Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

Interfacial Motion and Convective Shutdown DUNCAN HEWITT, ITG, DAMTP, University of Cambridge, JEROME NEUFELD, ITG, DAMTP, & Department of Earth Sciences & BP Institute, University of Cambridge, JOHN LISTER, ITG, DAMTP, University of Cambridge — We present theoretical, numerical and experimental models of the shutdown of convection in a sealed porous domain that is initially stably stratified in two fluid layers. The equation of state is such that the solution which forms at the interface is more dense than either layer. The resultant convective flux across the moving interface slowly shuts down due to the increase in the average lower-layer density. We examine a variety of physical systems, comprised of either immiscible or miscible fluids. In the latter case, diffusion above the interface has a surprising and significant effect at late times. In each case, we develop theoretical box models, based on a rigid-lid assumption for the moving interface, which compare very well with numerical simulations. We explore the validity of the rigid-lid approximation using numerical simulations and experimental results from a Hele-Shaw cell. These both show that interfacial deformation can significantly increase the convective flux, particularly for miscible fluids. Our results have application to a range of geophysical systems, and are particularly relevant to the long-term stability of geologically sequestered CO_2 in a saline aquifer.

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Date submitted: 06 Aug 2012 Electronic form version 1.4