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.

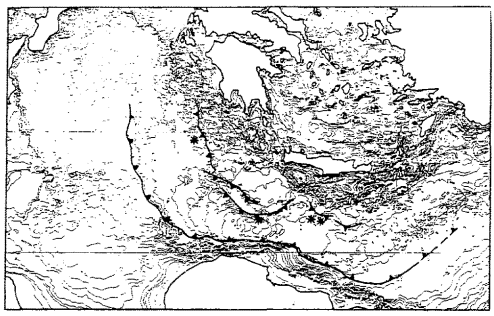
The deep origin of the diapiric material is documented by a) the Cretaceous, Oligocene and Miocene age, supported by characteristic planktonic foraminifera and calcareous nannofossils, b) the presence of methane with partial thermogenic origin (CAMERLENGHI *et al.*, in press), and c) the steep salinity 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.



REFERENCES

CAMERLENGHI A., CITA M.B., HIEKE W. and RICCHIUTO T., in press.- Geological evidence of mud diapirism on the Mediterranean Ridge accretionary complex. *Earth Planet. Sci. Lett.*

CITA M.B., RYAN W.F.B. and PAGGI L., 1981.- Prometheus mud-breccia: An example of shale diapirism in the Western Mediterranean Ridge. *Ann. Geol. Pays Hellen.*, 30 :543-570.

CITA M.B., ERBA E., McCOY F.W., CASTRADORI D., CAZZANI A., GUASTI G., GIAMBASTIANI M., LUCCHI R., NOLLI V., PEZZI G., REDAELLI M., RIZZI A., TORRICELLI S. and VIOLANTI D., 1989.- Discovery of mud diapirism in the Mediterranean Ridge. A preliminary report. *Boll. Soc. Geol. It.*, 108:537-543.

DE LANGE G.J. and Other Participants to the Marflux Expedition, 1991.- Variability in biogeochemical fluxes in the Eastern Mediterranean. *EOS*, 72(51):53 (abstract).

KASTENS K.A., BREEN N. and CITA M.B., in press.- Progressive deformation of an avaporite-bearing accretionary complex: SeaMARC I, Seabeam, and piston-core observations from the Mediterranean Ridge. *Mar. Geophys. Res.*