In-situ characterisation techniques used to test the biogenicity of biomorphic structures in 2.72 Ga pristine drill core samples from the Tumbiana formation, Western Australia

K. LEPOT[1] , P. PHILIPPOT[1], K. BENZERARA[1,2] AND M. COTTE[3]

[1] Institut de Physique du Globe de Paris, Equipe Geobiosphère Actuelle et Primitive; lepot@ipgp.jussieu.fr, philippo@ipgp.jussieu.fr

[2] Institut de Minéralogie et de Physique des Milieux Condensés; benzerar@impmc.jussieu.fr

[3] European Synchrotron Radiation Facility; cotte@esrf.fr

In the Tumbiana Formation (2.72 Ga), microbial mats lining domical stromatolites, individual microbe morphology, strongly depleted organic matter $\delta^{13}C$ values and molecular biomarkers are strong support in favor of microbial life taking place in a shallow water environment. However, morphology alone is known to be equivocal and bulk rock analysis is subject to strong uncertainties due to potential post-Archaean contamination.

Here, we used a combination of high resolution techniques in order to link the mineralogy of laminated stromatolitic domes and potential biomarkers in situ, that is within putative microfossil-like objects. Raman micro-spectroscopy allowed identifying the distribution of carbonaceous material (CM) within individual laminates and its degree of ordering. Fourier Transform Infrared (FTIR) analyses revealed that the CM preserves short aliphatic chains. Carbon K-edge NEXAFS spectroscopy using synchrotron Scanning Transmission X-Ray Microscopy (STXM) technique confirmed the occurrence of aliphatic carbon in association with aromatic and carboxylic functional groups in the form of one micron large objects with morphologies reminiscent of fossil microbes. High-Resolution Transmission Electron Microscopy (HRTEM) of the putative microfossils showed that the organic structures are associated with calcium carbonate nano-crystals. The remarkable preservation of such highly unstable objects will be discussed.

The approach developed might prove invaluable for the search of life in older rocks in which strong controversies persist and can provide new clues on the search of traces of life in Archaean rocks.