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Scaling of convective dissolution in porous media[1] JUAN J. HIDALGO, LUIS CUETO-FELGUEROSO, Massachusetts Institute of Technology, Cambridge MA, USA, JAIME FE, University of A Coruna, A Coruna, Spain, RUBEN JUANES, Massachusetts Institute of Technology — Convective mixing in porous media results from the density increase in an ambient fluid as a substance (a solute or another fluid) dissolves into it., which leads to a Rayleigh-Bènard-type instability. The canonical model of convective mixing in porous media, which exhibits a dissolution flux that is constant during the time period before the convective fingers reach the bottom of the aquifer, is not described by the Rayleigh number Ra [Hidalgo & Carrera (2009), J. Fluid Mech.; Slim & Ramakrishnan (2010), Phys. Fluids]. That suggests that dissolution fluxes should not depend on Ra. However, this appears to be in contradiction with recent experimental results using an analogue-fluid system characterized by a non-monotonic density-concentration curve, which naturally undergoes convection [Neufeld et al. (2010), Geophys. Res. Lett.; Backhaus, Turitsyn & Ecke (2011), Phys. Rev. Lett.]. Here we study the scaling of dissolution fluxes by means of the variance of concentration and the scalar dissipation rate. The fundamental relations among these three quantities allow us to study the canonical and analogue-fluid systems with high-resolution numerical simulations, and to demonstrate that both the canonical and analogue-fluid systems exhibit a dissolution flux that is constant and independent of Ra. Our findings point to the need for alternative explanations of recent nonlinear scalings of the Nusselt number observed experimentally.

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