Cyanobacterial intracellular carbonatogenesis: phylogenetic distribution, mechanisms and environmental implications

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When we published with Gordon and others the discovery of a cyanobacterium forming amorphous Sr- and Ba-rich carbonate intracellularly, we were puzzled [1]. What is the difference between this species and other cyanobacteria which at that time were all thought to form carbonates extracellularly? How this species forms Sr- and Ba-rich carbonates when growing in a solution with very little Sr and Ba? What is the advantage for a cell to precipitate intracellular carbonates?

Five years later, we have made significant progress using e.g., solution geochemistry, diverse microscopies, as well as genomics. We now know that intracellular carbonate biomineralization is widespread in cyanobacteria, phylogenetically- and environmentally-wise [2, 3]. It was overlooked due to sample preparation artefacts [4]. Cyanobacteria forming intracellular carbonates accumulate alkaline earth metals to a far higher level than other species. They can form intracellular carbonates in undersaturated environments at a certain energy costs. Moreover, some of these species accumulate preferentially Ba over Sr and Ca, opening stimulating perspectives for bioremediation [5, 6].

Cryo-TEM offers clues to where in the cells alkaline earth metals are concentrated and whether nucleation occurs in a compartement. We will moreover show how genome analysis allows to pinpoint molecular mechanisms involved in intracellular carbonatogenesis in cyanobacteria and further our knowledge of the evolutionary history of this process.

[1] Couradeau *et al.* (2012) *Science* **336**, 459-462. [2] Ragon *et al.* (2014) *Front Microbiol* **5**, 331. [3] Benzerara *et al.* (2014) *Proc Natl Acad Sci USA* **111**, 10933-10928. [4] Li *et al.* (2016) *Minerals* **6**, 10. [5] Cam *et al.* (2015) *Geochim. Cosmochim. Acta* **161**, 36-49. [6] Cam et al (2016) *Env Sci Technol*, **50**, 11654-11662.