

Biom mineralization of Mg-rich Calcite (Mg_xCa_{1-x}CO₃) by *Proteus mirabilis*

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Recently bacterially induced carbonate precipitation has been proposed as an environmentally friendly method to apply CO₂ sequestration and fixation [1]. The objectives of this study were to investigate biom mineralization of the carbonate minerals using microorganisms enriched from rhodoliths and to identify environmental factors that control the formation of calcite by the microorganisms.

Carbonate forming microorganism (CFM) was enriched from rhodoliths using D-1 medium for microbial activity and aerobically cultured at 25°C using D-1 medium with containing 30:30 mM Ca-:Mg-acetate concentrations to confirm formation of carbonate minerals. Enriched microorganisms were analyzed by 16S rRNA gene DGGE analysis to confirm microbial diversity. Various ratios of Ca and Mg-acetate concentrations (60:0, 60:20, 20:60, 0:60 mM) were added to D-1 medium to examine how different Ca and Mg ratios affect the biom mineralization of carbonate minerals. Mineralogical characteristics of bio-precipitates were determined by XRD and SEM-EDS analyses.

A 16S rRNA sequence analysis showed the enriched microorganisms contained CFM such as *Proteus mirabilis* [2]. XRD analyses showed that the precipitates were calcite with Ca-:Mg-acetate (60:0, 60:20 mM), Mg-rich calcite with Ca-:Mg-acetate (30: 30, 20:60 mM) and huntite with Ca-:Mg-acetate (0:60 mM) were formed, whereas any carbonate minerals were not formed without the microorganisms in D-1 medium. Also, through various ratios of Ca/Mg concentrations, we observed that the formation of Mg-rich calcite and huntite occurred when the level of Mg ion was much higher than that of Ca ion in D-1 medium. SEM-EDS analyses showed that the carbonate minerals formed by the microorganisms were a rhombohedron shape consisted of Ca, Mg, C, and O and irregular shaped extracellular polymeric substance (EPS) with Ca, Si, and Mg component.

These results indicate that the microorganisms induce precipitation of carbonate minerals on the cell walls and EPS via the accumulation of Ca and/or Mg ions on the cells. Therefore, microbial precipitation of carbonate minerals may play one of important roles in metal and carbon biogeochemistry as well as carbon sequestration in natural environments.

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Redox processes in the Earth's mantle

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Redox reactions are crucial for many geological processes, but especially how Earth's surface and atmosphere became oxidized enough to form a habitable planet is a key question. To understand redox controls in Earth's mantle is of prime importance, because oxygen fugacity (fO₂) regulates the biogeochemical cycles of volatiles such as C-O-H or S and their respective fO₂-dependent species. These volatiles also link deep mantle reservoirs and Earth's surface because they promote mantle convection and initiate volcanism through solidus depression in various tectonic settings.

The redox state of the mantle may be reconstructed, for instance, by investigating mantle melts. Subduction related basalts (IAB) have higher Fe³⁺-ΣFe ratios than mid-ocean ridge basalts (MORB) or ocean island basalts (OIB) [1]. A matter of debate is, whether these higher redox states are a source signal from the mantle wedge with higher Fe³⁺-ΣFe compared to the MORB source [2], or, if IAB melts are affected by post genetic oxidation at some stage between early crystallization and solidification. Fe³⁺-ΣFe ratios in basalt glasses correlate with H₂O content [1] but differ from results based on other redox proxies such as V/Sc [3,4], Zn/Fe_T [5], or Fe isotopes [6]. Key problems, e.g., if and how subduction related fluids oxidize the mantle, if subduction causes a secular variation in mantle fO₂, or if the mantle is buffered with respect to fO₂ remain highly controversial.

Oceanic crust, lithosphere and overlying sediments are generally more oxidized than the ambient mantle if subducted to depths >100 km, because cratonic lithosphere and potentially also the asthenosphere become increasingly reduced with increasing depth [7,8]. The redox contrast between delaminated oxidized blocks from the slab and reduced ambient mantle sets the frame for hydrous and carbonatitic redox melting processes in the deeper mantle [9,10].

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