Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Gravity currents arrested by convective mixing CHRISTOPHER MACMINN, MICHAEL SZULCZEWSKI, JUAN HIDALGO, RUBEN JUANES, Massachusetts Institute of Technology — The large-scale injection of carbon dioxide (CO2) into deep saline aquifers is a promising tool for reducing atmospheric CO2 emissions to mitigate climate change. Trapping of the buoyant CO2 after injection is essential in order to minimize the risk of leakage into shallower formations through a pre-existing well or fracture, or via the activation of a fault. However, traditional reservoir-simulation tools are currently unable to resolve the impact of small-scale trapping processes on fluid flow at the scale of a geologic basin. Here, we use analog experiments to study solubility trapping of the CO2 via convective mixing, where dense fingers of CO2-rich groundwater carry CO2 away from the buoyant plume as it dissolves. We study the impact of convective mixing on a buoyant gravity current migrating up-dip in a sloping aquifer (a Hele-Shaw cell packed with glass beads), and we show that a simple upscaled model reproduces the macroscopic features of this complex physical process both qualitatively and quantitatively. We then estimate the dimensionless rate of solubility trapping for several large saline aquifers in the United States in order to assess the importance of solubility trapping in practice.

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Date submitted: 04 Aug 2011 Electronic form version 1.4