High Resolution late neogene Paleoceanography and climatic variability in a critical area of the Central Mediterranean

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A drilling proposal aiming at a reconstruction of the depositional history and environmental development during the deposition of sapropels in the eastern Mediterranean has recently been submitted (ZAHN *et al.*, 1991). To assist in this effort and to add a wider geological perspective, we propose here a location in the Sicily Channel that is ideally suited to investigate the paleocirculation of the Mediterranean since the Pliocene. The Sicily channel is an area critical for the connections among the western basins and the deeper, more distal eastern basins.

Current reversals that may have changed the present-day nutrient-desert to a highly productive nutrient trap are believed to have happened throughout the Plio-Quaternary. They must be recorded at the bottle neck of circulation, the sill in the Sicily Strait.

Water depth at the proposed drillsite is approximately 600 m. Coring should be continuous (APC and XCB) to the base of the Pliocene (top of the Messinian or Horizon M) that has an estimated depth of approximately 500 m

This expanded hemipelagic section lies some 30 km seaward of the classic exposure of Capo Rossello in Sicily, where the early Pliocene Zanclean stage has been defined (CITA & GARTNER, 1973), the Miocene/Pliocene boundary type section has been proposed (CITA, 1975) and the Rossellian superstage as well (CITA & DECIMA, 1975). Further detailed biostratigraphic, cyclostratigraphic and magnetostratigraphic investigations confirmed the excellent continuity and resolution of the land section, so that the "Rossello composite" is now considered a Mediterranean and global reference section for the Early and early Late Pliocene (LANGEREIS & HILGEN, 1991).

Cyclic bedding, interpreted as an expression of orbital forcing on sedimentation, is pervasive in the Trubi Formation of Zanclean age (HILGEN, 1987) and in the overlying M.Narbone Formation. The latter, as exposed on land, documents a progressive shallowing accompanied by increase in terrigenous input and sedimentation rate. Manganese-rich interbeds characterize the basal part of the M.Narbone Formation, and dark layers (?sapropels?) its upper part. Both types of sediments indicate periodic deposition at orbital frequencies.

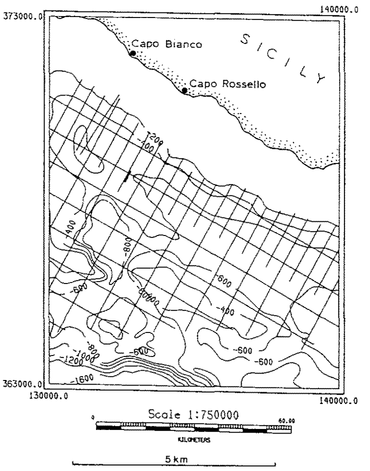
The proposed location is ideally suited also to investigate the PlioPleistocene boundary in an undisturbed equivalent of the Vrica section of Calabria.

Seismic profiles suggest that the sedimentary strata have not been affected by tectonism because the drilling target lies landward of the Strait of Sicily rift zone, in a fairly undeformed belt of the foreland basin (ARGNANI, 1990).

The rift system is considered to be of Pliocene age and, on its northern side, contains two small foredeep basins related to the Maghrebian fold-and-thrust belt (ARGNANI *et al.*, 1987). The Gela foredeep has a NW-SE trend (fig.1): its outer ramp where the proposed drillsite is located should allow the sedimentary record to be continuous: the parallel, low-amplitude, continuous reflectors seen on the seismics (fig.2) suggest that the ramp was out of the turbidite reach.

This drilling proposal is strongly supported by the Subcommission of Neogene Stratigraphy of IUGS.

Fig. 1 - Location of the study area with bathymetry and seismic grid. Line of fig. 2 indicated in bold.



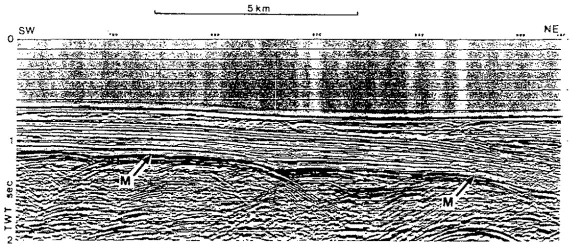


Fig.2 - Profile G82-122. Seismic facies of the outer ramp of the Gela Foredeep situated to the NE of the line. M is the top of Messinian evaporites.

