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The Pressure Impact of CO2 Storage Operations on Neighboring Sites

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SUMMARY

Numerical simulations of CO2 storage are usually either generic, using simple brick or pie slice grids, or site specific, predicting CO2 flow and pressure increase for a given storage site. The pressure impact of CO2 storage operations on neighboring sites, where competing operational interests might exist, is still largely unknown. Here we present a saline aquifer showcase model from the Northeast German Basin (NEGB), predicting the regional pressure impact of an industrial scale CO2 storage operation on its surroundings. We emphasize that we do not intend to predict safe operation pressures at or near the well as this would require a very different model setup (grid resolution, injection schedule).

The static model is based on real geology while the injection program is fictitious. The geological model mimics the Buntsandstein Group of the NEGB in a slightly simplified fashion. We simulated a rate controlled injection of 2.5 Million tons CO2 per year through a single vertical well into the structural top of a dome shaped anticline, over a period of 10 years. The target is a 20 m thick sandstone layer intercalated in low permeability claystone sequences. We used ECLIPSE300 with its CO2STORE module and MUFTE-UG to predict pressure at the top of the sandstone layer in 1, 5, 10, and roughly 30 km distance to the injection point. The farthest point represents the structural top of a neighboring anticlinal dome, another favourable potential storage site. We varied the model s boundary conditions, permeability, permeability anisotropy, rock compressibility, and injection temperature. Comparison of the reference scenarios showed that the results of both simulators match well.

The parameters that had the largest impact on regional pressure increase are the model s boundary conditions, rock compressibility and permeability. In a model scenario with Dirichlet boundary conditions, pressure increase is lowest and dissipates back to the pre-injection state within 30 years after injection shutdown. In fully closed model scenarios with Neumann boundaries, pressure peaks are high, equilibrating to a remnant, model-wide overpressure several decades after the end of injection. In model scenarios which are laterally closed on one side, but open on the other, pressure relief is seriously retarded in comparison to the fully open model. In all cases, the pressure maximum arrives at the neighboring structure much later than the actual injection shutdown - at least 5 to 10 years in the open model and several decades in the no flow boundary models (depeding on permeability).