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Stochastic characterization of gravity currents in heterogeneous porous media

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The migration of the CO_2 injected in a saline aquifer is controlled by the gravitational and viscous forces. Initially, the buoyant CO_2 advances as a gravity current that dissolves into the underlying brine by diffusion. The CO_2-brine mixture is denser than the two initial fluids, leading to a Rayleigh-Bénard-type instability known as convective mixing, which greatly accelerates CO_2 dissolution. The advancing front can display a stable (gravity current) or fingering shape depending on the relation of the governing forces. The properties of the porous medium, which is usually considered homogeneous, are also important for the dynamics of the problem. The effect of heterogeneity and the scale dependency of dispersivity in the gravity current generated during CO_2 injection is studied by means of a stochastic approach. In the stochastic approach, the spatially varying conductivity field is modeled as a typical realization of an ensemble of conductivity fields, which is characterized by its joint distribution density. Numerical simulations using sets of randomly generated conductivity fields realizations (Mote Carlo approach) will be used to obtain ensemble and effective parameters. Numerical results are used to analyze the impact of variance and spatial correlation of conductivity fields on the fingering or stable behavior of the plume, its shape and migration velocity.