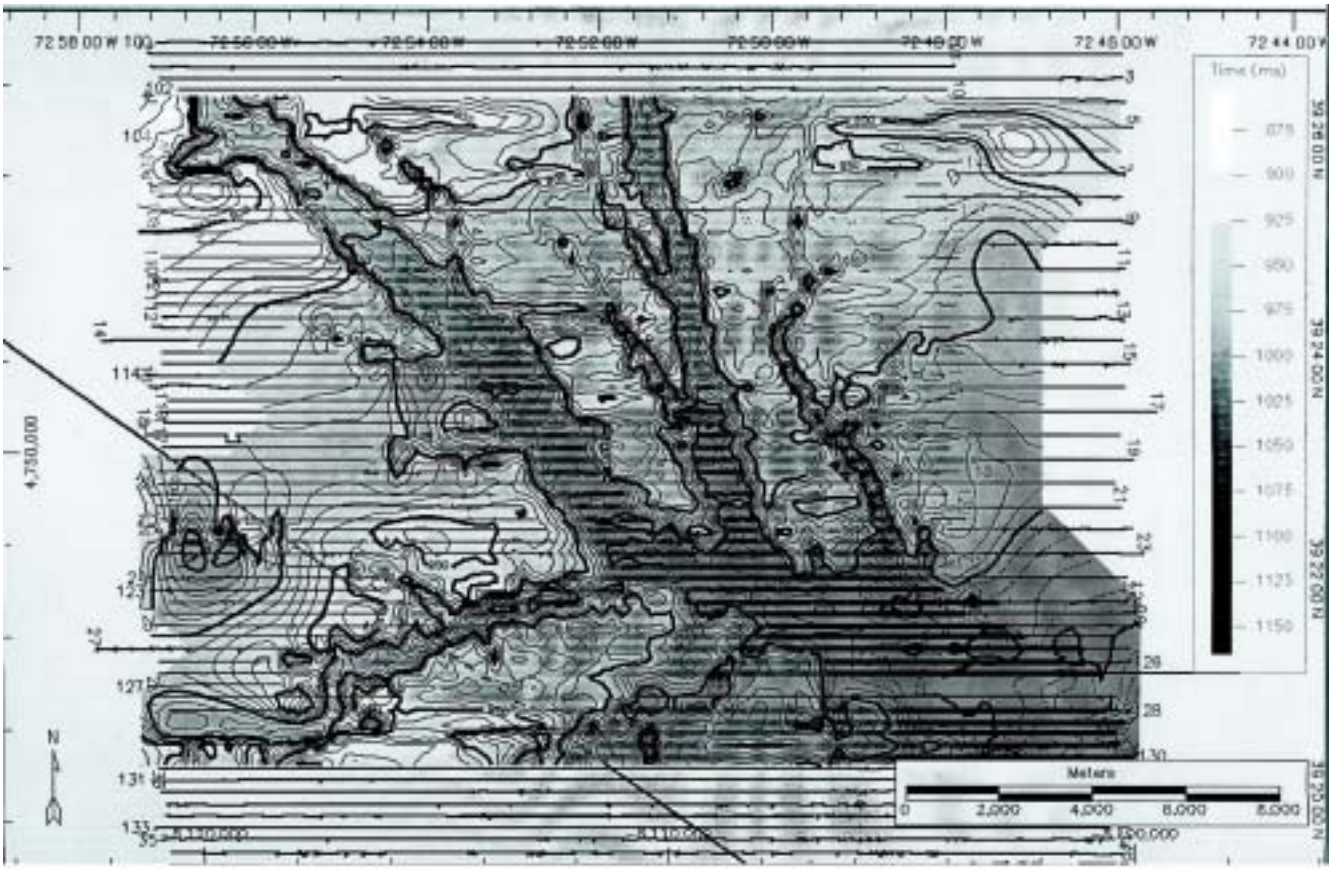

Figure 2: Dendritic drainage mapped in shallow subsurface, northern part of Area 1.

Figure 2: Structure map (in travel-time, see scale to the right) of a latest Pleistocene-Holocene dendritic drainage system shallowly buried (< 10 m) beneath the northern part of Area 1 (see Figure 1 for location). The system trends generally NW-SE, and drains towards the modern shelf edge. Tributaries meander; one prominent feeder trends WSW-ENE, almost orthogonal to the trunk channel in the SE. Widths of tributaries vary from ~100 m or less to kilometers; the trunk channel is at least 3 km wide (see scale, lower right). Braiding of multiple thalwegs occurs within the bounds of the trunk channel; these details are obvious in individual deep-towed chirp sonar profiles, but are not evident in this preliminary interpretation.