Inner Shelf Facies Character & Stratal Signatures, Northern California

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LONG-TERM GOALS

The long-term objective of this research is to investigate processes influencing the emplacement and modification of strata on the continental shelf. It is part of a coordinated effort to study processes influencing strata on the Eel River continental shelf. A primary goal is to identify the modern processes that form strata and to track the modification and ultimate destruction or preservation of such layers into the geologic record

OBJECTIVES

The research objectives of this project include:

1) to investigate the formation of flood-deposits

In 1995 and 1997, the Eel shelf experienced significant flood events. Close examination of the rates and locations of sediment deposition January and March of 1995 and January of 1997 suggest that similar processes controlled deposition during all three floods. Examination of the sedimentary structures and sediment textures in the deposits provides clues as to the physical processes that were most influential during sedimentation. A particularly interesting area is the landward edge of the deposits where the mid-shelf facies interfinger with inner shelf sands. The influence of waves should be most intense on the inner shelf and resulting modifications most apparent.

2) to investigate the inner-shelf stratigraphy

Cores are used to document the sedimentary character of the dominantly sandy deposits, provide insight to the potential incorporation of muddy sediments in the inner shelf sands, and provide groundtruth for the side-scan sonar and swath mapping on the inner shelf.

APPROACH

The Eel River shelf of northern California is the selected study site. The approach is to sample the inner shelf in detail and correlate the examination with work that is being conducted on the outer shelf and slope. The sampling includes coring, side-scan sonar and SUBSCAN Chirp sonar to correlate short-term processes with longer term deposit characteristics.

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RESULTS

Formation of flood-deposits

The rates and locations of sediment deposition during floods in 1995 and 1997 suggest that similar processes controlled deposition during both flood events. The alongshelf character of the deposit was examined for the January 1997 flood, based on sampling conducted in May 1997. Using core x-radiographs as a reference, a roughly 1-cm^2 column of sediment was extracted from the flood deposit and analyzed in bulk to provide a layer-averaged representation of grain size. The resulting data reveal that (a) the deposit is very fine-grained, with a mean diameter in the coarse clay size class (approximately 3 microns), and (b) the deposit has negligible spatial variability on the shelf; of particular note is the apparent absence of any proximal-distal indication in the grain size pattern.

The examination of the sedimentary structures and sediment textures in the deposit provide additional clues as to the physical processes that were most influential during sedimentation. On the inner- and mid-shelf, flood deposits are dominated by fine silts and clays, in locations that are normally comprised of coarser sediments. The flood deposit sits atop a rippled surface of sand or coarse silt, suggesting the nature of the bed prior to flood sedimentation. In the direction of alongshore currents during flooding (i.e. to the north of the river) the flood deposit is seen as three layers that are easily identified in core x-radiographs. Just above the pre-flood surface is a layer of high porosity (>85%) fine silts and clays (modal diameter 10 microns. mean size 2-5 microns) that is relatively transparent to x-rays. Immediately above is a layer of lower porosity (80-85%) that is more opaque to x-ray transmission, is commonly rippled, and is composed of slightly coarser sediments that are better sorted (modal size 16 microns, mean size 5-10 microns). Atop this rippled layer is a layer similar to the bottom-most layer in the deposit. The flood layer has the appearance of a “ripple sandwich” with more x-ray transparent mud above and below the rippled zone.

Two possible formation mechanisms for the “ripple sandwich” are suggested: (a) during flood sediment deposition, a period of increased shear (perhaps accompanied by a waning sediment supply) produced improved sorting and ripple formation, or (b) flood deposition occurred in multiple pulses, with at least one pulse associated with gravity-driven bottom flow that produced turbidite-like bedforms. In either case, conformable contacts between the rippled layer and the overlying layer imply that the upper layer was deposited soon after the ripple-forming event, under more quiescent conditions.

Inner-shelf Stratigraphy

Determining the ultimate fate of Eel River flood sediment is a central issue to the STRATAFORM program and has been addressed by other researchers. One of the open-ended questions in this research has been the amount of fine-grained sediment that is potentially stored in the inner-shelf sands, shallower than 50 meters. A hydraulically-damped piston corer (a Slow Corer) was used to collect cores at 18 stations on the inner shelf (45 to 20 meters depth). Sediment porosity and grain size distributions were determined for the upper 50 cm of these cores. The data indicate that sediment porosity averaged 42% and that about 10% (range of 4 - 26 %, by station) of the sediment residing between 20 and 45 meters depth on the Eel shelf is less than 62 microns in size. This indicates that roughly 5 million metric tons of silt- and clay-sized sediment resides in the upper 10 cm of the seabed,

integrated along a 50-km section of coast. This sediment mass is a potentially important sink for fine-grained Eel River sediment. From the data, it is clear that some fine-grained sediment is indeed stored on the inner shelf; what is unclear is the time period represented by the upper 10 cm of sediment accumulating on the inner shelf (i.e. does it represent 1 years or 100 years of accumulation).

To better address this question, deeper cores were collected to evaluate longer-term accumulation. Rossfelder VibraCores revealed buried peat deposits overlain by very coarse sands and gravel, 1-2 meters below the seafloor in cores collected just west of Humboldt Bay. The recovered stratigraphy typically included a basal peat and/or clay layer overlain by a shell or gravel lag, overlain by a fining upward sequence of sands. This buried facies consisted of peat and very fine-grained muds indicative of a low energy environment such as would be found in a bay or coastal lagoon. This fine-grained estuarine facies was in sharp contact with coarser-grained sand and gravel. The coarse sand and gravel fined upwards to medium to fine sands similar to those found today, offshore of Humboldt Bay.

SCIENTIFIC IMPACT

The STRATATFORM research program has had the opportunity to closely monitor the evolution of stratigraphy on the Eel River margin. The examination has yielded new ideas as to the development of event-related strata as well as new ideas as to the interpretation of older preserved strata in similar margin settings. In addition, we have been able to couple techniques to make some new discoveries. For example, the use of the SUBSCAN Chirp sonar enabled us to locate coring sites where penetration through upper Holocene sands was possible. These results should allow the creation of a local relative sea-level curve. This will allow the importance of local tectonics and variable riverine sediment supply to be examined and evaluated for their importance in the evolution of
the continental margin.

PUBLICATIONS

Borgeld, J.C., Hughes Clarke, J.E., Goff, J.A., Mayer. L.A. and Curtis, J.A. (1999) Acoustic backscatter of the 1995 flood deposit on the Eel shelf: *Marine Geology*, V.154, p. 197-210.

Borgeld, J.C. and D. O'Shea (in press) Flood-Related Particle Sorting and Deposition on the Shelf: a Seabed Perspective: EOS, Abstracts with Programs, Ocean Sciences Conference 2000, San Antonio, TX.