Mesoscale Priority Research Direction

Emergent Transport Phenomena in Natural Systems

Opportunity

Natural systems are complex and heterogeneous on many scales. Describing transport and reactions at nanometers to micron scales is fundamental to the development of predictive tools for fluid-solid interactions in the Earth's crust. It is a key, yet not fully explored, prerequisite to several DOE missions (e.g., gas and oil extraction, CO_2 sequestration, enhanced geothermal system, and radioactive waste disposal).

Meso Challenge

- Characterize mesoscale pore structures of geological media and their evolution under field relevant conditions.
- Establish functional relationships between mesoscopic pore structures as emergent transport phenomena to macroscopic properties (e.g., porosity and surface area) of geological media.

Approach

- Neutron scattering and tomography
- We have demonstrated the feasibility of pore characterization at the mesoscale for clays and rock salt, the proposed media for nuclear waste repository systems, using Small-Angle Neutron Scattering (SANS) at varying humidity, high temperature and pressure.
- Up-scaling approaches to integrate nano to macro scales through mesoscale studies.

Impact

As emergent transport properties, phenomena and characterizations at the mesoscale are envisioned to connect physical and chemical processes from the atomic scale with continuum transport models at the macroscale, bridging the knowledge gaps of fluids (both liquids and gases) transport in natural systems. It will significantly improve applications in field prediction models.

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