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Field-scale Modeling of CO2 Injection into Highly Reactive Rocks

Wednesday, 1 June 2022 16:00 (15 minutes)

Injection of anthropogenic carbon dioxide into deep geological formations requires one or more trapping mechanisms to keep the CO2 contained in the injection formation. The most stable of these trapping mechanisms is mineral trapping where the injected carbon is ultimately trapped in solid form via precipitation of carbonates. While mineral trapping in most sedimentary formations is extremely slow and not of practical relevance, injection into highly reactive rocks like flood basalts may result in substantial mineral trapping on shorter time scales. Laboratory and small-scale field experiments show very fast reaction time scales, on the order of months to years. To understand how such systems will behave at large spatial scales, consistent with practical field-scale injection operations, we have developed a field-scale model for CO2 injection and migration that includes mineral reactions. The model assumes the injection takes place in a deep saline aquifer and uses a vertically integrated set of governing equations, based on a vertical equilibrium assumption for the buoyant two-phase flow system. The model includes CO2 dissolution into the aqueous phase with an associated upscaled representation of convective mixing in the brine, residual CO2 saturations that lead to capillary trapping of separate-phase CO2, a set of reactions both within the aqueous phase and involving the rock matrix, and calculation of porosity changes associated with the mineral reactions. The model allows for many different scenarios to be investigated. Simulations results show how mineral reactions that proceed rapidly at small spatial scales are tempered by mass-transfer limitations between different regions in the vertical equilibrium model. Results also provide quantification of porosity changes with associated implications for possible pore clogging due to carbonate precipitation. Advantages and disadvantages can also be identified for different injection strategies including comparison between injection of separate-phase CO2 and injection of an aqueous phase pre-saturated with dissolved CO2.

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Time Block Preference

Time Block B (14:00-17:00 CET)

Participation

In person

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