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Dissolution of K-feldspar at CO_2-saturated conditions

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Underground storage of carbon dioxide on a very large scale is widely considered to be an essential part of any strategy to reduce greenhouse gas emissions to the atmosphere. Aquifers in deep sedimentary basins have been identified as suitable targets for geological carbon dioxide storage, especially aquifers located in sandstone host rock. This has led to renewed interest in studying the interaction between sandstone minerals and aqueous fluids, as there is a paucity of data for CO_2-containing systems at relevant conditions. In an attempt to improve data coverage for important silicate minerals, we have measured the dissolution kinetics of K-feldspar in CO_2-saturated fluids over a range of temperatures.

K-feldspar fragments were hand-picked from a larger sample, crushed to a narrow size range and cleaned. The grains were reacted with water in batch-type reactors at temperatures from 20°C to 200°C and pressures up to 200 bar, and the dissolution was followed by periodic withdrawal of aliquots of solution. The mineral grains were allowed to react with pure water for a number of weeks before injection of CO_2 into the system. Excess CO_2 was provided to ensure CO_2 saturation in the experimental systems. While the reaction time before injection was not long enough to attain complete equilibrium, it did considerably lower the degree of undersaturation with respect to K-feldspar and helped highlight the effect of CO_2 injection into a rock-equilibrated aqueous fluid.

At all temperatures studied, injection of CO_2 resulted in a rapid increase in the soluble concentrations of K and Si (and also Na from a plagioclase component). The dissolution then reached apparent steady state conditions after a few days, with observed dissolution rates in the range of 1E-9 to 1E-12 mol/m2/s over the temperature range studied. The CO_2-saturated solutions maintained mildly acidic conditions throughout the experiments and the observed rates therefore fall roughly between rates measured in strong acids and rates measured in unbuffered aqueous solution. However, our rates are slightly slower than those predicted based solely on pH, a fact that we preliminary attribute to our choice to pre-react the mineral and fluid before the CO_2 injection. The exact cause of this effect is still under investigation.