

Next-Generation Theory and Modeling Approach for Multiphase Flow in Porous Media

Opportunity

Multiphase flow in porous media is important for a number of research areas, including CO₂ geological sequestration and reactive transport in vadose zone. However, the currently used theoretical framework simply assumes the same form of physical laws for multiphase flow at different scales and has failed predicting flow behavior in many cases.

Approach

Multiphase flow in porous media is a complex (chaotic) process whose features can be used for developing large-scale physical laws. For example, self-organization may result in emergent flow patterns corresponding to minimal flow resistance.

Meso Challenge

While multiphase flow theory is well established at small scales, physical laws for multiphase flow at relatively large scales of practical interest are still lacking due to the strong non-linearity of the flow processes. It is highly needed to develop these physical laws based on small-scale counter parts.

Impact

Preliminary results already indicate that large-scale physical laws for multiphase flow is fundamentally different from small-scale ones. The proposed work may provide a new direction for multiphase flow research by linking parameters and physical laws at different scales.

References: Liu, H.H. , 2011. A conductivity relationship for steady-state unsaturated flow processes under optimal flow conditions. Vadose Zone Journal 10: 736-740.

