Investigation of Geochemical Reactivity at the Pore Scale

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The reactivity of carbonate and silicate minerals is at the heart of porosity and pore geometry changes in rocks, which ultimately control the evolution of flow and transport properties of fluids in porous and/or fractured geological reservoirs. Minerals and rocks exhibit heterogeneous and anisotropic reactivity, which challenges the continuum description of porous media and assumptions required for reactive transport modeling at large scales. The global reactivity of rocks is also highly dependent of interplay between surface reaction kinetics and transport both near the fluid−mineral interface and along the flow paths.

Here, we present methods combining experimental with imaging techniques (i.e., X-ray micro-tomography, atomic force microscopy, vertical scanninng interferometry, focused ion beam – electron microscopy) to resolve the fluid-mineral interface and the 3D geometry of porous media, and improve our understanding of rock reactivity. We will show how the combined impacts of physical and chemical heterogeneities in both minerals and rocks can lead to paradigm shifts in conventional descriptions of solid reactivity [1]. In particular, the growth of alteration layers in silicates (i.e., amorphous Si-rich surface layers, ASSLs) or in polymineralic rock matrix (e.g., resulting from the difference in reactivity between silicates and carbonates) prevent contact between the dissolving solids and the pore fluid and slows the transport in the vicinity of the fluid-solid interface, potentially inhibitating the dissolution/carbonation processes.

[1] Noiriel C. and Daval D. (2017) Pore-Scale Geochemical Reactivity Associated with CO_2 Storage: New Frontiers at the Fluid-Solid Interface. Accounts of Chemical Research, special Issue on Chemistry of Geologic Carbon Storage, DOI: 10.1021/acs.accounts.7b00019