Geophysical Research Abstracts
Vol. 15, EGU2013-4142-1, 2013
EGU General Assembly 2013

Is there any impact of CO_2 injection on sandstone reservoir rocks? - Insights from a field experiment at the CO_2-storage site of Ketzin (Germany)

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The importance and viability of Carbon Capture and Storage (CCS) is an issue of intense discussion both in the science community and the public society. The effects of CO_2 on formation fluids, minerals, and perspective reservoir rocks have been investigated by several laboratory experiments, but studies on the long-term CO_2-impregnation of rocks are sparse. With the installation of a pilot CO_2-injection site at Ketzin, near to the German capital of Berlin, the impact of CO_2 on reservoir sandstones is investigated at field scale. Ketzin is located on the top of an anticline structure, which belongs to a double anticline formed during several episodes of halokinetic uprise of Permian salt. The storage reservoir belongs to the Stuttgart Formation (Keuper, Upper Triassic) and consists of two main sedimentary facies types. Channel sandstones (CH) formed by meandering river systems are considered as most perspective reservoir rocks for CO_2 storage. For storage considerations the second type of facies, characterized by overbank fine (OF) siltstones, is less important. These sediments exhibit only low porosity and permeability. During field operation of four years about 61,000 tons of almost pure CO_2 were injected.

This contribution presents preliminary results of an ongoing study of petrographic-mineralogical and geochemical features of rocks which suffered CO_2 attack during this period of time. Due to the high porosity and permeability, which promote gas-brine-rock interactions, analytical investigations were focused on the reservoir sandstones of the CH facies. In general such reactions will strongly affect reservoir quality. These processes are mainly controlled by fluid and rock chemistry and associated pH- and Eh-conditions. On one side, the precipitation of mineral phases (esp. pore-filling cements) can induce porosity and permeability deterioration, which will retard further fluid flow and an expansion of the CO_2 plume. On the other side, due to the dissolution of minerals, new porosity can be generated. One feasible way in trapping higher amounts of injected CO_2 will be the fixation of CO_2 by the precipitation of newly formed carbonate minerals.

In the studied samples which were exposed to CO_2 injection no indication of increased carbonate content (by precipitation) was established until now. Similarly, any indication for dissolution of preexisting carbonates is missing. Preexisting analcime cement is neither altered nor newly formed. Also no evidence for substantial mineral alteration, like corrosion and dissolution is provided. Porosity (as determined by point counting) remained virtually unchanged. Precipitation of minor amounts of anhydrite and (?) albite seems most reasonable. However, such small variations in rock composition are most probably in the range of the pristine natural heterogeneity of the samples.

This subordinate impact of CO_2 on reservoir quality is considered to be dominated by slow mineral reaction kinetics, implying that during the 4-year-period of injection, CO_2 was mainly capillary trapped and dissolved in the brine. These first results have to be substantiated by more detailed investigations, which are in progress.