Fossilization of micro-organisms embedded in silica: An experimental perspective

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Assessing the biogenicity of Archean carbonaceous microstructures is challenging because of the inevitable degradation of biosignatures occurring during fossilization [1]. Decoding the molecular fossil record requires experimental simulations to investigate the degradation pathways of biogenic molecules during fossilization. Intriguingly, a number of Archean organic microstructures has been found in silica-rich cherts. Althought some recent experimental studies investigated the influence of biomineral matrices during burial [2] [3], little is known regarding the influence of such silica matrices on molecular biosignatures.

We conducted 'fossilization' experiments with two micro-organisms (prokaryotic cyanobacteria and eukaryotic algae). After entombment within a silica gel, we submitted these analogues of microfossiliferous chert precursors to pressure and temperature conditions mimicking burial (250°C, 250 bars) for different durations (1 to 100 days). 'Blank' experiments have also been performed under the same conditions in the absence of silica.

All experimental residues have been characterized using synchrotron-based XANES and NMR spectroscopies. Results demonstrate that the entombment within a silica matrix significantly delays the chemical degradation of both precursors. In the absence of silica, significant aromatization and concomitant defunctionalization are observed even after short-time experiments. In contrast, initial molecular signatures of the investigated micro-organisms are only slightly modified in the presence of silica, even after long-term experiments. Mechanistic pathways that may be invoked to explain such differential behaviour will be discussed.

Although, further work appears required to properly extrapolate the results of such experiments to natural settings, the present approach appears valuable to help decoding the Archean fossil record in a uniformitarian perspective.

[1] Bernard and Papineau (2014) *Elements* **10**, 435-440. [2] Li *et al*. (2014) *Earth Planet. Sci. Lett.* **400**, 113-122. [3] Picard *et al*. (2015) *Nat. Commun.* **6**, 6277.