Pore scale reactive transport modeling of microbial dynamics in heterogenous porous media

H. JUNG[1] AND C. MEILE[1]

[1]Department of Marine Sciences, University of Georgia, Athens, GA 30602, USA, heewon.jung@uga.edu; cmeile@uga.edu

A quantitative understanding of microbial processes and activities is of particular interest when predicting rates of reactions catalysed by microorganisms. Such rates depend on the conditions in the immediate surrounding of a microorganism. However, traditional approaches utilizing macroscopic parameters ignore the local environments relevant to microbial activities and hence may fail to correctly predict the system behaviour. Here, we present pore scale model simulations that resolve local biogeochemical conditions and microbial activity, with the goal to establish model formulations applicable in larger-scale reactive transport models.

To assess the impact of pore scale heterogeneity on reaction rate estimates, we first carried out pore scale simulations that differed in the distribution of microorganism. Our results show the most pronounced effect of the distribution of microorganisms on macroscopic reaction rates estimates at fast fluid flow and reaction conditions.

We further investigate the feedback between pore scale biogeochemical conditions and microbial growth, using a pore scale lattice Boltzmann model that integrates physical, chemical, and biological factors governing microenvironments and microbial activities in heterogeneous porous media. Microbial dynamics are formulated to depend on attachment to and detachment from surfaces, transport in the fluid phase, as well as growth and death. Our simulations are exploring the effect of microbial dynamics, including the feedback on the spatial distribution of reaction zones, and on fluid flow, across a range transport conditions and reaction kinetics.