Pore-Scale and Multiscale Numerical Simulation of Flow and Transport in a Laboratory-Scale Column

Objective

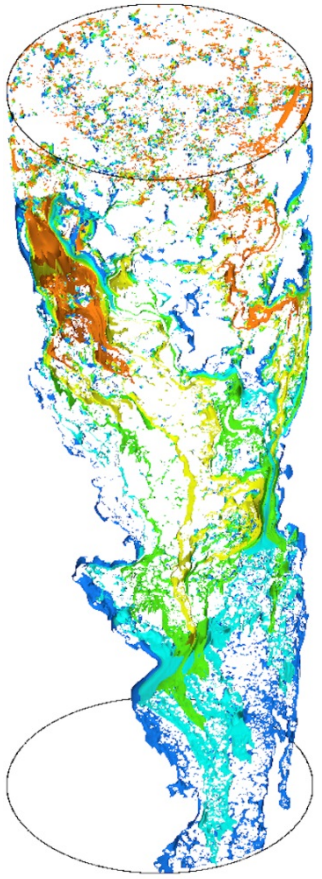
- Develop and demonstrate methodology and high-performance simulation code for modeling pore-scale water flow and solute transport over a decimeter-scale domain.

Approach and Results

- Ternary segmentation of X-ray microtomography images to define geometry of large pores, solids, and microporous solid regions.
- Computational fluid dynamics (CFD) solution of Navier-Stokes equations in open pores, combined with linear momentum loss term to simulate flow in microporous regions.
- Simulation of flow and transport using the ternary segmentation provided an excellent match to laboratory observations.

Significance and Impact

- Simulation of flow and transport at the pore scale is mechanistically-based and provides high-fidelity information not available from conventional continuum-scale models.
- Continuum-scale models must be utilized to simulate field-scale systems at which pore-scale resolution is infeasible.
- This is the largest known explicit simulation of pore-scale processes and begins to link process knowledge at fundamental (pore) scales with model conceptualizations and parameterizations at application (continuum) scales.



Complex solute movement simulated with pore-scale fidelity over a domain corresponding to a laboratory column. Colors represent solute concentrations.

Scheibe, T.D., W. Perkins., M. Richmond, M. M. McKinley, P. Romero-Gomez, M. Oostrom, T. Wietsma, J. Serkowski, and J. Zachara (2014) Pore-scale and multi-scale numerical simulation of flow and transport in a laboratory-scale column. *Water Resources Research*, In press, DOI: 10.1002/2014WR015959.