



Biogeochemical significance of Intracellular calcification by Cyanobacteria

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Cyanobacteria are an abundant and diverse group of photosynthetic bacteria that have shaped Earth's environment for billions of years and play a vital role in the cycling of numerous elements such as carbon, calcium, and phosphorus. In particular, their impact on the global carbon cycle is of significant interest in the context of carbon capture and climate change, as they sequester atmospheric CO₂ into organic carbon and biogenic calcium carbonates (CaCO₃) through a process called calcification. The process of calcification has long been considered as extracellular and non-biologically controlled. However, recently, several cyanobacterial species have been reported to form intracellular amorphous calcium carbonate (ACC) inclusions. These cyanobacteria were found in diverse environments and accumulate high concentrations of AEE (Ca, Ba and Sr) from solutions undersaturated with respect to AEE-carbonate phases. Moreover, one of these cyanobacteria species, *G. lithophora* was shown to selectively accumulate stable and radioactive alkaline earth elements (AEE) within the intracellular amorphous carbonates and/or polyp inclusions (Mehta et al., 2019). Recently, it was confirmed that cyanobacteria forming intracellular ACC contained a much higher content of alkaline earth elements (AEE) than all other cyanobacteria (DeWever et al., 2019). The high concentration of Ba and Sr within these intracellular inclusions was surprising because Ba and Sr have usually been considered as having no physiological role at all. The high concentration of Ca within these intracellular inclusions was directly in contrast with the traditional paradigm of cells maintaining a state of homeostasis with respect to Ca. Furthermore, Sr/Ca and Ba/Ca ratios in these ACC inclusions were very different from those expected from abiotic precipitation in the solution surrounding the cells (Cam et al. 2015). To understand the biological driver behind these observations, first, I will present a review of the above mentioned "vital effects" in the context of intracellular calcification in cyanobacteria. Second, using batch incubation experiments, I will show that high Ca concentrations are vital not only for the growth of *G. lithophora*, but also for the uptake of Ba by *G. lithophora*. Lastly, I will examine Ca homeostasis in ACC forming cyanobacterial strains by using an antagonist/inhibitor of a known channel/transporter involved in Ca transport. Overall, these insights will shed some light on the role of cyanobacteria forming intracellular ACC on carbonate (bio)mineralization, in both modern and ancient Earth's environment.

Reference:

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