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The Mud diapirs of the Mediterranean Ridge : A window to the deep composition of the Mediterranean Ridge accretionary complex

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Core analysis of the "mud breccia" recovered from four fields of mud diapirs and mud volcanoes identified on the crest of the Mediterranean Ridge (CITA *et al.*, 1981; 1989) allows to identify the source material from Cretaceous, Oligocene, and Early Miocene formations, with age progression from west (oldest) to east (youngest) (Figure 1).

The mud diapirs and volcanoes occur at the top of a steep escarpment on the inner side of the western and central Mediterranean Ridge. Although mud mobilization seems to be restricted to this narrow area of the ridge, high resolution seismic reflection data suggests that diapirs may be present also on the escarpment, and we interpret this prominent physiographic feature as the inner landward vergent deformation front of the Mediterranean Ridge.

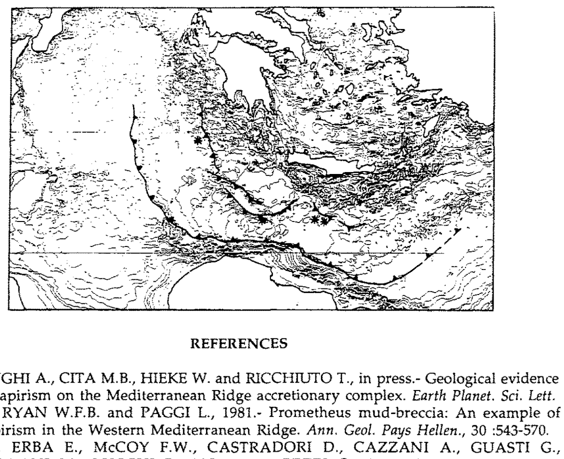
The deep origin of the diapiric material is documented by a) the Cretaceous, Oligocene and Miocene age, supported by characteristic planktonic foraminifera and calcareous nannofossils, b) the presence of methane with partial thermogenic origin (CAMERLENGHI *et al.*, in press), and c) the steep salinity gradient in the pore water (DE LANGE *et al.*, 1992) which indicates a provenance from pre-evaporitic strata. In addition, assuming that the diapiric material behaves like a fluid and that the domes are in hydrostatic balance with the host sedimentary sequence, a minimum source depth ranging from 600 m and 1000 m is required to produce the observed relief of the domes.

The smectite-rich clay mineral assemblage of the the three easternmost diapiric fields and the presence of quartz-arenites similar to the Numidian Flysh indicates that the source formations belong to the subducting African plate and that offscraping of preMessinian sediments occurs at least in the deepest portion of the ridge. Late Oligocene-Early Miocene gray clays of transitional depositional environment outcropping on the Northern African margin can be considered the analogue formation to those presently extruded as diapiric mélange on the Mediterranean Ridge.

An important implication of the deep origin of the diapiric material is that in some places of the ridge the décollement must be within Tertiaty sediments older that the Late Miocene, since mud diapirs are not thought to originate from below the décollement. If the present day décollement at the toe of the ridge occurs within the Messinian evaporites (KASTENS *et al.*, in press) then an upward migration of the décollement must have occurred during the evolution of the accretionary wedge since the Late Oligocene. Using the taper angle that can be measured at the Sirte deformation front on MCS line MS-33 (2.2°) a figure of 5-7 km depth is obtained for the upper Oligocene décollement below the ridge crest, where mud diapirism occurs.

Could mud diapirs be a drilling target? The presence of the Messinian evaporitic layer at shallow depth on the Mediterranean Ridge accretionary complex suggests a two-step (i.e. multileg) approach to investigate the structure of the ridge. The pre-Messinian sedimentary sequence on the Eastern Mediterranean is poorly known, and the structure of the ridge below the Messinian is even poorerly known. In addition, drilling through deformed salt layers is dangerous and in the case of the Mediterranean Ridge the dissipation of interstitial deep fluid pressure from sediments could be prevented by the evaporitic seal, so that anomalous overpressure could be expected. The mud diapirs and mud volcaneos found on the ridge crest have brought pre-Messinian sediments from the core of the ridge right to the surface, although in the form of mélange. If detailed stratigraphic work on a diapiric mélange will be impossible, detailed investigations of the geochemistry of the fluid and solid diapiric material obtained during shallow drilling (step 1) will provide useful informations on the deep composition of the ridge in preparation for a deep Mediterranean Ridge leg. (step 2).

Figure 1 - Location of mud diapirism (asteriscs) on the Mediterranean Ridge accretionary complex.



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