Geophysical Research Abstracts, Vol. 9, 05968, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-05968

Quaternary Marine Ecosystem Response to Fertilization (MERF) collaborative research project: overview and progress

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In MERF, a European network of scientists is studying the marine productivity response to natural Quaternary fertilization. We selected the Mediterranean basin that is characterized by sapropel horizons indicating periodic anoxia and natural fertilization. These horizons occur every 23,000 years, suggesting that the forcing mechanism is a precessional modulation of monsoon strength. The mechanisms of ecological change and propagation of nutrients through the surface ocean ecosystem remain poorly constrained. This limits our ability to use anoxic events to predict likely analogue situations as a result of present day climate change and eutrophication. Our studies focus on three time intervals representing interglacial conditions (Early Holocene, MIS.1 and Eemian, MIS5.5) and glacial conditions (Late Saalian, MIS6.5). These time intervals correspond to the deposition of sapropel S1 (Early Holocene, 9-6 Kyr B.P.), sapropel S5 (climate optimum of the last interglacial) and sapropel S6 (high insolation during the early part of the penultimate glaciation) and on the calibration of biogeochemical proxies in culture experiments and the modern Mediterranean. We summarize here the main progress that we have obtained in this collaborative research project. 1) Culture results have shown a carbonate ion effect on coccolith δ^{13}C and δ^{18}O; in addition,

positive correlation of δ^{13}C and δ^{18}O in near-monospecific coccolith fractions suggest this carbonate ion effect and cannot be explained by equilibrium effects. 2) Coccolith Sr/Ca ratios are used as a productivity proxy and are coherent with Ba/Al ratios in identifying productivity during eastern Mediterranean sapropels, and absence of similar features in coeval sediments of western Mediterranean. 3) The general pattern of $\delta\ ^{15}$N in Mediterranean surface sediments is neither a result of decay nor of the production intensity. This suggests that modern Mediterranean Sea surface sediments reflect the source signal of $\delta\ \ ^{15}$N, whereas $\delta\ \ ^{15}$N in older sediments could be affected by diagenesis. 4) Long time series (1993—2006) of coccolithophore fluxes in the Gulf of Lions shows interesting changes in seasonal and interannual production both in species number and carbonate production. 5) A unique very high resolution core spanning S1 in the SE Aegean allows detailed paleoenvironmental conditions and the direct correlation with pollen assemblages showing terrestrial responses to rapid climatic change. Overall, future activities will further integrate results from different groups.