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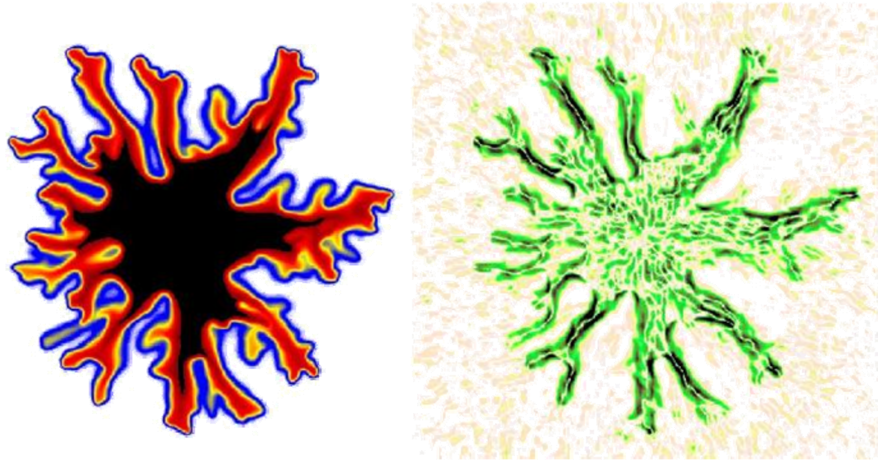

Figure 1 Viscous fingering is a morphological pattern in an unstable interface between two fluids in a porous medium. It occurs when a less viscous fluid displaces a more viscous one. The images demonstrate the concentration (left) and vorticity (right) of injecting a miscible fluid of lower viscosity in a heterogeneous porous medium associated with a correlation length of *l=0.02* and variance *s=0.6*.

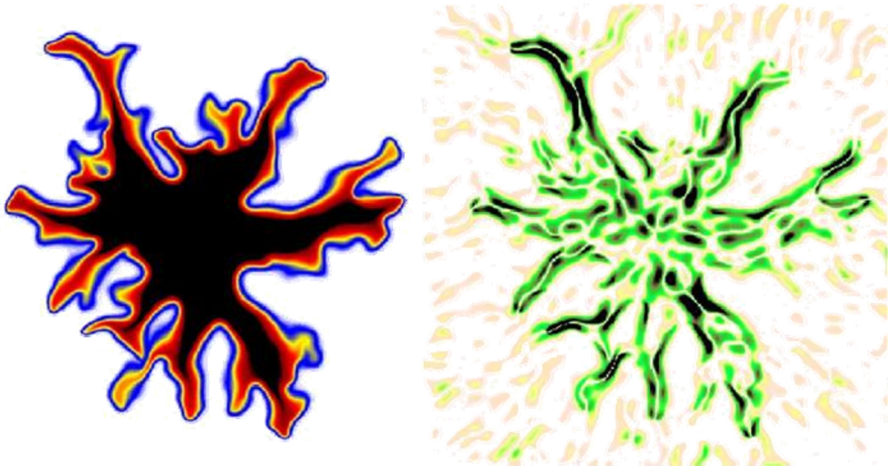

Figure 2 The images demonstrate the concentration (left) and vorticity (right) of injecting a miscible fluid of lower viscosity in a heterogeneous porous medium associated with a correlation length of *l=0.05* and variance *s=0.8*.

Miscible Injection in a Heterogeneous Porous Medium *

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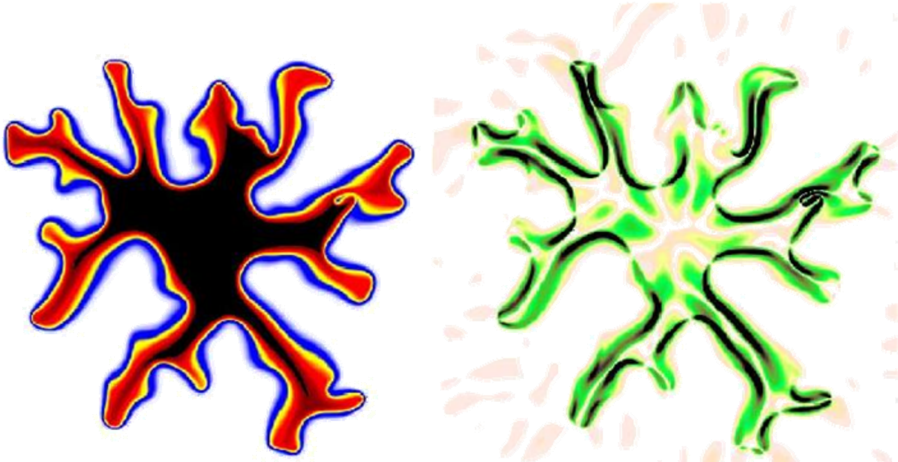

Figure 3 The images demonstrate the concentration (left) and vorticity (right) of injecting a miscible fluid of lower viscosity in a heterogeneous porous medium associated with a correlation length of *l=0.1* and variance *s=0.6*.

Radial injecting flows in porous media are highly relevant to the oil recovery process. To enhance oil recovery, miscible or immiscible fluids are injected into the oil reservoir to displace the crude oils toward the production well. The injected fluids are often much less viscous than the displaced crude oils. Because of the significant viscosity contrast, fingering instability occurs on the interface. Nevertheless, presences of the fingering instability generally reduce the recovery efficiency. As a result, significant efforts had been devoted to investigate the fingering patterns and control to the injection processes [1]. One of the important parameters dominates the fingering patterns is the permeability heterogeneity [2-4], which might commonly encounter in the practical reservoir. Coupled by additional permeability heterogeneity, which is statistically dominated by the correlation length scale and variance, the pattern morphology could appear dramatical alternation from a homogenous displacement. Simulated images representing pattern formation of miscible interfacial fingerings in a 2-dimensional heterogeneous porous medium are demonstrated for various statistical parameters of permeability heterogeneity, such as the correlation length (*l*) and the variance (*s*).

Two dimensional Darcy's law is numerical solved by a highly accurate scheme [3,4]. Heterogeneous permeability fields k(x,y) associated with desired statistical distribution are expressed in terms of a characteristic value K and random function g(x,y), whose Gaussian distribution is characterized by the variance s and the spatial correlation scale *l* [2-4]. We thus obtain

$$k(x,y) = Ke^{g(x,y)},$$

$$g(x,y) = s^2 \exp(-\pi \left[(\frac{x}{l})^2 + (\frac{y}{l})^2 \right]).$$

Shown in the figures are representative comparisons of fingering patterns and their corresponding induced vorticity, in which the injected fluid is 24.5 times less viscous than the displaced fluid. The fingering patterns appear more irregularly coupled by permeability heterogeneity. Growths of fingers tend more preferred toward the regions of higher permeability. The correlation length scales affect significantly to the widths and prominences of branching fingers, which is originally dominated by the diffusion. While vigorous thin branching fingerings are observed in a smaller correlation length of *l=0.02* as shown in Figure 1, side branches are gradually suppressed for increasing correlation lengths of *l=0.05* and *l=0.1*, which are respectively demonstrated in Figure 2 and 3.

ACKNOWLEDGEMENT

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