High Resolution Bathymetry and Backscatter of a High-Frequency Test Area

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LONG-TERM GOAL

Our long-term goal is to understand the processes which create and modify the sea bed in the coastal zone and to understand how seabed morphology can be studied using high-resolution swath mapping techniques (for bathymetry and backscatter).

OBJECTIVES

We used our EM 3000 multibeam echosounder, a research-grade shallow-water multibeam echosounder operating at 300 kHz, to produce a high-resolution map of the sea bed bathymetry and backscatter in the High Frequency Sound Interaction in Ocean Sediments DRI (SAX99) study area. The prime study area has is about 600 m by 600 m at a water depth of 18 m. The interaction of sound with ocean floor sediments depends on many factors, including the shape of the sea floor and the distribution of roughness elements. Our survey characterized bottom topography, bottom roughness and backscatter patterns immediately prior to the emplacement of bottom equipment. We will also seek to understand the factors that cause the observed backscatter patterns by integrating our results with those produced by others at the SAX99 study area.

APPROACH

For this project, the MSRC/SUNY EM 3000 system was installed on the Research Vessel R/V Tommy Munro (University of Southern Mississippi) with the transducer mounted on a pole attached to the side of the vessel. The EM 3000 system includes the Simrad EM 3000 (echo sounder transducer, surface electronics, logging computer), a TSS POS/MV (ship attitude and DGPS navigation), and a CTD (for determining the sound velocity profile during the survey). Additional components include backup computers for near real-time data reduction, a printer for data display, and a CD-ROM writer for data distribution. We also deployed a bottom-mounted pressure gauge for measuring water surface

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elevation (tide) changes during the survey. Preliminary data products were provided to other investigators on CD-ROM by the end of the cruise.

The EM 3000 collects bathymetric and backscatter data across a swath that is about four times the water depth. We planned a minimum track spacing of 9 to 18 m (0.5 to 1 times water depth) at several different orientations. This track spacing will allow a final gridding interval of 25-30 cm for backscatter and bathymetry and for backscatter to be measured at several different incident angles.

This is a cooperative effort between MSRC/SUNY (Flood) and the Ocean Mapping Group at New Brunswick (Mayer). MSRC (with assistance from Dale Chayes at LDEO) built the transducer mounting and installed the equipment on the vessel, and MSRC operated the system during the survey. We used standard OMG SwathEd programs to reduce the bathymetric and backscatter data. Larry Mayer (OMG) will provide additional analysis of the 300 kHz backscatter data. We will work jointly to interpret the backscatter and bathymetric information in terms sediment characteristics to be determined by others as part of the acoustics experiment.

