Drilling the Eratosthenes Seamount: Mediterranean collision tectonics and Plio-Quaternary palaeo-oceanography in the light of the geology of Cyprus

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Continental collision is one of the tectonics themes of COSOD 2. Drilling the Eratosthenes seamount and adjacent base-of-slope to the north affords an excellent opportunity to investigate initial continental collision processes. Also, the Plio-Quaternary sediment cover is capable of documenting Palaeoceanographic events, including sapropel formation.

The enormous Eratosthenes seamount (relief over 2000m), sited south of the Cyprus base-of-slope is widely believed to be a continental fragment located near the northern margin of the African plate. The crust to the S and W is believed either to be oceanic with a thick sediment cover, or thin continental crust, related to Mesozoic rifting of Neotethys in the Eastern Mediterranean. Recent data suggest more oceanic conditions to the west and more continental to the east. The foot of the slope south of Cyprus is believed by many to be an active northward dipping subduction zone. A trench is well expressed off SW Cyprus. Subduction is less well constrained to the east of Cyprus and this area may be undergoing collisional and/or strike slip deformation.

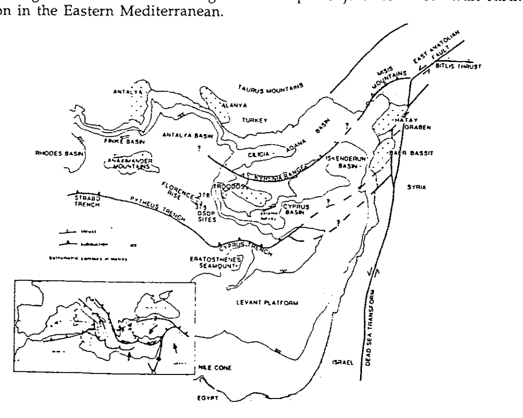
Available seismic, dredge and scarce piston coring data (from more than 8 international cruises over 20 years) suggest that the Eratosthenes seamount is a preMessinian structure, overlain by a thin, but complete Plio-Quaternary succession. The seamount is surrounded by a deep sediment filled moat, possibly caused by tectonic downwarping. The north margin is rugged and fault controlled, while the south margin is smoother. Dredging has retrieved samples of granite, Jurassic and Cretaceous limestones, serpentinite, arkosic sandstone and Mn-deposits, but the stratigraphy of these units is unknown.

An added advantage of drilling the Eratosthenes seamount is that the Neogene-Quaternary sedimentation and tectonics of Cyprus to the north is now extensively documented. During the Miocene, southern Cyprus was compressed and uplifted along several broadly E-W trending lineaments. These lineaments were colonised by patch reefs in the Late Miocene, while intervening basins were infilled with mainly bioclastic gravity flows and pelagic carbonates. The Messinian evaporates precipitated in small, semienclosed basins created by local tectonic processes. During the early-Mid Pliocence, southern Cyprus was relatively tectonically quiescent, undergoing shallow marine clastic sedimentation derived from the, by then partly uplifted Troodos ophiolites to the N. By contrast, areas to the north of the Troodos ophiolite (Mesaoria plain) were dominated by extension processes during Late Miocence/mid Pliocene time. During Late Pliocence-Quaternary the whole of central Cyprus was strongly uplifted. Sedimentation was controlled by the combined eifects of accelerating, then waning tectonic uplift, punctuated by glacio-eustatic sea-level change. Alluvial fans and fan deltas shed coarse ophiolitederived sediments into the Mediterranean Sea around Cyprus. A flight of marine terraces (containing dated corals) were cut during sea-level highstands and back-filled with littoral/shallow marine carbonate during regressions. During the Late Quaternary/Holocene, tectonic uplift of southern Cyprus slowed: archaeological evidence points to submergence of some coastal areas. Drill results from the Eratosthenes seamount can thus be evaluated in the light of a substantial on-land data base.

To solve tectonic and palaeo-oceanographic problems two drill holes are proposed, which can be selected for drilling based on existing data (further site surveys however may be necessary).

