Tracking marine deoxygenation during the Cambrian SPICE event using thallium isotopes

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The stable isotopic composition of thallium (ε^{205}Tl) in organic-rich, sulfidic sediments has recently emerged as a new proxy for tracking changes in global marine redox conditions in the geologic record [1, 2]. Here we employ this proxy to interrogate the record of the Cambrian SPICE (Steptoean Positive Carbon Isotope Excursion) — a putative Paleozoic oceanic anoxic episode that coincides with a marine extinction event.

We examined two stratigraphic successions which span the SPICE: the Alum and Outwoods Shales (from Sweden and the U.K, respectively). Both records reveal a shift to less negative ε^{205}Tl values that correspond with the onset of the SPICE and extinction event. This suggests a reduction of Mn-oxide burial and the expansion of anoxic bottom waters as previously hypothesized from other global geochemical records. Interestingly, the shift to less negative ε^{205}Tl values during the SPICE continues after the carbon isotope peak, suggesting expanded anoxia may have continued after the organic carbon burial event — a pattern also observed during OAE 2 of the Cretaceous [1]. This suggests a comparable timeline for organic carbon burial relative to marine deoxygenation during each event. Our results demonstrate that the Tl isotope proxy captures a detailed view of marine redox changes not recognized using previously employed proxies and improves our understanding of the biological response to marine deoxygenation during the SPICE and other similar events.

1] Ostrander et al. (2017) Science Advances 3(8). [2] Nielsen et al. (2011) Geochimica et Cosmochimica Acta 75(21): 6690-6704