Sediment Transport on the Continental Shelf of the SE Mediterranean Sea - Indirect Evidences

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More than 30 years ago, EMERY and NEEV (1960) proposed a model for sediment transport along the Israeli continental shelf. According to this model, which was based on the orientation of the Israeli coastline and the direction of the highest waves which may approach the Israeli coast (Az 275 - 292), longshore sand transport in the surf zone is directed northward from Rafah to Natanya, on the southern part of the Israeli coastline, whereas from Natanya northward the littoral drift is in a southward direction. As the source of sand is undoubtedly from the Nile, this model provided no explanation for the quartz sand found on the beaches north of Natanya. EMERY and NEEV therefore proposed an additional mechanism for sediment transport, namely the Mediterranean counterclockwise current, which carries sediment along the continental shelf from south to north and also feeds with sand the surf zone of the Israeli coastline. Recent findings may shed light on the validity of this part of the model.

In a study carried out by COLEMAN *et al.* (1981) off the eastern flank of the Nile Delta, bedforms such as sand ribbons and mega ripples were recorded by a side scan sonar. When a composite of these bedforms records was put together, their orientation indicated sand movement from southwest to northeast. Sediment distribution as well as current measurements supported this conclusion.

A side scan sonar survey carried out by GOLIK (1988) off Ashdod, Israel revealed the presence of small rocky mounds at a water depth of 90 to 105 m. These mounds (see figure) are 30 to 70 m in diameter, having a relief of 5-7 m, and are probably projections of a buried eolianite ridge. The records show a crescent shaped trench surrounding each of these mounds with the concave side of all of them facing to the northeast, parallel to the general orientation of the coastline. It is proposed that these crescent shaped trenches were formed as a result of bottom currents which exist in the area and cause sediment moment from the southwest to the northeast.

Between 1982 and 1990 nine surveys were conducted in the vicinity of the marine coal terminal off the Hadera power plant, aimed at monitoring the dynamics of coal particles which fall to the sea bottom during coal unloading (GOLIK and AVERBACH, 1985; GOLIK, 1986; GOLIK, *in prep.*). In all these surveys, the distribution of coal particles was that of a plume oriented northward, to a distance of at least 15 km, parallel to the coastline, at water depths greater than 13 m. South of the terminal, coal was very scarce. It is estimated that since the terminal started operation in 1981, some 10,000 tons of coal dropped to the sea bottom, yet underwater photographs, taken some 50 m from the unloading point, show that although coal is dispersed on the bottom, the seabed is not covered by a layer of coal as one would expect. The consistent presence of coal particles only north of the terminal, and the absence of a continuous coal layer under the unloading point, indicate that the net bottom currents' direction off Hadera is northward, and that they are strong enough to prevent coal accumulation there.

All the cases mentioned above, demonstrate that the general flow regime on the sea bed in the southeastern Mediterranean is oriented parallel to the coastline in a general northeast and northward direction. Recent current measurements which were conducted throughout the water column at several stations on the Israeli shelf by ROSENTRAUB (1990) also show that most of the time the currents flow northward. All these support the hypothesis of EMERY and NEEV concerning the sediment transport on the Israeli continental shelf.

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Littoral morphology and sediment distribution in the Ebro Delta (NW Mediterranean)

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The Ebro Delta is a fluvial wave dominated delta, with a surface of 325 km^2. Its 50 km long sandy shoreline is characterized by the presence of two spits which individualize lagoons to the North and South of the delta plain (MALDONADO, 1975). The microtidal nearshore depicts several bar and trough systems as the main morphological features. Coastal sediment erosion has been analyzed for a five years period (1988-1992), with financial support from the Autonomous Government of Catalunya. Each 4 months, bathymetric surveys and sediment sampling were performed in the littoral zone (0-15 m water depth).

Littoral morphology is controlled by the location of river mouths and the wave climate. Four major delta lobes were developed during the last centuries (MALDONADO, 1972; 1986). These lobes are located in the southern, northern, central and, the most recent, northeastern sectors of the delta plain (Fig. 1). The bathymetry shows that littoral slopes are gentle offshore abandoned lobes and steep in front of the presently active lobe and at both spit ends. A submerged platform is observed off abandoned delta lobes, which is deeper proportionally to the age of the lobe. Three types of littoral profiles have been recognized: (1) progradational profiles, located offshore the present river mouth and in the spit ends, where depositional processes are dominant; (2) erosional profiles, situated in the recently abandoned delta lobes, that are in an erosion-dominated evolution, and (3) equilibrium profiles, located in the more ancient abandoned delta lobes, where the processes of reworking and deposition are in equilibrium (Fig. 2). These littoral profiles allow also to differentiate two areas in the coastal zone separated by a sharp change in slope : (1) the nearshore area, with steep slopes is characterized by the bar and trough systems, which extend from the shoreline to 4-6 m water depth, and (2) the transitional area between the nearshore area and the inner shelf, which is smooth and gently sloped.

Littoral sediment distribution is closely related to delta morphology, sediment input and wave climate. The grain size of the nearshore deposits is medium sand (250 μm) (Fig. 2). The sand-mud transition normally starts in the sea-side of the more distal sand bar and the sediment becomes progressively fining toward the inner shelf. In progradational profiles, the sand-mud transition is sharp and is located close to the shoreline (4-7 m) (Fig. 2A). Erosional profiles are characterized by the presence of mud outcrops corresponding to ancient delta lobes and relict sand bars located offshore of the influence of the mean wave climate (Fig. 2B). In equilibrium profiles, the sand-mud transition is more widely spread and complex. In these profiles grain-size decrease between the distal sand bar and about 10 m water depth, without mud in this zone. Between 10 and 15 m water depth, mixed medium and very fine sand is present, probably as result of reworking of ancient nearshore and delta lobe deposits. From this zone toward the inner shelf, the sediment is progressively finer and mud is usually observed at about 20 m water depth (Fig. 2C). The wave climate is the main factor controlling the long-shore sediment transport from delta erosion and river input. It cause changes in the littoral slope and the across-shore sediment distribution patterns.

During this Century, sediment supplied by the Ebro River has been drastically reduced by dam construction, modifying the coastal evolution of the Ebro Delta (MALDONADO, 1986; PALANQUES *et al.*, 1990). Littoral profiles have a tendency towards the erosion-dominated type and a landward migration of the shoreline, while sandy deposits are eroded and transported both offshore to deeper areas and landward infilling the coastal lagoons. During periods of low fluvial sediment input, as the 1988-1991 period, coastal erosion increase and littoral sediment becomes progressively coarser, because the finer-grained fractions are transported offshore.

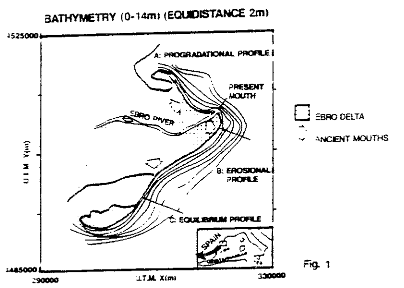

Fig. 1

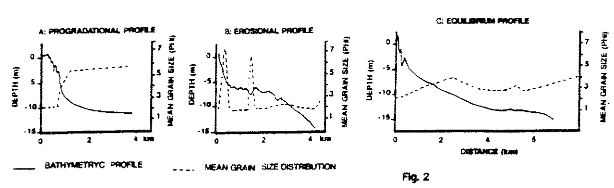

Fig. 2

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