Mediterranean undercurrent contourites in the Gulf of Cadiz (Spain) : (II) Quaternary sediments and depositional processes

Jesus BARAZA[1], C. Hans NELSON[2], Andrés MALDONADO[3],

[1]Inst. Ciencias del Mar, CSIC, BARCELONA (**Spain**)
[2]U.S. Geological Survey, MENLO PARK, CA. (**USA**)
[3]Inst. Andaluz Geologia Mediterranea, CSIC/Univ. GRANADA (**Spain**)

In the Gulf of Cadiz there is a significant development of bottom-current deposits because the outflowing of the Mediterranean Undercurrent, shears along the Cadiz continental slope on its way from Gibraltar Strait. The sediment distribution pattern along the slope is a consequence of the interaction between the dense, saline Mediterranean water outflow, and the irregular bathymetry resulting from an unusually complex tectonic setting. Variations in current speed of the Mediterranean Undercurrent affect the distribution of surficial sediment and the type and size of seafloor bedforms (NELSON *et al*, in press).

The presence of the Mediterranean Undercurrent impinging on the seafloor below 300 m water depth controls the sediment dispersal on the upper slope, whereas the presence of two smooth terraces on the middle slope, and abrupt diapiric ridges and steep valleys in the central area, control the sediment dispersal in deeper areas. On the upcurrent slope terrace and along the upper slope, a tongue-like surficial deposit develops parallel to the general SE-NW bathymetric contours (Fig. 1). In this contourite deposit there is a clear gradation from medium-fine sand beds interbedded with mud close to the Gibraltar strait, changing northwestward to coarse silt beds. Immediately to the west near the Faro Drift off Portugal, the second downcurrent terrace on the middle slope is mostly covered by finegrained, silty-clayey deposits interbedded with biogenous sands. Lithology of the contourite sediment drift bodies banked against the diapiric ridges also varies from fine sand on the SE to sandy silt on the central ridge and valley area, and silt in the NW area.

On the middle to lower slope, the sediment distribution pattern is complex in the ridge and valley area where the Undercurrent flows down valley with higher current speeds and is locally erosive or depositional. Because of the Mediterranean Undercurrent shows both contour-parallel and valley perpendicular flow, the coarse-grained sediment of valley facies trends perpendicular to the small-scale bedforms and the finer-grained contourite deposits of adjacent sediment drift facies. Gravelly, shelly, coarse to medium sand lag deposits that are transported from the outer shelf and upper slope by high-energy processes, form on valley floors. The margins of eastern valleys are covered by sand dune deposits, whereas western channels are covered by sandy to clayey silt.

Similar to the surface texture, the composition of the sand fraction in the surface sediment also varies from SE to NW and from valley floor to intervalley areas and slope terraces. The central and SE valley floors contain mostly bioclastic debris, and a low content of planktonic constituents is found in the SE and upper slope regions. However, high quantities of planktonic constituents, mostly foraminiferal tests, are found in the sand fraction of the contourite deposits in the NW area.

Lithology of the upper 2 meters of sediment consist of sandy contourite layers interbedded with mottled, silty contourites, and hemipelagic silty clays, the coarser sand layers and the greater variations in grain-size occur on the SE sector. Along the slope there is a surficial sandy contourite layer between 0.2-1.2 m thick; this layer formed during the present Holocene high sea level that results in maximum water depth over the Gibraltar sill and full development of the Mediterranean Undercurrent. In some locations a second sandy contourite layer was recovered, having the same general SE to NW gradations as the upper layer. Both valley and contourite deposits are characterized by reverse graded bedding and sharp upper bed contacts in coarse-grained layers, low deposition rate and a regional pattern of textural variation and compositional gradation. Cores from the slope areas show sedimentary structures, through cross lamination, flat lamination or massive bedding within the contourite layers, but these structures do not occur in any vertical sequence. The typical reverse grading in sediment texture of the contourite layers indicates that with rising sea level and increasing Gibraltar sill cross-sectional area of water flow, the Mediterranean Undercurrent strength has gradually increased throughout the Holocene. Since the origin of the contourite sequence the rates of deposition have been low on the upper slope (<5 cm/1000 yr) and higher in the middle slope sediment drift (>13cm/1000 yr).

The late Pleistocene age of the mud underlying the surface sand sheet correlates with the age of the last sea-level lowstand and apparent weak Mediterranean Undercurrent development. The initial control on the sandy contourites system of the Gulf of Cadiz slope has been the opening of the Strait of Gibraltar at the beginning of the Pliocene.

Since that opening, high sea level equivalent to present or greater water depth over the Gibraltar sill has permitted circulation through the Strait and the development of a strong Mediterranean Undercurrent.

Thus the cyclic deposition of sand or mud layers and contourite or hemipelagic drape sequences appears to be related to late Pliocene and Quaternary sea level changes and Mediterranean water circulation patterns.

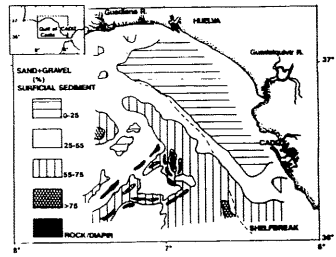

Figure 1. Textural map (% sand + gravel) of surficial sediment from the Gulf of Cadiz continental shelf and slope (modified from NELSON *et al*, in press).

REFERENCES

NELSON C.H., BARAZA J., and MALDONADO A., in press. - Mediterranean Undercurrent sandy contourites, Gulf of Cadiz, Spain, *In* : Stow, D.A.V. and Faugeres, J.C., eds., Contourites and hemipelagites in the Deep Sea, *Sedimentary Geology Special Issue*, 40 p.