Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.18302

Reconstruction of sedimentation rates and nannofossil fluxes using extraterrestrial ^{3}He across the Paleocene-Eocene transition in the North Pacific

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The Paleocene-Eocene transition was punctuated by several hyperthermals, events of massive carbon input to the atmosphere from controversial sources and abrupt increases in global temperature. The most prominent of these events, the Paleocene-Eocene Thermal Maximum (PETM; 55.9 Ma), led to a warming of surface and bottom waters by 4-5°C in a few millennia at tropical latitudes. The PETM onset is characterized by a sudden 3-4 per mil negative excursion in $\delta^{13}C$ recorded in deep marine sediments associated with a major lithologic change from carbonate to thin clay-rich layer. This change is thought to have been triggered by a shoaling of the CCD due to lower pH and higher CO_2 level. Early Paleogene hyperthermals are assumed to follow the same pattern over a shorter time span. Carbonates are of particular interest as they are produced in open-ocean primarily by accumulation of calcareous nannofossil that are deeply affected by abrupt environmental changes. Although calcareous nannofossils represent the bulk of the sediment at ODP Site 1209 (North Pacific), an accurate reconstruction of their fluxes has never been estimated so far.

By measuring extraterrestrial ^{3}He concentrations at high-resolution (1 sample per 30 ka), we reconstructed sedimentation rates and calcareous nannofossil fluxes over 4 Ma and ~10 hyperthermals, including the PETM and the ETM2 (57.5-53.5). Our new dataset evidences a drastic drop in nannofossil fluxes during the PETM onset, from 0.70 to a minimum of 0.02 g/cm^2/ka, followed by a second decrease in the lowermost Eocene (~0.30 g/cm^2/ka). Surprisingly, mass accumulation rate of nannofossils abruptly increased to ~0.80 g/cm^2/ka for at least 500 ka after the ETM2, notably related to increased flux of *Zygrhablithus bijugatus*, a nannofossil with a poorly constrained ecology.

The comparison of these calculated fluxes with bottom-water dissolution proxies shows that these two parameters are only coupled at the onset of some hyperthermals, challenging the widely accepted hyperthermal models in which calcium carbonate accumulation is a function of bottom-water saturation. Our data thus suggest that the accumulation of nannofossil fluxes across hyperthermals was strongly modulated by additional factors such as changes in productivity or supralysoclinal (metabolic) dissolution, with important carbon cycle implications.