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Microfluidic measurements of gypsum dissolution kinetics

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The dissolution of highly soluble minerals and rocks produces macro-scale features such as caves, and micro-scale features such as wormholes, the shape of which depends on reaction kinetics. Despite numerous studies on gypsum dissolution, a wide range of kinetic constants have been obtained, spanning several orders of magnitude. This discrepancy can be explained by poor understanding of the impact of hydrodynamics and transport in existing experiments using powders and rotating discs. Flow in microfluidic cells is controlled by their design, allowing a system to be created that can be easily modeled. We construct a microfluidic cell with a cutout for gypsum casting in a bottom plate, and flow channeled by the top plate. The hydrodynamics of this system are governed by flow between two plates. Spacing between the gypsum and top plate is controlled by tapes of known thickness, allowing aperture height to be set. Deionized water is pumped at a controlled rate through the system, and the concentration of calcium is measured from the effluent. Comparison of outlet concentration to simplified 1-D and full 3-D reactive transport models of the system allows the reaction kinetics to be constrained. With this system, we estimate the kinetics of gypsum dissolution by running the experiment at different flow rates, apertures, and temperatures.