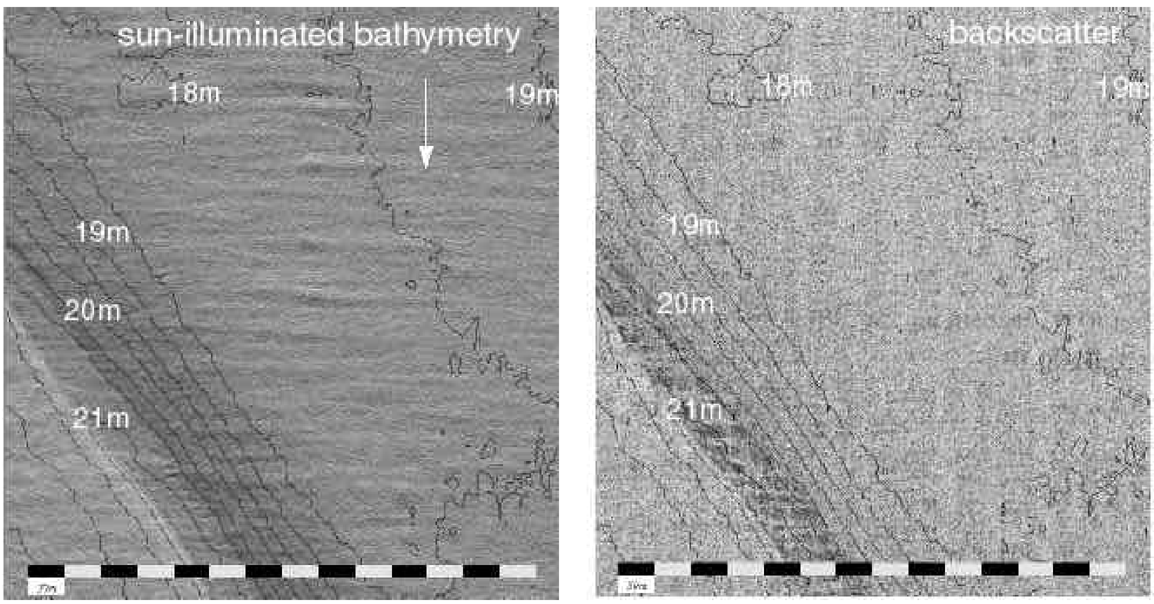
WORK COMPLETED

Our EM 3000 survey, conducted between September 27 and 30, 1999, covered an area of about 1.5 km on a side centered around the SAX99 site. We ran survey lines in north-south, east-west, northeast-southwest, and southeast-northwest directions to understand how backscatter changes with orientation. Additional data was collected at other orientations. A pressure gauge provided surface elevation data at the study site. Dr. Robert Stoll (LDEO) joined us for about 1 day and we deployed his bottom sled and free-fall penetrometer within the SAX99 area. We also collected three sediment samples to help understand what the backscatter patterns observed. Survey data from the initial north-south and east-west surveys was reduced on board to produce maps of bathymetry, sun-illuminated bathymetry, and backscatter. These maps were given to Dr. Eric Thorsos and others planning SAX99 immediately at the end of the survey in order to assist in determining the mooring locations.

RESULTS

Our results show that the sea bed here is made up of a number of shallower ridges (about 18.5 m deep) separated by 1 to 2 m deep troughs, separated by about 1 km, trending generally downslope (Figure 1). The shallower ridges generally dip slightly towards the east, and the eastern sides of the troughs are generally slightly steeper than their western sides. Some troughs do not go very far in the onshore-offshore direction, while other troughs cross the survey area. The troughs that have limited onshore-offshore extent form closed topographic depressions. The floors of the troughs tend to be flat and between 50 and 100 m wide. In almost all cases, the trough floors have lower backscatter than do the ridges. The walls of the troughs also tend to have slightly lower backscatter values. We collected grab samples from the high-backscatter ridge (medium sand), from the low backscatter trough (sandy silty mud), and from a closed depression at the eastern edge of our study area where the backscatter was very low (mud). Thus in this area lower backscatter appears to correlate with increased mud content. When viewed at full resolution (ca. 0.25 m pixels), our data do image the wave oscillation ripples reported by others from the SAX99 study area. However, the ripples are too small to be observed on the 1 m gridded images in Figure 1.

The proposed position for one of the acoustic tower moorings was on the eastern flank of the channel shown in Figure 1. Based on our survey data, the mooring site was moved into the more uniform region between the 18 and 18.5 m contours.



1. A portion of the preliminary EM 3000 survey collected at the SAX99 site south of Fort Walton Beach. Left: sun-illuminated bathymetry created by shining a synthetic light across the image from the top. One-half meter contours are shown as black lines. Right: backscatter from the same section of the sea bed imaged on the left (higher backscatter is lighter gray shade). Ship tracks are east-west and north south, alternating bands on scale bar are each 50 m wide, grid size is 1 m. These data show that a 2 m deep trough is present in the lower-left. The floor of the trough has lower backscatter. A grab sample from the trough floor showed a significant mud fraction.

IMPACT/APPLICATIONS

Our work to date clearly demonstrates the high quality of the data generated by the EM 3000 system and the importance of multibeam data in understanding seabed morphology in the coastal regions. The system can be installed on a variety of vessels after the design and installation of appropriate mounting systems. Use of the system by our group and others in a number of environments in support of a wide range of problems is anticipated and encouraged.

TRANSITIONS

We are in the testing and evaluation phase for our system, but we anticipate that the this system will become an important part of many coastal study programs.

RELATED PROJECTS

We have used our EM 3000 system in several studies for research and educational programs in 1999. In addition to this survey of the High Frequency Sound Interaction in Ocean Sediments DRI (SAX99) area, we also completed an ONR-supported survey of the inshore end of the S-Transform survey in the STRATAFORM area. Educational programs include classes with SUNY Stony Brook WISE (Women in Science and Engineering) and UREC (Undergraduate Research program) students and participation in the MSRC/SUNY Research Experience for Undergraduate (REU) programs. Other research programs include completing the mapping of 35 miles of the Hudson River (for the New York State Department of Environmental Conservation) and mapping from about 10 to 40 m water depths off Grays Harbor off southwest Washington State (for the Washington State Department of Ecology). We used a dual-head system for the Washington State survey. Users of our multibeam data for both the SAX99 and the Washington State studies say that our results caused experiments using bottom-mounted arrays to be revised to take into account local topography. This kind of impact is possible using our system because preliminary results of the survey are available shortly after the survey is completed.