# Coordinator's report

extracts

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## 3 - Information on scientific drilling in the Mediterranean (A. Robertson)

**a - Ocean Drilling Program**

The current phase of scientific ocean drilling (Ocean Drilling Program) will continue until autumn 2003, scientifically directed by the Long Range Plan, which highlights potential "Earth processes" related to the earth's interior and exterior. Currently, two complete proposals (under review) aim to drill in the Mediterranean during the present phase: Droz *et al.*, "Western Mediterranean deep-sea fans", and Kopf *et al.*, "Mediterranean backstop". Any further proposals will need to be submitted to ODP in the near future (as complete proposals) if they are to stand a realistic chance of being seriously considered for drilling by the end of 2003. A number of proposals have recently been submitted to drill in the N-Atlantic region and thus there is a realistic chance that the *Joides Resolution* will return to the Atlantic during the 2002/2003 time window.

**b - IODP International Ocean Drilling Program**

After five years of discussion, the Japanese have now committed to build (and fund) a new drill ship with riser/B.O.P. potential. This ship is scheduled to come into service in 2006 and will initially be able to drill up to ~5 km in water depth of <2.5 km. The ship is expected to focus on drilling the seismogenic zone off Japan for the first few years, but could then move to other areas. It is, therefore, worth beginning planning for future riser-ship drilling in the Mediterranean (*e.g.* Mediterranean Ridge and/or Corinth Graben).

**c - Future non-riser ship?**

The recent COMPLEX meeting in Vancouver (June 1999) demonstrated a major international demand for continued deployment of a *Joides Resolution*-type non-riser ship, largely to work on "climatic change" projects that require relatively short (<1000m) high resolution cores (using hydraulic piston cover) from many regions of the world ocean. A national proposal is likely to be put to the US National Science Foundation to fund a future non-riser vessel, which might come into service at the end of the present ODP phase (2004), or later. The greater the scientific demand, the greater the chance of having a future non-riser ship. The Mediterranean community should thus aim to submit future targets for non-riser Mediterranean drilling in the near future as preliminary proposals.

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## 4 - Earth's interior group : main conclusions (Coordinator : A. Robertson)

The group identified the "subduction factory" and "collisional processes" as related over-arching themes, in the length of the existing ODP Long Range plan, and the aims of future International Scientific drilling, as proposed at the COMPLEX meeting (Vancouver, 1999).

**a - Subduction factory/collisional processes**

The Eastern Mediterranean is the world's ideal location for study of fundamental processes of progressive and diachronous continental collision (*e.g.* fluid flow, mass transfer). The primary target is the Mediterranean Ridge accretionary prism.

**b - Rifting processes**

Back-arc areas provide an excellent opportunity to study fundamental processes of crustal extension, fluid flow and related seismicity. A major European project is currently devoted to multi-disciplinary study of the Corinth graben.

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In summary, the current studies of "Earth's Interior" drilling topics in the Mediterranean are as follows:

- Mediterranean Backstop, Kopf, Mascle, Robertson *et al.* - complete proposal, under revision;
- Mediterranean Collisional Transect, Mascle *et al.* - preliminary proposal in preparation;
- Mediterranean Subduction Transect, Della Vedova *et al.* - preliminary proposal in preparation;
- Easternmost Mediterranean Collisional, Mart, Woodside, Robertson - preliminary proposal in preparation.

Each of these drill topics/targets is of global significance and highlights societal relevance (i.e. seismic hazard) and integration with local geology (ICDP).

## 5 - EARTH'S EXTERNALPROCESSES GROUP : MAIN CONCLUSIONS (Coordinator: K. Emeis)

**a - Stratigraphy, climate evolution, and sea level variations**

The setting of the Mediterranean Sea and the adjacent Black Sea with respect to climatic zones and influences by high- and low-latitude climatic processes offers a wide range of drilling targets to address questions of sea-level change, stratigraphy, and climate evolution. The Nile River monitors precipitation in equatorial regions and is regulated by the monsoon system. The history of glaciation in high-latitude northern continental areas is mirrored in Black Sea sediments fed by large river systems, and the evolution of climate in the Western Mediterranean Sea, which is influenced by climate in the Atlantic Ocean, is recorded in the fans of rivers that drain into the Western Mediterranean Sea. Climatic and hydrographic changes in the Mediterranean catchment have resulted in a pronounced cyclicity of sedimentary deposits since the basal Pliocene (Lourens *et al.*, 1996) and beyond to at least the Serravallian (Hilgen *et al.*, 1997). These cycles have been used successfully to establish high-resolution stratigraphies by tuning proxy records to orbital cycles. Stratigraphic studies on land outcrops and in cores drilled during ODP Legs 160 and 161 show that first-order patterns of sapropels and their occurrence through time on land and in the marine records are similar in the Pliocene to the Holocene (Kroon *et al.*, 1998; Lourens *et al.*, 1998; Sprovieri *et al.*, 1998). Most are even isochronous in the temporal resolution afforded by tuning the sapropel occurrences to insolation curves (Hilgen, 1991; Lourens *et al.*, 1996). Similar studies on cyclic peat and lignite deposits on land in the Northern Mediterranean borderlands (*e.g.*, Mommersteeg *et al.*, 199; van Vugt *et al.*, 1997) suggest that combined drilling efforts on land and at sea may be able to perform detailed climate reconstructions in a variety of climate settings that are all mirrored in discrete deposits of the Mediterranean Sea. Some of these possible targets have been identified during the CIESM workshop.

