Two-phase flows of yield-stress fluid in porous media : Flow regimes and invasion patterns

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Résumé

We investigate flows of yield-stress fluids using a pore-network model, a simplified representation of porous media. Dynamic two-phase flows are considered, where a Newtonian fluid is injected into a medium initially saturated with a yield-stress fluid. A breakthrough criterion is derived and three novel flow regimes are identified and studied : a stable-front regime, and two invasion patterns that arise from the presence of the yield stress. When the invading Newtonian fluid is highly viscous, preferential flow paths develop for high yield stress values and lead to the formation of a column-like invasion pattern. In contrast, for lower viscosities, a directed tree structure emerges from the branching of the advancing paths. To distinguish these different flow regimes, we introduce a set of dimensionless parameters and construct a phase diagram using qualitative observables.

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