Elevated terrestrial temperatures during the Paleocene-Eocene Thermal Maximum: a multi-proxy perspective

GORDON N. INGLIS[1*], B. DAVID A. NAAFS[1], MEGAN ROHRSSEN[2], LIZ KENNEDY[3], RICHARD D. PANCOST[1]

[1] Organic Geochemistry Unit, University of Bristol, Bristol, UK (*correspondance: gordon.inglis@bristol.ac.uk)
[2] Geology and Environmental Sciences, Central Michigan University, Michigan, USA
[3]Deparment of Palaeontology, GNS Science, Lower Hutt, New Zealand

The Paleocene-Eocene Thermal Maximum (PETM; ca. 55.8 Ma) is associated with a transient increase in global temperatures (ca. 5 to 9°C). This appears to have been responsible for enhanced high-latitude precipitation, heightened mid-latitude seasonality and changes in both floral and faunal assemblages. However, our understanding of terrestrial temperature change during the PETM is restricted to a few, well-sampled regions which provide only a 'snapshot' of climate. As such, there is a need to obtain new records of terrestrial temperature during the PETM.

Here, we have generated a multi-proxy record of terrestrial temperature change during the PETM using lignite and marginal marine sediments from Otaio Gorge (New Zealand). Using branched glycerol dialkyl glycerol tetraethers (GDGTs), we reconstruct ~4 to 7°C of warming during the PETM. The magnitude of warming is comparable to estimates obtained from other sites (e.g. North America). However, there is a systematic offset in absolute temperature estimates obtained from lignite and marginal marine sediments, indicating the need to decouple facies variation when reconstructing past temperatures.

Warming is also associated with an increase in the relative abundance of branched and isoprenoidal H-GDGTs (i.e. across two domains of life). Crucially, the relative abundance of H-GDGTs in modern settings is positively correlated to temperature and the relative abundance of H-GDGTs during the PETM is comparable to modern-day tropical settings. We also identify isoGDGTs with more than 4 cyclopentane rings. These compounds have heretofore only been observed in thermophiles and hyperthermophilic settings and provide further support for high temperatures.

Elevated terrestrial temperatures have major implications for the hydrological and biogeochemical cycle during the PETM. Indeed, they are consistent with nearby evidence for enhanced runoff, increased physical erosion and enhanced terrigenous sediment flux during the PETM.