

‘Seeing’ the breaking or making of bonds in mineral-fluid systems.

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To follow complex and highly dynamic mineral-fluid-microbe interaction reactions at high spatial and temporal resolution is not easy. However, with the continual development of novel *in situ* and real time methods employing X-ray, electron or neutron sources our ability to follow in a quantitative manner reactions in complex systems now allow us to derive knowledge that has fundamentally changed our understanding of a many geochemical or biological processes. Such studies however only advance the state of knowledge if conducted through intensive and multidisciplinary collaborations between disparate disciplines and if observations are carried out at multiple scales, and with multiple complementary methods. With these new developments it is now feasible to carry out high-resolution, *in situ* and time resolved measurements and high-resolution imaging of processes that mimic natural processes in aquatic soils, sediments, aerosol or other geo-bio systems.

I will describe in a few examples how such new methods have helped us elucidate the molecular-level mechanisms of for example mineral formation and transformations, how we evaluated the role of biology in mineral weathering and soil formation, or how we assessed if and why the delivery of iron-rich nanoparticles into the ocean teach us something nutrient cycling, primary productivity and mineral chemistry in modern or ancient geological settings.