New insights into the Messinian salinity crisis: Zanclean reflooding erosion in the Gibraltar-Alboran Sea connection area

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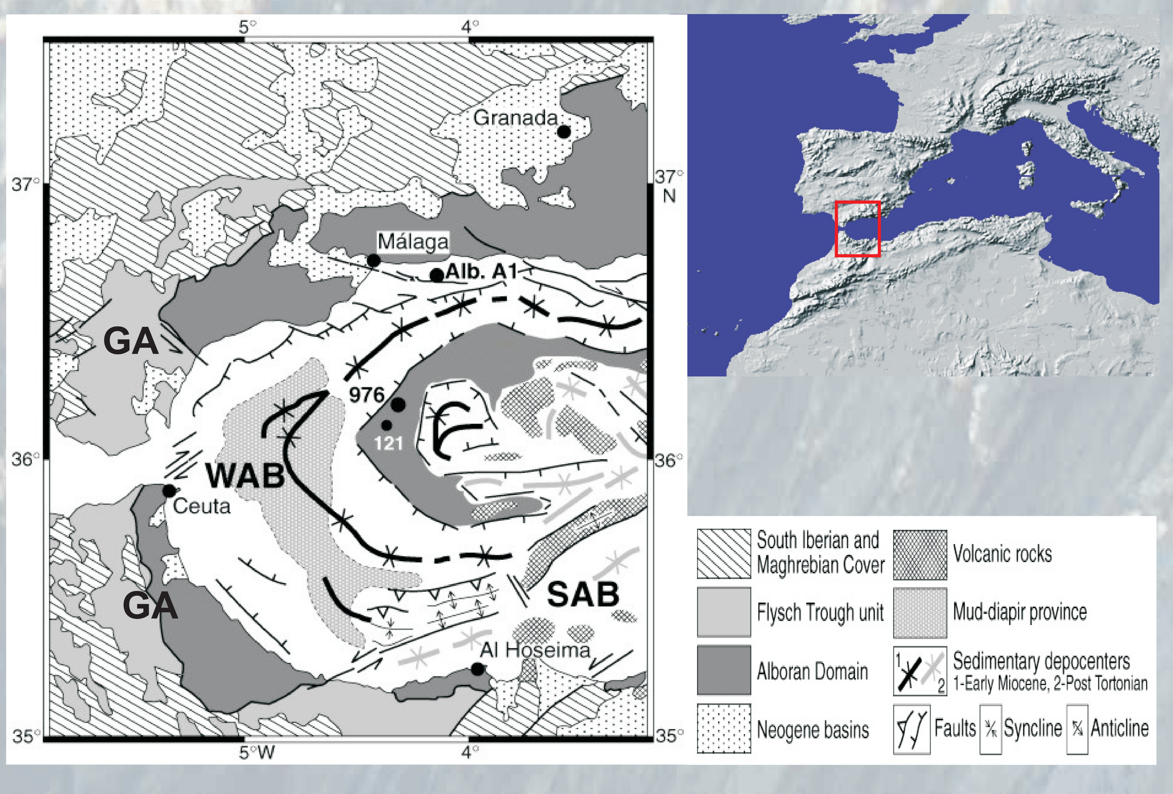
The Gibraltar Strait-Alboran Sea connection is a key area to understand the zanclean reflooding of the Mediterranean basin, at the end of the messinian salinity crisis. In spite of this importance, suggested by many authors, little is known about the submarine geological record of this area where the large magnitude of the Earliest Zanclean reflooding had to produce a great impact in the sedimentary record. In order to fill this gap, an integration of recent an ancient seismic data (single and multichannel profiles) around the Alboran side of the Gibraltar Arc has been done. The study of these data has permitted an improvement of the seismic stratigraphy trough correlation with the DSDP 121 and ODP 976 drills, and a detailed view of the messinian surface. The prelimirary results indicate the existence of a striking erosive channel-like feature in front of the Gibraltar Strait related with the Zanclaean reflooding of the Mediterranean Sea. Likewise, several terraces and canyons are identified on the Spanish margin nearby the Gibraltar Strait probably related with sea level fluctuations during the Messinian salinity crisis.

