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Trace metals and Nd isotopes in 3.35 Ga old stromatolites of the Strelley Pool Formation (Australia) unravel the genesis of carbonates and chert

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Stromatolites are laminated, presumably microbial, structures, consisting largely of an authigenic precipitate, thus providing potential geochemical archives of early Earth aqueous environments and their habitability. In this study, we report trace element and Sm/Nd isotope data from Palaeoarchean stromatolites and adjacent cherts of the Strelley Pool Formation (NW Australia), obtained by ICP-MS and TIMS, to test their reliability as archives for palaeo-environmental reconstruction and to understand authigenic mineral formation. Stromatolitic carbonates plot together with the stratigraphically underlying Marble Bar cherts on a linear Sm-Nd regression line yielding an age of 3253 ± 320 Ma. In contrast, associated crystal-fan carbonates yield 2718 ± 220 Ma, suggesting that their Sm-Nd isotope system was altered after deposition. Geochronological information via Sm-Nd dating of black and white cherts is limited, probably due to a reset of the isotope system during an unknown Paleoproterozoic or younger alteration event. Carbonates, as well as white cherts, show shale-normalized rare earth element and yttrium patterns (REY_{SN} ; except for redox-sensitive Ce and Eu) parallel to those of modern seawater, indicating a seawater-derived origin. Positive Eu_{SN} anomalies (2.1 - 2.4), combined with heterogeneous $\epsilon Nd_{3.35Ga}$ values (-3.2 to +5.8) within alternating stromatolite laminae, support that seawater chemistry was affected by both continental weathering and high-temperature hydrothermal fluids that episodically delivered chemical elements from young mafic and older felsic rock sources into the stromatolite environment. In contrast, black cherts show REY_{SN} patterns characteristic of a non-seawater source and significant amounts of elements leached from the surrounding rocks, overprinting the pristine geochemical composition of ancient seawater. In conclusion, Archaean stromatolites indeed preserve pristine authigenic phases at the mm-scale that contain signatures representative of the water chemistry prevailing in the depositional environment of the time.