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The mid-Paleocene biotic event at the Zumaia section (western Pyrenees): evidence of an abrupt environmental disruption

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The quantitative analyses of calcareous plankton and benthic foraminifera across the MPBE at the Zumaia section have evidenced abrupt environmental disruptions in both the photic zone and the seafloor. Changes in calcareous nannoplankton assemblages mainly consist of a replacement of R-mode specialists such as T. *pertusus* and P. *bisulcus* by warmer, more oligotrophic taxa such as *Ericsonia*, *Sphenolithus*, H. *kleinpellii*, and C. *pelagicus* (which are thought to be K-mode specialists), suggesting a shift from relatively cooler mesotrophic to warmer oligotrophic conditions during the event. Planktic foraminiferal assemblages were more severely affected during the MPBE, as is evidenced by a sharp drop in their total abundance and species richness. In addition, test-size minima would indicate a clear disruption of the photic zone, with most planktic foraminiferal species living outside their ecological optima. Benthic foraminifers were also significantly affected during the MPBE, as recorded by the drop in relative abundance of laevidentalinids and buliminids, and the increase of deep-water (e.g., S. *beccariiformis* and N. *truempyi*) and opportunistic species (*Haplophragmoides*, *Karrerulina*, and *Recurvoides*). These changes suggest oligotrophic and unstable conditions at the seafloor during the MPBE, similar to those reported in early Eocene hyperthermal events from Walvis Ridge. The reorganization of planktic

ecosystems may have affected both surface productivity and the transfer of organic matter from the surface to the seafloor, thus triggering changes in the benthic communities.

The core of the biotic event coincides with a negative excursion of δ^{13}C that, as in the PETM of this section and elsewhere, may be interpreted as an input of a large mass of isotopically depleted carbon into the ocean and atmosphere. The CO_2 input lowered deep-sea pH, triggering a rapid shoaling of the lysocline and contributing to a greenhouse warming.

The MPBE was short lived: according to limestone- marl couplets (the stratigraphic expression of precession cycles throughout the Zumaia section), the event lasted for $\sim$52–53 k.y., with the core of the event, characterized by the negative δ^{13}C excursion, representing $\sim$10–11 k.y. This cyclostratigraphic approach also allows pinpointing the approximate position of the MPBE relative to the NP5-NP6 zone boundary ($\sim$13 precession cycles above) and the base of C26n ($\sim$8 precession cycles below).

The Zumaia section is the first land-based locality with a well-preserved record of the MPBE and thus may prove to be a reference locality for the study of this and other short-lived events during the early Paleogene.

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