



Microbial induced changes of mineral composition in a CO₂ storage site, Ketzin, Germany

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Microbial activity in subsurface habitats can significantly alter the geochemical and biogeochemical conditions by inducing dissolution or precipitation of minerals. Such microbe mineral interactions, which are mostly the result of redox reactions or changes in pH, may play an important role for the injection and storage of CO₂ in subsurface reservoirs. Microbial processes can be beneficial as they may help sequestration of CO₂ by buffering the pH and shifting the carbonate equilibrium toward HCO₃⁻, thereby inducing carbonate precipitation. Produced biomass and mineral growth could support the reservoir sealing, known as self-sealing effect. However, microbial alteration of reservoir conditions may also be unfavourable as it may accelerate corrosion processes within the well or cause major changes in porosity and permeability in the near-well area, therefore minimizing injectivity.

In this study we focus on mineral components with emphasis on iron minerals and iron concentration in samples taken from the observation well Ktzi 202 (627 - 633 m depth), a testing site for CO₂ injection near Ketzin, Germany. Iron plays an important role in biogeochemical cycles due to its function as electron donor or acceptor for microbial processes in the deep biosphere. In subsurface reservoirs microbial iron metabolism may lead to the formation of precipitates, such as iron (hydr)oxides, sulphides or carbonates. Therefore, mineralogical and elemental composition of Stuttgart Sandstone from Ketzin storage site were incubated in long-term experiments under p/t *in-situ* conditions and were investigated using X-ray fluorescence, X-ray diffraction, and scanning electron microscopy with energy dispersive spectrometry, and differently reactive solid phase iron fractions were sequentially extracted using the iron extraction scheme of Poulton and Canfield (2005).

The reservoir rock is a porous, poorly cohesive sandstone, which was deposited in a fluvial environment partly under arid conditions during the Triassic. They are mainly composed of quartz and feldspar. Common in studied samples are phyllosilicates like illite, and chlorite-group minerals (chamosite). Several samples contain considerable amounts of evaporite minerals, halite, gypsum and anhydrite, with one sample entirely cemented with anhydrite. Total iron content is with 2-4 weight% relatively high, however, results from sequential extraction (of crushed but not ground) samples revealed only about 1% of the total iron as extractable. Extractable iron mainly falls into the goethite/hematite fraction and may be due to coating of some silicate minerals. While some iron oxide may be present as inclusions within silicate minerals, most of it probably falls into the poorly-extractable silicate fraction, such as chamosite. Also the reduced, sulphide-bound iron fractions (acid volatile and chromium reducible iron sulphide fractions) were small while total organic carbon content is less than 0.3 wt%.

Despite the very high iron content, iron-reducing activity is strongly limited both by the availability of reactive iron and by possible electron donors and carbon sources. Nevertheless, over long time periods a potential way of liberating more reactive iron could occur through leaching effects of supercritical CO₂ or weathering of the silicate due to acidification by CO₂. Microbial activity itself may contribute to this process. Long term monitoring studies are conducted in order to trace such slow proceeding changes of sediment composition, mineralogy, and fluid chemistry within the CO₂ reservoir.

Poulton S.W. and Canfield D.E. (2005) Chemical Geology 214, 209-221.