Hole 1: on the crest of the seamount where the Plio-Quaternary sediment cover is most intact and the basement can be sampled. This site will document the Plio-Quaternary succession including sapropels, determine subsidence history and the nature of basement (including its possible tectonic rotation).

Hole 2: beneath the N slopes of the seamount down to basement. This will test the hypothesis of tectonic downbuckling of the seamount and possible break-up due to northward subduction. An alternative hypothesis that a southward (rather than northward-dipping) subduction zone underlies S. Cyprus (K. HSU) might also be tested. Finally it is assumed that these shallow drilling objectives will be piggy-backed onto a drill leg including the Mediterranean Ridge area. Deeper objectives must await further data collection in the Eastern Mediterranean.



REFERENCES

AFANASJEVA *et al.*- Gravity field of the high seismicity zone southward of Cyprus. Report of the 12th cruise of *'Ac. Pertrov'*. 9.

KEMPLER D. and BEN-AVRAHAM Z., 1987.- The tectonic evolution of the Cyprean Arc. *Ann. Tectonicae*, v. 1, p. 58-71.

McCOY F. and MART Y., 1988.- Eratosthenes seamount a mid-ocean dip stick recording the late Tertiary and Quaternary marine geological history in the Eastern Mediterranean. *Rapp. Comm. int. Mer. Médit.* V. 31, p. 2.

POOLE A.J. and ROBERTSON A.H.F., 1991.- Quaternary uplift and sea-level change at an active plate boundary, Cyprus. *J. Geol. Soc. Lond.*, v. 148, p. 909-921.

POOLE A.J. *et al.*, 1991.- Late Quaternary uplift of the Troodos ophiolite, Cyprus: Uraniumseries dating of Pleistocene coral, *Geology*, v. 18, p. 894-897.

ROBERTSON A.H.F. *et al.*, 1991.- The role of tectonics versus global sea-level change in the Neogene evolution of the Cyprus active margin. *Spec. Publ. Int. Ass. Sediment.*, v. 12, p. 331-369.

SAGE L. and LETOUZEY J., 1990.- Convergence of the African and Eurasian plate in the Eastern Mediterranean. *In*: J. LETOUZEY (ed). Petroleum and Tectonics in mobile belts, *Edit. Technip*. Paris, 1990, p. 49-68.

Deformed units of continental basement in a collisional setting: the Sardinian-African Strait in Central Mediterranean

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Geological evolution and tectonic setting

The main geological features of the Sardinian-African Strait are shown in figure 1 (TRICART *et al.*, 1991). A 350 km wide submarine collisional chain, involving several tectono/stratigraphic units of the European and African plates, extends from Sardinia island to the Pelagian sea foreland.

Tectonically this collisional belt is composed (from top to bottom) of continental crystalline nappes and cover thrustsheets, mainly emplaced with S and SE vergences in latest Oligocene to Pliocene times (CATALANO *et al.*, 1989; COMPAGNONI *et al.*, 1989; BEN AVRAHAM *et al.*, 1991).

The main regional tectonic features are two low-angle SE-verging overthrusts. The outermost one, Burdigalian-Langhian (?) in age, represents the overthrust of the Kabylo-Calabrian crystalline nappes (CPK zone of Fig. 1) over the carbonate and clastic foredeep sequences of the African margin. The inner overthrust, perhaps Early Miocene in age, marks the tectonic contact between the Kabylo-Calabrian units and the superimposed Sardinian ones. The overall tectonic style, driven by the drifting and counterclockwise rotation of the Corsica-Sardinia microplate, records a large-scale intracontinental collision with development of a wide crustal shear zone, accompanied by a low-grade metamorphic re-equilibration in the Kabylo-Calabrian Hercynian assemblages. After this event tensional and strike-slip tectonics developed in the region during most of the Neogene.

Since late Pliocene the area is involved in compressional and transpressional deformations producing basin inversion and small-scale thrust faults along the contact between the Corsica-Sardinia block and the Kabylo-Calabrian units (TRICART *et al.*, 1990, 1991; TORELLI *et al.*, 1992).

