Coupled dissolution-precipitation processes on calcium carbonate exposed to cadmium-rich aqueous solutions

Maude Julia[a,*], Christine V. Putnis[a,b], Helen E. King[c], François Renard[d,e]

[a]Institut für Mineralogie, Universität Münster, Corrensstrasse 24, 48149 Münster, Germany, [b]School of Molecular and Life Sciences, Curtin University, Perth, 6845, Australia, [c]Department of Earth Sciences, Universiteit Utrecht, 3584 CB Utrecht, The Netherland, [d]The Njord Centre, Departments of Geosciences and Physics, University of Oslo, Oslo, Norway, [e]ISTerre, Univ. Grenoble Alpes, Grenoble INP, Univ. Savoie Mont Blanc, CNRS, IRD, Univ. Gustave Eiffel, 38000 Grenoble, France

Due to anthropogenic activities cadmium contamination of effluents and ground water has become a concern in some areas. Calcium carbonate rocks have been studied as a potential material for cadmium capture due to the existence of a nearly perfect solid-solution between $CaCO_3$ and $CdCO_3$. In this study we have investigated the $CaCO_3$-Cd fluid interaction using different types of calcium carbonate: calcite (Iceland spar) single crystals, Carrara marble, a polycrystalline calcite rock and aragonite single crystals. These materials have been chosen to investigate the impact of grain boundaries and change of crystallographic structure on the reaction observed between calcite single crystals and cadmium in previous studies. Atomic Force Microscopy (AFM) dissolution and growth experiments and hydrothermal experiments have been conducted on the different samples. Calcite single crystals have been observed to be passivated by the epitaxial growth of a $CdCO_3$ layer, wheras a replacement reaction took place in the Carrara marble and aragonite samples, replacing $CaCO_3$ by a porous $(Ca,Cd)CO_3$ solid solution. Surface passivation compared with coupled dissolution-precipitation replacement reactions are investigated in terms of molar volume changes and solubility differences between parent ($CaCO_3$) and product ($(Ca,Cd)CO_3$) phases as well as reaction kinetic considerations.