GEOLOGICAL SETTING



Geological map of the Gibraltar Arc (GA), Western Alboran Basin (WAB) and Southern Alboran Basis (SAB) (Comas et al., 1999).

Two main tectonic sectors are differentiated: the Gibraltar Arc (GA) and the Western Alboran Basin (WAB). These sectors have a similar stratigraphy, characterized by a Miocene sequence, whose messinian deposits are locally lack, and a Pliocene-Quaternary sequence formed by several units. Both sequences are separated by the prominent messinian erosive surface (MES), formed by the messinian salinity crisis. In general, the Miocene sequence is tilted towards the centre of the subsiding basin (WAB) but it appears strongly folded, probably thrusted and exhumed, in the GA of the spanish continental margin. Locally, in the Western Alboran Basin both sequences are disturbed during pulsed activity of the clay-"diapiric" tectonic.

DATA SET AND FIGURE LOCATION

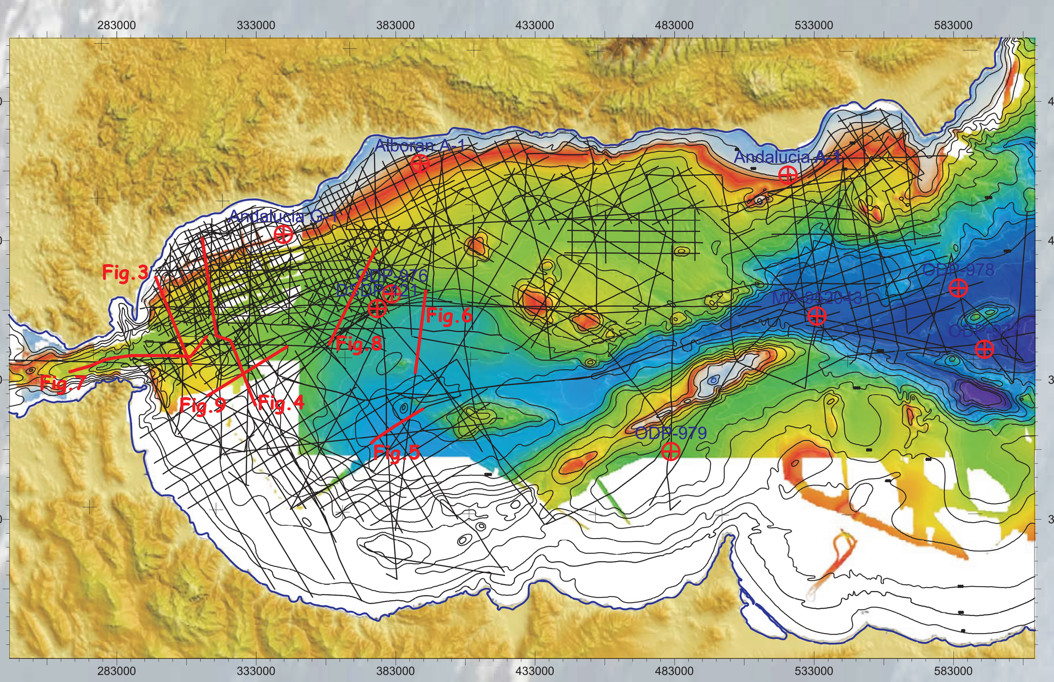


Figure 1. Multibeam bathymetry map of the Alboran Sea showing the seismic data base and commercial and scientific wells integrated in a Kingdom Suite project.

The isobath map of the top of the Messinian surface (Fig. 2) reveals four main features: a main channel, terraces, canyons and diapirs. The **main channel** is an important W-E incision off the Gibraltar Strait that extends at least for 50 km. Beyond this point it bifurcates into two 84 km long branches roughly parallel to the margin that reach the centre of the WAB. The main channel including the southern branch displays a U-cross section with dimensions that decrease eastward, from 610 m relief and 15 km wide to less than 300 m by 6 km (Figs. 3; 4; 5 and 6). The northern branch is a wider but less incised channel (Fig. 6); locally it is 20 km wide and 250 m deep. The channel axis in the transition Gibraltar Strait-Alboran Sea display and irregular erosive surface characterized by step-like features (Fig. 7). The location, orientation and dimensions, as well as the age (stratigraphic position) of this erosional surface, indicate that such large incision could be formed during the Zanclean flooding of the Mediterranean Basin, due to the opening of the Gibraltar gateway and consequent catastrophic flooding. This flooding produced the enlarging and remodelling of the previous Messinian erosional surface.

