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Form Approved
OMB No. 0704-0188

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1. REPORT DATE 30 SEP 2002		2. REPORT TYPE		3. DATES COVERED 00-00-2002 to 00-00-2002	
4. TITLE AND SUBTITLE Optically Relevant Measures of Bottom Roughness:COBOP Data Analysis				5a. CONTRACT NUMBER	
				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) College of Oceanic & Atmospheric Sciences,,Oregon State University,,Corvallis,,OR, 97331				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 ultimate objective of this research program is to identify and obtain a predictive understanding of the physical and biological processes responsible for the formation and maintenance of the microtopography (decimeter to millimeter) of the sea floor. To achieve this goal, it is necessary to study 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, compaction) which generally lessen microtopography. The approach to this area of interest is predominantly field-oriented, with a secondary emphasis on model development.					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 3	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

Optically Relevant Measures of Bottom Roughness: COBOP Data Analysis

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Grant Number: N00014-99-1-0046

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 formation and maintenance of the microtopography (decimeter to millimeter) of the sea floor. To achieve this goal, it is necessary to study 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, compaction) which generally lessen microtopography. The approach to this area of interest is predominantly field-oriented, with a secondary emphasis on model development.

OBJECTIVES

The objective of this project, which is part of the Coastal Benthic Optical Properties (CoBOP) DRI, is to study the impact of bottom roughness (biological and physical), bioturbation and near-surface porosity on benthic optical properties. Field studies at sites offshore of Lee Stocking Island, Bahamas, conducted in 1998-2000, yielded a rich set of data. Focus during this biennium is on elucidating the mechanisms leading to the observed patterns of roughness and near-surface porosity.

APPROACH

Measurements of bottom roughness were made using a 35-mm PhotoSea 2000 metric stereocamera mounted on a neutrally-buoyant, diver-manipulatable vehicle ("survey") or using a similar stereocamera mounted on a tripod ("time-lapse"). Following standard film development, the images were digitized at a high resolution (i.e., > 4000 ppi) by a third-party aerial mapping firm and stored on CD-ROMs. Sea floor height information is obtained from analytically rectified (epipolar transformation) digital stereo-images using matching algorithms. Independent, co-located measurements of sediment bioturbation intensity and mode are made during the field studies. The bioturbation measurements involve the spreading of glass beads onto a patch of sea floor, followed by tube coring and vertical sectioning after periods of days to months. Tracers were enumerated by dissolving the ambient carbonate grains. Near-bed flow information was collected during the time-lapse deployments using a Sontek ADV. Measurements of near surface porosity were made using an in situ resistivity profiler (IRP).

WORK COMPLETED

Work completed in this fiscal year has been in one of three areas. First, laboratory analyses during the year have focused on generation of accurate digital elevation models (DEMs) for the time-lapse and survey stereophotographs and the statistical characterization of the DEMs. Second, tracer profiles from North Perry reef have been analyzed to extract estimates of bioturbation intensity. Third, a significant amount of time was devoted to manuscript revision (see publications).

RESULTS

The survey DEM data clearly indicate differences between the roughness near (i.e., 0-5 m) versus far (> 50 m) from the North Perry reef. In particular, the far-reef seafloor height spectrum exhibits significant low-frequency energy that corresponds to the wavelength of relict wave ripples. In contrast, the near-reef roughness is dominated by biogenic microtopography, especially animal mounds (10-cm width). Although these results are consistent with anecdotal observations that indicate greater biological activity near reef has destroyed the ripples and replaced it with biogenic structures, independent estimates of sediment bioturbation intensity have been equivocal. In particular, vertical transport rates and modes (e.g., diffusive vs. nonlocal) for the near versus far reef sites are approximately equal. This result suggests potential anisotropic mixing (i.e., horizontal rates may differ at the two sites), and has prompted a focus on the time-lapse photographs.

IMPACT/APPLICATIONS

The development of a photographic system capable of quantifying sea floor microtopography is likely to have widespread application in oceanography. For example, studies of sediment transport and acoustical interactions with the sea bottom would both benefit from knowledge of the short-term evolution of bottom roughness.

RELATED PROJECTS

The seafloor DEM data are being shared with E. Boss (University of Maine) to help in his study of roughness effects on bottom reflectance. In addition, the ADV data from North Perry and the Rainbow Gardens South closure site were shared with Boss, D. Burdige (Old Dominion University) and K. Voss (University of Miami) for various purposes. Lastly, M. Allison (Tulane University) and I are collaborating on the influence of near-surface porosity on light penetration.

PUBLICATIONS

Wheatcroft, R.A. 2002. In situ measurements of near-surface porosity in shallow-water marine sands. *IEEE Journal of Oceanic Engineering*, 27(3):

Decho, A.W., T. Kawaguchi, M.A. Allison, E. Louchard, C. Stephens, R.P. Reid, K. Voss, R.A. Wheatcroft, B. Taylor. 2002. Sediment properties influencing up-welling spectral reflectance signatures: The "biofilm gel effect" *Limnology and Oceanography*, (in press).