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Deformation of a 3D granular media caused by fluid invasion
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— Multiphase flow in porous media plays a fundamental role in many natural and engineered subsurface processes. The interplay between fluid flow, medium deformation and fracture is essential in geoscience problems as disparate as fracking for unconventional hydrocarbon production, conduit formation and methane venting from lake and ocean sediments, and desiccation cracks in soil. Several experimental and computational studies have shown that the competition between capillary and friction forces can lead to different regimes of deformation, from frictional fingering to hydro-capillary fracturing (Sandnes et al., Nat. Comm. 2011, Holtzman et al., PRL 2012). Most of these investigations have focused, however, on 2D or quasi-2D systems. Here, we develop an experimental set-up that allows us to observe two-phase flow in a fully 3D granular bed and measure the fluid pressure while controlling the level of confining stress. We use an index matching technique to directly visualize the injection of a liquid in a granular media saturated with another, immiscible liquid. We extract the deformation the whole granular bulk as well as at the particle level. Our results show the existence of different regimes of invasion patterns depending on key dimensionless groups that control the system.

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