DRIVERS OF MEDITERRANEAN DEEP-WATER SEDIMENTATION

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Abstract
This contribution is intented to show the relevance of dense shelf water cascading (DSWC) (i) as a sediment transport process able to carry large amounts of sediment to the deep margins and basins in the Mediterranean Sea during short periods of time, and (ii) as an efficient sea floor shaping process.
Keywords : Deep Sea Sediments, Deep Sea Processes, Western Mediterranean, Eastern Mediterranean.

Sediment input to the Mediterranean Sea mostly comes from fluvial sources. Relatively large continental shelves, deep-sea fans and channel-levee complexes have developed off the main river systems. UNEP/MAP/MED POL [1] has estimated an overall sediment flux of 730 M Tm yr^{-1} to the Mediterranean Sea, with about 75% entering the eastern basin. The theoretical overall sediment yield is 175 Tm km^{-2} yr^{-1}, which is close to the global average, and 580 Tm km^{-2} yr^{-1} if the Nile River is not accounted. The later figure is very high compared to other regions of the world.

While part of the sediment delivered by Mediterranean rivers has contributed to the development of continental shelves, another part has been exported to the deep margins and basins. The classical view is that turbidity currents and associated processes are the main transport mechanisms for sediment to be transferred from shallow to deep.

Megabeds (300-600 km^3) with distinct characteristics forming the Late Pleistocene to Holocene sedimentary sequence in the Mediterranean abyssal plains have been interpreted as megaturbidites [2, 3]. Those in the Balearic and the Herodotus abyssal plains were formed during the last sea level low stand at 22,000 and 27,000 cal. y. BP, respectively.
According to published interpretations, the megaturbidite on the Balearic abyssal plain derived from the southern European margin that is mainly fed by the Rhone river while the Herodotus abyssal plain megaturbidite originated from the continental margin west of the Nile delta [3].

The megaturbidite in the Balearic abyssal plain (60,000 km^2, 8-10 m thick) has been interpreted as the result of one single event of catastrophic slope failure evolving into a large turbidity current [2, 3]. However, a relatively young event able to release such an amount of sediment should have left a major scar or set of scars in its source area. More than a decade of swath bathymetry mapping of the margins to the north of the Balearic abyssal plain failed to identify such major headwall area. Instead, a large number of deeply incised submarine canyons with their heads cut into the continental shelf have been identified in the Gulf of Lions (GoL) and in nearby margins [4].

Recent in situ measurements have shown that DSWC is able to carry large volumes of coarse sediment that erodes shelf, slope and canyon floors [5]. Current speeds measured in the Cap de Creus submarine canyon, GoL, during the year 2005 cascading event were as high as $\sim$100 m s^{-1}. Evidence of energetic sediment transport, seafloor erosion and bottom-current deposits associated to episodic DSWC has been described recently in the Adriatic Sea as well [6]. The most striking evidence of sediment transport and erosion by cascading waters is canyon floor sand-filled axial channels, in-canyon sand beds, contourite drifts, sediment waves, fields of giant furrows, giant comet marks, scours and erosion surfaces.

Therefore, it appears that DSWC is a highly significant process for massive off shelf sediment transport and seafloor shaping at specific locations in the Mediterranean Basin. The three shelf areas of dense shelf water formation in the Mediterranean Sea (i.e. GoL, Adriatic Sea and Aegean Sea; Fig. 1) would then act as powerful drivers for deep-water sedimentation. More frequent and intense cascading at specific intervals during the Pleistocene climatic oscillations over successively shrinking and expanding flooded shelves, associated to climatically controlled cyclic variations in sediment fluxes from river mouths, could provide an alternate explanation to the turbidite hypothesis for the accumulation of megabeds in the deep Mediterranean Sea. The combination of direct fluvial sediment discharge on the outer shelf and canyon heads during low stands and DSWC has a tremendous potential for transporting large volumes of sediment sthat may eventually contribute to the formation of megabeds in the deep margin and basin, at least in the western Mediterranean.

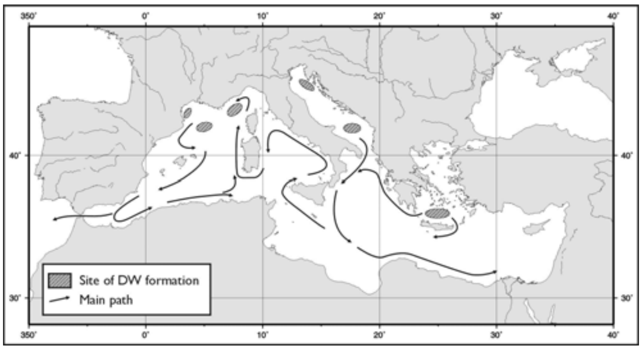

Fig. 1. Sites of deep water (DW) formation and main path of deep water circulation in the Mediterranean Sea (simplified from [7]). Dense shelf waters form in the Gulf of Lions, the Adriatic Sea and the Aegean Sea.

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