Flow barriers and channels in heterogeneous porous media: Detection and visualization by viscous energy dissipation

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Résumé

Flow and transport in heterogeneous porous media strongly depend on the connectivity of the high conductivity component. Frequently, small critical regions determine the overall flow behavior.
Energy dissipation approaches make it possible to detect these regions, yielding more accurate effective properties (1).
We have simulated flow in a synthetic binary medium (b) with a high conductivity (khigh = 100m/day) and a low one (klow = 0.01m/day). No flow boundary conditions are applied in the vertical boundaries while a pressure gradient exists between the inlet (bottom) and the outlet (top). The resulting energy dissipation maps are shown in (a) (with khigh: , klow :), and in (c) (with khigh: , klow :). Zooms over a small critical region are shown in the bottom row (d, e, f).
When khigh paths connect inlet and outlet (i.e. when percolation of the khigh component occurs) energy dissipation is distributed mostly along flow channels (a, d). Otherwise, channelization is absent and energy dissipation is distributed along barriers (c, f).

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