Porosity-permeability evolution in heterogeneous mineral dissolution and precipitation scenarios

LAUREN E. BECKINGHAM[1], JACOB BENSINGER[2], JEFFERY H. STEINWINDER[2], MOLLIE SABO[2]

[1]Department of Civil Engineering, Auburn University, Auburn, AL, USA, leb@auburn.edu
[2]Department of Civil Engineering, Auburn University, Auburn, AL, USA

Mineral dissolution and precipitation reactions can impact the porosity and permeability of porous media in complex ways. Permeability evolution is particularly challenging to predict and depends on the spatial distribution of reactions in individual pores and the larger pore network. Mineral reactions have been observed to occur both uniformly on all surfaces and non-uniformly, controlled by the distribution of reactive surfaces or pore and throat sizes, for example. Pore network modeling is a computationally efficient way to simulate the impact of pore-scale reactions on permeability evolution, requiring only pore and pore-throat size distributions and pore connectivity. Here, pore network models are developed and used to examine permeability evolution for a variety of uniform and non-uniform mineral reaction scenarios. The impact of variations in pore and pore-throat size distributions on porosity-permeability evolution and systems where porosity and permeability occur concurrently are also considered. Simulation results are compared with common macroscopic porosity-permeability relationships. Simulated porosity-permeability evolution depends on the spatial location of mineral reactions and is not qualitatively largely impacted by pore and pore-throat size distributions. Macroscopic porosity-permeability relationships work well for some scenarios but are unable to reflect permeability evolution when reactions initiate in small or large pores and pore-throats and a new modified version of the Verma-Pruess relationship is developed here for these scenarios.