Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.15898

Hyperspectral study of visible fluorescence in modern and ancient microbialites to detect traces of life

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Stromatolites have served as emblematic objects to search for signatures of life. This search is usually based on their macroscopic morphology, texture and/or the presence of microfossils. Most modern stromatolites comprise diverse microbial communities, including abundant phototrophs covering a mineral “fossil” component. There is a steep gradient of the proportion of organics/inorganic mineral phases between these two components. Two remaining questions are: what is the fate of the organics when the communities are lithifying? And how much may be preserved within the rocky component of stromatolites?

Here we used confocal laser scanning microcopy (CLSM), cathodoluminescence and synchrotron-based visible fluorescence excited by x-rays to analyze modern stromatolites collected in Mari Ermi, a coastal pond in Western Sardinia. This pond experiences seasonal droughts associated with substantial salinity variations, which are reflected in the mineralogical composition of the stromatolites at the submicrometer scale [1]. Based on the analysis of hyperspectral data, we evidenced pervasive fluorescence throughout the stromatolites. Different kinds of spectra were detected, that were attributed to different types of organics and inorganic compounds, including chlorophyll/phycocyanin pigments. Changes along a transect across the stromatolite laminae suggest transformation of the signal over time for some compounds. Moreover, it revealed the potential preservation of degraded photosynthetic pigments related to past microbial activity. Last, we also analyzed ancient analogues from the Messinian (Upper Miocene). We compared the observed signals with the ones measured on modern samples and we will discuss their meaning in term of preservation of traces of life.

[1] Debrie, Prêt, Estève, Saint Martin & Benzerara (2022), *Chemical Geology* 609, 121059