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Contribution ID: **576** Type: **Oral Presentation**

Rayleigh-Taylor Instability in 2D and 3D Dispersive Porous Medium

Friday, 4 June 2021 15:30 (15 minutes)

CO_2 injected in deep saline aquifers for subsurface carbon sequestration is supercritical (sCO_2), and thus less dense than the resident brine. The plume of sCO_2 to the top of the formation and widens under the cap rock, where it is placed above the brine. Due to its partial solubility in the brine, sCO_2 dissolves into it, leading to the formation, at its interface with the brine, of an aqueous mixture which is denser than the brine. A gravitational instability then develops, and the convection that ensues allows dissolved CO_2 to be transported deeper into the formation, where it remains trapped by gravity. The convection also puts the sCO_2 with CO_2-devoid brine, which nurtures the dissolution process. This convective dissolution in essence results from the coupling between dissolution of sCO_2 into the aqueous phase, buoyancy-triggered flow of the latter phase, and transport of the dissolved CO_2 within it. When modeled at the continuum (i.e., Darcy) scale, the solute transport equation must take into account dispersion. Continuum scale numerical simulation of convective dissolution has attracted much attention ; many of these previous studies have considered simple diffusive transport (i.e., a constant diffusion/dispersion coefficient in the transport equation), and few of them have tackled three-dimensional (3D) geometries. We present a numerical investigation, based on the open source numerical toolbox OpenFOAM associated to a custom-written solver relying on the stream function, of convective dissolution in two-dimensional (2D) and 3D geometries, taking into account dispersive transport through a classic anisotropic dispersion tensor proportional to the local Darcy velocity and featuring two main parameters: (i) the dispersion's strength (as compared to molecular diffusion), and (ii) the ratio of the longitudinal dispersivity to the transverse dispersivity. A systematic study was performed as a function of these two parameters and of the Rayleigh number, which quantities the relative importance of convection-controlled advective transport and dispersive transport. The convective dissolution process is characterized in terms of the onset times of the linear instability and of nonlinear convection, the number density of convective fingers, and the associated flux of dissolved CO_2. The onset time of nonlinear convection is found to strongly depend on the Rayleigh number, but not of the intensity of dispersion. However the two parameters characterizing dispersion have a strong influence on the global time scale of CO_2 dissolution. We also discuss the differences in convective finger structures between the 2D and 3D geometries, and their consequences on the convective dissolution process.

Time Block Preference

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

References

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