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Forced Imbibition in Stratified Porous Media NANCY LU, AMIR PAHLAVAN, CHRISTOPHER BROWNE, DANIEL AMCHIN, HOWARD STONE, SUJIT DATTA, Princeton University — Imbibition plays a central role in diverse energy, environmental, and industrial processes, including oil and gas recovery from unconventional reservoir rocks. In many cases, the medium has multiple parallel strata of different permeabilities; however, how this stratification impacts imbibition is poorly understood. We address this gap in knowledge by directly visualizing forced imbibition in three-dimensional (3D) porous media with two parallel strata. We find that imbibition is spatially heterogeneous: for small capillary number Ca, the wetting fluid preferentially invades the fine stratum, while for Ca above a threshold value, the fluid instead preferentially invades the coarse stratum. This threshold value depends on the medium geometry, the fluid properties, and the presence of residual wetting films in the pore space. These findings are well described by a linear stability analysis that incorporates crossflow between the strata. Thus, our work provides quantitative guidelines for predicting and controlling flow in stratified porous media.

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