71i Multiscale Modeling of Transport in Fractured Porous Materials

Le Yan, Matthew Balhoff, and Karsten E. Thompson

The transport of fluid and solutes through fractured porous materials is governed by multiple length scales: fracture asperities and other heterogeneities affect the flow pattern in the fractures, while a much smaller length scale governs transport within the porous matrix. The coupling of these two scales means that this problem cannot be modeled effectively with traditional continuum approaches.

To address this problem, we have developed a multiscale approach. The fracture geometry is created using a simulated annealing algorithm, which reproduces the statistical geometry of naturally fractured materials. Fluid flow within the fracture is modeled using a microscale approach. Fluid in the porous matrix is modeled using a continuum numerical solution. The regions are coupled using an iterative technique that ensures flux boundary conditions match over the fracture surfaces.

We present the details of the model followed by simulations that illustrate the dependence of transport on key parameters in the system: matrix permeability, fracture geometry, and the overall boundary conditions. We also illustrate how this model can be integrated into a macroscopic model, which would capture a third much larger relevant scale.