Silicon cycling across the paleocene-eocene thermal maximum

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A wealth of terrestrial and marine archives document the effects of a large and geologically rapid input of ^{13}C depleted carbon into the ocean-atmosphere-biosphere system at about 55 Ma, often referred to as the Paleocene-Eocene Thermal Maximum (PETM). Although the precise mechanisms and timings of the carbon input are debated, the consequences - increased temperature, ocean acidification and large-scale biotic changes - are well established. It is generally considered that recovery from the PETM was driven by a combination of enhanced silicate weathering and increased organic carbon burial.

Silicate weathering is a key step in the sequestration of atmospheric CO_2 as marine carbonates, while also releasing dissolved silica (H_4SiO_4) and forming clays. The silicon isotopic composition ($\delta^{30}Si$) of both the dissolved silica and the secondary clays can provide information about weathering rate and efficiency. However, despite being a key component of the PETM recovery, potential modifications of the global Si cycle have not been investigated. With the use of a simple box model, we demonstrate that reasonable scenarios of changes in terrestrial silicate weathering rates and styles compatible with the PETM should be visible as excursions in the silicon isotope record of terrigenous clays and marine siliceous organisms.

To test these model predictions, we present new SIMS and MC-ICP-MS $\delta^{30}Si$ data from sponge spicules, radiolarian tests and detrital clay separates from Ocean Drilling Program (ODP) site 1051B, where the PETM is well characterised. This is supplemented with bulk sediment elemental composition and biogenic silica (BSi) concentrations. Together with our box model, these data can be used to begin to constrain aspects of the global Si cycle and the silicate-weathering/CO_2 feedback before, during, and in the recovery from the PETM.