Erosion and Transport of Suspended Sediment Near the Po River Delta, Northern Adriatic Sea.

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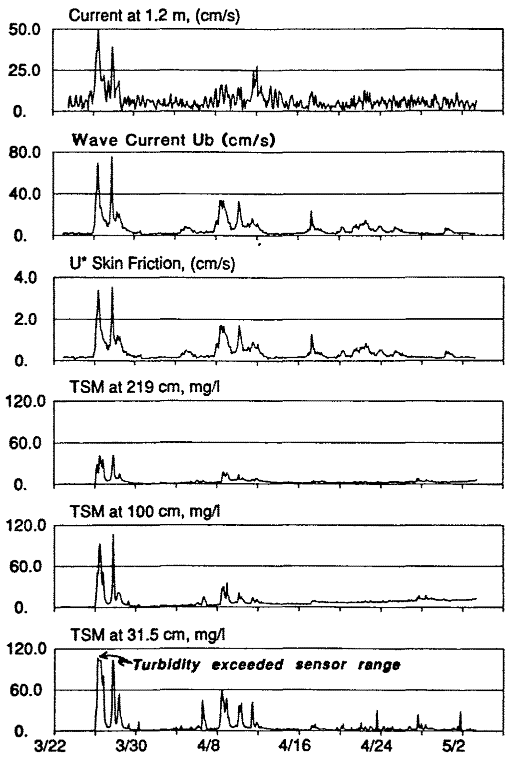
During the 41-day period from 22 March 1990 to 2 May 1990, an instrumented bottom tripod (GEOPROBE) and two sediment traps, at 2 m and 10 m above the seafloor, were deployed about 8.5 km off the Po River delta in 22.5 m water depth. This experiment was part of a cooperative project between the Istituto di Geologia Marina (Italy) and the U. S. Geological Survey (USA) to investigate the erosion and transport of sediment and pollutants on the inner continental shelf in this region. The GEOPROBE data, discussed in detail separately by CACCHIONE *et al.*, included time-series measurements of horizontal current velocity at three levels above the bed, near-bottom pressure and temperature, light transmission at three levels and optical backscatter at four levels. Bottom photographs were taken every 4 hours with a 35 mm camera-strobe system. Bottom sediment samples collected by divers are principally composed of terrigenous silt and clay with less then 10% sand; mean diameters are 5-8 μm.

Although winds were light and variable for most of the deployment, two storms of moderate intensity transited the northern Adriatic on 23-25 March and 11-12 April. Currents and waves, which were weak during the non-storm periods, increased significantly during the storms and generated combined bed shear stresses as large as 12 dynes/cm^2 at the GEOPROBE site (see figure 1). The oscillatory currents produced by the surface waves made the major contribution to the elevated bed shear stress. The bed stresses during the storms were well above the erosion threshold (about 1 dyne/cm^2) for the local sediment, as shown by the rapid increases in suspended sediment detected by the optical sensors.

Suspended sediment concentrations at 7 levels within the bottom 2.2 m of the water column were estimated from the GEOPROBE optical data using laboratory calibration curves developed specifically for the local bottom sediment. The results show that suspended particulate matter (SPM) concentrations during low energy conditions were of the order of 1-5 mgl^{-1} and the material was relatively uniformly distributed in the bottom boundary layer. In contrast, during the March storm, SPM concentrations increased to a maximum of >175 mgl^{-1} at 0.3 m above the bottom and there was a strong vertical decrease in SPM concentration with height above the bed (figure 1).

The observed vertical SPM decrease in a strongly turbulent flow (U^*c > 3 cm/s) suggests that the average settling velocity of the eroded sediment grains was equivalent to fine quartz sand (d = 0.01 cm). Since the local bed contains <10% sand, it is likely that the sediment was eroded as large clumps and aggregates during the storms. This hypothesis is also indicated by the rapid decrease in SPM concentrations after the storm waves began to diminish.

The combined-flow bottom boundary layer model of Glenn and Grant (1987) was used to predict flow characteristics and SPM concentrations during the storm periods. Using the *disaggregated* grain size distribution of the local bed sediment as input, the model-derived estimates of the SPM concentration at z = 0.3 m were within 50% of the measured concentration. However, the model predicted nearly uniform concentrations owing to the small mean grain size. Accurate predictions of sediment transport in regions of fine-grained and cohesive beds will require knowledge of the sizes and densities of the particles in suspension.



