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Partitioning of Mg in calcite as a function of precipitation rate

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Calcium is often replaced by other cations in naturally occurring calcium carbonate minerals like calcite and aragonite. One of the most common replacements observed is that of calcium by magnesium in calcites, which is extending from trace levels up to several moles % in the crystal lattice of this mineral phase. Although calcite is a carbonate phase forming in many of the earth's surface aquatic environments the factors responsible for this wide range of magnesium incorporation in calcite are still poorly understood. In order to better understand the major mechanisms controlling this incorporation of magnesium in calcite crystal lattice, a series of carefully designed precipitation experiments were performed at 25°C and for different pHs of reacting solution as a function of precipitation rate.

Mg-calcite crystal growth on calcite seeds was induced by the addition at similar flow rates of two individual $Ca_{1-x}Mg_xCl_2$ and Na_2CO_3 solutions of equal concentrations in a flow through reactor. Reaction pH, controlled by continuous bubbling of a known composition of N_2/CO_2 gas mixtures, ranged from $\sim$6.2 to $\sim$8.7.

Results indicate that magnesium partitioning in calcite is independent of ionic strength but significantly increases with increasing precipitation rate. Furthermore, results from experiments with similar inlet solution concentrations, show an increase of Mg-calcite precipitation kinetics with increasing pH and a decrease with aqueous Mg concentration. These results demonstrate that in addition to temperature and the presence of biomolecules, the precipitation rate proves to be a very important parameter controlling magnesium incorporation in calcite. Environmental parameters potentially affecting precipitation rate should not be overlooked when interpreting paleo-environmental proxies based on trace metal incorporation in calcite.