

Dissolution at the pore scale: comparing simulations and experiments

Anthony Ladd, Vitaliy Starchenko, Filip Dutka, and Piotr Szymczak

University of Florida

Flow and transport in porous media is usually modeled at the Darcy scale, where the system is comprised of representative elementary volumes (REV's) described by average properties such as porosity, permeability, dispersion coefficients, and reactive surface area. However, if there is rapid dissolution, such as when brine pressurized with CO₂ encounters calcite, the validity of the averaging process is called into doubt by the strong gradients in concentration within a single REV. Pore-scale modeling overcomes many of the limitations of Darcy-scale models, albeit at much greater computational cost. Here we describe some preliminary results of comparisons of numerical simulations of the dissolution of a soluble cylinder with microfluidic experiments, and with approximate calculations from conformal mapping.

The numerical simulations use a finite-volume discretization, with an unstructured mesh that conforms to the shape of the dissolving object. By exploiting the intrinsic separation of time scales between transport and dissolution, precise simulations can be carried out with limited computational resources. We used the OpenFOAM toolkit with customized libraries to support mesh motion and relaxation around the dissolving object. Simulations take a few hours, in comparison with 1 month for the laboratory experiments.

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