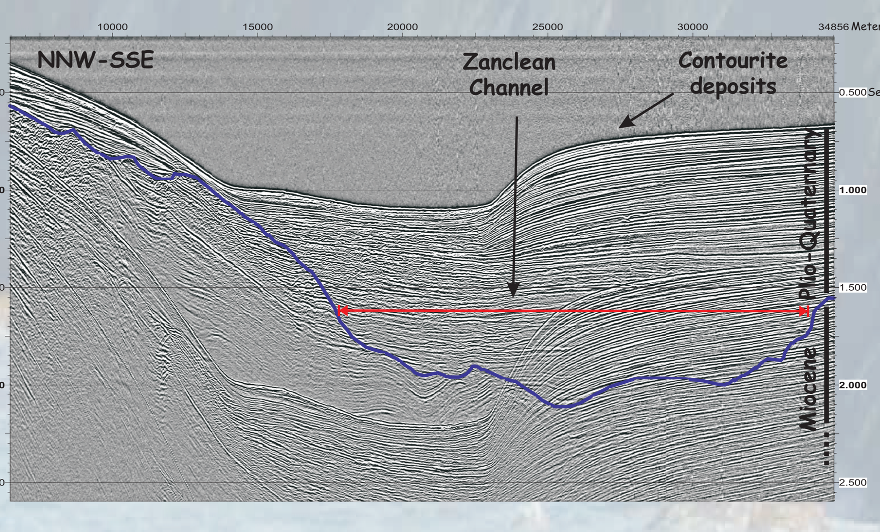


Figure 3. Airgun singlechannel seismic profile showing the Zanclean erosive surface at the mouth of the Gibraltar Strait (Alboran Sea). Legend: red arrows (diapirs); see figure 1 for location.

