Relative Permeability of microfractured formations

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ABSTRACT:

Most subsurface formations are fractured and fractures are present on a variety of length scales. Fractures control the overall conductivity (permeability) of the rock; whereas the rock matrix provides the storage space. The connectivity and mass exchange of the matrix-fracture system is presently not well understood, primarily because it is difficult to experimentally capture the dynamics of the transfer in three dimensions.

In this study, we focus on two phase flow in microfractures and the neighboring matrix, both of which are in capillary dominated regime (millimeter scale or less). We use a combination of the level set method based progressive-quasistatic (LSMPQS) algorithm and lattice-Boltzmann simulation to characterize the capillary dominated flow properties (capillary pressure-saturation and relative permeability-saturation relationships) of the matrix and fracture in a polyethylene sample. At the same time we use image analysis tools to characterize the connectivity and tortuosity of the pore space, as well as individual fluid phases at different saturations. We find that in order to describe (relative) permeability of the microfractured system, and link it to tortuosity of each phase, we have to clearly distinguish the length scales of pore space pathways incorporated in tortuosity calculation.