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Hematite and K-feldspar dissolution rates in an exhumed CO_2reservoir, Green River, Utah

M. Wigley, M Bickle, B Dubacq, and N Kampman
Univesity of Cambridge, Earth Sciences, United Kingdom (mmw36@cam.ac.uk)

Reactions between CO_2 injected into geological formations and aquifer minerals may lead to permanently storage of the CO_2 as carbonate minerals, or cause leakage via corrosion of caprock and well seals [1]. Reactive transport models aimed at predicting the long term fate of injected CO_2 suffer from a poor knowledge of kinetic reaction rate parameters, which is in part due to a 2-5 orders of magnitude discrepancy between reaction rates measured in the field and laboratory experiments [2]. Despite the need for accurate determination of these key model parameters, very few studies have calculated mineral dissolution rates from natural CO_2-water-rock systems (e.g. [3]).

Near Green River, Utah, USA, regionally extensive portions of the red-bed Entrada sandstone have been locally bleached white/yellow by CO_2-charged fluids [4]. This bleaching is related to dissolution of fine-grained iron oxide grain coatings, which give the rock its distinct red coloration. Secondary calcite precipitation is observed together with growth of a band of oxide and carbonate at the reaction front. The site therefore provides an analogue for long term fluid-mineral reactions between CO_2-charged brines and reservoir minerals.

We calculate kinetic dissolution rates for hematite and K-feldspar in CO_2-charged brines by fitting the reactive transport equation to mineralogical profiles across reaction fronts. We show that dissolution rates for K-feldspar are between $2.04 \mathrm{x} 10^{-15}$ and $3.86 \mathrm{x} 10^{-15}$ mol/m^2/sec. These are several orders of magnitude lower than those predicted by laboratory studies, and are consistent with other estimates from natural CO_2 systems [3]. Hematite reaction rates range from $2.94 \mathrm{x} 10^{-14}$ to $6.69 \mathrm{x} 10^{-13}$, several orders of magnitude faster than those for K-feldspar.

Calculated mineral dissolution rates are used to build a simple model including mineral dissolution-precipitation, advective-diffusive transport and trace metal adsorption. The model reproduces the observed patterns of primary and secondary mineral dissolution/precipitation, as well as trace element geochemical profiles across the reaction front.

References

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