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Improving understanding of mineral surface area and reaction rates in porous media

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Natural weathering processes, environmental contamination, and energy storage systems including geologic CO_2sequestration all can create conditions favorable for mineral dissolution and precipitation reactions in natural porous media. As reactions progress, formation properties including porosity and permeability can evolve, impacting flow and transport. Predictive capabilities of implications of reactions on formation properties are limited, largely due to limitations in understanding of mineral reactions and reaction rates in porous media. Additionally, orders of magnitude discrepancies exist between laboratory and field measured reaction rates. This may be a result of a misunderstanding of mineral reactive surface area in porous media where grain coatings or cements and variations in connected porosity may inhibit contact of reactive fluids with mineral surfaces. Mineral accessible surface area, which reflects mineral surfaces that will be in contact with reactive fluids, improves simulation of mineral reaction rates in porous media. This surface area can be obtained from a multi-scale imaging analysis, but this process is time and resource intensive. Also, there is not a good understanding of variations in quantified accessible surface areas with approach (image resolution, accounting for nanopore connectivity, etc.) or sample properties (porosity, mineralogy, etc.). In this work, multi-scale imaging is combined with laboratory experiments and reactive transport simulations to enhance understanding of mineral accessible surface area and simulation of mineral reaction rates in porous media. Results show that accessible surface areas vary with image resolution, but variations have little implication on overall simulated reaction rates, especially in comparison with other common means of surface area estimation. Accessible surface areas quantified for sandstone samples of varying composition show some relationship with mineralogy, but additional analyses are needed to improve predictive capabilities.