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Flow-induced compaction of soft poroelastic materials JAPINDER S. NIJJER, DUNCAN R. HEWITT, M. GRAE WORSTER, JEROME A. NEUFELD, Univ of Cambridge — Fluid flows through poroelastic materials can result in solid deformation driven by the distribution of viscous shear stresses. The porosity and permeability of the solid matrix is altered spatially through a non-trivial coupling to the fluid flow. This behaviour is studied experimentally by examining fluid flow through a packing of soft hydrogel spheres driven by an imposed pressure head. The pressure head is varied, and, for each pressure, the steady-state mass flux and solid deformation are measured. For large pressure gradients, the fluid flow is found to decrease the permeability in such a way as to produce a flux that is independent of the applied pressure gradient. Measurements of the internal deformation, obtained by particle tracking, show that the medium compacts non-uniformly, with the porosity being lower at the outlet compared to the inlet. Intriguingly, we find a reproducible hysteresis of the poroelastic deformation between increasing and decreasing increments of the applied pressure head. The experimental results are compared to a simple one-dimensional model that accounts for non-linear elasticity of the solid and non-constant permeability.

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