Molecular preservation of organic microfossils in Paleoarchean cherts

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Fossilization processes and the increase of temperature and pressure conditions associated with burial inevitably alter the original biochemical signatures of organic molecules. At a certain stage, biogenic and abiotic organic structures may become undistinguishable [1].

Cherts (*i.e.* silica-rich rocks) are well known for the morphological preservation of fossilized microorganisms. Recently, spatially resolved investigations using synchrotron-based XANES microspectroscopy revealed that molecular information about the organic precursor of 3.4 Ga microfossils, was preserved in the Strelley Pool chert (Pilbara, Western Australia), despite a metamorphic history so far believed to be incompatible with such preservation (lower greenschist facies - peak temperature ≅ 300 °C; [2]). Laboratory experiments showed that silica-organic interactions are likely to play a key role in the molecular preservation of microorganisms fossilized in cherts [3]. Altogether, these results demonstrate that ancient organic microfossils may exhibit a high level of chemical preservation in appropriate settings independent of a long and complex geological history.

Here, we use spatially resolved microspectroscopy techniques, including STXM-based XANES spectroscopy, to investigate the chemical nature and molecular preservation of individual microfossils from the 3.4 Ga Buck Reef chert (Barberton, South Africa). The latter experienced slightly higher peak temperature conditions (≅ 360 °C) during their geological history compared to the Strelley Pool chert. These molecular data provide key constraints to understanding the impact of increasing metamorphic temperature on the preservation of the organic molecules composing some of the oldest microbial fossils on the Earth.

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2. Alleon, J., et al., *Chemical nature of the 3.4 Ga Strelley Pool microfossils.* Geochemical Perspectives Letters, 2018. **7**: p. 37-42.

3. Alleon, J., et al., *Early entombment within silica minimizes the molecular degradation of microorganisms during advanced diagenesis.* Chemical Geology, 2016. **437**: p. 98-108.