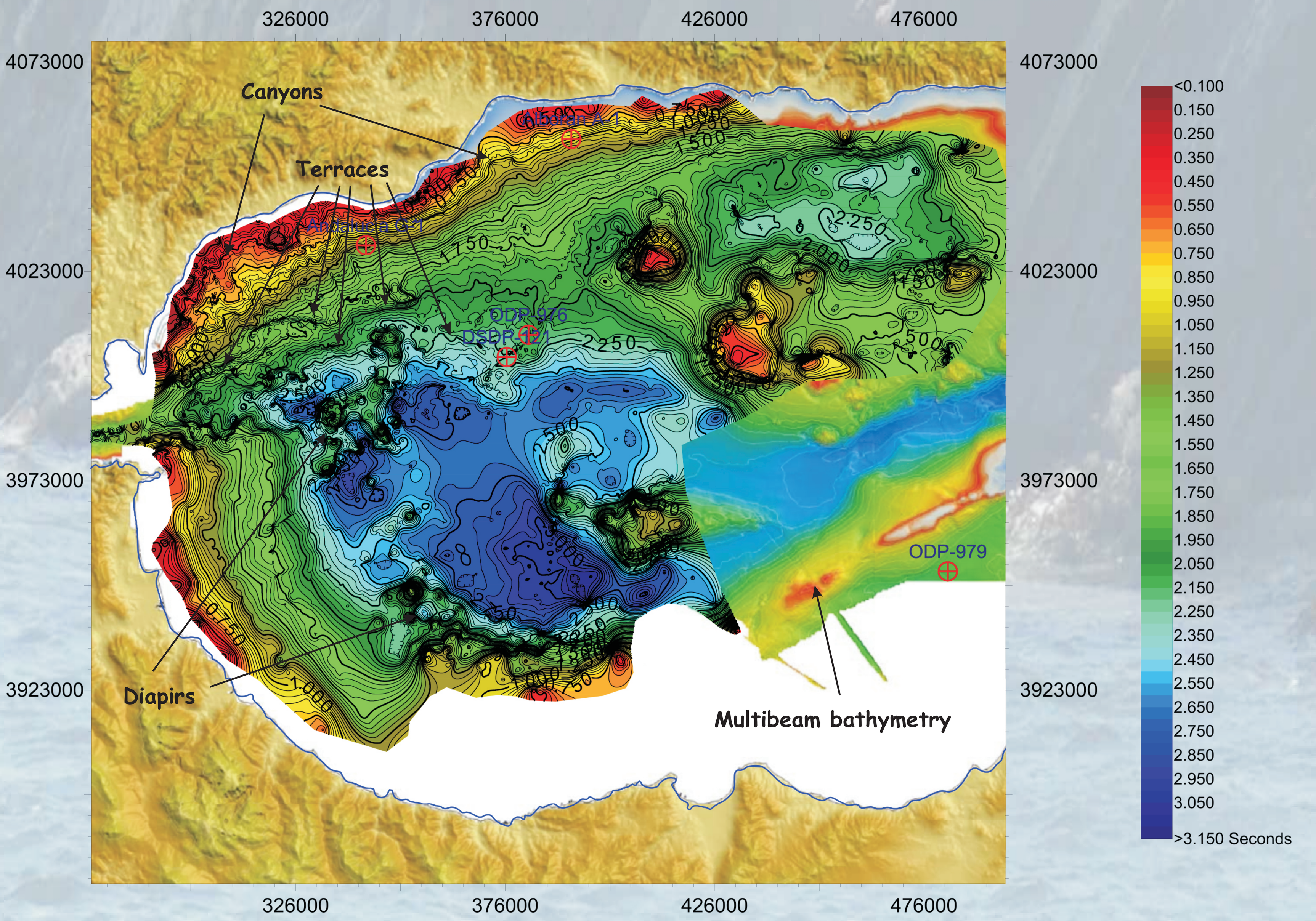


Figure 2. Composite map of the top of the Messinian isobath (coloured and contoured area) and multibeam bathymetry of the present-day sea surface.

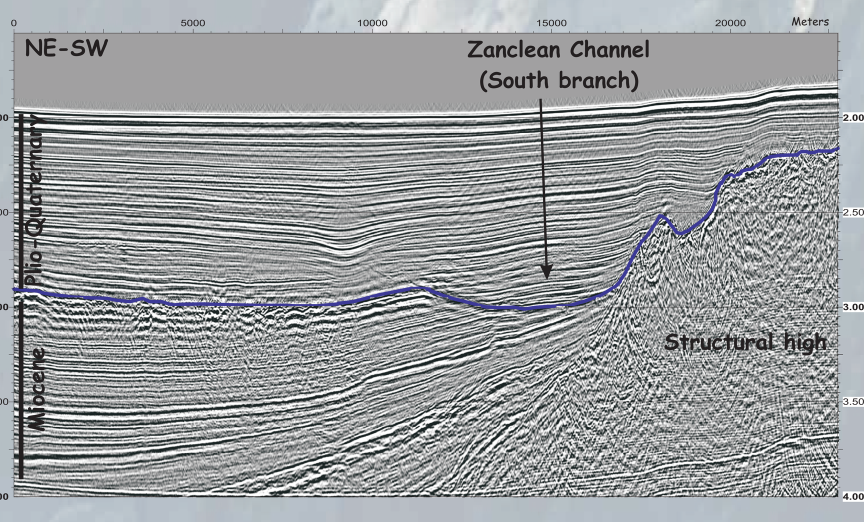


Figure 5. Multichannel seismic profile, showing the erosive channel-like feature related with the Zanclean reflooding of the Mediterranean Sea in Western Alboran Basin far from the Gibraltar Strait. See figure 1 for location.

