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Dr. Joseph H. Kravitz
Program Manager/Officer ONR: 322
Office of Naval Research
Ballston Tower One
800 North Quincy Street
Arlington, Virginia 22217-5660

Reference: Final Report N00014-95-1-1084, "DURIP: Long Term Mooring
Instrumentation for Shelf Sediment Transport Studies in Support of Strataform Research
Initiative"

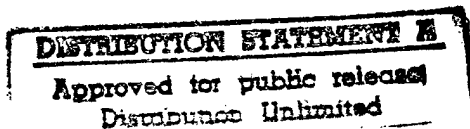
Dear Dr. Kravitz:

Attached find the final report for the grant referenced above. The report includes a short narrative detailing how the equipment was used in support of the STRATFORM project. Included in the report is a listing of the equipment purchased including manufacturer and cost. We have also included the same information for equipment purchased by the Institute to match the federal funds. In accordance with paragraph 9 (Equipment) in the grant agreement, title to all equipment acquired with federal and match funds is vested in the Institute.

If additional information is required, please call at (804) 684-7028 or E-mail at jerry@vims.edu.

Sincerely,

Jerry Harrison
Grant Programs Administrator



Copies to:

Director, Naval Research Laboratory
Defense Technical Information Center
Administrative Grants Officer

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**FIELD MEASUREMENT OF SEDIMENT TRANSPORT
PROCESSES IN SUPPORT OF THE *STRATAFORM*
SHELF DYNAMICS STUDY:
PROGRESS REPORT FOR 1995-1997**

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Objectives

The global objective of the VIMS involvement in the *STRATAFORM* program continues to be to improve understanding of the spatially and temporally varying mechanisms that suspend, transport, and deposit sediment on the continental shelf in the vicinity of the mouth of the Eel River specifically and on continental shelves generally. Common objectives of the 1995-1996 and 1996-1997 field campaigns included: a) to characterize the nature and spatial variability of bed roughness by means of side-scan sonar surveys; and b) to obtain estimates of time-varying bed stresses over contrasting bottom types at two sites and to evaluate sediment resuspension in response to those stresses by means of bottom boundary layer tripod deployments. Field activities in 1996-1997 were also aimed at supporting the team efforts of the Eel River Plume Study.

Approach

Our approach has involved field observations of bed micromorphology (roughness), benthic flow, bed stress, and suspended sediment flux on the Northern California continental shelf to address questions in support of the larger *STRATAFORM* community, but with specific emphasis on continental shelf processes, stratigraphy and plume dynamics. Field campaigns were carried out in the Winters of 1995-1996 and 1996-1997.

In FY 1996, the VIMS group contributed to *STRATAFORM* as members of the Shelf Dynamics Team. Specifically, we obtained regional measurements of bottom roughness at the *STRATAFORM* shelf sites via side-scan sonar surveys and made more quantitative, localized measurements using plan-view and sediment-water interface-profiling cameras. We also deployed two fully-instrumented tripods on the "S" profile, at depths of 60m and 70m beginning on 5 January and continuing through the month of February 1996 during which time two high energy events occurred. We also provided DURIP-funded instrumentation for the long-term mooring component and conducted a survey of bottom roughness (micromorphology) in December, 1995 with a repeat of the side-scan survey in January 1996. The two tripods were retrieved in the first week of March, 1996. . Data reduction, dissemination, and analyses began

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immediately upon recovery of the tripods and most of the analyses have been completed. A Status Report including initial results and a disc containing burst-averaged data was distributed to other *STRATAFORM* participants by the Spring of 1996; results were presented at the AGU Fall Meeting in San Francisco in December 1996; and a manuscript reporting the results has been submitted for publication in a special issue of *Marine Geology*.

In FY 1997, our field program was designed to address the same general questions concerning bottom boundary layer dynamics and sediment transport as in FY 1996 and also to provide field data on the dynamics of river plumes issuing onto the shelf from the mouth of the Eel River. In November 1996, our two tripods were deployed on "G" line, to the south of "S" line and near the Eel River mouth at depths of 30m and 60m. The 60m tripod was retrieved in February 1997 and initial data analyses from that system are nearly completed. Persistent rough seas and a failed recall device confounded initial attempts to recover the 30m tripod. Retrieval of that system is scheduled for early May 1997.

Side-Scan Sonar and Benthic Camera Surveys

Bottom roughness survey instruments included an EG&G model 260 TH Side-Scan Sonar system with a model 272 TD tow fish operated at 105 KHz. A digital magnetic tape system recorded the raw data and was interfaced with a Magellan Global Positioning System equipped to provide real time differential corrections broadcast by the United States Coast Guard. The benthic camera survey employed a Benthos model 3731 Sediment Profiling Camera and a Benthos model 372A Edgerton Deep-Sea Standard Camera. Color slide film was used in both cameras. Both cameras were attached to a single frame. As the frame approaches the bottom the standard camera fires and provides a close-up image of the sediment surface in plan-view. After the frame lands on the bottom, the profiling camera slices vertically into the sediment and fires to provide a vertical cross-section image of the sediment surface and sub-surface features. Sample site positions were recorded and stored with the image analysis data. Surveys were conducted aboard *R/V Pacific Hunter* on December 6-7, 1995 immediately prior to the onset of the intense "AGU Storm".

Tripod Deployments

The primary objectives of the VIMS tripod deployments were to obtain estimates of time-varying bed stresses over contrasting bottom types at two depths during each field campaign and to evaluate sediment resuspension and flux in response to those stresses. Secondly, the instruments were intended to add data on waves and mean currents for use by all *STRATAFORM* investigators.

