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The plot thickens: an updated view on stromatolite biogenicity in the 3.48 billion-year-old Dresser Formation, Australia

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Sulfidized stromatolites from the 3.48 Ga Dresser Formation are widely considered as a benchmark for the oldest preserved evidence of life on Earth. However, since their 1980 discovery, a biogenic interpretation has relied on morphological and microtextural characteristics[1]. Recent microanalytical characterization of unweathered stromatolites from drillcore provided additional evidence for biogenicity, as: i) putative microbial remains, ii) micromineralogy typical for sulfidization of stromatolites, iii) enrichments of Zn, Ni within crinkly laminae consistent with adsorption onto a microbial substrate[2-4].

Elemental mapping of newly acquired drillcore samples of Dresser sulfidized stromatolites aid in documenting diagnostic biological morphologies and internal microtextures that interfere with, or contrast sharply to, immediately adjacent – and demonstrably abiotic - rock microfabrics arising from geological processes [5-6]. Integration of these data with micromineralogical analyses and mapping via Raman Spectroscopy for organic matter indicate the paragenesis of stromatolite formation as: i) primary accretion of abundant organic matter, occasionally preserved as coherent filaments and strands that resemble degraded biofilm remains; ii) (near-) coeval, early diagenetic precipitation of micro-spherulitic barite, the morphology of which is indicative of low-temperature precipitation onto organic matter; iii) early precipitation of nano-porous pyrite that is enriched in various transition metals and metalloids, together with iron-rich dolomite and chert; iv) termination of stromatolite growth by evaporative exposure and subsequent sediment infill; and v) widespread later diagenetic growth of coarse, compositionally-zoned, barite crystals in the immediate subsurface, which cut up into, or plastically deform, the sulfidized stromatolites. This depositional-diagenetic cycle is repeated numerous times in the stratigraphy. An important new finding is the high abundance of micro-spherulitic barite in the stromatolites, in some instances greater than that of nano-porous pyrite, which reaffirms that the Dresser stromatolites flourished in barium- and sulfate-rich, hydrothermally recharged, fluctuating shallow marine evaporating brines of a tectonically active caldera complex.

[1] Walter et al., 1980. Nature 284, 443-445; [2] Baumgartner et al., 2019. Geology 47, 1039-1043; [3] Baumgartner et al., 2020. Geobiology 18, 415-425; [4] Baumgartner et al., 2020. Geobiology 337, 105534. [5] Murphy et al., 2016. Geobiology 14, 413-439; [6] Van Kranendonk et al., 2022. This session.

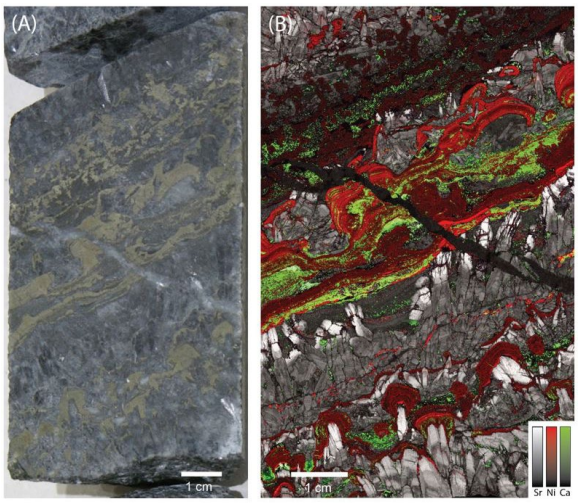

Figure 1. Optical image (A) and qualitative X-ray fluorescence microscopy (XFM) elemental maps (B) of strongly sulfidized – mainly Nickel-rich pyrite and lesser sphalerite – stromatolites and coarse barite crystal growths. Note that in B), Ni delineates the presence of wavy/wrinkly sulfidized stromatolite stromatolites, Ca is a proxy for dolomite, and Sr is strongly concentrated in barite, delineating repeated intervals of complexly zoned barite crystals that push up, or cut across overlying stromatolite layering.