

Boron proxy evidence for surface ocean acidification & elevated pCO₂ during the PETM

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The Paleocene-Eocene Thermal Maximum (~55Ma) is recognized as a rapid (<10ka) input of a large mass (~4500-6000 GtC) of ¹²C-enriched carbon into the ocean-atmosphere system. Patterns of CaCO₃ dissolution at the suggest that this was accompanied by a rapid decrease in ocean pH, followed by a gradual recovery phase. A further result of such modeling studies is the suggestion of an 'overshoot' or supersaturated ocean phase after the recovery, when the carbonate lysocline deepened to below its Paleocene depth and surface water carbonate saturation states rose to above pre-excursion levels. In an effort to quantify changes in the carbonate chemistry of surface waters and infer potential effects on calcifying organisms and Mg/Ca and δ¹⁸O-based temperature estimates, we have measured B/Ca and Mg/Ca in mixed-layer planktic foraminifers from IODP site 1209 in the Pacific and sites 1262 and 1263 in the Atlantic. Previous work at these sites has documented large increases (~50%) in Mg/Ca ratios in the mixed-layer planktic foraminifer species *M. velascoensis* and *A. soldadoensis* consistent with 5 to 6°C of sea surface warming. Our B/Ca measurements in both species suggest a large drop in surface water pH and [CO₃⁼] coincident with the rise in temperature at the onset of the carbon isotope excursion, followed by a gradual recovery to pre-excursion levels. The latter feature, coupled with the rise in total alkalinity caused by the dissolution of CaCO₃ is taken as evidence of an overshoot phase starting ~100ka after the onset of the event. We are currently measuring boron isotopes in the same taxa in order to quantify the pH changes suggested by the B/Ca data. Additionally, we plan to measure B/Ca and δ¹¹B in thermocline-dwelling planktic species in order to examine the depth-dependence of the pH changes. Estimating the magnitude of the pH drop at the onset of the event will facilitate calculations of the mass and rate of carbon input that triggered the PETM, as well as the magnitude of change in atmospheric pCO₂ levels and Paleogene climate sensitivity.

Can multiple sulfur isotopes be used as a tracer of sub-continental lithospheric mantle in the Bushveld?

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The Bushveld Complex (BC) is the world's largest layered intrusion and contains most of its reserves of platinum group elements. The ultimate source of BC magma is thought to have been the mantle. Strontium, Nd and Os isotopic compositions of BC rocks are heterogeneous, however, and along with O isotopes indicate a source contaminated by sedimentary-derived material. Sub-continental lithospheric mantle (SCLM) has been proposed as a source of some of these anomalies. The multiple S isotopic composition of primitive mantle is thought to be Δ³³S = 0 ± 0.01‰ (1σ). Thirty whole-rock and sulfide separate analyses from a variety of locations within the BC have positive Δ³³S values, with an average Δ³³S = 0.13 ± 0.05‰ (1σ). Since high-temperature processes are not thought to produce significant change in Δ³³S, this high Δ³³S indicates that the BC sulfur contains a sedimentary or surface-derived component. There are geographic and stratigraphic variations in δ³⁴S and Δ³³S possibly reflecting hydrothermal alteration and/or localized wall rock interaction. Platreef δ³⁴S=+2.7 to +9.2‰, Δ³³S=0.03 to 0.26‰; Main Zone δ³⁴S=-3.5 to -1.6‰, Δ³³S=0.1 to 0.2‰; UG2 and Merensky Reef δ³⁴S=-6.2 to +3.2‰, Δ³³S=0.05 to 0.15‰. We are measuring the Δ³³S of Premier kimberlite mantle xenoliths to evaluate the hypothesis that SCLM has a non-zero Δ³³S.