Use of Ba and Cd isotope systematics to reconstruct microbialite paleo-habitats and bio-productivity

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Microbialites i.e. lithified microbial mats that formed under shallow marine or lacustrine conditions can record the chemical composition of the ambient water in which microbial life thrived. Further enrichments in bio-available trace metals (e.g. Mo, Ba, Cd, U, Zn, Cu, Ni and potentially Cr, see poster by Bruggmann et al.) can be used to infer on paleo-environmental conditions in the microbial habitats. Here we try to asses changes in paleo bio-productivity based on biological induced fractionation of isotopes from nutrient-like trace metals in bio-carbonates. We present two studies of Cd and Ba isotope analyses obtained in stromatolites from the Mesoproterozoic Paranoá Fm. (Brazil) and thrombolites from the Cambrian Orolgo Gorge Fm. (W-Altai, Mongolia). Microbialites from both locations show seawater-derived and lagoonal shale-normalized REY patterns, respectively, and show no evidence of syn- or post-depositional alteration. The recorded total Cd and Ba isotope fractionations exceed the reported variations in crustal rocks and correlate with abundances of bio-available and redox-sensitive trace metals arguing for combined mechanisms of bio-geochemical metal uptake and recycling within a complex redox and light controlled microbial mat architecture of aerobic and anerobic phototrophs. In the Mesoproterozoic, "light" εCd values found in carbonates with high Cd concentrations may be best explained by oxidation of organic matter followed by subsequent biomass recycling, while reducing conditions in the Cambrian thrombolites and some layers of the Paranoá stromatolites caused opposite fractionations, where "heavy" isotopic compositions in carbonates may account for isotopic fractionation Ba into organic matter (OM) and Cd into OM and cadmium sulfides (CdS) under euxinic conditions respectively. Overall, our approach of combined trace metal concentrations and their stable isotopes in microbialites may provide new and powerful bio-geochemical proxies for future research to gather unique insights into ancient microbial habitats on the early Earth and beyond.