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Assessment of brine migration risks along vertical pathways due to CO_2 injection

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Global climate change, shortage of resources and the growing usage of renewable energy sources has lead to a growing demand for the utilization of subsurface systems. Among these competing uses are Carbon Capture and Storage (CCS), geothermal energy, nuclear waste disposal, “renewable” methane or hydrogen storage as well as the ongoing production of fossil resources like oil, gas and coal. Additionally, these technologies may also create conflicts with essential public interests such as water supply. For example, the injection of CO_2 into the subsurface causes an increase in pressure reaching far beyond the actual radius of influence of the CO_2 plume, potentially leading to large amounts of displaced salt water.

In this work we focus on the large scale impacts of CO_2 storage on brine migration but the methodology and the obtained results may also apply to other fields like waste water disposal, where large amounts of fluid are injected into the subsurface. In contrast to modeling on the reservoir scale the spatial scale required for this work is much larger in both vertical and lateral direction, as the regional hydrogeology has to be considered.

Structures such as fault zones, hydrogeological windows in the Rupelian clay or salt domes are considered as potential pathways for displaced fluids into shallow systems and their influence has to be taken into account. We put the focus of our investigations on the latter type of scenario, since there is still a poor understanding of the role that salt diapirs would play in CO_2 storage projects.

As there is hardly any field data available on this scale, we compare different levels of model complexity in order to identify the relevant processes for brine displacement and simplify the modeling process wherever possible, for example brine injection vs. CO_2 injection, simplified geometries vs. the complex formation geometry and the role of salt induced density differences on flow.

Further we investigate the impact of the displaced brine due to CO_2 injection and compare it to the natural fluid exchange between shallow and deep aquifers in order to asses possible damage.