CAPILLARY PINNING OF CO2 GRAVITY CURRENTS

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Gravity currents in a porous medium have attracted much interest recently in the context of geological carbon dioxide (CO2) storage, where CO2 is captured from the flue gas of power plants and injected underground into deep saline aquifers. Capillary effects can be very important in the spreading and migration of the buoyant CO2 after injection because the typical pore size is very small (~100 um), but the impact of capillarity on these flows is not well understood.
Here, we study the impact of capillarity on the classical problem of the density-driven exchange flow between adjacent reservoirs, or "lock exchange". Via simple, table-top experiments, we show that capillarity leads to the development of striking features not present in the classical lock-exchange solution, including a vertical pinned interface and sharp corners. However, the right- and left-propagating currents nevertheless advance according to the classical scaling of x~t1/2. The magnitude of the deviation from the classical solution scales linearly with the strength of capillarity relative to gravity, as measured by the inverse of the Bond number. We further show that the unique flow features can be well captured by incorporating capillarity into the classical gravity current model.