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3D numerical simulation of pore pressure and stress coupling for CO_2 storage in deep saline aquifers: A case study from the Northeast German Basin

F. Magri (1), E. Tillner (1), E. Jolie (1), T. Kempka (1), O. Kolditz (2,3), I. Moeck (1), W. Wang (2), N. Watanabe (2), and G. Zimmermann (1)

(1) Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences, Potsdam, Germany (fabienma@gfz-potsdam.de), (2) Helmholtz Centre for Environmental Research - UFZ, Leipzig, Germany, (3) TU Dresden, Faculty of Forest, Geo and Hydro Science, Dresden, Germany

Geological storage of carbon-dioxide (CO_2) in saline aquifers has emerged as a promising method to reduce greenhouse gas emissions. Deep saline aquifers are quite common in sedimentary basins and are overlaid by natural sealing features such as impervious caprocks that prevent the CO_2 and formation fluids from leakage.
However, pressure buildup during injection as well as pressure falloff once injection stops can induce hydro-mechanical processes that can alter the physical properties within the reservoir and permeability distribution in the surrounding units. These transient hydro-physical conditions will in turn affect the migration of both, the CO_2 plume and residual brine. To numerically study these phenomena, the flow and the mechanical equations have to be solved together, requiring a hydro-mechanical coupling.
In the present study, numerical simulations of coupled pore pressure and stress are used to investigate the hydro-mechanical behavior of the CO_2 storage system with regard to the initial geological stress, pressure as well as porosity and permeability distribution. A prospective CO_2 storage site located in the Northeast German Basin serves as 3D geological framework for the investigation of potential hydro-mechanical processes. The open-source software packages TOUGH2 (Pruess et al., 1999) and OpenGeoSys (Wang et al., 2009) were used to solve the coupled hydro-mechanical equations.
The presented results illustrate a real study-case of hydro-mechanical effects in a well-constrained 3D geological basin based on characterization of residual rocks, and can therefore be representative for CO_2 storage in the Northeast German Basin.

References

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