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A Field-Data Based Numerical Investigation of Factors Controlling CO2 Plume Migration in Storage Candidate Sites

Wednesday, 1 June 2022 11:45 (15 minutes)

Field-data-based numerical simulations of CO2 injection and plume migration are carried out to investigate competing impacts of geo-heterogeneity, top-seal topography, and flow rate on the shape of the evolving injection plume and the ensuing CO2 saturation distribution. The presented sensitivity analysis is performed on cylinder-shaped well-spot models, which capture property distributions and spatial correlations of the heterogeneous fluvio-deltaic sandstones in the Otway basin, Victoria, taking into account novel rate-dependent and heterogeneity-aware saturation functions derived from an analysis of thinly-bedded sandstone cores. To resolve the impact of this lithologic complexity, we use the Australian CO2 Geo-Sequestration Simulator (ACGSS), a hybrid finite element –finite volume compositional simulator for space-time adaptive simulation.

Preliminary results indicate that the nested bedforms and other intermediate-scale geologic features determine plume spreading in models with a flat top-seal. Due to its high mobility, CO2 displacement is unstable and confined to high-permeability streaks, leading to multi-layer plumes. Seal topography controls plume spreading in uneven models, where permeability heterogeneity still has a major impact on plume shape. Comparisons for different injection rates shows that high injection rates cause viscous and heterogeneity-induced fingering. Low injection rates lead to gravity override and buoyant rise of the plume. For closed lateral boundaries, the plume develops a more cylindrical compact shape than for constant pressure open boundaries. An asymptotic build-up of fluid pressure is observed. Since CO2 velocity in the nested heterogeneous rocks varies over many orders of magnitude, the novel anisotropic flow rate-dependent saturation functions operate between the capillary and viscous limits, creating significant differences in the shape of the evolving saturation front and the plume saturation as compared with standard saturation functions.

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References

Time Block Preference

Time Block A (09:00-12:00 CET)

Participation

Online

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