Tracking microbial signatures in stromatolites at micrometer scale through *in situ* iron isotope analyses.

Marie-Noëlle Decraene[1*], Johanna Marin Carbonne[1], Christophe Thomazo[2], Nicolas Olivier[3], Emmanuelle Vennin[2], Pascal Philippot[4], Etienne Deloule[5]

1 Institut des sciences de la Terre, Université de Lausanne, Lausanne, Suisse
[2] UMR CRNS 5561 Biogéosciences, Université de Bourgogne, Dijon, France.
[3]Laboratoire Magmas et volcans, Université Clermont Auvergne, 63038 Clermont-Ferrand, France.
[4]Géosciences Montpellier, Université de Montpellier, France.
[5]CRPG-CNRS, BP20, 54501 Vandoeuvre les Nancy, France.

** Email: marie-noelle.decraene@unil.ch*

Stromatolites are laminated organosedimentary structures formed under the influence of microbial consortium. The study of actual stromatolites helps to constrain chemical reactions at the biofilm scale and the role of microbial metabolisms on mineralization (Dupraz *et al.*, 2005). However, the microbial origin of Archean stromatolites is still discussed due to the absence of diagnostic fossil evidence for photosynthesis and chemolithotrophy.

Micrometric syngenetic sedimentary pyrites (FeS_2) closely associated with organic matter are widespread in Archean stromatolites and modern microbial mats. Iron isotope compositions recorded in sedimentary pyrites are used as a proxy of paleoredox conditions of the ocean because change of the redox state of iron (between Fe^{2+} and Fe^{3+}) led to important isotope fractionations ($\Delta_{Fe(III)-Fe(II)} = +3‰$, Welch *et al.*, 2003). This reaction can be driven abiotically through a redoxcline or induced by microbial metabolisms such as Dissimilatory Iron Reduction (DIR, Johnson *et al.*, 2005). Dissimilatory Iron Reduction is thought to be one of the earliest metabolisms on the Earth (Vargas *et al.*, 1998) and can fractionate Fe isotopes up to 3‰ during Fe-oxide reduction. We therefore propose to explore Fe isotope signatures of pyrites as a proxy of the early traces of redox microbial activity using *in situ* SIMS equipped with a Hyperion Radio Frequence Plasma source. This technique, applied on Archean (2.7 Ga stromatolites of the Tumbiana Formation, Western Australia) and Triassic (250 Ma sediments of the Sonoma Basin, USA), allows to obtain a spatial resolution of 3µm and a reproducibility better than 0.25‰ (2σ). The comparison of these data yields a unique view of the evolution of the iron isotope signatures through geological time and provides original constraints on pyrite formation at a biofilm scale.

Key words: Biogeochemistry, stromatolites, microbial respiration, biominerals, SIMS.

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