Sediment variability in the mixing layer in the inner shelf: implications for sediment transport

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Sediment fluxes in the coastal zone are usually estimated from simultaneous measurements of flow velocity and water turbidity at different locations above the sea bottom. These measurements fit with different models to obtain a continuous vertical profile of velocities and suspended sediment concentrations and, using this information, sediment fluxes can be properly estimated from the seabed to the highest sensor above the bottom. The grain size of the available sediment is one of the crucial parameters for the application of models because it determines the bottom roughness, the critical conditions for resuspension and armouring effects. However, the sediment grain size displays temporal changes that should be taken into account. Direct "in situ" measurements of suspended sediment characteristics (grain characteristics and settling velocity) is the most adequate technique for resolving this topic (Sternberg et al., 1999), although to obtain long time-series including this information is complex in high-energy environments and indirect methods have been developed (Madsen et al., 1993).

This paper analyses the variability of the bottom sediment grain size at two sites located at 8.5 and 12.5 m depth across the Ebro Delta inner shelf during one year. The objective is to study the vertical and temporal sediment grain size variability in order to evaluate its effect on the estimation of the thickness of the *active layer* and quantifying sediment fluxes. Sediment cores were taken by a diver at 8.5 and 12.5 m depth in December'96, January'97, April'97, May'97, August'97 and September'97. Subsamples were taken every centimetre from the surface to 10-cm depth and at 15 and 20 centimetre depth. The sediment was disaggregated and the grain size analysed with settling tube for the sand fraction and Sedigraph for the mud fraction. Waves, currents and suspended sediment concentration were simoultaneously measured during these periods. Bottom photographs were done at the site at the beginning and the end of each deployment.

The median grain size of the superficial sediment (0-1 cm layer) displays significant changes in both sites along the study period. In the shallow site, the average median of the sediment was 137 µm, with maximum values of 145 µm and minimum of 125 µm. The mud content ranged from 5 to 9%. At 12.5-m water depth, the average median sediment grain size was 114 µm (91-143 µm), with a mud content that represents between 5 and 42 % of the total sediment. The temporal evolution of the median grain size and the mud content also displays significant changes along cores (Fig. 1). In the deeper site, maximum differences occur between December'96 and January'97 campaigns, when a layer of fine sediment (about 3 cm thick) was deposited, and in September'97, when a general coarsening of the sediment is observed. Cores located at 8.5 m water depth show similar temporal changes: fining of the sediment grain size in January'97 and a general coarsening during the "summer" period (August' 97).

Several processes that produced changes in the grain size of the bottom sediment have been identified during this period:

- deposition of a mud layer during high-water discharge conditions of the Ebro river ("fining")
- erosion of the mud layer caused by waves ("coarsening")
- deposition of storm sandy-layers (no significant grain size changes)
- bioturbation during fair-weather conditions ("coarsening")

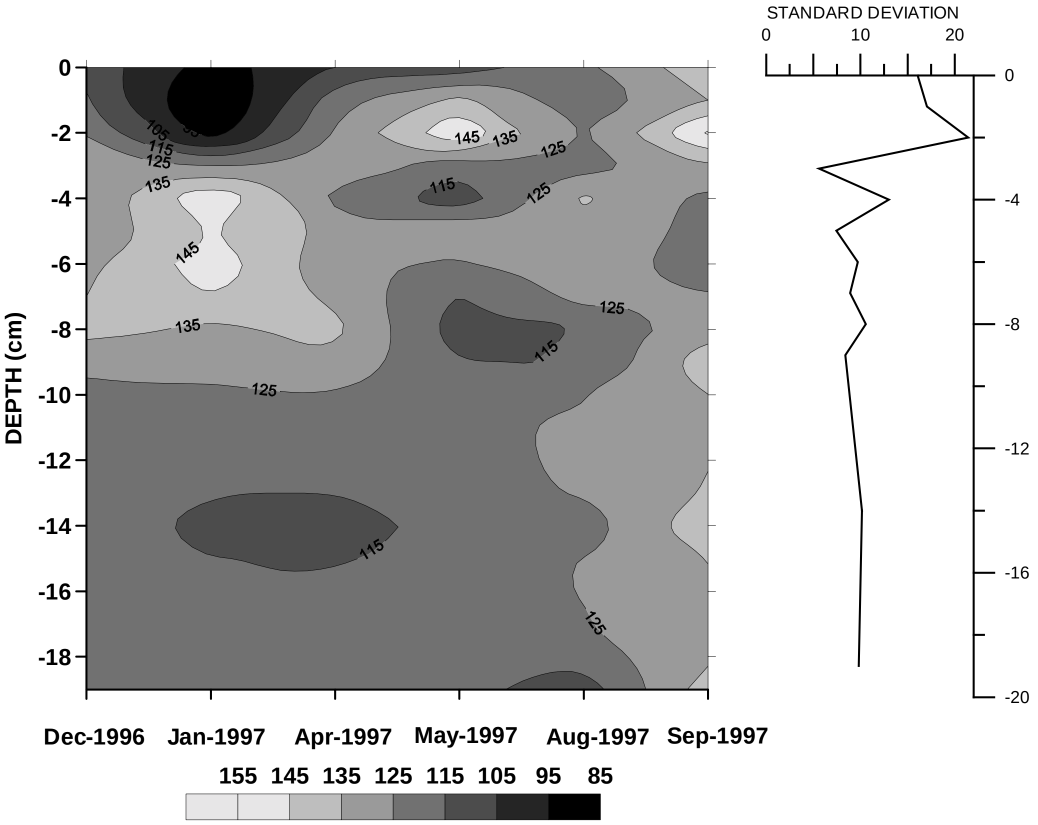

Figure 1.- Temporal evolution of the mean grain size (D50) at the site located 12.5 m depth (grain size in microns). Variability of the grain size expresed as the standard deviation (in microns)

Potential implications of these sediment changes in the estimation of near bottom sediment fluxes were addressed. Results from these analyses indicate that the bottom sediment variability that has been observed in the Ebro inner shelf produces significant differences in the determination of the suspended sediment concentration from turbidity measurements and in the estimation of the concentration profile. Therefore, a continuous control of bottom and suspended sediment grain size is required if an accurate evaluation of the sediment fluxes should be achieved. If information about the grain size variability is not available, a very significant error must be taken into account in the estimation of sediment fluxes. In a similar way, the vertical variability of the sediment grain size can be an additional source of error in those models that consider a moving active layer in an homogeneous sediment.

References

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