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The effect of CO2 on the stability of fault zones in cap rocks of interest for CO2 storage

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The denseness and stability of cap rocks are important criteria regarding the selection of potential geological CO2 storage sites. Fault zones in the overburden can represent potentially weak zones in which CO2 leakage from the storage site may develop. Leakage might also change the stress field and thus the rock mechanical properties of the fault area.

To investigate these relationships, an experimental setup was designed within the BMBF-funded GEOTECHNOLOGIEN joint project CO2SEALS, to study experiment-related shear planes in natural rock samples, the changes in the mineralogical and rock mechanical properties and their interactions.

Within this project we investigate whether mineral reactions, which are caused by exposure of cap rocks to CO2-saturated formation water, increase the permeability in the fault zones or lead to self-healing.

We have experimentally produced annual shear planes will in several pelitic reference rocks. The punched samples are then installed in specially constructed reaction vessels, in which they are continuously percolated with a CO2-saturated NaCl-brine at defined pressure (5 bar) and temperatures (45 to 100 °C). By varying temperature and reaction time (up to 24 months) we expect to extract reaction rates from the experiments and also study the extent of alteration.

First results of experiments on the Opalinus Clay lasting 3 and 6 months show that the interaction between the CO2-saturated brine and the cap rock is mainly controlled by carbonate dissolution and precipitation processes. Changes observed in the chemical composition of the effluent suggest that other interactions –i.e. silicate alteration- also must have occurred between the CO2-saturated NaCl solution and the Opalinus. However, alterations of the solid phase caused by these experiments have not yet been documented.

Further shear test will reveal whether and to what extent such alterations affect the geomechanical properties and thus the stability of the cap rocks. For this purpose thin-layer shear tests at pressures up to 40 MPa normal stresses on powder samples (before and after reaction with CO2) will be carried out.