Environmental magnetic expression of the MECO event in different oceanic basins

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Abstract: The Cenozoic Era has witnessed major changes in paleoclimate and paleogeography. Stable isotope records ($\delta^{18}O$ and $\delta^{13}C$) from pelagic foraminifera show a long-term cooling trend starting at ~55 Ma, which ends abruptly at the Oi-1 event (~34 Ma), near the Eocene/Oligocene transition, which correspond to the main episode of glaciation in Antarctica (Zachos et al., 2008). Superimposed on this cooling trend, brief intervals of extreme warm occur globally. These warm events, known as hyperthermals, last for less than 300 kyrs and may correspond to a global temperature increase of 5° to 6°C. In the middle to late Eocene, a strong transient warming event has been recognized in the oceanic record at ~40 Ma, the Middle Eocene Climate Optimum (MECO) (Bohaty et al., 2009). The amplitude of the MECO warming is similar to that of hyperthermals, but its duration is two times longer, and its origin and global nature are still debated. In this work, we present environmental and rock magnetic data from sedimentary successions from the Indian Ocean (ODP Hole 711A) and eastern Neo-Tethys (Monte Cagnero, Contessa, and Bottaccione sections). The high-resolution record obtained for Monte Cagnero (MCA) section shows an interval of very high productivity comprising the MECO peak and its aftermath marked by a higher abundance of fossil magnetotactic bacteria. A relative increase in eutrophic nannofossil taxa spans the culmination of the MECO warming and its aftermath and coincides with a positive carbon isotope excursion, and a peak in magnetite and hematite/goethite concentrations. The magnetite peak reflects the appearance of magnetofossils, while the hematite/goethite apex are attributed to an enhanced detrital mineral contribution, likely related to aeolian dust transported from the

continent adjacent to the Neo-Tethys Ocean during a drier, more seasonal MECO climate. Based on our new geochemical, paleontological and magnetic record, the MECO warming peak and its immediate aftermath are interpreted as a period of high primary productivity. Sea-surface iron fertilization is inferred to have stimulated high phytoplankton productivity, increasing organic carbon export to the seafloor and promoting enhanced biomineralization of magnetotactic bacteria, which are preserved as magnetofossils during the warmest periods of the MECO event in the MCA section. Environmental magnetic parameters show the same behavior for Contessa, Bottaccione and ODP Hole 711A. We speculate that iron fertilization promoted by aeolian hematite during the MECO event has contributed significantly to increase the primary productivity in the oceans. The widespread occurrence of magnetofossils in other warming periods suggests a common mechanism linking climate warming and enhancement of magnetosome production and preservation.

Keywords: paleoproductivity, MECO, magnetofossils, Monte Cagnero, Contessa, Bottaccioni, ODP 711A, Indian Ocean, Italy.

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