Abstract Submitted
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Convective dissolution in porous media JEROME NEUFELD, University of Cambridge, MARC HESSE, University of Texas at Austin, AMIR RIAZ, University of Maryland, MARK HALLWORTH, University of Cambridge, HAMDI TCHELEPI, Stanford University, HERBERT HUPPERT, University of Cambridge — Motivated by the geological storage of buoyant carbon dioxide (CO_2) we investigate dissolution of CO_2 into brine which increases security of storage over time. The rate of CO_2 dissolution is determined by convection in the brine driven by the increase of brine density with CO_2 saturation. We present a new analogue fluid system that reproduces the nonlinear density behaviour of CO_2 and brine. We show that the convective flux is proportional to the Rayleigh number to the 4/5 power through a combination of laboratory experiments and high-resolution numerical simulations, in contrast with a classical linear relationship. This relationship allows us to extrapolate from the laboratory scale to geophysical scales. A scaling argument that incorporates the effect of the large-scale flow on mixing at the CO_2-brine interface confirms this nonlinear relationship for the convective flux and provides a physical picture of high Rayleigh number convection in a porous medium. The resultant model makes quantitative predictions of the CO_2 dissolution rates in natural and anthropogenic CO_2 accumulations. For example, at the Sleipner field we estimate a dissolution rate of roughly 10% of the annual injected mass suggesting that storage security is significantly enhanced.

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