

Diagnostic analysis of contourite drifts and contour currents around small-scale topographic features: some examples from the Italian Seas (Mediterranean Sea)

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Abstract: We analyse here contourite drifts presumably related to a topographic control given by promontories or seafloor depressions (e.g., slide scars) in some Italian Seas. We therefore investigate the local effect of a topographic unevenness (such as a landslide scar) on flow contouring a cape by applying the classical conservation of marine water potential vorticity (PV). We further analyse the presence of non-linear and/or baroclinic instabilities that may lead to erosive or depositional conditions which, in turn, inhibit or favour the formation of contourites. Such an analysis is performed by applying the classical theory for conservation of potential vorticity (PV) in a cylindrical frame, which is able to describe the fluid properties by means of bathymetric curvatures.

Key words: Contourites, Bathymetric curvatures, Flow instabilities, Potential vorticity.

PRINCIPAL TEXT

The complex relationship between currents flowing around bathymetric discontinuities and their related contourite deposits is becoming an interesting and debated topic, both from a sedimentologic and oceanographic perspective. Both scientific communities are therefore seeking to bridge the gap between what the seafloor shows up in terms of contourites and what causes their formation. We analyse here contourite drifts presumably related to a topographic control given by promontories or seafloor depressions (e.g., slide scars) in the Tyrrhenian Sea. The use of bathymetric and seismo-stratigraphic data, numerical and tank experiment, and analytic results allows one to investigate the relationship between the occurrence of contourite deposits and the fluid dynamic processes that are affected by seafloor topographic features.

The surface layer of the Tyrrhenian Sea offshore the Calabrian margin is constituted of the Modified Atlantic Water (MAW). At intermediate depths (200-700m) the Levantine Intermediate Water (LIW) flows geostrophically along the continental margin, contouring the two case study we consider here: Cape Suvero and Cilento Promontory (Figure 1).

Position and occurrence of the analysed contourite drifts, with respect to the cape tip, are here analysed by means of both (i) large scale turbulence caused by promontory itself and (ii) the influence of uneven topography.

We find that Cilento Promontory is characterized by a rather strong turbulence occurring downstream its tip. Such a feature leads to erosive (or non-depositional) conditions in the lee zone, in agreement with the contourite deposits observed in the upstream zone only (Martorelli et al., 2010). Based on the same dimensionless analysis, similar conditions should

apparently occur for Cape Suvero. However, for this Cape this is contrasting with the observed presence of deposits downstream the tip (Figure 1). We argue that the influence of a more realistic topography, i.e. the landslide scar, on the local development of contourites can play an important role (Figure 2).

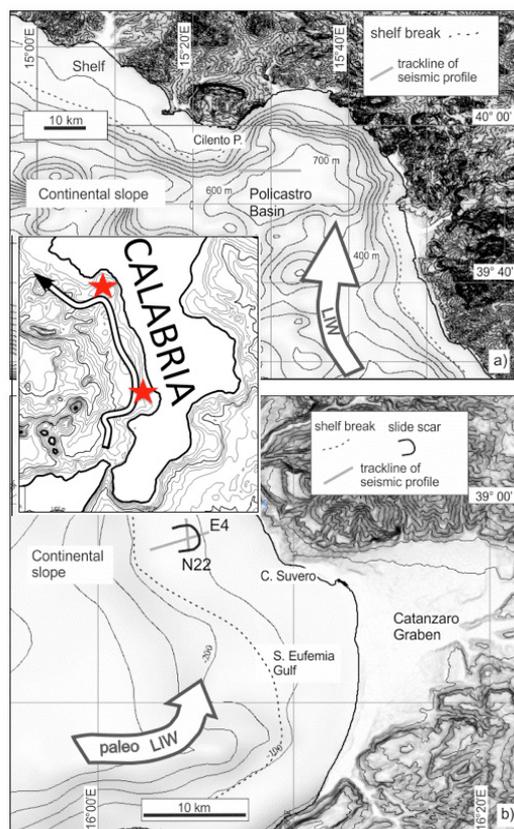


FIGURE 1. Bathymetry and subaerial topography of a) Cilento Promontory study area and location of seismic profile (not shown), and b) Cape Suvero study area and location of seismic profile shown in Figure 2. Inset: sketch of the calabrian margin with the possible pathway of LIW water mass. Red stars indicate study areas of Cilento promontory to the north and Capo Suvero to the south. Bold isobaths 1,000m

