Quantifying Sediment Volume Heterogeneities: SAX99 Data Analysis II

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LONG-TERM GOALS

The ultimate objective of this research program is to identify and obtain a predictive understanding of the physical and biological processes responsible for the sediment volume heterogeneity field of marine sediments. To achieve this goal we are studying formative processes occurring on the sediment surface (e.g., biogenic mound formation, ripple development), as well as processes occurring within the seabed (e.g., bioturbation and compaction). The approach to these areas of interest is predominantly field-oriented, with a secondary emphasis on model development.

OBJECTIVES

The objective of this project, which is part of the High-Frequency Sediment Acoustics DRI, is to quantitatively document the patterns of sediment volume heterogeneities at the Fort Walton Beach, FL study site – the location of SAX99. A secondary objective is to estimate temporal rates of change of volume heterogeneities.

APPROACH

We measure quantitatively the sediment volume inhomogeneity (SVI) field using a digital x-radiography system and an in situ resistivity profiler (IRP). Precisely located (using an acoustic triangulation system) and oriented cores were collected by divers at multiple separation lengths, transported to the ship and immediately radiographed onboard. Brightness data are transformed to bulk density data, based on empirical laboratory correlations. The bulk density fields are described and analyzed using a variety of spatial statistical measures, as well as classical sedimentological nomenclature. Independent estimates of bulk density profiles are made using a diver-deployed in situ resistivity profiler. In addition, deliberate-tracer bioturbation experiments were conducted during the experiment. The purpose of this activity was to document rates of biological mixing that could contribute to temporal changes in the SVI field.

WORK COMPLETED

During FY02, focus has been on laboratory analysis and preparation of peer-reviewed publications. Activities have been centered on three fronts: (1) revision of a manuscript describing the in situ resistivity data, (2) quantifying shell debris concentration and orientation in the digital x-radiographs,

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14. ABSTRACT

The ultimate objective of this research program is to identify and obtain a predictive understanding of the physical and biological processes responsible for the sediment volume heterogeneity field of marine sediments. To achieve this goal we are studying formative processes occurring on the sediment surface (e.g., biogenic mound formation, ripple development), as well as processes occurring within the seabed (e.g., bioturbation and compaction). The approach to these areas of interest is predominantly field-oriented, with a secondary emphasis on model development.

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and (3) measurement of sand tracers to estimate the impact of fish bioturbation in the study site. The latter has been conducted using ICP-MS.

RESULTS

The analysis of the digital x-radiographs indicates the following characteristics of the shell debris. (1) When integrated over the upper 10 cm of the seabed, shell concentrations (number concentration or volumetric concentration) are approximately uniform over the SAX99 study area. (2) At smaller spatial scales (i.e., within x-ray cores) there is evidence for appreciable non-uniformity (Figure 1) that likely reflects physical sedimentary structures. (3) The shape of individual shell fragments varies as a function of size, whereby large fragments are highly elliptical compared to the nearly spherical small fragments.

The second area of results involves measurement of noble-metal tracers for the purpose of quantifying bioturbation intensity in areas with and without significant fish concentrations. Preliminary results (in need of verification) indicate differences between the two bottom types, but in ways that are counter intuitive. That is, the tracer was observed to penetrate deeper into the seabed in areas without high fish concentrations. A possible explanation is that fish predation on infauna slowed mixing.

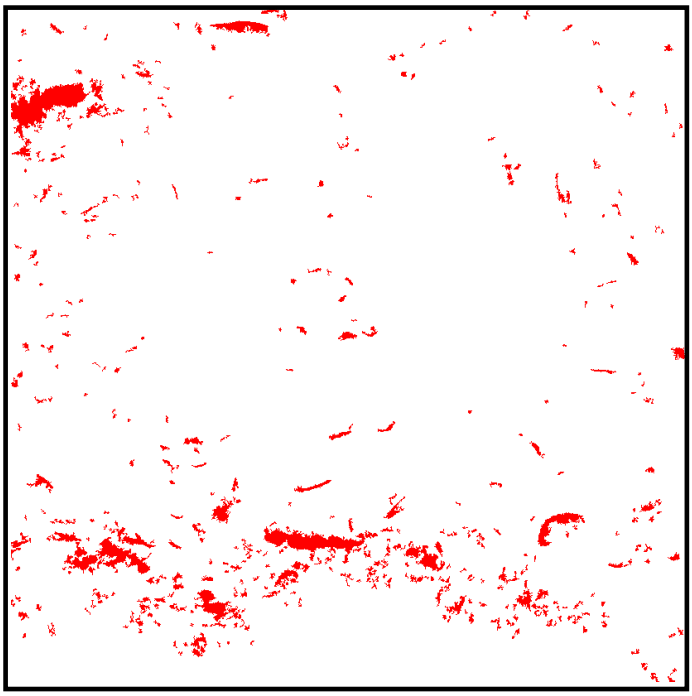

Figure 1. A binary image of a 10 by 10-cm slice of the seabed shows the distribution of shell debris (red). Note the non-uniform distribution on the small scale.

IMPACT/APPLICATIONS

For a range of spatial scales, digital radiographs have the greatest potential for providing acousticians with high-quality data on the sediment volume heterogeneity field. Further development of this research topic has wide-ranging applications.

TRANSITIONS

None are presently known, however, the digital x-radiography system would seem to have potentially wide application in the Fleet.

RELATED PROJECTS

Sediment volume inhomogeneity data is shared with DJ Tang and Darrel Jackson (APL-UW) for use in their acoustical modeling efforts. In addition, Dick Bennett (Seaprobe) and I are comparing macro- (using the digital x-radiography system) and micro-scale views of the sediment fabric.

PUBLICATIONS

Wheatcroft, R.A. 2002. In situ measurements of near-surface porosity in shallow-marine sands. *IEEE Journal of Oceanic Engineering* (in press, July issue).