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Large poroelastic deformation of a soft material CHRISTOPHER W. MACMINN, University of Oxford, ERIC R. DUFRESNE, Yale University, JOHN S. WETTLAUFER, Yale University, University of Oxford — Flow through a porous material will drive mechanical deformation when the fluid pressure becomes comparable to the stiffness of the solid skeleton. This has applications ranging from hydraulic fracture for recovery of shale gas, where fluid is injected at high pressure, to the mechanics of biological cells and tissues, where the solid skeleton is very soft. The traditional linear theory of poroelasticity captures this fluid-solid coupling by combining Darcy's law with linear elasticity. However, linear elasticity is only volume-conservative to first order in the strain, which can become problematic when damage, plasticity, or extreme softness lead to large deformations. Here, we compare the predictions of linear poroelasticity with those of a large-deformation framework in the context of two model problems. We show that errors in volume conservation are compounded and amplified by coupling with the fluid flow, and can become important even when the deformation is small. We also illustrate these results with a laboratory experiment.

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