

Formation and inhibition of calcite, aragonite and vaterite

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Calcium carbonates (CaCO_3) are widespread in sediments and organisms and highly relevant materials for industrial applications. The formation of calcium carbonate is strongly affected by dissolved magnesium ions (Mg) and polyaspartic acid (Pasp). In the present study the formation of the anhydrous CaCO_3 polymorphs calcite, aragonite and vaterite were investigated at various temperatures ($6 < T < 40^\circ\text{C}$), carbonate accumulation rates ($0.15 < R_{\text{CO}_3} < 320 \mu\text{mol h}^{-1}$), concentrations of Mg ($\leq 55 \text{ mmol l}^{-1}$) and Pasp ($\leq 3.4 \text{ mg l}^{-1}$) by using the CO_2 diffusion technique at constant pH. Nucleation of CaCO_3 was retarded from few minutes up to several hours at $T \leq 10^\circ\text{C}$, and up to several hundreds of hours at elevated [Mg] and [Pasp]. Distinct CaCO_3 polymorph formation is mainly controlled by [Mg], [Pasp], T and R_{CO_3} . $[\text{Mg}]/[\text{Ca}] > 0.2$ (40°C) to $[\text{Mg}]/[\text{Ca}] > 2$ (6°C) promote the formation of aragonite and suppress the formation of vaterite. Pasp inhibits aragonite formation and favours vaterite formation, whereas combining both Pasp and Mg causes calcite formation. In the presence of Pasp, CaCO_3 nucleates only in case of supersaturation with respect to monohydrocalcite. The present study provides conditions to synthesize tailored CaCO_3 polymorphs. Moreover, the results can be used to obtain an advanced understanding for the mechanisms of CaCO_3 biomineralization and to evaluate CaCO_3 scaling mechanisms with special regard on inhibition of CaCO_3 polymorphs and nucleation times.

Conductive filaments and electric fields associated with electric currents in marine sediment

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Electric currents have been found to explain tightly coupled but spatially separated sulphide oxidation and oxygen reduction in marine sediment [1]. In the present study we searched for electron conductors and additional measures of electric activity in the sediment. Networks of filaments resembling bacterial conductive pili ('nanowires') were observed in the sediments and electron conductivity was documented with nanofabrication approaches [2]. Down-core measurements of self-potentials revealed an electric field that matched the geochemical evidence of electric circuits extending from the sediment surface to a depth of 2 cm. The upwards charge transfer by electrons was thus balanced by ion drift in the pore water.

The results suggest that sediment electric networks are engineered by microorganisms using nanowires as electron conductors.

[1] Nielsen *et al.* (2010) *Nature* **463**, 1071–1074. [2] El-Nagggar *et al.* (2010) *PNAS* **107**, 18127–18131.