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Revisiting Smithian–Spathian Cooling: Insights from Triple Oxygen Isotopes of Conodont Bioapatite

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The Early Triassic represents a climatically dynamic interval in the aftermath of the end-Permian mass extinction. In particular, the Smithian–Spathian boundary (SSB; ~249.2 Ma) is marked by pronounced variations in $\delta^{18}O$ recorded in both marine carbonates and bioapatite across diverse sedimentary settings. Several studies of oxygen isotopic composition of conodont bioapatite ($\delta^{18}O_{apatite}$) have documented a significant cooling event at this interval. The observed ~+2‰ shift in $\delta^{18}O_{apatite}$ across the SSB is indicating a ~8 °C temperature drop, with the implicit assumption, that the isotopic composition of conodont body water is identical to seawater. However, it has been shown that metabolic water produced from food and air O_2 may significantly affect the oxygen isotope composition of body water and thus of bioapatite (Feng et al. 2022).We have analyzed the triple oxygen isotope compositions ($\Delta'^{17}O$) of conodont elements from seven beds spanning the SSB cooling interval in Oman (subtropical palaeolatitudes) to test if bioapatite values plot on the theoretical phosphate equilibrium curve with seawater. Additionally, we analyzed the extracted body water of a lamprey, considered the best extant analogues of conodonts, to constrain the isotopic composition of its body water relative to ambient water. Consistent with previous $\delta^{18}O_{apatite}$ studies, our data confirm a +1.8‰ shift across the SSB. However, $\Delta'^{17}O_{apatite}$ values are elevated relative to those predicted for equilibrium with seawater. Similarly, elevated $\Delta'^{17}O$ values observed for lamprey body water relative to ambient water confirm that body water compositions are affected by animal physiology. Our results demonstrate that quantitative temperature reconstructions based on bioapatite require robust quantitative modeling of body water isotopic composition, incorporating oxygen fluxes into and out of the organism. Feng et al. [1] demonstrated significant differences in $\Delta'^{17}O$ between sharks and sea-mammals, reflecting the contrasting physiologies. The exceptionally high $\Delta'^{17}O$ observed for conodonts likely reflects another characteristic physiology.

[1] Feng, Tütken, Löffler, Tröster, & Pack (2022), *Geochimica et Cosmochimica Acta 328*, 85-102.