Why Drill Sapropels (Again)?
An effort to study the depositional history and environmental development during the formation of Sapropels in the Mediterranean.

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The discovery of multiple layers of sapropels and sapropelic sediments in the Eastern Mediterranean Sea during the Swedish Deep-Sea Expedition (KULLENBERG, 1952) marks the onset of a controversial dispute among marine geologists concerning the depositional environment responsible for their formation. In spite of considerable scientific effort and an increasing data base on their sedimentological, faunal, chemical, and isotopic characteristics, sapropels still elude simple explanations.

Opinions are divided into two broad lines of thinking: One line favors intermittent anoxia of deep waters, which would impede remineralisation of organic matter at the sediment-water interface and enhance its preservation. Anoxia could have been established by either increased fresh-water runoff due to increased monsoonal rainfall or increased runoff after melting of continental ice sheets, by inhibition of deep-water formation, or by capping the Mediterranean surface water with less saline water from the Atlantic. The other line of reasoning argues that pulses of high biological productivity in the surface waters is the key to understanding sapropel formation (PEDERSEN and CALVERT, 1990). It is well demonstrated that most of the correlative and coeval sapropel layers in the eastern Mediterranean were deposited during climatic optima in the Pleistocene glacial epoch (RYAN, 1972; THUNELL *et al.*, 1978; ROSSIGNOL-STRICK, 1984; Fig. 1). In analogy with climatically-induced changes in biological productivity during the Pleistocene in other parts of the world ocean, production and accumulation of organic carbon may have been greatly increased in response to changes in water circulation leading to upwelling of nutrient-rich waters. Both hypotheses agree that sapropels signal distinctive changes in the physical circulation and chemical environment of the Mediterranean Sea (Fig. 2), and that climate changes are the driving factor (CITA *et al.*, 1977). The discovery of sapropels throughout the entire stratigraphic succession of post-messinian marine sediments in the eastern basins of the Mediterranean and the Tyrrhenian Sea shows that the entire basin was affected by the changes, even if resulting facies variations were much less pronounced in the western basins.

A renewed effort to elucidate the responses of the carbon cycle in the Mediterranean to climatic forcing on one hand, and the relative importance of preservation and production in burial of organic carbon in the geologic record on the other hand is needed and timely: Clarification of environmental conditions in the Mediterranean during times of sapropel formation and the exact timing of environmental changes will thus have implications exceeding any regional interest and may be applicable to the entire world ocean. New tools and concepts that evolved during the last few years may aid in this clarification: A transect of piston-core drill sites targeted on hemipelagic, undisturbed sedimentary sections deposited on structural highs since the end of the Messinian and bracketing all major basins of the Mediterranean will permit to trace the physical, chemical, and biological response to external forcing in high resolution. In addition to traditional sedimentological and paleontological work, focus of post-cruise work should be on :

- high-resolution isotope analyses of foraminiferal carbonate to establish a basin-wide and detailed stratigraphy,
- statistical treatment of faunal and floral assemblages to constrain surface- and bottom-water conditions at each site through time,
- analyses of redox-sensitive chemical tracers to establish the importance of bottom-water oxygenation for sapropel deposition,
- reconstruction of biological productivity and carbon burial through organic and inorganic tracers,
- determining the temporal variations of temperature and salinity as recorded by chemical and faunal indicators through time.

Given the large carbon reservoir of the world ocean, study of boundary conditions during sapropel deposition the the Mediterranean will provide a better understanding of the mechanisms which define the architecture of the ocean s carbon reservoir. This in turn controls the atmospheric chemistry and hence Earth's climate.

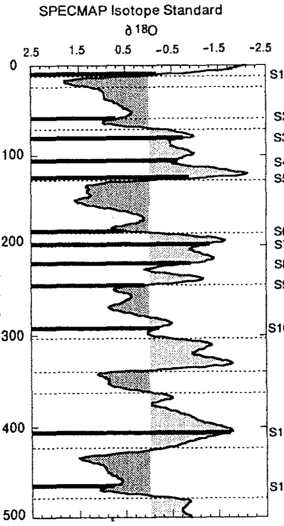

Fig. 1:
Sapropel occurrences in relation to the global record of isotope changes in planktonic foraminifers Shaded are warm and cold periods, respectively.

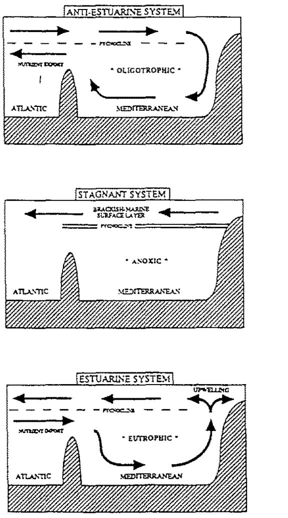

Fig. 2:
Models of possible oceanographic and chemical variability responsible for sapropel formation.

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