Deep Sea Drilling for Earliest Pliocene Sediments in the Eastern Mediterranean

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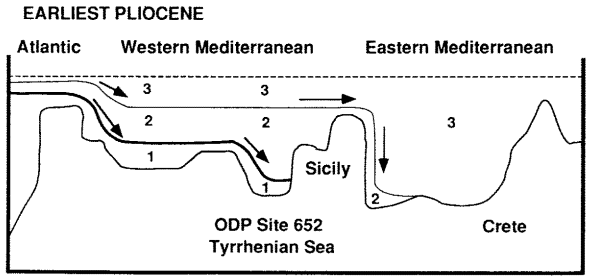
During the Messinian (latest Miocene) Salinity Crisis, the normal water exchange pattern between the Atlantic and Mediterranean was disrupted due to the relative lowering of the sea level in the latter with respect to the former. Marine waters flowed into the desiccating basins with no return flow to the open ocean (CITA and RYAN, 1973). The Zanclean (earliest Pliocene) termination of evaporite conditions in the Mediterranean was apparently facilitated by a major eustatic rise in sea level that allowed increasingly greater amounts of marine water to flow into the Mediterranean and overcome the extreme negative hydrologic balance that had produced the Salinity Crisis (MCKENZIE *et al.*, 1988). This terminal flood is manifested in the sedimentary record by marine pelagic sediments directly overlying the continental evaporitic sediments and marks the stratigraphic boundary between the Miocene and Pliocene.

Deep sea drilling in the Mediterranean during DSDP Legs 13 and 42 demonstrated that the earliest Pliocene sediments overlying the continental deposits were not always time synchronous, i.e. the flooding and infilling of the multiple basins were undoubtedly progressive dynamic processes (RYAN, HSU *et al.*, 1973; HSU, MONTADERT *et al.*, 1978). During ODP Leg 107, deep sea drilling at Site 652 in the Tyrrhenian Sea recovered a sedimentary sequence comprising an apparently complete Miocene/Pliocene boundary section (SHIPBOARD SCIENTIFIC PARTY, 1987). The sediments appeared to have been continuously and subaqueously deposited during the transition from continental to marine conditions. A high-resolution bio-, magneto-, and chemostratigraphic study of this sequence delineated a series of paleoceanographic events within the 300,000 yrs. period following the initiation of the earliest Pliocene terminal flood (MCKENZIE *et al.*, 1990). These events can be correlated to changes in amount and depth of water exchange between the Atlantic and Western Mediterranean with the infilling of the western basin occurring progressively during the first 250,000 yrs. post flood. Moreover, preliminary studies of the relative strontium isotope ratios (87Sr/86Sr) of the lowermost Pliocene sediments from three locations in the Mediterranean (ODP Site 652-Tyrrhenian Sea, Sicily, and Crete) indicate that the marine flooding and infilling of the Tyrrhenian Basin may have occurred earlier with continental conditions in the Sicilian and Cretian Basins being maintained progressively longer with increasing distance from the Atlantic source (MCKENZIE *et al.*, 1989). The figure below illustrates the progressive infilling of the Mediterranean from west to east.

Our understanding of the timing and consequences of these paleoceanographic events recorded in basinal sequences deposited across the Miocene/Pliocene boundary has been limited by the quality of material available for study. Using the advanced drilling technology of the JOIDES Resolution, it would be possible to have excellent recovery of sediments from a number of sites in the deep Mediterranean basins. In particular, selection of an appropriate site (or sites) in the Eastern Mediterranean to compliment Site 652 would provide a record of environmental changes that could be correlated with the paleoceanographic events delineated for the Western Mediterranean. Specific factors to be evaluated could include: (1) the relative timing of the cessation of continental conditions in the Eastern Mediterranean, (2) the influence of paleoclimate on the hydrologic balance between meteoric input and marine inflow across the shallow sills to the west and, hence~ on the evolution of the earliest Pliocene water body and (3) the development of two-way exchange of marine waters between the western and eastern basins and its significance for the Mediterranean paleoceanography and global climate.



