

Experimental benchmark for testing reactive transport codes

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The evolution of porosity due to mineral alteration processes and the associated change of transport parameters are of major interest for natural geological environments or engineered underground structures. Numerical codes used to evaluate porosity evolution and feedback on transport need to be calibrated with quantitative experiments. We designed a reproducible and fast to conduct 2D experiment [1], which is flexible enough to investigate several process couplings – advective-diffusive transport of solutes, effect of liquid phase density on advective transport, and kinetically controlled dissolution/precipitation reactions causing porosity changes – implemented in the numerical code OGS-GEM. A quasi 2D Plexiglas tank of dimension 10 × 10 cm was filled with a 0.01m thick reactive layer, consisting of a bimodal size distribution of celestite (SrSO_4), sandwiched between two layers of sand. A barium chloride solution was injected into the tank causing an asymmetric flow field to develop. Once the barium chloride reached the reactive layer, it enhanced the dissolution of celestite and barite (BaSO_4) precipitated. Due to higher molar volume of barite, its precipitation caused a porosity decrease. Dyes tracer tests performed before and after barium chloride injection revealed changes in the flow field. This suggested local porosity and permeability changes. Post mortem analysis of the reactive media suggested that smaller celestite grains dissolved to form a nano-crystalline phase of barite in the pore space while the larger celestite grains were passivated with barite. The nano-crystalline phase cements the celestite grains together, creating isolated pores in some cases. Tests with non-reactive tracers performed prior to barium chloride injection as well as the density-driven flow (due to the high concentration of barium chloride solution) were well reproduced by the numerical model. For the reactive transport experiment, chemical and structural changes occurring at the pore scale and interface had to be considered in the continuum scale approach. This allowed reproducing mineral bulk transformation and measured pressure increase with time.

[1] Poonoosamy et al. (2015) *J. Contam. Hydrol.* **177-178**