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Developing an arsenic-based biosignature to unravel metabolisms involved in the formation of stromatolites microfabrics: Hamelin Pool (Australia)

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The substantial levels of arsenic that characterized the Archean Earth certainly favored the early emergence of primitive arsenic-based life. Those metabolisms have been implicated in the precipitation of carbonates, evidence of which was discovered in the 2.7 Ga old Tumbiana stromatolites[1]. Studies of As biogeochemical cycling in modern analogue environments are required to better understand the mechanisms by which As is incorporated into microbial carbonates. Recent work in Laguna La Brava (Argentina) showed that arsenate reduction increases alkalinity and carbonate saturation state, facilitating the precipitation of carbonate to a higher degree than sulfate reduction[2]. However, the initial concentrations, distribution, and preservation potential of As in the carbonates produced by actively accreting stromatolites with confirmed biogenic origin are unknown.

Motivated by these knowledge gaps, our goal is to evaluate arsenic concentrations as a chemical biosignature in the well-constrained modern stromatolites of Hamelin Pool where four distinct microbial mats produce recognizable internal microfabrics. Some fabrics are mainly the result of photosynthetic influences, others are dominated by anoxygenic metabolisms which include As-based microbial activity[3]. We evaluated the spatio-temporal partitioning of this metalloid in the lagoon by (1) quantifying the incorporation of As into multiple stromatolite microfabrics, (2) assessing changes of [As] through two styles of diagenetic alteration, and (3) calculating As distribution coefficients between the different stromatolite components and the surrounding water. To accomplish this, we conducted a sequential leach experiment aimed at chemically isolating the organic matter and carbonate for measurement of [As] on an ICP-QQQ-MS. Preliminary data indicate that each microfabric contains distinct arsenic concentrations. This abundance pattern may be related to the dominant metabolism inducing carbonate precipitation, stromatolite accretion mechanisms (*i.e.,* trapping and binding vs. direct precipitation), and successive diagenetic evolution of the structure. Our results serve as a first step towards assessing the utility of [As] as an indicator of biogenicity in the fossil record of early Earth and, possibly, other planets such as Mars.

[1] Sforna, M. C. et al. (2014), Nature Geoscience 7, 811–815.
[2] Visscher, P. et al. (2020), Communications Earth & Environment, 1(1), 1-10.
[3] Ruvindy, R. et al. (2016), The ISME journal 10, 183–196.