Based on preliminary strontium isotope ratios, the earliest Pliocene marine infilling of the Mediterranean from the Atlantic occurred in three stages: Stage 1 - as eustatic sea level rose, the deeper basins of the Western Mediterranean, such as the Tyrrhenian, were gradually infilled by waters cascading down the western sill, Stage 2 - the waters gradually filled the deeper basins and transgressed across shallower morphology, such as the Sicilian Basin, and finally cascaded into the Eastern Mediterranean, and Stage 3 - with continued rising eustatic sea level, a threshold level was passed allowing waters to completely infill the basins of the Eastern Mediterranean. Diagram by A. Isern after CITA and RYAN (1973).

REFERENCES

CITA M.B. and RYAN W.B.F., 1973.- The Pliocene record in deep sea Mediterranean sediments. V. Time-scale and general synthesis. In W.B.F. Ryan, K.J. Hsu *et al.*, Init. Rep. DSDP, 13 (2) *U.S. Govt. Printing Office*, Washington, D.C.: 1405-1416.

HSU K.J., MONTADERT L. *et al.*, 1978.- Init. Rep. DSDP, 42A, *U.S. Govt. Printing Office*, Washington, D.C. :1249p.

MCKENZIE J.A., EIERMANN E., HSU K.J., CHANNELL J.E.T., MUELLER D.W., MUELLER P.A., PALMER S.C. and SPROVIERI R., 1989.- Stepwise eastward infilling of the earliest Pliocene Mediterranean basins. In Abstract Volume, Third International Conference on Paleo-oceanography, Cambridge: 35.

MCKENZIE J.A., HODELL D.A., MUELLER P.A. and MULLER D.W., 1988.- Application of strontium isotopes to late Miocene-early Pliocene stratigraphy. *Geology*, 16: 1022-1025.

MCKENZIE J.A., SPROVIERI R. AND CHANNELL J.E.T., 1990.- The terminal Messinian flood and earliest Pliocene paleoceanography in the Mediterranean: results from ODP Leg 107, Site 652, Tyrrhenian Sea. *Memorie della Società Geologica Italiana*, 44: 81-91.

RYAN W.B.F., HSU K.J. *et al.*, 1973.- Init. Rep. DSDP, 13, *U.S. Govt. Printing Office*, Washington, D.C. :1447p.

SHIPBOARD SCIENTIFIC PARTY, 1987. Site 652: lower Sardinian margin. In K.A. KASTENS, J. MASCLE *et al.*, Proc, Init. Repts. (Pt. A) ODP, 107, Ocean Drilling Program, College Station, TX, 403-597.

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The OGS multichannel seismic coverage of the Mediterranean Sea (MS-lines)

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From 1969 to 1982 the Osservatorio Geofisico Sperimentale (OGS), with seat in Trieste, collected 39,500 km of multichannel sesmic reflection lines in the Mediterranean Sea (Figure 1). These lines can be regarded as the only comprehensive seismic datatset of the Mediterranean and the Black seas collected by a public research institution.

Unfortunately, only part of the dataset is known to the Italian and European scientists: some lines have been published (FINETTI, 1976; FINETTI and MORELLI, 1972; 1973; FINETTI, 1982), others have been made available to scientists for detailed studies. Nevertheless, a systematic analysis of all the lines according to the latest re-processing techniques has never been done. Recently, a test performed on a few lines from the central Tyrrhenian Sea has shown that the application of widely used re-processing steps like deconvolution in the FX domain allows to outline details that could not be resolved with the 20 year old processing technique, thus improving greatly the data quality.

Since about half of the Mediterranean and Black seas data set is recorded on 21traces tapes (an obsolete format) OGS has started a program, partly supported by public funding, of systematic copying and re-formatting in standard SEG Y format of all the lines, so that they can be re-examined and re-interpreted in the frame of new national and international cooperation.

