The utility of modern microbialites for recording environmental conditions

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Microbially-mediated sedimentary carbonates pervasively precipitated in coastal environments during the Precambrian and are generally considered among the oldest evidence for life on Earth. They form due to an interplay of microbial growth, decomposition, mineral precipitation and sediment deposition. However, their chemical composition may preserve key information reflecting their depositional environments and thus the evolution of the early Earth.

Recent studies using trace elements and Cd isotopes as well as preliminary work with the Cr isotope system ($\delta^{53}Cr$) suggest these as promising tracers for constraining paleo-environmental conditions recorded in ancient microbialites. However, a variety of redox-independent processes affecting $\delta^{53}Cr$ values of (carbonate) sediments were recently identified. Moreover, incorporation mechnaisms of Cr and other metals/metaloids in microbialites and accompanying isotope fractionation are yet poorly understood.

We analysed Cr concentrations and isotopic compositions of various growth laminae of modern microbialites and ambient water samples to evaluate the potential and limitations of microbialtes to record the $\delta^{53}Cr$ value of their depositional environment. The modern microbialite samples show a tight range of $\delta^{53}Cr$ values of between 0.71 ‰ and 1.07 ‰ and a generally positive $\delta^{53}Cr$ offset from ambient seawater (+0.63 to +1.01 ‰; SE ±0.05 ‰). These offsets are in contrast to bulk samples of other biogenic carbonates that showed a tendency for isotopically light Cr isotope values compared to seawater.

We propose that thorough screening of pristine phases, mineralogical as well as additional chemical analyses (e.g., trace elements, non-/traditional isotope systems) of modern microbialites and ancient counterparts will deepen our understanding of past environments that prevailed at the time of microbialite formation.