Indeed, in the paleo Capo Suvero case, where turbulent phenomena downstream the paleo-cape were inhibited by the larger cape geometry, the slide scar would have favored even more the deposition of drift by generating an anticlockwise circulation over the depression (Figure 2). From the Potential Vorticity (PV) conservation theorem it indeed results that Cape Suvero topographic depression (i.e. the slide scar), induced an anticlockwise rotation (Pedlosky, 1986). The main effect of the slide scar is thus the deviation of incoming current, as this scar would represent a kind of natural obstacle. Consequently, the incoming LIW current (~ 5 cm/s) would be deflected. This hydrodynamic pattern implies that in the external, shallower part of the scar the water velocity is largely increased while, in the deepest part, the current is nil or inverted. The resulting deposition will therefore be minimal in the shallow part and is largely increased in the deepest part of the scar. Over time, this process would promote the accumulation of infill drift deposits, the attenuation of the influence of the scar and, at the end, the complete disappearance of the morphological unevenness.

These processes can be generalized in terms of non-linear instabilities that lead to erosive or depositional

conditions, which in turn inhibit or favor the formation of contourites. Such instabilities can be generally analyzed by applying the (PV) theorem in a cylindrical frame, which is able to describe the fluid properties by means of bathymetric (positive or negative) curvatures. All this generalizes previous findings by Martorelli et al. (2010), where contourites were associated to the presence of promontories only. Our work can be seen as a new approach to understand the basic role of any bathymetric curvature in forming contourite deposits by means of classic geophysical fluid dynamics and physical oceanography applications.

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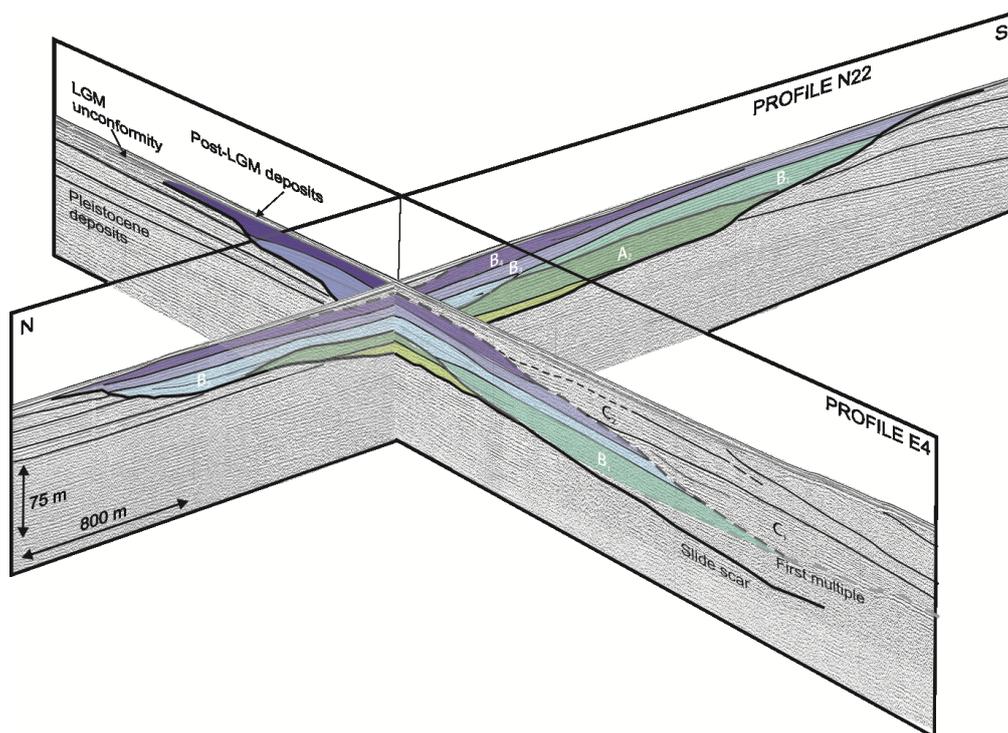


FIGURE 2. Fence perspective of 1kJ Sparker profiles depicting Cape Suvero contourite deposits. View from NE, location in Figure 1. The deposits are infill drifts developed within a slide scar.