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Fluid Drainage from Porous Reservoirs[1] ZHONG ZHENG, Department of Mechanical & Aerospace Engineering, Princeton University, BEATRICE SOH, Department of Chemical & Biological Engineering, Princeton University, HERBERT HUPPERT, Institute of Theoretical Geophysics, Department of Applied Mathematics and Theoretical Physics, University of Cambridge, HOWARD STONE, Department of Mechanical & Aerospace Engineering, Princeton University, STONE GROUP TEAM — We report theoretical and experimental studies to describe buoyancy-driven fluid drainage from a porous medium. We first study homogeneous porous systems. To investigate the influence of heterogeneities, we consider the case where the permeability varies transverse to the flow direction, exemplified by a V-shaped Hele-Shaw cell. Finally, we analyze a model where both the permeability and the porosity vary transverse to the flow direction. In each case, a self-similar solution for the shape of the gravity current is found and a power-law behavior in time is derived for the mass remaining in the system. Laboratory experiments are conducted in homogeneous and V-shaped Hele-Shaw cells, and the measured profile shapes and the mass remaining in the cells agree well with our model predictions. Our study provides new insights into drainage processes such as may occur in a variety of natural and industrial activities including the geological storage of carbon dioxide.

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