Comparative study of Messinian fossil stromatolites and modern analogues from Sardinia: towards a better understanding of paleogeobiological archives

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The Biomineralogy team of the Institute of Mineralogy, Physics of Matter and Cosmochemistry (IMPMC), in collaboration with CR2P and ESE are looking for a PhD student who will conduct a “Comparative study of Messinian fossil stromatolites and modern analogues from Sardinia: towards a better understanding of paleogeobiological archives. This work will be performed within an interdisciplinary consortium in mineralogy/paleontology/microbiology.

Stromatolites are particularly emblematic geobiological materials since they are the oldest evidence of life-mineral interactions, dated at several billion years. They are found throughout the history of the Earth and have received strong attention because of the information they provide about microbial paleobiodiversity and paleoenvironments. However, while this information is interpreted based on our knowledge about modern analogues, the latter remains very incomplete. For example, we know of only few modern stromatolites from coastal pond environments, where variations of physico-chemical conditions such as salinity are very strong.

The present PhD project aims at studying the mineralogical, geochemical, textural and biological properties of modern coastal pond stromatolites recently discovered in Sardinia from the field- to the nano-scale. They will be compared to fossil stromatolites from the Messinian (~6 Ma old) which are abundant in the Mediterranean basin and the coastal origin of which remains uncertain. Several questions will be addressed: Are there mineralogical or geochemical signatures of a coastal environment which are recorded by the mineral part of such stromatolites? Which part of the microbial diversity populating these stromatolites is fossilized in the form of cells encrusted/replaced by minerals? Are cell ultrastructures preserved by the early fossilization stages? And among these traces, which ones can be identified in Messinian fossil stromatolites? Last, what is the origin of laminae observed in these stromatolites?

Overall, Sardinian stromatolites may become a unique model of stromatolites subjected to severe environmental variations, in particular in terms of salinity. Their comparison with fossil stromatolites from the Messinian will open a unique insight on this stage of great interest for paleontologists.

The student will use diverse techniques of petrology, mineralogy and geochemistry in order to characterize major and accessory mineral phases, their distribution and texture within stromatolites. In parallel, geochemical analyses of the aqueous solutions surrounding stromatolites will be performed together with speciation calculations in order to determine the operating chemical equilibria.
Spectroscopy (Raman, FTIR, visible fluorescence, synchrotron-based μ-XRF) and/or microscopy (MEB, MET, STXM) analyses will be conducted in order to identify potential mineral-microorganisms assemblages and/or cells partly/totally replaced by minerals. There is a possible option for candidates at the Earth science-biology interface to also characterize the first microbial communities initiating the formation of microbialites based on molecular biology tools (metabarcoding) in collaboration with our colleagues of ESE in Orsay.

The candidate should be able to learn how to use analytical tools. She/He will take charge of data acquisition and processing and should be able to develop a critical view on their implications and limits. Funding will last for 3 years, the standard PhD duration in France. The grant is provided by the DIM île de France « Matériaux anciens et patrimoniaux » and the employer will be the CNRS. The position will start as soon as September 1st 2019 or at the latest on December 1 2019 depending on the availability of the candidate. Candidates should send their detailed CV and a motivation letter to Karim Benzerara: karim.benzerara@upmc.fr and Jean-Paul Saint-Martin: jean-paul.saint-martin@mnhn.fr

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