Lithium isotope evidence for more efficient CO_2 drawdown across the PETM

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Chemical weathering of silicate rocks is considered to be the primary mechanism for mitigating atmospheric CO_2 levels over geologic time, likely via a temperature-driven “thermostat” feedback. However, the rates by which this thermostat affects or responds to climate are poorly known. The Palaeocene-Eocene Thermal Maximum (PETM) is a hyperthermal event that allows us to test how weathering responds to, and controls, climate change. This period is characterised by rapid warming, ocean acidification, a major biotic turnover and significant changes to the hydrological cycle, likely triggered by a carbon release event. It is of relatively short duration (~100 kyr, plus another ~100 kyr recovery phase).

We investigate weathering across the PETM using lithium isotopes, a tracer of silicate weathering processes. Negative isotopic excursions are observed in marine carbonates in three different IODP cores, as well as two detrital silicate sections from Denmark and Spitsbergen. In all cases we observe a negative excursion of around 3–4‰, which is broadly synchronous with the onset of the carbon isotope excursion.

The data imply that silicate weathering rates increased fairly dramatically across the PETM. In addition, a shift in the weathering regime to lower intensity (more congruent) weathering promoted more efficient CO_2 drawdown, in turn stabilising/lowering global temperatures. Furthermore, the data suggest that the assumption that silicate weathering responses and CO_2 removal are too slow to affect carbon on PETM-length scales are likely incorrect.