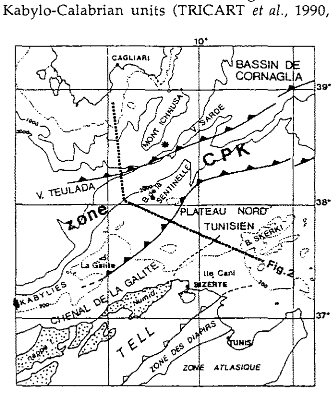

Fig.1

The proposed drilling and its main goals

We propose to drill one deep Hole (> 1 km bsf) in the Sardinian-African Strait (Fig. 2), in order to penetrate through the thrust surface separating the upper crystalline units of Sardinian type from the lower units of Kabylo-Calabrian type. Although this feature developed mostly in Early Neogene times, there are indications that tectonic activity, both with compressional and strike-slip character, is still active in the Sardinian-African Strait.

The purpose of the Hole would be to determinate the rheological nature (brittle vs. ductile), the fluid characters and the physico-chemical rock parameters associated with the thrust surface, which is clearly shown on figure 2 as a strong reflector inside acoustic basement intervals.

This data set should elucidate the mechanics of thrusting of continental basement units, at least at shallow crustal levels, and the interpretation of similar reflectors detected on deep seismic profiles shot in continental crust.

Additional goals of the proposed Site would be a better resolution of regional geology of the Central Mediterranean and of the stratigraphic and structural data obtained during Leg 107 for the nearby Tyrrhenian basin.

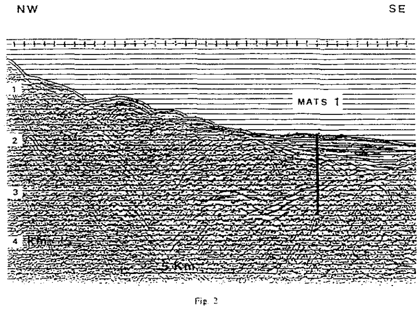

Fig. 2

REFERENCES

BEN AVRAHAM Z., BOCCALETTI M., CELLO C., GRASSO M., LENTINI F., TORELLI L. e TORTORICI L., 1991.- Principali domini strutturali originatisi dalla collisione continentale neogenico-quaternana del Mediterraneo Centrale. *Mem Soc. Geol. It.* (in press).

CATALANO R., D'ARGENIO B. and TORELLI L., 1989.- From Sardinia Channel to Sicily Strait. A geological section based on seimic and field data. *In* : The Lithosphere in Italy, A. BORIANI, M. BONAFEDE, G.B. PICCARDO and G.B. VAI eds., *Acc. Naz. Lincei, Atti*, 80: 109-127.

COMPAGNONI R., MORLOTTI E. and TORELLI L., 1989.- Crystalline and sedimentary rocks from the scarps of the Sicily-Sardinia troughs and Cornaglia Terrace (southwestern Tyrrhenian Sea): paleogeographic and geodynamic implications. *Chemical Geology*, 77: 375-398.

TORELLI L., ZITELLINI N., ARGNANI A., BRANCOLINI G., DE CILLIA C., PEIS D. e TRICART P., 1992.- Sezione geosismica crostale dall'Avampaese pelagiano al Bacino di retroarco tirrenico (Mediterraneo Centrale). *Mem. Soc. Geol. It.* (in press).

TRICART P., ZITELLINI N., TORELLI L. *et al.*, 1990.- La tectonique d'inversion récente dans le Canal de Sardaigne: résultat de la campagne MATS 87. *C. R. Ac. Sc.*, Paris II, t. 3 10: 1083- 1088.

TRICART P., TORELLI L., BRANCOLINI G. *et al.*, 1991.- Dérives d'arcs insulaires et dynamique méditerranéenne suivant le transect Sardaigne-Afrique. *C. R. Ac. Sc.*, Paris II, t. 313: 801-806.

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