REFERENCES

GLENN S.M. and GRANT W.D., 1987. - A suspended sediment stratification correction for combined wave and current flows. *J. Geophys. Res.*, 92, 8244-8264

The Rhone Fan (Gulf of lions) and the Var ridge (ligurian margin) : Mediterranean turbiditic systems with contrasting architectures and growth patterns

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The comparison of the architecture of the Rhone Fan and Var Ridge, located in contrasting physiographic and tectonic settings of the northern mediterranean margin, emphasizes some of the main factors controlling the deep turbiditic sedimentation.

Despite strong differences in size and in physiographic and tectonic settings, the structure of both turbiditic systems is comparable and is defined by the stacking up of depositional units represented on seismic sections by two main types of acoustic bodies (DROZ and BELLAICHE, 1985; BELLAICHE *et al.*, 1986) which are also recognized in other fans (DAMUTH *et al.*, 1988) :

-the turbiditic lenticular units: they are grouped within larger acoustic bodies, the channel/levee complexes. Within these complexes, the geometry of the stacking of the units evolves downstream and is specific of the different environments of the fans. This type of acoustic bodies is the most frequent and can represent up to 80-90 % of the sediments of the fans

-the chaotic bodies representing mass-movement deposits are much less frequent and seem to be grouped at specific stratigraphic levels of the fan.

The main differences opposing these two fans concern their growth pattern:

-Seismic analyses indicate that sedimentation in the **Rhone Fan** results from (Fig.1):

*periodic **lateral displacements of the depocenters**, which are responsible for the individualisation of the channel/levee complexes. They are most commonly tectonically- or morphologically-induced and can be or not linked to preferential periods of instability.

***longitudinal displacements of depositional area** which are probably mainly eustatically-controled. Quaternary sedimentation in the Rhone Fan is marked by a general but discontinuous progradation of the turbiditic front, probably reflecting the effects of the quaternary glaciations.

-In contrast, the structure of the **Var Ridge** (highly asymmetrical upper part of a larger turbiditic system, the Var Fan) is apparently more simple: deposition did not significantly suffer **neither lateral** (except for a progressive and local northwards migration of the upper Var Valley) **nor longitudinal displacement**. This structure results from the combination of tectonic and physiographic influence which induced the stability of the depositional area and the overgrowth of the ridge.

The contrasting characteristics of the two fans are presumably related to the difference of intensity with which sea-level variations control deep turbiditic sedimentation. An important parameter that influence the intensity of this factor is the physiographical characteristics of the margin:

-in the first example, the **Rhone Fan**, sedimentation is **primarily controlled by sea-level fluctuations**. The contrasting physiography of the Gulf of Lion (wide shelf and well-expressed shelf break) is highly favourable to a good record of the effects of this factor.

-in the second example, the **Var Ridge**, deposition is **mainly under tectonic and physiographic influence**. Sea-level changes are of much lower influence because of specific morphological characteristics of the ligurian margin: the absence of continental shelf prevents any accumulation on the upper parts of the margin during high sea-levels, and leads to the permanent feeding of the basin.

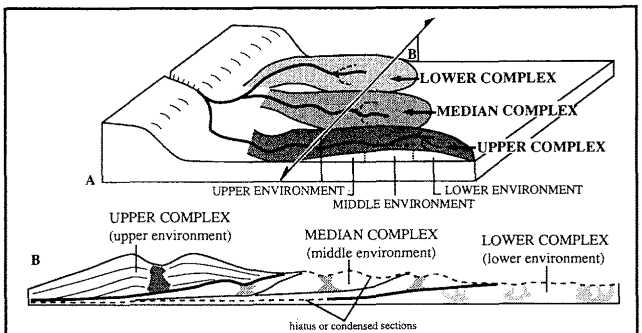

Figure 1 : Lateral and longitudinal shifts of depocenters in the Rhone Fan (slightly modified from Droz, 1991)

REFERENCES

BELLAICHE G. *et al.*, 1986. - Seismic evidence of widespread mass transport deposits in the Rhone deep-sea fan: their role in the fan construction. *Marine Geol.*, 7 1: 327-340.

DAMUTH J. E., FLOOD R. D., KOWSMANN R. O., BELDERSON R. H. et GORINI M. A., 1988. - Anatomy and growth pattern of Amazone Deep-Sea Fan as revealed by long-range side-scan sonar (GLORIA) and high-resolution seismic studies. *A. A. P. G. Bull.*, 72 (8) : 885-911.

DROZ L., 1991. - Les éventails sous-marins profonds : structure et evolution sédimentaire, à partir de l'étude comparative de trois édifices, l'Eventail du Rhône, la Ride du Var, le Cône de l'Indus. Habilitation à Diriger des Recherches, Université Paris IV, 271 p.

DROZ L. and BELLAICHE G., 1985. - Rhone deep-sea fan: morphostructure and growth pattern. *A. A. P. G. Bull.*, 69 (1): 460-479.