Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Non-Boussinesq Dissolution-Driven Convection and Pattern Formation in Confined Porous Media MOHAMMAD AMIN AMOOIE, MOHAMMAD REZA SOLTANIAN, JOACHIM MOORTGAT, Ohio State Univ - Columbus — Geological carbon dioxide (CO2) sequestration in saline aquifers has been recognized as a technology to stabilize the atmospheric carbon concentrations. Solubility trapping as one of the storage mechanisms is associated with diffusion-driven slow dissolution of gaseous CO2 into the aqueous phase, followed by fast density-driven convective mixing of CO2. We study the fluid dynamics of CO2 convection in the underlying single aqueous-phase region. Two modeling approaches are presented: (i) constant-concentration condition for CO2 in aqueous phase at the top boundary, and (ii) sufficiently low, constant injection-rate for CO2 from top boundary. The latter allows for evolution of CO2 composition against the rate at which the dissolved CO2 convects. We model the full nonlinear phase behavior of brine-CO2 mixture in a confined domain altered by dissolution and compressibility, while relaxing the common Boussinesq approximation. We discover new flow regimes and present quantitative scaling relations for global characters of spreading, mixing, and dissolution flux in two- and three-dimensional media. Our findings confirm the sublinear Sherwood-Rayleigh scaling for the constant-concentration case, while reconciling the classical linear scaling for the constant-injection model problem.

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Date submitted: 31 Jul 2017 Electronic form version 1.4