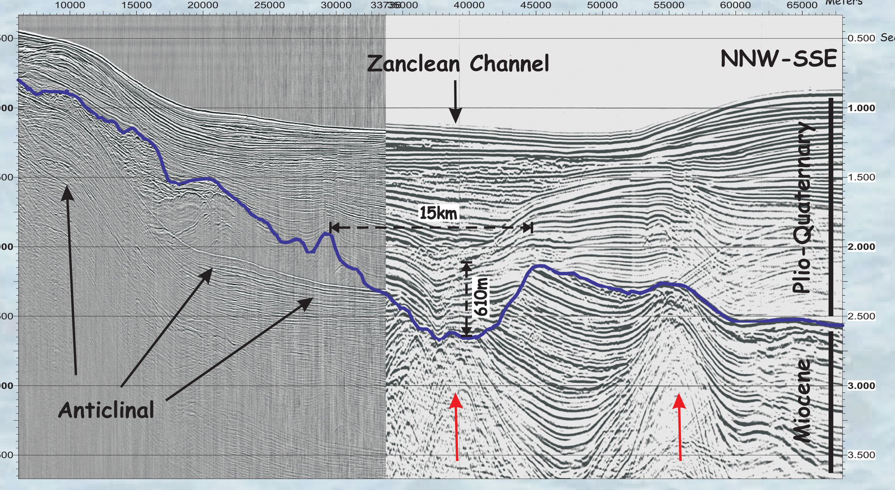


Figure 4. Composite seismic profile, single (left) and multichannel (right), showing the erosive channel-like feature related with the Zanclean reflooding of the Mediterranean Sea. Note diapirism affecting the Miocene units and compressional structures (folding) in the Spanish margin (North). Legend: red arrows (diapirs); see figure 1 for location.

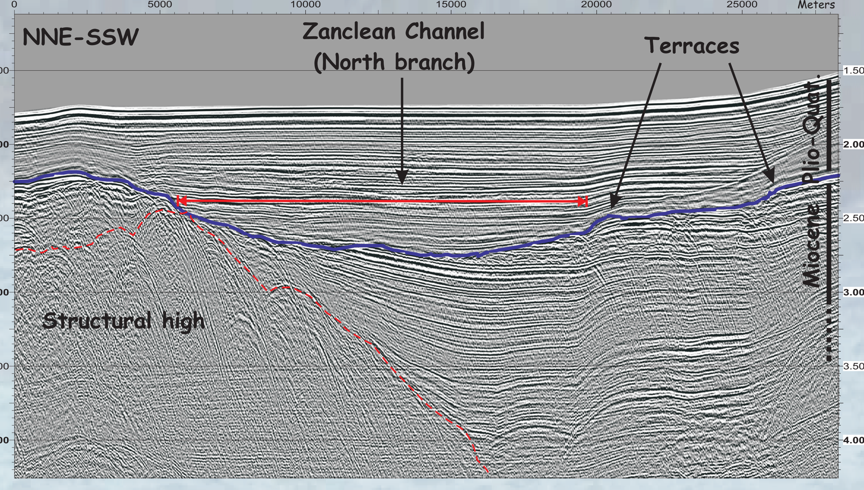


Figure 6. Multichannel seismic profile showing terraces and the north branch of the Zanclean channel. See figure 1 for location.

