

Microscale spectroscopic imaging of interfacial Fe redox reactions in “hard-rock” systems

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It's a joy to celebrate the career and contributions of Gordon E. Brown Jr. and colleagues. Working with Gordon previously stimulated us to develop methods to probe the distribution and redox state of trace metals across complex mineral-water and mineral-microbe interfaces. In this session we will take the opportunity to show what we have recently learned from our intensive focus on capturing the mechanisms and controls on interfacial Fe redox reactions during the low-temperature alteration of mafic and ultramafic rocks.

Fe(II) released during the hydration of basalts and peridotites participates in diverse electron-transfer reactions. This reactivity drives the formation of electron carriers such as H₂ and formate, which are critical energy sources to sustain *in-situ* microbial activity in hard-rock aquifers. The timing and localization of such redox processes, as well as the formation of metastable intermediates, are recorded by the mineralization of discrete Fe(II/III)-hydroxides, oxides and silicates. We will present examples of how x-ray reflectivity, X-ray standing waves, grazing-angle XANES, and multiple-energy microXRF imaging across the Fe K-edge (including pre-edge) can be utilized to spatially and quantitatively define Fe-redox transitions during progressive water/rock reaction. We will then discuss why Fe(II)-driven electron transfer has the potential to control biogeochemical processes in diverse Earth and Planetary systems.