Microscale characterization of pyrites from Archean sediments brings new constrains on past microbial metabolisms

J. MARIN-CARBONNE[1], C. THOMAZO[2], V. BUSIGNY[3], M-N. DECRAENE[1], M. SAITOH[1], J. ALLEON[1]., L. REMUSAT[4] AND S. BERNARD[4].

[1]ISTE-Université de Lausanne, Suisse
[2]Biogeosciences Université Bourgogne Franche Comté,
[3]Institut de Physique du Globe de Paris (IPGP), France
[4]IMPMC, Paris

The identification of microbial signatures preserved in the geological record is crucial for understanding life evolution in the Early Earth. Iron and sulfur isotopes offer the most direct means to track the biogeochemical cycling of these elements through time, but their joint use as biomarker of specific metabolic activity has been relatively limited to date. Archean sediments contain small sulfides, that can be formed either by abiotic processes (reaction between H_2S and Fe(II)) or by metabolic activity like microbial sulfate reduction (MSR) or dissimilatory iron reduction (DIR). We have developed a microscale approach using correlative microscopy and SIMS and NanoSIMS analyses. In situ Fe and S isotope analyses as well as high-resolution mineralogy of pyrites in Archean sediments from the Buck Reef Chert (3.41 Ga, basal member of the Kromberg Formation, South Africa), the Mendon (3.33 Ga, South Africa) and the Tumbiana (2.7 Ga, Western Australia) Formations reveal not only post-depositional metasomatic influence but also a well-preserved primary microbial signature inherited from early diagenetic reactions in the sediment. This microscale approach allows us to distinguish microbial signatures from late overprints. Our results demonstrate the existence of microbial iron respiration as early as 3.26 Gyr ago, providing new time calibration of the tree of life for this type of metabolism.