

Reproducing the formation of stromatolites in a Si-rich environment

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Cyanobacteria have been responsible for the formation of massive amounts of carbonate rocks in the form of stromatolites for several billion years. When the first of them were formed ~3.5 Ga ago, concentrations of Si in Precambrian oceans were high [1]. Although authigenic Mg silicates are frequently observed in modern stromatolites [2], experimental evidences of the formation of silicate minerals in presence of cyanobacteria are lacking. Moreover, the physico-chemical factors (pH, pCO₂, Mg:Si ratio, supersaturation degree) that determine the nature and quantity of precipitated hydrous Mg carbonate and silicate minerals in Si-rich environment remain poorly constrained. The present study attempted to reproduce, in a laboratory microcosm, the processes of biomineralization in a carbonate- and Mg-bearing medium under high Si concentrations (1.1 to 2.1 mM), in the presence of various cyanobacteria in order to characterize the mineralogical nature of precipitates and establish the relationship between solution saturation state and the mineralogical identity of solid precipitates. For this, we chose 3 representative cyanobacteria of different morphologies: unicellular *Synechococcus* sp., capsular *Chroococciopsis* sp., and *Aphanothece clathrata*, capable to form a large amount of exopolymeric substances (EPS).

The results demonstrated that all 3 cyanobacteria induced the precipitation of both carbonate and silicate minerals by increasing the pH of the medium via photosynthesis. FTIR analyzes of the solid phase identified Mg carbonates and silicates. Transmission electron microscopy observations including EDS analyzes confirmed the presence of these minerals around the cells, mostly in the EPS-rich sheaths and cell surfaces. Taken together, the results obtained in this study allow efficient reproduction of combined Mg hydroxyl carbonate and hydrous silicate precipitation under cyanobacterial activity in Si-Mg-bicarbonate solutions.

[1] Knoll *et al.* (2016), *Phil. Trans. R. Soc. B* **371**, 20150493. [2] Pace *et al.* (2018), *Geobiology* **16**, 378-398.