



Strength and Deformation Behaviour of Cap Rocks Above the CO₂SINK-Reservoir

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The cap-rock of the CO₂SINK storage site close to Ketzin consists of clay rich rocks which are typical for cap rock formations above CO₂ storage reservoirs. The strength and deformation behaviour of such claystone samples are therefore of fundamental importance for the characterization of secure geological storage of CO₂. The elastic and anelastic deformation behaviour limits the maximum injection pressure during CO₂-injection and is part of the security measures for the long term storage of CO₂. The laboratory experiments were performed on samples gathered from the injection well of the Ketzin pilot test site in Germany and are compared with the elastic and anelastic behaviour of samples from the same Keuper formation in a near-surface outcrop in the Southwest of Germany showing a similar lithology. The samples from the outcrop allowed drilling of samples with a standard size of 100 mm diameter and 200 mm height as well as large samples with a diameter of 550 mm and a height of 1200 mm.

The investigations have a special emphasis on the viscous behaviour of the clay stones and its scaling behaviour. A special triaxial testing procedure is applied both on standard and large size samples allowing the determination of the strength, stiffness and viscosity behaviour of the rock in one experimental run. Multi-stage technique (stepwise variation of the confining pressure) gives the strength behaviour of each single sample while applying a constant deformation rate. Stepwise varied deformation rates on the other hand lead to steps in the stress-strain-curve from which the viscosity index is determined. The viscosity index is directly used in the Norton's constitutive relations for viscoplastic simulations. The combination of tests allows for the determination of a broad range of elastic and anelastic properties.

The comparison of results – both for elastic and anelastic behaviour – from standard and large samples shows that for the examined rocks a scale effect is negligible. Transition from cataclastic to non-cataclastic behaviour – the transition limit – occurs in a similar range of applied levels of pressure and deformation rates even at room temperature. The obtained transition limit is very important for the judgment of the sealing capacity and integrity of the cap rock. The deformation rates predicted for the pressure and temperature conditions of the caprock at Ketzin test site are far beneath the determined transition limit during the injection and after stop of injection. As a 0° friction angle is used for pressure and deformation limit at Ketzin, the measured elastic and anelastic behaviour of the real caprock act as additional safety margin during injection and in the post injection phase. As the examined rocks are typical for many possible storage sites, the discussed results are of importance beyond the Ketzin Pilot Experiment CO₂SINK.