Ocean acidification and the permo-Triassic mass extinction: Process and manifestation

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Ocean acidification triggered by Siberian Trap volcanism was a possible kill mechanism for the Permian-Triassic Boundary (PTB) mass extinction, but direct evidence for an acidification event is lacking. We present a high resolution seawater pH record across this interval, utilizing boron isotope data ($\delta^{11}B$) combined with petrographic analysis and a quantitative modeling approach. Through this integration we are able to produce an envelope that encompasses the most realistic range in pH, which then allows us to resolve three distinct chronological phases of carbon cycle perturbation, each with very different environmental consequences for the Late Permian-Early Triassic Earth system. In the latest Permian, increased ocean alkalinity, primed the Earth system with a low level of atmospheric CO_2 and a high ocean buffering capacity. The first phase of extinction was coincident with a slow injection of carbon into the atmosphere and ocean pH remained stable. During the second extinction pulse, however, a rapid and large injection of carbon caused an abrupt acidification event that drove the preferential loss of heavily calcified marine biota.

The boron signal cuts across primary lithological boundaries, including micritic carbonates, grainstones, and intervals with calcispheres. $\delta^{11}B$ trends are therefore both facies and fabric independent but the short-lived acidification event is manifest in a preferential loss of biotic calcifiers, and unusual and anomalous carbonate precipitates, that indicates profound carbon cycle disruption.