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Neoproterozoic glaciations and their tally on seawater evolution: Stable C, O and Cr paired with radiogenic Nd, Sr isotope-stratigraphy of the Witvlei Group (Namibia)

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The Neoproterozoic witnessed several global low latitudes glaciations (e.g., the Sturtian and Marinoan) and the geodynamic reorganization of cratonic blocks after the breakup of Rodinia, followed by fluctuating oxygen increase in Ediacaran to Cambrian seawater and the rise of metazoans. To gain an increasingly global picture of the bio-geochemical conditions in late Neoproterozoic seawater, we present new results for redox-sensitive trace elements, radiogenic (Nd, Sr), and stable (C, O, Cr) isotope records of carbonates from the Cryogenian to Ediacaran Witvlei Group, Namibia.

Shale normalized REE + Y patterns of post-Sturtian and post-Marinoan carbonates parallel modern seawater; negative Ce anomalies argue for their preservation in increasingly more oxidizing Witvlei Basin sea/porewater conditions from the Ediacaran onwards.

While Cryogenian carbonates underwent radiogenic basin-fluid type overprinting, Ediacaran carbonates record pristine Sr isotopic compositions that match the global Neoproterozoic seawater curve. Coupled negative correlations between Sr and Nd suggest long-term shifts in continental weathering and short-term changes in ocean circulation patterns.

The $\delta^{13}C$ values range from -7.2 to +3.5 ‰ and record a negative isotope excursion in the upper part of the Witvlei stratigraphy equivalent to the 'Shuram' carbon isotope excursion. Less pronounced Ce anomalies, lower Y/Ho ratios, and lower bio-essential and redox-sensitive trace metal concentrations are associated with the putative Shuram excursion, arguing for periodic redoxcline oscillations in a late Neoproterozoic shelf environment. Cr isotope compositions of carbonates overlying the Sturtian glaciation match bulk silicate Earth compositions, while post-Marinoan samples are positively fractionated ($\delta^{53}Cr$ values up to +0.7 ‰).

The combination of changes in local weathering flux and ambient redox conditions in the late Neoproterozoic Ocean may have caused dynamic (bio)geochemical metal cycling, predating (and possibly promoting) the metazoan radiation documented in the overlying Nama Group, Namibia.