The geological themes covered by the lines are numerous, as complex and variegated is the geological structure of the Mediterranean Sea:

Black Sea lines: The Black Sea has gained recent growing attention for geological and oceanographic research. The structural relationship of the basin with the AlpineHimalayan orogen is important in terms of paleoceanographic reconstruction of the Paleo-Thethys ocean. The development of shale diapirism in the fine grained sediments of the Danube Cone is an additional theme of growing interest.

Levantine and Ionian seas lines: The Eastern Mediterranean is a unique geological laboratory where lithospheric, tectonic, paleoceanographic, and geochemical themes can be addressed, as demonstrated by the numerous drilling proposals submitted to the Ocean Drilling Program, mostly based on existing published and unpublished MS lines, and MAST-II proposals submitted to the EEC: nature of the Ionian and Levantine lithosphere, incipient continent-continent collision as the last stage of the AlpineHimalayan orgenesis, evolution of a salt-bearing accretionary complex, origin of sedimentary melanges of diapiric origin, relation between convergent plate margins and back-arc extension, mechanichs of emplacement of ophiolites; climatically induced stagnation of a marginal sea, paleoclimatic reconstruction in the post-Messinian; brine migration below the seafloor, deep fluid circulation in accretionary prims are the highlights.

Tyrrhenian Sea: The evolution of the Tyrrhenian back-arc basin has been addressed by ODP Leg 107 based on drill sites located on the existing versions of MS lines. The lithospheric theme of mechanism of emplacement and composition of upper mantle peridotites in an back-arc extensional setting has been introduced by this leg to the attention of the scientific community.

Sardinia Channel: The geological structure of this area has been recently interpreted as the off-shore extension of the Apenninic orogenic belt, in continuuity with the northern Africanan Meghrebian fold belt. Its evolution is thus critical in the study of a collisional processes where not only the sedimentary cover, but also the crysatalline basement can be easily reached by seismic investigation. An ODP drilling proposal based on the present version of MS lines has been filed to ODP.

West Sardinian Margin: This continental margin offers the possibility to investigate the crustal structure developed during the opening of the Balearic Sea. MS lines are presently employed within ECORS-CROP programs.

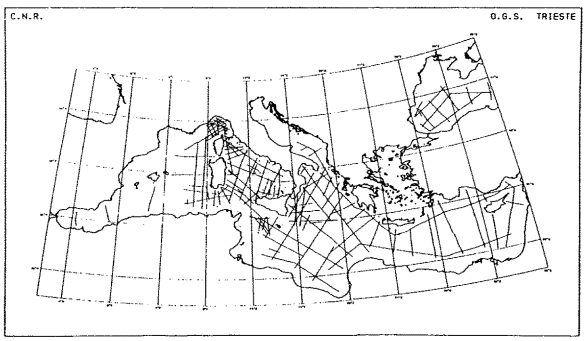

Figure 1. Location of Mediterranean Sea (MS) and Black Sea (BS) MCS lines collecte by OGS from 1969 to 1982.

REFERENCES

FINETTI I., 1982.- Structure, stratigraphy and evolution of Central Mediterranean. *Boll. Geofis. Teor. Appl.*, 24(96):247-312.

FINETTI I., 1976.- Mediterranean Ridge: a young submerged chain associated with the Hellenic Arc. *Boll. Geofis. Teor. Appl.*, 18(69):31-65.

FINETTI I. and MORELLI C., 1973.- Geophysical exploration of the Mediterraneran Sea. *Boll. Geofis. Teor. Appl.*, 15(60):261-241.

FINETTI I. and MORELLI C., 1972.- Wide scale digital seismic exploration of the Mediterranean Sea. *Boll. Geofis. Teor. Appl.*, 14(56):291-342.