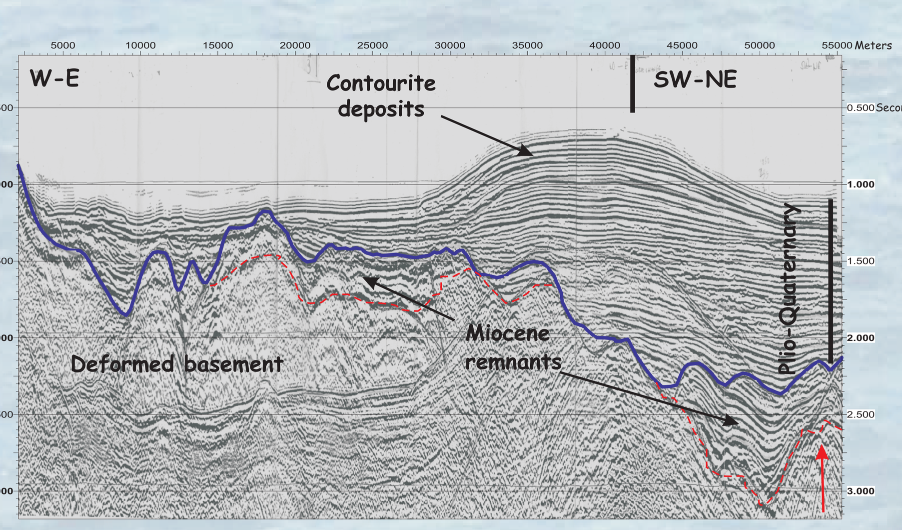
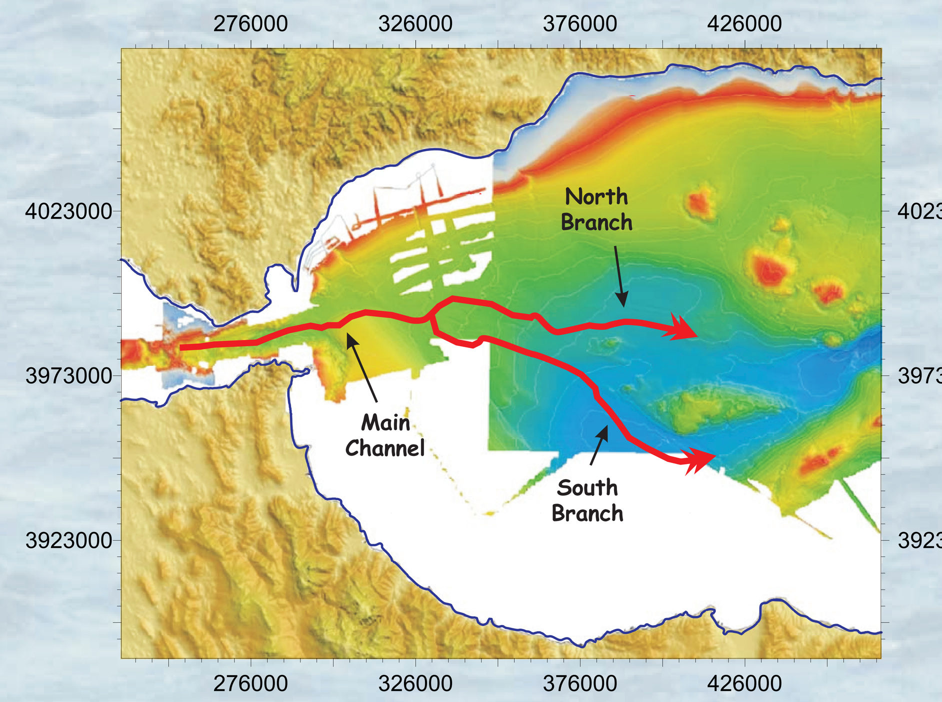


Figure 7. Multichannel seismic profile along the Zanclean channel axis in the eastern side of the Gibraltar Strait. Note the irregular erosive surface at the base of the Pliocene and the deformed basement. Legend: red arrows (diapirs); see figure 1 for location.



Bathymetric map showing the Zanclean channel path related with the opening of the Gibraltar Strait. Note that the main channel splits into two branches.

TERRACES

A set of terraces are identified paralleling the Spanish margin at different water depths (Fig. 2). They define striking scarps with the steep side oriented seaward, and are up to 140 meters of relief and from few to tens km long (Figs. 6 and 8). Tentatively, their origin could be related to erosive processes by sea level changes and/or the Zanclean reflooding stream.

