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Experimental investigation of interplay between transverse mixing and reaction for pH reaction in porous media

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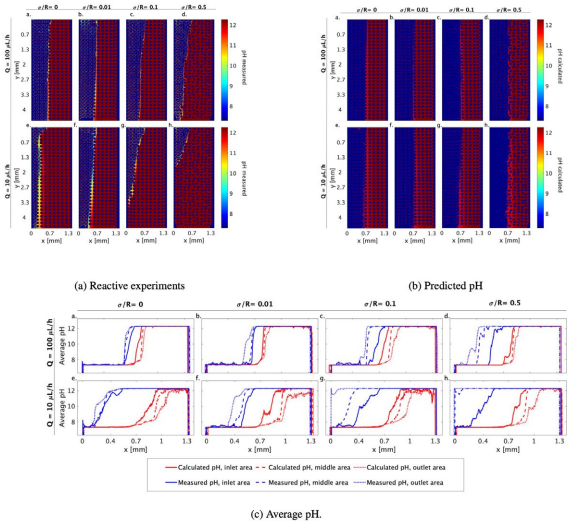
pH-induced reactive transport in porous environments is a critical factor in soil and rock sciences, influencing a range of natural and anthropogenic processes such as mineral dissolution/precipitation, adsorption/desorption, microbial reactions, and redox transformations. These processes, pivotal in carbon capture and storage (CCS) applications to groundwater remediation, are determined by pH transport and biogeochemical reactions. However, the uncertainty in these macroscopic processes' stems from pore-scale heterogeneities and Peclet. While practical for field-scale applications, traditional macroscopic models often fail to accurately predict experimental and field results in reactive systems due to their inability to capture the intricate details of pore-scale transport and reaction.

This study investigates the interplay between transverse mixing and pH-driven reaction in porous media. It focuses on how porous structure and flow rate affect mixing and chemical reaction dynamics. Utilizing confocal microscopy, the research visualizes fluorescently labeled fluids, revealing variations in mixing patterns from diffusive in homogenous to shear-driven in heterogeneous media. However, pH-driven reactions show a different pattern, with a faster reaction rate, suggesting quicker pH equilibration between co-flowing fluids than predicted by transverse dispersion or diffusion (see added figure). The study highlights the unique characteristics of proton transfer in water, which significantly influences reactive transport in porous media.



(c) Average pH.