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Trace elemental tracking of biogenicity in early Earth macrofossils

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Understanding the emergence and evolution of life is a fundamental question in exobiology and the early biosphere on Earth. One approach to elucidate the biogenicity criteria in early Earth involves the analysis of trace elements (e.g., As, Zn, Ni, Fe, Cu and Co) preserved in ancient marine sedimentary rocks. Hence, trace elements hold the unique potential to serve as valuable biogenic proxies when their geochemical signatures associated with biological processes are well-constrained. Because of exceptional preservation and absence of metamorphic overprinting, the Paleoproterozoic 2.1 Ga Francevillian biota from Gabon, considered to perhaps be Earth's oldest multicellular life forms [1], represent excellent examples of ancient biogenic relics in which trace element biogenicity can be constrained. For example, two independent studies recently associated the enigmatic macrofossils with metabolic Zn cycling [2,3]. Often, in order to track the complex elemental interplay between abiotic and biotic processes, sophisticated analytical techniques are used, including ICPMS, laser ablation, Synchrotron nano-XRF and XANES to quantify elemental concentrations, assess oxidation states and isotope distribution of bulk and single mineralogical assemblages. Here, using a combination of these high-resolution techniques, we analyzed the presence of key trace elements associated with biological metabolic activity to better elucidate prevailing interactions of elemental biogeochemical cycling and emergence of the Francevillian biota. In addition to exploring processes involved in the evolution of complex life on our planet, the data complement and strengthen morphological observations, which are not always decisive, as well as remains of organic biomolecules which are easily contaminated by modern materials.

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