



Magnesium and Strontium Incorporation into Calcium Carbonate Polymorphs and ACC – Experimental Study

A. Niedermayr (1), M. Dietzel (1), S.J. Köhler (1,2), and S. Petautschnig (1)

(1) Institute of Applied Geosciences, Graz University of Technology, Institute of Applied Geosciences, Rechbauerstr. 12, 8010 Graz, Austria (a.niedermayr@tugraz.at), (2) Department of Aquatic Sciences and Assessment, University of Agricultural Sciences, Ullsväg 31A, SE-756 51 Uppsala, Sweden

Incorporation of magnesium and strontium into aragonite and calcite is well known and has been extensively used for temperature reconstruction. Moreover, knowledge on element incorporation behaviour provides fundamental insight into calcium carbonate growth mechanisms. Element and isotope distributions are also used for monitoring aspects to evaluate ongoing sinter formation and inhibition effects in man made environments. However, the precipitation rate impact on magnesium and strontium incorporation in aragonite as well as the effect of magnesium on strontium incorporation in calcite is still a matter of debate, and little is known about the incorporation behaviour of magnesium and strontium in amorphous calcium carbonate (ACC) and vaterite.

In this study, magnesium and strontium incorporation into the three calcium carbonate polymorphs and ACC are experimentally investigated at low temperature. Spontaneous calcium carbonate precipitation experiments without seeds were carried out using a CO₂-diffusion technique (TANG et al., 2008) and batch mixing. Experiments are conducted (i) at various Mg/Ca ratios (up to 10), and/or (ii) in presence of polyaspartic acid at temperatures from 5° to 50°C and various CO₂-uptake rates. In the mixing experiments a metal chloride solution is rapidly mixed with a sodium (hydrogen-) carbonate solution.

Calcite is preferentially formed at lower temperatures, at lower supersaturation degrees (Ω) and low Mg/Ca ratios, while aragonite is preferentially formed at high Mg/Ca ratios and/or at elevated temperatures. Vaterite is formed at relatively high Ω values and in presence of polyaspartic acid. ACC is obtained at the highest supersaturation in mixing experiments and its formation is stimulated by magnesium. If magnesium is present, calcite crystals have a steep rhombic or pseudo dodecahedral shape with a rougher surface and acute sides are rounded. This affects strontium incorporation. Generally, strontium incorporation increases with increasing precipitation rate for calcite and vaterite, while the inverse is observed for aragonite. Incorporation of magnesium is similar for calcite, vaterite and ACC, and smallest for aragonite. Preliminary results indicate that strontium incorporation in ACC is correlated with magnesium incorporation. Respective processes and proposed models are discussed.

Reference:

Tang J., Köhler S.J. and Dietzel M. (2008) Sr²⁺/Ca²⁺ and ⁴⁴Ca/⁴⁰Ca fractionation during inorganic calcite formation: I. Sr incorporation, *Geochimica et Cosmochimica Acta*, **72**, 3718-3732.