LONG TERM GOAL

Our long-term goal is to construct mathematical descriptions of the processes that form sedimentary deposits at all spatial scales on continental margins, and to conduct numerical experiments that will allow us to predict the fabric of the resulting sedimentary deposits.

OBJECTIVES

A first objective is to investigate the pattern (fabric) of seabed stratification on continental margins at small time and space scales (1 cm-50 cm depth into the seabed; 1 hr-3 yrs sedimentary record). To this end, we are testing the hypothesis that on muddy shelves such as the northern California shelf, Holocene event stratigraphy consists of the deposits of high concentration storm regimes associated with river floods, alternating with deposits of low concentration storm regimes. In order to conduct the test, we are developing several “deterministic” algorithms (EVENT, RESUSPEND, and TRANSPORT), that are driven directly by STRATAFORM and NOAA current meter records.

At intermediate spatial scales (1-20 m depth into the seabed; 1-1,000 yrs), we are testing a second hypothesis. The hypothesis states that the hypothesis that facies assemblages are stacked on, or are capped by erosional bounding surfaces (source diastems,) in patterns reflecting fluid power gradients in the parent disposal system; and that these patterns are responses to progressive sorting and stratal condensation mechanisms. At intermediate time and space scales, Hood and Storm current records are not available. In order to conduct the test, we have embedded EVENT in an algorithm (FACIES) that is driven by probability density functions describing flood and storm current frequencies.

At large time and space scales (1-1,000 m depth into the seabed; 12.5 million yrs) we are testing a third hypothesis. The hypothesis states that that depositional sequences can be explained in terms of shifts in the equilibrium configuration of shelf surface in response to changes in sea level, the rate and character of sediment input, and the hydrodynamic climate. In order to conduct the test, we have developed a combined stratigraphic model (morphodynamic-geodynamic model; SEQUENCE), are modifying it to deal with multiple grain sizes (MULTISEQUENCE), and will embed the intermediate scale model (FACIES) within it.
Modeling Sedimentation on the Continental Margin

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See also ADM002252.
**APPROACH**

We propose to test the “:flood” bed hypothesis by driving event bed simulation directly from times series of bottom velocity and concentration measurements, and by comparing these hindcasts with observations. At ODU, we have developed a simplified 2-D event bed model (EVENT). The hypothesis will be tested by simulation of the 1995-1997 stratigraphy of the Eel River sector of the Northern California Shelf, as revealed in time series obtained from STRATAFORM tripods. The simulations will be constrained by the box cores collected on the 1997 MELVILLE Cruise and the 1998 WECOMA and CORAL SEA cruises). These samples will be subject to grain size analysis and Xradlography.

Initial studies will take place at the 50, 60, and 70 m stations of the S, 0 and K lines and on 60M and 60Q. Eventually, the full data M9707 data set will be subjected to correlation length scale analysis for grain size and stratal thickness.

We propose to test the Facies assemblage hypothesis by linking deterministic algorithms for boundary layer sediment suspension, redeposition and strata formation (EVENT) with a probabilistic algorithm for stratal succession. (FACIES; Zhang et al., 1997, in press). We propose to incorporate in this model the effects of variable sea level change, sediment input and hydraulic climate. We will compare results by statistical means with observations of box cores, piston cores and seismic records. We will coordinate with NRL in the development of the Seabed classification system (high resolution profiling system) and with NRL in laboratory intercalibration of grain size methods.

We propose to test the equilibrium margin hypothesis by combining the morphodynamical model for continental margin evolution developed by URS Greiner--Woodward Clyde (1995) with &Eke Steckler's (1993) geodynamical model, leading to a combined stratigraphic model (SEQUENCE). Initial results are exciting, and we have several papers in press (Carey et al., in press, in revision). The WCI group has developed a preliminary expansion of the algorithm in which multiple grain sizes are transported and deposited (MULTISEQUENCE).

**WORK COMPLETED**

During FY98, we (Chris Reed, URS-Greiner--Woodward Clyde) have developed a 2-D version of TRANSPORT that evaluates cross-shelf sediment transport in response to waves, tides and wind-driven currents. We (Shejun Fan, ODU) have developed a modified I-D version of TRANSPORT, in order to explore the behavior of high Concentration regimes (RESUSPEND). We (D. Swift and R. Clayton, ODU) have taken part in the 1997 WECOMA Cruise (Leg 4) and the CORAL SEA cruise, in order to collect constraining data (Box Cores, Piston cores and Bothner cores; and "chirp" seismic records).

**RESULTS**

During FY 98, Simulations using EVENT and RESUSPEND show that short lived, coasthugging, surface flood plumes, forming over the inner shelf of Northern California during winter storms, leave behind them slowly consolidating, high-concentration, near-bottom suspensions (fluid mud). During the first subsequent storm, bottom shear stress levels on the inner shelf are sufficient to break the lutocline
and resuspend flood deposits, hence inner shelf flood beds are rapidly removed and transported seaward by offshore bottom flows during subsequent events. In this manner, high-energy winter re-sedimentation events, occurring within days or weeks of the flood, rework mud-rich material. The resulting resuspension continues to maintain high concentrations, in which high rates of flocculation occur, leading to poorly sorted, muddy, post-flood storm beds on the central shelf. These sediments were brought to the depositional site by marine currents, and are “flood” beds only in that having formed in the immediate post-flood period, the storm events that deposited them were high concentration events.

Later spring and summer resuspension episodes involved higher levels of critical bed-shear stress, and a reduced supply of fine sediment. They create less dense concentrations that are not high enough to “freeze” the turbid bottom flow, and not high enough to form large floes with high shear resistance, so the settling process leads to better sorting, resulting in thin, sandy “storm” beds that are the product of low-concentration regimes. The resulting storm beds (Fig. 1) are thin and sand rich, partly as a consequence of in situ winnowing, and partly as a consequence of advection of sand from the further inshore. In years characterized by major floods, these thin beds may appear as an upward-coarsening, bluturbated cap on the top of a thick “flood” bed.

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**Fig. 1 Diagram illustrating relationship between depositional regime and bed architecture on Northern California Shelf.**
IMPACT AND APPLICATIONS

EVENT will predict the geotechnical and acoustic properties of first meter of the sea floor. FACIES will predict the geotechnical and acoustic properties of first 10 meters of the sea floor. SEQUENCE will predict seafloor structure at depths up to several kilometers, for foundation studies and petroleum exploration.

TRANSITIONS

We are, in structural terms, the most “downstream” component of STRATAFORM in the sense that we use the results of other STRATAFORM groups as constraining data. The process is linear however, but has feedbacks; our modeling results have lead to changes in the approach of our observationist Colleagues (Mike Field's seismic work, USGS, Menlo Park, and Neal Dnscol's seismic work, WHOI). The larger oceanographic community outside of STRATAFORM are also consumers of our products. We are presently exchanging code with Peter Cowell, University of Sidney, Australia, and other members of the PACE group (Predicting Aggregate Coastal Evolution) funded by the European Economic Community.

RELATED PROJECTS

We are calibrating the models against dynamical data sets collected by STRATFORM investigators (Cacchione, Sternberg, and Wright). We are validating the models by comparison with the sea floor observations of other STRATFORM investigators (Drake, Wheatcroft, Borgeld, Bentley, Traykovski, and Nittrouer). We are cooperating closely with ongoing STRATFORM modeling efforts by Syvitski and students (IAAR), and by Steckler at LDEO. We plan also to collaborate with Wiberg (UVA).

PUBLICATIONS


