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Experimental and modeling investigations of two-phase reactive transport processes

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Two phase flow is present in many geochemical systems, such as water and air in soils, and CO_2 liquid and water in geologic carbon storage reservoirs. Two phase flow dynamics has complex interplay with aqueous and heterogeneous reactions, affecting transport and mixing in the aqueous phase and the reactive surface area. Prior microfluidic experiments and pore-scale modeling have observed that two-phase flow can lower mineral reaction rates compared to the corresponding single phase case [1, 2]. However, paired experimental and numerical studies are lacking, making mechanistic interpretation of observed phenomena challenging. In this study, we developed a benchmark experiment that investigates calcium carbonate dissolution in a cylindrical channel with water-air bubble flow. Experiments with single phase flow were also conducted for comparison, and effluent samples were collected for ICP analyses to infer dissolution rates. Pore-scale reactive transport modeling of the experimental system was performed using CrunchFOAM and validated by the experimental data. The model was further expanded to a broader parameter space in investigating the impacts of two-phase flow on mineral dissolution rate.

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2. Li, P., H. Deng, and S. Molins, *The Effect of Pore-Scale Two-Phase Flow on Mineral Reaction Rates.* Frontiers in Water, 2022. **3**(188).