The Formation of Sedimentary Strata on Continental Margins

Charles A. Nittrouer
School of Oceanography
University of Washington
Seattle, WA 98195-7940
phone: (206) 543-5099 fax: (206) 543-6073 email: nittroue@ocean.washington.edu
Award #: N000149910028, N000149910179, N000149910605, N000149710595
http://strata.ocean.washington.edu

LONG-TERM GOALS

The ultimate goal of this research is to understand the mechanisms by which continental-margin sediment is deposited, modified and preserved, so strata recorded over various time scales (events to millennia) can be interpreted better.

OBJECTIVES

The fieldwork is undertaken on the Eel margin within the larger context of the STRATAFORM program, and has objectives that complement those of other groups. In particular, this project is designed to document shelf event beds (i.e., flood, storm) immediately after they form, to observe their subsequent modification and preservation, and to interpret geologic history from old beds buried at various depths within the seabed (10s of centimeters to meters). Another objective is to examine, through monitoring of sediment traps and CTD-transmissometer observations, the dispersal and deposition of sediment escaping the shelf and reaching the continental slope.

In addition, the overall STRATAFORM program is coordinated through efforts to: orchestrate program planning, organize field operations, and disseminate scientific results.

APPROACH

Rapid-response box coring occurred immediately after two very large floods of the Eel River (Jan 95 and Jan 97) and a large ocean storm (Dec 95). Subsequently, the shelf has been examined several times each year by box coring, piston coring, and recently by vibracoring. Investigations of sediment size and fabric are put into a chronologic context using a suite of radioisotopes (^{7}Be, ^{210}Pb, ^{137}Cs, ^{14}C), which are relevant for a variety of time scales (months to millennia).

Monitoring of sediment escape to the continental slope is performed at a mooring located north of the Eel River mouth in a water depth of 450 m (at site Y450). Three sediment traps (depths of 65, 200, 435 m) are maintained continuously, and the temporal variability of sediment fluxes (quantity and composition) is observed on time scales of 10-16 days in sequentially rotating cups. During FY99, replicate surveys of nepheloid layers (through CTD-transmissometer profiling) were undertaken near the Y and O transects and at the head of Eel Canyon.

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WORK COMPLETED

During FY99, seabed samples and suspended-sediment data were collected on four cruises. On the *R/V Wecoma* in October 1998, January 1999, and March 1999 samples and data were collected from the shelf and in the head of Eel Canyon. In August, a longer cruise (*R/V Thompson*) obtained a variety of core samples, but focused on vibracores between water depths of 20 m and 50 m. During all four cruises, mooring/tripod instrumentation was deployed and/or recovered. A fifth cruise in September 1999 allowed for swath mapping on the inner shelf near the S transect.

RESULTS

a) Evaluation of sediment transport seaward from shelf to slope – Through several different approaches, the seaward dispersal of sediment is being investigated. Monitoring studies have continued to measure fluxes into sediment traps. The largest fluxes yet measured to the Y450 mooring occurred during a large resuspension event (Jan 98) on the adjacent shelf, when river discharge was relatively low. Significant effort was undertaken with CTD-transmissometers to map the distribution of nepheloid layers leaving the continental shelf (near the depth of the shelf break) and expanding over the continental slope. This work reveals that the highest suspended-sediment concentrations within intermediate nepheloid layers occur in the Eel Canyon (at all times), and that the highest concentrations occur there during the winter. On the open slope (near O and Y transects) during winter, intermediate nepheloid layers have a jump-off point at about 150 m (also at the shelf break depth). These layers effectively disappear during the summer months on the open slope. Thick seabed deposits (i.e., > 5 cm) of Be-7 are observed in sediment cores collected from the entrants to Eel canyon during the winter. This radioisotope indicates input of sediment recently delivered (time scale - months) from a terrestrial environment (e.g., through Eel River discharge).

b) Characterization of inner-shelf sand deposit – 49 vibracores have been collected from the inner shelf sand deposit near and north of the Eel River mouth. Those cores have been logged for P-wave velocity, gamma density, and magnetic susceptibility. In addition, core halves have been examined by x-radiography and photography, and have been subsampled for grain-size analysis. Much of the deposit is homogenous sand with faint physical sedimentary structures. Silt and clay content is typically less than 1%. Some cores reveal mud and/or gravel layers. These strata are most pronounced where structural highs have compressed the transgressive sequence. For example, directly above an anticlinal structure (north of the Little Salmon fault) is a region that reveals a dramatic sequence changing upward from mud to gravel to sand within the upper 3 m of the seabed. This may record the transition from estuarine to beach to inner shelf environments. Processing of cores is just beginning. In addition, swath mapping with a Simrad EM-3000 was tested in a small region near the S transect, between water depths of about 10 m and 50 m. This data is still being processed.

c) STRATAFORM coordination - Program planning was completed at the annual meeting (San Francisco, Dec 98) and several conferences and workshops: AGU symposium (Dec 98), EuroSTRATAFORM workshop (Feb 99), slope workshop (Jun 99). In addition to the four cruises on large ships (*Thompson, Wecoma)*, 13 days of cruises occurred on the *Warrior II* and *Coral Sea* for instrument recovery/deployment and swath mapping. The STRATAFORM special volume of *Marine Geology* was finalized and published. A second workshop for EuroSTRATAFORM was organized for November 1999, and plans began for a Chapman Conference in winter 2001. A trip to Sydney in June

allowed investigation of the PROD drilling system, and plans were made for testing and utilization of the system in FY00.

IMPACT/APPLICATIONS

For a mountainous collision margin (typical of the Pacific Ocean), this research provides data needed to understand strata formation and allows specifically for better interpretation of long cores recording the environmental history of the Eel margin. Because much of the insight gained about strata formation is generic in nature, this work interfaces at the short and intermediate time scales of the nested spectrum studied by STRATAFORM.

TRANSITIONS

The research results are being utilized by numerous other STRATAFORM groups; for example: by shelf seabed group, because microfabric and radioisotope profiles are part of the integrated effort to document seabed characteristics; by boundary-layer hydrodynamics group, because observations document the seabed at instrument sites; by plume-dynamics group, because flood deposits demonstrate the fate of plume sediment; by slope sedimentation group, because trap fluxes document sediment deposition rates; by seismic stratigraphers, because core logs provide impedance profiles; by stratigraphic modeling group, because sediment accumulation rates and biological mixing rates are important parameters.

RELATED PROJECTS

As described above, examples of the related projects are: R. Wheatcroft, shelf seabed; R. Sternberg, boundary-layer hydrodynamics; R. Geyer, plume dynamics; C. Alexander, slope sedimentation; N. Driscoll, seismic stratigraphy; D. Swift, stratigraphic modeling. The entire STRATAFORM program is related to the efforts for program coordination.

PUBLICATIONS (Refereed publications during FY99)

Bentley, S.J. and C.A. Nittrouer, submitted. Emplacement, modification and preservation of event stratigraphy on a flood-dominated continental shelf, Eel shelf, northern California. *Jour. Sed. Res.*

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