Challenges and strategies for contextualizing pore scale experimental observations at the field scale

BENJAMIN M. TUTOLO[1], ANDREW J. LUHMANN[2], TIMOTHY KIESEL[3], XIANG-ZHAO KONG[4], MARTIN O. SAAR[4], WILIAM E. SEYFRIED, JR.[3]

[1]University of Oxford Department of Earth Sciences
[2]New Mexico Tech Dept. of Earth & Environmental Science
[3]University of Minnesota Department of Earth Sciences
[4]ETH-Zürich Department of Earth Sciences

The techniques available to geochemists for characterizing pore scale processes have grown so numerous that the challenge in interpreting these complex systems now often lies in the ability to produce a coherent description that meshes well with all of the available data rather than in simply producing the data itself. This richness of data is rapidly advancing our understanding of pore scale geochemical processes, but an additional layer of complexity arises when attempting to contextualize these pore-scale observations at the field scale. The growing ability of fully coupled reactive transport models to simulate complex, 3-dimensional systems over long time scales has made the problem of integrating and upscaling these various data sets increasingly tractable.

In this energy-themed session, we will present the results of flow-through CO_2 sequestration experiments conducted on K-feldspar-rich sandstones, glauconitic sediments, and dolomites. Utilizing a variety of characterization techniques, including small and ultra small angle neutron scattering ((U)SANS), laboratory and synchrotron X-ray computed tomography (XRCT), Mössbauer spectroscopy, and other fluid and solid chemical analyses, we will present fundamental constraints on the evolution of solid and aqueous phase geochemistry, porosity, and permeability, with reaction progress. In particular, the utility of coupled XRCT and (U)SANS observations for elucidating the contribution of nanoscale pores to bulk geochemical changes will be emphasized, as will the value of Mössbauer analyses for distinguishing Fe mineral transformations. Using these experimental results and a reservoir-scale modeling study from the dolomite system, we will emphasize the utility of RTMs for interpreting and upscaling laboratory experiments. Finally, we will offer lessons learned from these various experimental results and RTMs for improving experimental approaches to pore-scale geochemical systems.