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Multiple early Eocene benthic foraminiferal assemblage and $\delta^{13}C$ fluctuations at DSDP Site 401 (Bay of Biscay — NE Atlantic)

Simon D'haenens [a,*], André Bornemann [b], Peter Stassen [a], Robert P. Speijer [a]

[a] Department of Earth and Environmental Sciences, KU Leuven, Celestijnenlaan 200E, B-3001 Leuven, Belgium
[b] Institut für Geophysik und Geologie, Universität Leipzig, Talstrasse 35, D-04103 Leipzig, Germany

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ABSTRACT

Within the last decade, several early Eocene hyperthermals have been detected globally. These transient warming events have mainly been characterized geochemically – using stable isotopes, carbonate content measurements or XRF core scanning – yet detailed micropaleontological records are sparse, limiting our understanding of the driving forces behind hyperthermals and of the contemporaneous paleoceanography. Here, detailed geochemical and quantitative benthic foraminiferal records are presented from lower Eocene pelagic sediments of Deep Sea Drilling Project Site 401 (Bay of Biscay, northeast Atlantic). In calcareous nannofossil zone NP11, several clay-enriched levels correspond to negative $\delta^{13}C$ and $\delta^{18}O$ bulk-rock excursions with amplitudes of up to ~0.75‰, suggesting that significant injections of ^{12}C-enriched greenhouse gasses and small temperature rises took place. Coeval with several of these hyperthermal events, the benthic foraminiferal record reveals increased relative abundances of oligotrophic taxa (e.g. *Nuttallides umbonifera*) and a reduction in the abundance of buliminid species followed by an increase of opportunistic taxa (e.g. *Globocassidulina subglobosa* and *Gyroidinoides* spp.). These short-lived faunal perturbations are thought to be caused by reduced seasonality of productivity resulting in a decreased C_{org} flux to the seafloor. Moreover, the sedimentological record suggests that an enhanced influx of terrigenous material occurred during these events. Additionally, the most intense $\delta^{13}C$ decline (here called level δ) gives rise to a small, yet pronounced long-term shift in the benthic foraminiferal composition at this site, possibly due to the reappraisal of upwelling and the intensification of bottom water currents. These observations imply that environmental changes during (smaller) hyperthermal events are also reflected in the composition of deep-sea benthic communities on both short (<100 kyr) and longer time scales. We conclude that the faunal patterns of the hyperthermals observed at Site 401 strongly resemble those observed in other deep-sea early Paleogene hyperthermal deposits, suggesting that similar processes have driven them.

1. Introduction

The Paleocene–Eocene Thermal Maximum (PETM; ~55.8 Ma) is a geologically brief (~170 kyr; Röhl et al., 2007) climate perturbation that is characterized by an increase of global temperatures by ~5–10 °C (Kennett and Stott, 1991; Zachos et al., 2003; Tripati and Elderfield, 2005; Sluijs et al., 2008). The onset of the PETM is also marked by a prominent negative carbon isotope excursion (CIE) of more than 2‰ in both marine and terrestrial sedimentary sequences (McInerney and Wing, 2011) and by $CaCO_3$ dissolution in deep-sea sediments (Zachos et al., 2005; Zeebe and Zachos, 2007). The CIE and dissolution phenomena associated with this hyperthermal event are generally considered to be caused by a massive injection of ^{12}C-rich carbon released by methane hydrates into the ocean–atmosphere system, yet the sources and mass of the input remains uncertain and controversial (Dickens, 2011). The repercussions on faunal and floral communities were significant, with numerous biotic turnovers both on land and in the oceans (Crouch et al., 2001; Bralower, 2002; Raffi et al., 2005, 2009; Wing et al., 2005; Gibbs et al., 2006; Gingerich, 2006; Scheibner and Speijer, 2008), but the most notable biotic event is the large extinction (30%–50% of species) of deep-sea benthic foraminifera (Thomas, 1990, 1998, 2003, 2007; Kennett and Stott, 1991; Thomas and Shackleton, 1996). This extinction sharply contrasts to the K–Pg boundary, when deep-sea benthic foraminiferal assemblages displayed no significant changes (Culver, 2003; Alegret and Thomas, 2007, 2009).

Thomas and Zachos (2000) suggested that the PETM might not be a singular event, but only the most extreme example of a series of similar events. The first evidence for this hypothesis was a stacked high-resolution global carbon isotope record based on early Paleogene deep-sea sites (DSDP Sites 550 and 577; ODP Sites 690 and 1051), which revealed several late Paleocene and early Eocene CIEs, and which were labeled with an alphanumeric scheme (A–K) (Cramer et al., 2003). Several studies have confirmed the

* Corresponding author. Tel.: +32 16 32 64 29; fax: +32 16 32 29 80.
E-mail address: simon.dhaenens@ees.kuleuven.be (S. D'haenens).

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