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Assemblage level and intraspecific response of calcareous nannofossils during early Eocene hyperthermal events.

C. Joachim and J. Mutterlose

Institut für Geologie, Mineralogie und Geophysik, Ruhr-Universität, Bochum, Germany (Christian.Joachim@gmx.de)

The composition of calcareous nannofossils across the early Eocene has been investigated at the equatorial Atlantic (Demerara Rise; ODP Site 1260A, 277.17 - 227.04 mbsf & 1260B, 256.16 - 235.10 mbsf), including the Paleocene - Eocene Thermal Maximum (PETM), Eocene thermal maximum 2 (ETM2) = Eocene layer of mysterious origin (Elmo) and ETM3 ("X"-event). These hyperthermal events are marked by a substantial input of isotopically light carbon into the oceans, related to a general warming trend, which led to ocean acidification. Perturbations of the carbon system are thought to have caused significant changes in the composition of marine biota.

The PETM interval of Site 1260, defined by the onset and the termination of a negative carbon isotope anomaly with a value of $\sim$ - 2 ‰ is 1.39 m thick (1260A, 276.87 - 275.48 mbsf). The lowermost 65 cm thick interval (1260A, 276.87 - 276.22 mbsf) with a carbonate content lower than 20 % includes a distinctive basal clay layer of approximately 40 cm thickness. The ETM2 is 78 cm thick (1260B, 238.93 - 238.15 mbsf) and marked by a negative carbon isotope excursion of $\sim$ - 1 ‰The final ETM3 is 17cm thick (1260A, 227.06 - 226.89 mbsf) and shows a negative shift of the carbon isotopes of - 1.2 ‰.

The PETM is preceded by two short eutrophic events, where the nannofossil-based productivity index shows very high values, with concomitant low temperatures, the latter eutrophic event is directly preceding the onset of the carbon isotope excursion. The PETM excursion flora can be divided in three groups: 1) Small taxa – or taxa with a big aperture, like Coccolithus minimus, Coccolithus latus and Coccolithus foraminis, which are regarded as stress forms of Coccolithus pelagicus, reacting to possible surface water acidification during the initial phase of the PETM. 2) The large sized Coccolithus bownii, which appears as an acme during the body and early recovery, may profit from increasing pH and decreasing DIC conditions. 3) Teratoid ("malformed") discoasters are not restricted to the PETM and are therefore rather related to higher temperatures then to changes of the oceans carbonate system.

Size measurements in the common species of C. pelagicus, including several ecophenotypes like C. minimus and C. latus, show marked changes during the events.