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Viscous, gravitational and capillary forces in 3D experiments with a synthetic porous media

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We explore the interplay between viscous, gravitational, and capillary forces in flow in porous media, using two different boundary conditions and employing our unique 3D-scanner, based on optical index matching [1]. Our findings are considered in comparison with experiments on 2D systems, investigating how the transitions between flow regimes can be captured by a dimensionless fluctuation number, as described in [2,3]. In both cases we look at a more viscous, more dense fluid invading a less viscous, less dense one from above. Gravity here destabilizes the invasion, but this is countered by the viscous pressure drop in the invading fluid. We capture the transition, as a function of flow rate, and find a crossover at F = 0 between viscosity-stabilized and gravity-unstable invasion. In the first case (Figure 1), we inject from a point high in a sealed cell, with an outlet at a constant pressure at the bottom. We observe a stabilized, dense invasion body near the inlet, with increasing size and a well-defined spheroid shape as we increase the flow rate. The flow transitions to unstable fingering at a radius corresponding to F = 0. In the second case, we present ongoing experiments with the same fluid pair, with the more viscous, more dense fluid now invading from above with a front initialized spanning the full cell cross section. We measure a front width that is a function of the flow rate and investigate if we also here can find a crossover at F = 0.

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Participation

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