***i) Evolution of the Nile deep-sea fan as an indicator of low-latitude climate evolution***

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Drilling on the Nile fan, which has recently been mapped and investigated by acoustic methods, may shed light on the history of the African Monsoon, on the role of tectonic uplift in the East African region, and on the influence of southern hemisphere climate on Nile runoff. In conjunction with studies on deep-sea fans in the Western Mediterranean Sea and on the evolution of sedimentary deposits in the Black Sea region proposed by workshop participants **(...)**

***ii) Records of high-resolution climatic variability***

Sediments in the Eastern Mediterranean are known to provide ideal archives of global paleoclimatic continental and marine signals. This is partly due to :

- the highly sensitive nature of this semi-enclosed basin regarding climatic change, and
- the distinct differences in rock/soil type and climatic/weathering history of surrounding continental areas (provenance of terrigenous detritus).

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The Eastern Mediterranean, therefore, is an ideal area to study land-sea interactions of global paleoclimatic variations, in particular as this area is influenced and preserved paleoclimatic signals from the mid to high latitude northern borderlands to the low latitude monsoon influenced southern borderlands. Owing to the extreme sensitivity of these borderlands to subtle climatic changes, the Eastern Mediterranean is a potential treasure for paleoclimatic research, especially at locations with high sedimentation rates.

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Heinrich-type events have been found amongst others in Atlantic and N-Indian Ocean sediments, and possibly in the Alboran Sea. It seems therefore likely that these rapid climatic events will also have been recorded in this environment that is sensitive to climatic changes. The excellent time control from Recent to Miocene or beyond for the high sedimentation rate sites in the eastern Mediterranean would permit not only the detection of such events, but also the establishment of their exact timing beyond 14C ages down to at least the Miocene (if present), and their relation to the astronomical cyclicity.

**b - The Deep Biosphere : questions that can be addressed in the Mediterranean Sea**

In the early to mid-1990's, geomicrobiologists working with samples recovered from drill holes cored by the Ocean Drilling Program (ODP) discovered that bacteria are not only present at much greater depths (>750 meters) beneath the deep seafloor than was previously thought, but they actually thrive there in colossal numbers (Parkes *et al.*, 1994). This exciting discovery has led to a major new initiative within ODP to study the deep sub-seafloor biosphere. The extent of this major biosphere and the nature of the "extremophiles" living there are essentially unknown. Ocean drilling offers the potential to probe this unexplored world of the deep sub-seafloor, which represents a unique habitat that couples biosphere/geosphere cycles. Exploring down to the base of the deep sub-seafloor biosphere will have important societal implications for new biotechnology applications, for better understanding the generation of hydrocarbons and ore deposits, for defining as yet unknown components of the carbon cycle, and for evaluating the origins of life on Earth and elsewhere.

The Mediterranean Sea is an ideal location to undertake drilling campaigns to investigate the deep sub-seafloor biosphere. During the late Neogene, the Mediterranean sedimentary basins were repeatedly the location of peculiar environmental conditions, which led to the deposition of highly organic carbon-rich sediments, known as sapropels. In addition, during the Messinian Salinity Crisis in the Mediterranean, a thick sequence of evaporite sediments was deposited basin-wide with the desiccation of the deepest basins. Beneath the evaporite are older sediments, which also contain high amounts of organic matter. The thick evaporite sequence essentially serves as a cap-rock seal limiting the upward migration of altered organic matter (petroleum) or gases. This trapping effect produces an obvious safety/pollution hazard and has prevented drilling deep into and through the Messinian evaporites. If it were possible to drill through these traps using advanced drilling technology with blowout prevention equipment, an unusual isolated deep biosphere community could be penetrated and sampled.

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Preliminary microbial studies were undertaken on the recent ODP Legs 160 and 161 with encouraging results. In particular, studies were conducted on the sedimentary sequence from Site 969, which is located in 2202 m deep water in the Eastern Mediterranean and contains approximately 80 sapropel beds (Cragg *et al.*, 1998). The collected data demonstrate that microbial activity occurs with depth throughout the entire 116-m-thick Pliocene/Pleistocene sequence, even in sediment as old as 5 myr. The microbial activity varies within the sequence, with the bacterial counts being higher in the sapropel layers than in the surrounding sediments (Fig. 1).

High sulfur concentrations present in the form of pyrite also reflect this bacterial activity. The total amount of sulfur increases with depth showing that bacterial sulfate reduction does not occur only at shallow depths but continues after deep burial. This continued activity is supported by the flux of sulfate from below, as shown by the pore-water analyses. The sulfate concentration throughout the sequence was always equal to or greater than seawater and increased with depth. This preliminary work indicates that the combination of viable organic matter in the sapropel layers and sustained high sulfate concentrations are essential ingredients for promoting continued bacterial sulfate reduction with burial.

Thus, an excellent potential to study the processes governing the deep sub-seafloor biosphere exists in Mediterranean sedimentary deposits. In particular, the regular injection of organic matter into the sediments at frequent intervals to form the sapropel layers provides conditions for controlled experiments in a natural laboratory. The sapropel layers are produced at specific intervals, approximately every 21 to 23 kyr., in response to precession-controlled climate changes. Knowledge of this timing allows for good age control, making it possible to study changes in the microbial community and their organic substrate with depth and determine how such a system evolves with time. Future drilling of the deep sub-seafloor biosphere in the Mediterranean will require a dedicated leg(s) to undertake such experiments and will be possible with the currently available drilling technology. To study the even deeper and potentially more active and more isolated biosphere will require the technical ability to drill in regions which have been previously avoided, such as drilling into the Messinian evaporite sequences and penetrating potential hydrocarbon oil and gas rich zones. Such a program in the Mediterranean must await the arrival of a drill-ship capable of drilling safely in these environments.

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