Use of multi-scale imaging to enhance understanding and simulation of reactive porous media

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Heterogeneities at the nanometer to meter scale are not well understood, yet may control the geochemical and structural evolution of porous media. Mineral dissolution and precipitation reactions further contribute to heterogeneities by altering porous media in complex manners and across multiple scales. A suite of imaging and analyses techniques, including SEM, X-ray CT, FIB-SEM and neutron scattering have emerged to classify the nature of the pore structure across multiple scales. When combined with techniques that enable mineral identification, a multi-scale characterization of the pore structure including variations in mineralogy can be obtained. Used before, during, and/or after reaction, these techniques can reveal new insight to mineral dissolution and precipitation reactions and the corresponding changes in the pore network. However, these analyses are time and resource intensive and results may vary largely between samples. Transferring observations to numerical simulations remains additionally challenging given ongoing questions of upscaling, mineral reaction rates, and our understanding of mineral reactions in general. Here, the use of multi-scale imaging to enhance understanding of the nature and reactive evolution of porous media is examined. This includes analysis of nano- to macro-scale porosity and pore connectivity, advanced quantification of accessible mineral surface area as a means to enhance simulation of mineral reaction rates, and characterization of changes in the pore structure resulting from mineral dissolution and precipitation reactions.