High local iron enrichments in modern microbialites from Mexico: Speciation and origin

NINA ZEYEN[1]*, KARIM BENZERARA[1], ALEXIS TEMPLETON[2], SAMUEL WEBB[3] AND EMMANUELLE GERARD[4]

[1]IMPMC, Sorbonne Universités, UMR 7590, UPMC, CNRS, IRD UMR 206, MNHN, 4 Place Jussieu, 75252 Paris Cedex 05, France, nina.zeyen@impmc.upmc.fr
[2]Department of Geological Sciences, University of Colorado, Boulder, CO, USA
[3]SSRL, SLAC, University Stanford, Menlo Park, USA
[4]IPGP, Sorbonne Paris Cité, UMR 7154, Université Paris Diderot, CNRS, Paris, France

Microbialites are found in abundance throughout the geological record back to 3.5 Ga. Although they are considered as among the oldest life remains on Earth, the diversity of processes leading to the formation of these ancient rocks is poorly understood. A better characterization of modern microbialites is crucial to improve such interpretations based on actualism. Here, we evidenced surprising micrometer-sized laminae highly enriched in Fe within modern microbialites, located in the oxic and alkaline surface water of the crater lake Alchichica (Mexico). In order to better understand the origin of these Fe enrichments, we performed a multiscale characterization approach.

These microbialites are mainly composed of hydromagnesite and aragonite as suggested by bulk x-ray diffraction. Synchrotron based x-ray microfluorescence mapping as well as scanning electron microscopy on polished sections showed hot spots of iron arranged along discrete fine laminae which formed authigenically. The structure and chemical composition of these iron-rich areas were further studied down to the nanometer scale using a combination of focused ion beam milling, transmission electron microscopy and scanning transmission x-ray microscopy at the carbon K-edge and iron $L_{2,3}$-edges. These results showed that these iron-rich laminae are composed of a poorly cristalline oxyhydroxides, associated in variable proportions with chlorine and magnesium. Moreover, organic carbon is associated with this iron-rich phase.

The iron enrichment of microbialites suggests temporary high concentrations of Fe in the solution in Lake Alchichica which is surprising considering the high oxygen fugacity and pH prevailing at this depth. Possible sources of iron in this lake will be discussed. Overall, microbialites in Lake Alchichica, which are ponctually rich in iron, could be an interesting model for the interpretation of Fe-enrichments in ancient lacustrine microbialites.