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Geomechanical characterization of an Upper Triassic reservoir rock (Stuttgart Formation) in the NE German Basin (pilot site for CO_2 storage at Ketzin, Germany)

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In order to investigate the influence of CO_2storage in a 730-710 m deep saline aquifer of Upper Triassic siliciclastic rock, a pilot project was set up at an anticlinal structure near the city of Ketzin/Havel, west of Berlin. Three new wells were drilled and since June 2008, about 57,000 tons of CO_2 (December 2011) have been injected. In 2011 an additional observation well was drilled. Lithologically, the Upper Triassic, which is referred asKeuper in Germany, consists of a multi-layered siliciclastic sequence ofpartly anhydriticclaystone, siltstone, sandstone and evaporitic deposits (halite, anhydrite and gypsum). Injection leads to a change of stress conditions in the reservoir and its faults wherefore it is necessary to understand and quantify structural geology, stress regime and geomechanical behavior from reservoir to cap rock. Notably, the interaction of faults, lithologic units and stress field in a multi layered sedimentary system might have a strong impact on fluid flow. The failure and faulting of the rock within a stress field is strongly governed by rock mechanical properties. Therefore a suite of geomechanical testing was undertaken on core material of reservoir rock. In particular the parameters unconfined compressive strength (UCS), Young's modulus E, Poisson's ratio ν, angle of internal friction φ and cohesion c were determined. The results of the geomechanical tests show a surprisingly wide range of values within one lithological unit. For the UCS the values vary between 8.1 and 177.5 MPa at which high values were measured for highly cemented, medium grained sandstone whereas very low test results were noted for weakly cemented, medium grained sandstone. Quite low compressive strengths ranging between 15.8 and 19.8 MPa was measured for clayey, fine sandy siltstone. Measurements on the partly well cemented, medium grained sandstone indicate medium range values from 59 to 76.2 MPa. Other important properties for estimation of the mechanical behavior of rock are the angle of internal friction φ and cohesion c, representing aspects determining failure occurrence that can be expressed and illustrated by the Mohr Coulomb failure criterion. As for the UCS there is also a wide range of values for φ (4.06° to 36.98°) and c (10.45 MPa to 49.41 MPa) which differ distinctly within similar lithologies. With respect to these differences further geomechanical tests in combination with petrographic investigations will be in focus to evaluate the impact of lithologal as well as lithofacial characteristics on geomechanical properties. Thus the lithological and lithofacial heterogeneous characteristics of the Stuttgart formation could influence significantly the geomechanical behavior and transmission of stresses resulting from CO_2 injection. Therefrom knowledge about these rock mechanical properties helps to provide a save and long term injection and prevent leakage scenarios.