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Gravity currents with residual trapping in confined, sloping aquifers[1] MARC HESSE, FRANKLIN ORR, JR., HAMDI TCHELEPI, Stanford University — Motivated by geological CO_2 storage, we present a sharp-interface vertical equilibrium model for the migration of immiscible gravity currents with constant residual trapping in a two-dimensional, sloping, confined aquifer. The continuous trapping decreases the current volume until the current is exhausted. Analytic and semi-analytic solutions for the limiting hyperbolic problem are derived. Comparison with numerical solutions show that the limiting solutions are good approximation to the numerical solution for high mobility ratios, even for Peclet numbers of order unity. In these cases our analysis shows that the dimension less migration time and distance increase with increasing mobility ratio and decrease with increasing trapped saturation, but they are only a weak function of the slope as long as the slope is finite. In sloping aquifers the current evolution is divided into two stages: an initial stage of power-law decrease of volume - similar to horizontal aquifers - followed by a later stage of rapid volume reduction. Several large regional saline aquifers are gently sloping, but lack a structural closure. Our results suggest that the efficient residual trapping induced by slope of the aquifer may allow CO_2 storage.

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