Dolomite dissolution in natural sandstone during flow-through experiments with CO_2-rich brine

Jin Ma, Martin Saar, and Xiang-Zhao Kong

Geothermal Energy and Geofluids Group, Department of Earth Sciences, ETH Zurich (majin@ethz.ch)

This study explores the kinetics of dolomite ($Ca_{1.05}Mg_{0.75}Fe_{0.2}(CO_3)_2$) dissolution, induced by flooding of CO_2-rich brine into a multi-mineral sandstone. The sandstone sample was cored from a deep geothermal reservoir in Lithuania and consists of dolomite (12.22 vol.%), quartz (45.53 vol.%), K-feldspar (9.93 vol.%), muscovite (4.76 vol.%), kaolinite (5.64 vol.%), and ilmenite (0.27 vol.%). The chemical formulas of individual minerals were determined using a combination of methods, namely Scanning Electron Microscopy (SEM), X-Ray Fluorescence (XRF), and Laser Ablation - Inductively Coupled Plasma - Mass Spectrometry (LA-ICP-MS). During the flow-through experiments, CO_2-rich brine (0.8 mol/L CO_2(aq) and 1 mol/L NaCl) was injected and recycled through a sandstone specimen at 100 bar and 40 C for 210 hours.

During the experiment, the specimen's porosity increased by 13.6% while its permeability decreased by 66%. Fluid samples were collected both from the inlet and the outlet of the reaction cell during selected cycles. We observe that, when the system is far from equilibrium for dolomite dissolution (first 2 cycles), Ca is released into the solution faster than both Mg and Fe. From then on, stoichiometric dissolution of dolomite is established till the end of the experiment. We also performed speciation calculations to obtain the solution pH and individual mineral saturation indices. In particular, we derive the kinetic rate of dolomite dissolution over the duration of the experiment, based on the sample's reactive surface area, which we determined using both BET and image-based methods. These results can help improve understanding of geochemical reactions when dolomite-bearing sandstones are the reservoir host-rock formation, with implications for various geological processes.