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Malformations in Discoaster species related to the PETM and ELMO hyperthermal events

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Several studies, focused on calcareous nannofossil assemblages at the Paleocene/Eocene transition (e.g., Bralower, 2002; Raffi et al., 2005; Gibbs et al., 2006; 2007; Agnini et al, 2007; Mutterlose et al., 2007), have evidenced changes and turnovers, some of them occurring on global scale. These features seem to be related to dramatic changes in environmental conditions during the well-known Paleocene-Eocene Thermal Maximum (PETM). The PETM was a period of extreme, transient global warming interpreted as possible consequence of a massive release of light carbon in the ocean-atmosphere system. This rapid injection of ^{13}C-depleted carbon into the geo-biosphere results in a remarkable increase of CO_2 levels that, in turn, caused significant changes in the chemical and physical proprieties of oceanic waters which profoundly influenced productivity and biogenic sedimentation.

The PETM affected biogeochemical cycles and ecosystems, including significant biotic turnovers observed in terrestrial and marine realms. In particular , calcareous nannofossil assemblages is characterized by the occurrence of transient excursion taxa, which include *Rhomboaster calcitrapa* group and peculiar forms of asymmetrical discoasterids ascribed to species *Discoaster araneus* and *D. anartios*. This unusual assemblage is restricted to the carbon isotope excursion (CIE) of the PETM, as documented in all the known PETM reference sections studied so far. Moreover, a detailed study of ODP Site 1263 (Walvis Ridge) showed that *Discoaster* specimens are consistently affected by malformations both during the PETM and the ELMO hyperthermal events (Raffi and De Bernardi, 2008). These findings have been interpreted as a possible result of the chemical stressed water conditions linked to the anomalous CO_2 levels during the CIE-PETM interval (Agnini et al., 2006). This study documents that malformed *Discoaster* specimens are consistently present in other subtropical Atlantic Ocean sections (ODP Sites 1262 and1265) and in the Tethyan domain (Italy) concomitantly with PETM and ELMO events. These data suggest a wide biogeographic distribution for the deformed short-lived discoasterids, and document similar biotic characteristics between the ELMO horizon and Paleocene-Eocene thermal maximum.