The two tripods deployed by VIMS were intended to obtain estimates of time-varying bed stresses over contrasting bottom types at two sites and to evaluate sediment resuspension in response to those stresses. They were configured to collect benthic boundary layer profiles of velocity and suspended sediment concentration as well as to provide general information on

waves and mean currents. An array of four Marsh-McBirney electromagnetic current meter (EMCM) sensors at 10, 41, 71, and 101 cm above the bed as well as an independent single point electromagnetic Marsh-McBirney velocity sensor and a Paroscientific pressure gage located at elevations of 126 and 138 cm above the bed respectively. Five Downing infrared optical backscatter (OBS) sensors for suspended sediments profile determination were situated at 15, 42, 71, 104, and 131 cm above the bed and interfaced to a separate data logger. All of these instruments were programmed to start sampling every 3 hours and collect 2048 samples at 1 second intervals (34 minutes of data per burst). All data loggers on each tripod were synchronized and controlled by a single "master" logger. In 1996-1997, the tripods deployed on "G" line also supported DURIP-funded acoustic velocimeters (ADV's) and acoustic-Doppler current profilers (ADCP's).

1995-1996 Results and Conclusions

Biogenic roughness prevailed at both sites on "S" Line in winter of 1996-1997 and yielded z_0 heights that averaged 0.08 cm at the 60 m site and 0.07 cm at 70 m; apparent roughness heights, z'_{oc} , during high energy events were on the order of 1.0 cm at both depths. Wind-driven mean currents at 1.26 m above the bed exceeded 35 cm/s at the 60 m site during both events and reached 30cm/s at the 70m site during the first event. The strongest currents, which occurred in the early phase of a wind event, set to the north and were accompanied by wave orbital velocities of over 35 cm/s. Southerly setting mean currents with weaker orbital velocities prevailed during the late phase of the event. Current friction velocities, u_{*c} , had maxima of 2.5 cm/s at both depths but, during storms, wave-current values, u_{*cw} , reached 5.0 cm/s at 70m and 5.8 cm/s at 60m. Hydraulic roughness, z_0 , with estimated wave effects removed, increased measurably during high waves suggesting that physically-induced roughness replaced or augmented biogenic roughness during those events. Skin-friction shear velocities, u'_{*cw} , were subcritical under "average" conditions but appreciably exceeded the threshold for sediment suspension during storms reaching 1.99 cm/s at 60m and 1.65 cm/s at 70m. During high energy events, near-bed suspended sediment concentrations reached 2 g/l at 60m and 1g/l at 70m. At those times, increases in current shear were accompanied by increases in stable stratification caused by sediment suspension with the result that the gradient Richardson number within the log layer remained near critical. Since the highest bed stresses and resultant suspended sediment concentrations were observed during the early phases of storms when mean near-bottom flows set to the north, northerly sediment fluxes prevailed over the event time scale.

Publications to Date

Wiberg P.L., D.A. Cacchione, R.W. Sternberg, and L.D. Wright, 1996. Linking sediment transport and stratigraphy on the continental shelf. *Oceanography*, **9**, 153-157.

Wright, L.D., Kim, S.C. and Friedrichs, C.T. *in review* Across-Shelf Variations in Bed Roughness, Bed Stress and Sediment Suspension on the Northern California Shelf: Field Measurements in Strataform submitted to *Marine Geology* special issue

Item Description	Vendor/ PO#	Direct 541301	Match 441301	Equipment Trust 205007	Location of Equipment
Edgetech 8011B Deck Unit	Edgetech/ P705895		6500.00		On Strataform Project-Eureka, CA
Edgetech 7500RC Transponder	Edgetech/ P705895		5500.00		On Strataform Project-Eureka, CA
1.5 MHZ ADP (1 of 2)	Sontek/ P604601	760.48		20689.52	Eureka, CA
Int. Press. Sens. Option	Sontek/ P604601	1000.00			Eureka, CA
Int. Compass Sens. Option	Sontek/ P604601	1900.00			Eureka, CA
Upgrade Recorder Capacity 40 MB	Sontek/ P604601	2400.00			Eureka, CA
Model 1245-001-0 Digiquartz Int. Trans.	Paroscientific/ P604477	4019.25 S 16.75			Eureka, CA
SST-320 Side Scan Transponder (2)	Datasonics/ P604309	5200.00 S 22.14			(1) Deployed-Eel River (1) Storage
Model S4A Current Meter (4)	Inter Ocean/ P505802	116080.00 S 1308.65			Deep Mooring-CA
EG & G Model 8242SR (6)	Electronic Sales of NE/ P603100	49500.00			(4) Deep Mooring (1) Eel River (1) Storage
TT6 Tattletale (2)	Onset Computer/ V505796	1390.00			Eureka, CA
PR-6 (2)	Onset Computer/ V505796	127.73			Eureka, CA
Kato Disk Drive (2)	Onset Computer/ V505796	300.00			Eureka, CA
TC-4 Cable (2)	Onset Computer/ V505796	130.00			Eureka, CA
Advofield System AD Velocimeters with Cables (2)	Sontek/ P505728	26410.00 S 315.00			(1) Deployed-Eel River (1) Storage
300 Workhorse Sentinel SC ADCP (2 of 2)	RD Instruments/ P705840		23300.00		Deployed-Eel River
	TOTALS:	\$210880.00	\$35300.00	\$20689.52	