Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.34130

Beyond seawater chemistry: Multi-variable controls on Sr/Ca ratios in deep-time biogenic apatite

BOYAN LIU AND YADONG SUN

China University of Geosciences

The chemical composition of biogenic apatite archives is routinely used to inform about the evolution of Earth's climatic and oceanic conditions in deep-time. While these archives provide a nearly continuous geochemical record, the full interpretative potential of trace element proxies, particularly the Sr-Ca system, remains hindered by a long-standing inability to disentangle overlapping biological vital effects from primary environment signals. This study evaluates the Sr–Ca system in conodont and ichthyolith apatite across a broad stratigraphic range to resolve these mechanistic constraints and disentangle biological vital effects from thermodynamic and palaeoceanographic signatures. Experimental results demonstrate that $(Sr/Ca)_{PO_4}$ ratios in biogenic apatite are largely resistant to diagenetic overprinting, ensuring the preservation of primary geochemical information. The analysis reveals that Sr incorporation is governed by a suite of parameters including biological, crystallographic and kinetic factors rather than dietary variations. Specifically, a reproducible quadratic relationship between $(Sr/Ca)_{PO_4}$ and specimen weight in conodonts reflects kinetic Sr^{2+} partitioning tied to mineral precipitation rates during ontogeny. This weight-dependent signature is remarkably conserved across taxa separated over ~300 Myr, indicating a profound conservatism in biomineralization strategies. Complementary to these mechanistic findings, a consistent negative correlation between $(Sr/Ca)_{PO_4}$ and $\delta^{18}O_{PO_4}$ in conodonts underscores the high potential for $(Sr/Ca)_{PO_4}$ to be used as a paleothermometer, provided that taxon-specific mass standardisation is applied. Systematic offsets between shallow- and deep-dwelling taxa further confirm the thermal sensitivity of this proxy. The mathematical bridging of $(Sr/Ca)_{PO_4}$ with co-measured $\delta^{18}O_{PO_4}$ establishes a new quantitative framework for reconstructing ancient seawater Sr/Ca ratios, providing a multi-purpose proxy for high-resolution deep-time oceanography.