

Lab-scale study of the calcium carbonate dissolution and deposition by marine cyanobacterium *Phormidium subcapitatum*.

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Background Suggestions that calcification in marine organisms changes in response to global variations in seawater chemistry continue to be advanced (Wilkinson, 1979; Degens *et al.* 1985; Kazmierczak *et al.* 1986; R. Riding 1992). However, the effect of [Na⁺] on calcification in marine cyanobacteria has not been discussed in detail although [Na⁺] fluctuations reflect both temperature and sea-level fluctuations. The goal of these lab-scale studies therefore was to study the effect of environmental pH and [Na⁺] on CaCO₃ deposition and dissolution by marine cyanobacterium *Phormidium subcapitatum*.

Methods Marine cyanobacterium *P. subcapitatum* has been cultivated in ASN-III medium. [Ca²⁺] fluctuations were monitored with Ca²⁺ probe. Na⁺ concentrations were determined by the initial solution chemistry.

Results It was found that the balance between CaCO₃ dissolution and precipitation induced by *P. subcapitatum* grown in neutral ASN III medium is very close to zero. No CaCO₃ precipitation induced by cyanobacterial growth occurred. Growth of *P. subcapitatum* in alkaline ASN III medium, however, was accompanied by significant oscillations in free Ca²⁺ concentration within a Na⁺ concentration range of 50 – 400 mM. Calcium carbonate precipitation occurred during the log phase of *P. subcapitatum* growth while carbonate dissolution was typical for the stationary phase of *P. subcapitatum* growth. The highest CaCO₃ deposition was observed in the range of Na⁺ concentrations between 200 – 400 mM.

Alkaline pH also induced the clamping of *P. subcapitatum* filaments, which appeared to have a strong affinity to envelop particles of chemically deposited CaCO₃ followed by enlargement of those particles' size. EDS analysis revealed the presence of Mg-rich carbonate (or magnesium calcite) in the solution containing 10 – 100 mM Na⁺; calcite in the solution containing 200 mM Na⁺; and aragonite in the solution containing with 400 mM Na⁺. Typical present-day seawater contains xxmM Na⁺. Early (Archean) seawater was likely less saline.

Conclusion The division of marine cyanobacterium *P. subcapitatum* is associated with periodic deposition and dissolution of CaCO₃, the rhythms and intensity of which are dependent on concentrations of both OH⁻ and Na⁺. Thus, the role of present-day marine cyanobacteria in the global carbonate cycle might be reduced to aggregation and re-crystallization of available CaCO₃ particles in marine water rather than long-term precipitation and accumulation of CaCO₃ deposits. For lower Na⁺ concentrations, precipitation of carbonates by cyanobacteria would be even less significant. These results suggest that the lack of calcified cyanobacteria in stromatalite-bearing Precambrian sequences can be explained not only by high dissolved inorganic carbon concentrations but also by lower salinity, as well as possible lower pH compared to present-day oceans.

1. Karakis SG, Dragoeva EG, Lavrenyuk TI, Rogochiy AB , Gerasimenko LM, McKay DS, and Brown II. The Joint International symposium for Subsurface Microbiology and Environmental Biogeochemistry. Jackson Hole, WY, August 14-19, 2005. P.115