

Influence of supercritical CO₂ on deep saline aquifer rock samples: from short-term exposure to long-term experiments

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It is well known that during injection of supercritical CO₂ (spCO₂), rock mineral constituents can be exposed to dissolution due to the weak acid character of spCO₂, when dissolved in pore water. However, the reactions with minerals can buffer pH decrease. A sequence of neutralisation reactions has been published (e.g. Apello and Postma, 2005), representing a progression of minerals, taking part in buffering reactions. Dissolution of rock mineral constituents and buffering solution pH decrease/increase of the solution can under certain conditions induce secondary reactions such as precipitation (e.g. gypsum, quartz, calcite). Such reactions, involving carbonate and sulphate minerals, are characteristic by fast reaction kinetics and can reach equilibrium within several hours. Therefore, those reactions are of the highest importance for injection phase of CO₂ storage and near-well environment (Gaus, 2009).

Following that, the series of interaction experiments were performed in the NRI lab. Two types of experiments were executed: static experiments, exposing rock samples to interaction with spCO₂ in a closed system rock sample – groundwater (brine) – supercritical CO₂ for longer time period (4 days and 3 months), and shorter dynamic experiments, where supercritical CO₂ flows through the rock samples (several hours).

Rock samples represented potential storage reservoirs of the Czech Republic, both deep aquifer sediments and caprocks from Northern Bohemia (Permian-Carboniferous rocks) and South Moravia (Tertiary Vienna Basin sediments). The rock samples differed in composition, from quartz sandstones (quartz ≤ 80%) to sandstones with high content of carbonates (e.g. 20% of calcite). The rocks were characterised for mineralogical composition before and after spCO₂ exposure, porosity, pore size distribution, water permeability, etc. Synthetic brine, prepared on the basis of real groundwater composition from potential aquifer storage sites, was used to represent the reservoir fluid.

The experiments showed that even short-time exposure of the rock can change its properties. Short-term exposure to spCO₂ during the dynamic experiment (6 hours) caused mineralogical and pore size changes in the sample. After 4-day exposure mineral content changes gained up the orders of first tens of percents (quartz, calcite, and dolomite).

Modelling of interaction reactions was performed using the PHREEQC geochemical programme. It proved some of the observed reactions; some of the processes are, however, still under discussion (e.g. quartz dissolution).

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Rereferences:

Apello A., Postma (2009): *Geochemistry, Groundwater and Pollution*. Balkema Publishers, P.O. Box 447, 2300 AK, Leiden, The Netherlands.

Gaus I. (2009): Role and impact of CO₂–rock interactions during CO₂ storage in sedimentary rocks. *Int. J. Greenhouse Gas Control*, Vol. 4S, Issue 1, 73-78.