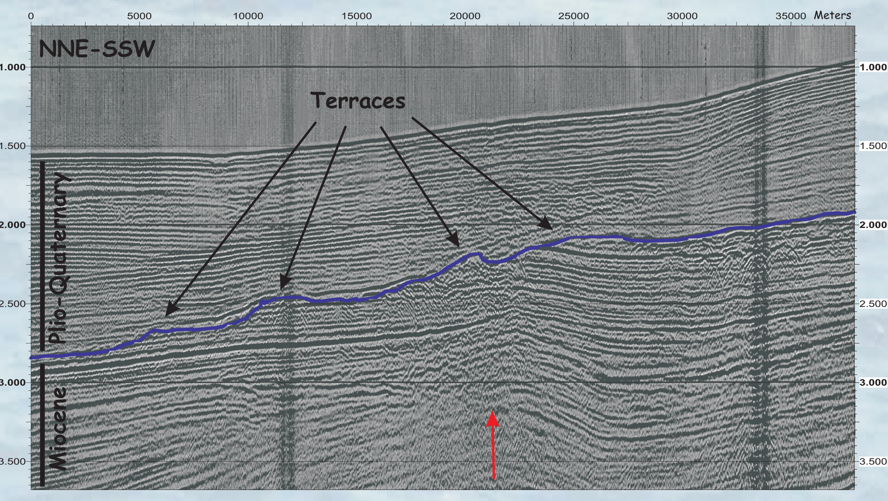


Figure 8. Multichannel seismic profile, showing erosive terraces-like features of the spanish continental margin affecting miocene deposits. Legend: red arrows (diapirs); see figure 1 for location.

CANYONS

A dense network of canyons drains the westernmost sector of the Spanish margin (Fig. 2). Contrasting, canyons are less developed and abundant in the Moroccan margin. In general these features are 20 km average long, from hundreds of meters to few km wide and few hundreds of meters deep. They extend from the shelf down to the terrace domain (middle slope) where their mouths remain as hanging features. This fact with the morphological characteristics points out to a subaerial origin of the canyons during the salinity crisis that later were eroded by the Zanclean reflooding stream.

MUD DIAPIRS

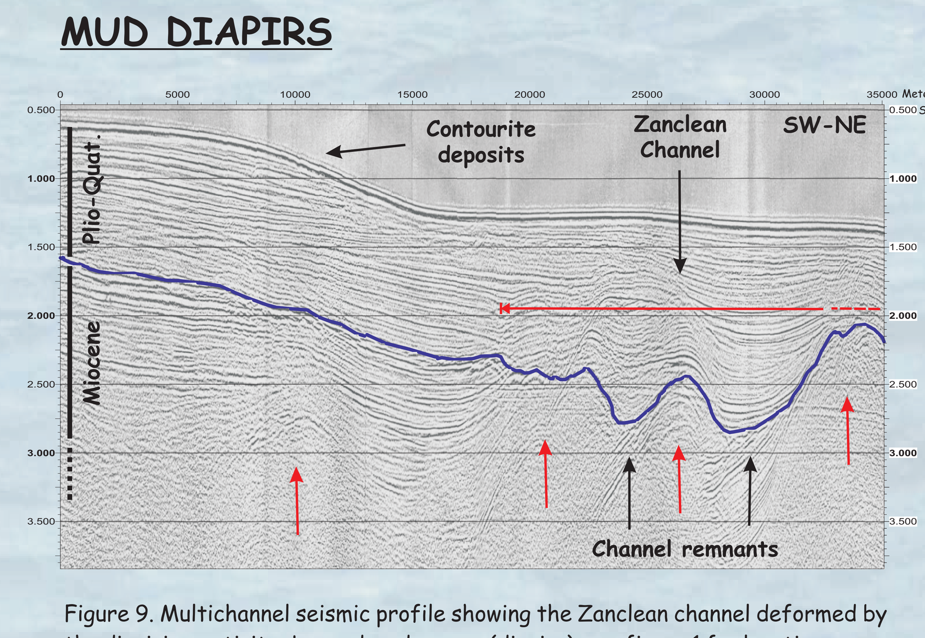


Figure 9. Multichannel seismic profile showing the Zanclean channel deformed by the diapirism activity. Legend: red arrows (diapirs); see figure 1 for location.

Mud diapirs are mostly mapped in the central part of the Western Alboran Basin (Fig. 2). Their activity occurs from the middle Miocene to present. The pulsed activity of diapirs has deformed the main Zanclean channel and modified the lateral continuity of its pathway (Figs. 4 and 9). Likewise, their topography affecting the sea bed could locally condition the flooding direction.