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Weakly nonlinear convection induced by the sequestration of CO_2 in a perfectly impervious geological formation LIET VO, LAYACHI HADJI, The University of Alabama — Linear and weakly nonlinear stability analyses are performed to investigate the dissolution-driven convection induced by the sequestration of carbon dioxide in a perfectly impervious geological formation. We model this situation by considering a Rayleigh-Taylor like base state consisting of carbon-rich heavy brine overlying a carbon-free layer. We quantify the influence of carbon diffusion anisotropy, permeability dependence on depth and the presence of a first order chemical reaction between the carbon-rich brine and host mineralogy on the threshold instability conditions and associated flow patterns. The weakly nonlinear analysis is performed using long wavelength asymptotics valid for small Damköhler numbers. We derive analytical expressions for the solute flux at the interface. We delineate necessary conditions for the onset of the fingering pattern that is observed in laboratory and numerical experiments when the constant flux regime is reached. Using the derived interface flux conditions, we put forth differential equations for the time evolution and deformation of the interface as it migrates upward while the carbon dioxide is dissolving into the ambient brine. We solve for the terminal time when the interface reaches the top boundary and the shutdown regime begins.

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