Geophysical Research Abstracts
Vol. 19, EGU2017-4032, 2017
EGU General Assembly 2017

Carbon sources during the Paleocene-Eocene Thermal Maximum

Joost Frieling (1), Francien Peterse (1), Daniel Lunt (2), Steven Bohaty (3), Jaap Sinninghe Damste (1,4), Gert-Jan Reichart (1,4), and Appy Sluijs (1)

(1) Department of Earth Sciences, Utrecht University, Utrecht, Netherlands, (2) School of Geographical Sciences, University of Bristol, Bristol, United Kingdom, (3) National Oceanography Centre Southampton, University of Southampton, Southampton, United Kingdom, (4) Netherlands Institute for Sea Research, Den Burg, Netherlands

The Paleocene–Eocene Thermal Maximum (PETM; ~56 Ma) was a period of rapid 4-5ºC global warming and a global negative carbon isotope excursion (CIE) of 3-4.5‰ signaling the input of at least 1500 Gt of δ13C-depleted carbon into the ocean-atmosphere system. Carbon cycle modeling has indicated that the shape and magnitude of this CIE are generally explained by a large and rapid initial pulse, followed by ~50 kyr of 13C-depleted carbon injection. Crucially, some of suggested carbon sources, e.g. submarine methane hydrates and permafrost thawing, may respond to warming and act as positive carbon cycle feedbacks on millennial timescales. Previous analyses showed that warming started prior to the CIE at some high and mid-latitude sites, but is still unknown whether this is a global signal and timing and magnitude of such a warming remain poorly constrained.
We generated a new high-resolution TEX86 and δ13C record from Ocean Drilling Program Site 959 in the eastern tropical Atlantic and find that initial warming preceded the PETM CIE by ~10 kyr. Moreover, cross-correlation functions on these new and published temperature-δ13C data imply that substantial (2-3 °C) warming lead 13C-depleted carbon injection by an average of 2-3 kyr globally. Finally, a data compilation shows that global burial fluxes of non-detrital Ba approximately tripled across all depths of the ocean studied, which on PETM time scales can only be explained by significant Ba addition to the oceans. Submarine hydrates are Ba-rich and require warming to dissociate. The simplest explanation for the temperature lead and Ba addition to the ocean is that methane hydrates dissociated as a response to initial warming and acted as a positive carbon cycle feedback during the PETM.
The attribution of the CIE to a carbon cycle feedback naturally leads to the question what caused the early warming. The absence of a 13C change during the early warming implies a 13C-neutral CO_2 source, such as volcanism, is the most likely explanation. Recent findings directly connected hydrothermal vent activity in the Voring and More Basins to the PETM CIE, explaining its' exceptionally long duration (Frieling et al., 2016 PNAS) and Storey et al. (2007 Science) already showed based on absolute dating that the most active phase of North Atlantic Igneous Province (NAIP) roughly coincides with the PETM. We speculate the NAIP played a central role in Paleocene-Eocene climate change and, in addition to the thermogenic methane, also supplied the CO_2 that drove the initial warming, which lead to massive methane hydrate dissociation during the PETM.