Department of Civil Engineering and Engineering Mechanics
Columbia University

Multi-scale characterization of geo-materials with nano-pores and coupled constitutive behavior of heterogeneous deforming porous media

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Location: 253 Engineering Terrace

Geomaterials containing nano-pores have become increasingly important for emerging problems such as unconventional gas and oil resources, enhanced oil recovery, and geologic storage of CO_2. Accurate prediction of coupled geophysical and chemical processes at the pore scale requires realistic representation of pore structure and topology. Single and multiphase flow and deformation of all porous media strongly depend on pore-scale processes. This is especially true for shales and carbonate rocks, where pore networks are small and complex, and require characterization at sub-micron scale.
In this work, we apply multi-scale imaging techniques which include laser scanning confocal microscopy to characterize pore structures and microlithofacies at micron- and greater scales and dual focused ion beam-scanning electron microscopy (FIB-SEM) for 3D imaging of nanometer-to-micron scale microcracks and pore distributions. Moreover, a state-of-the art aberration corrected scanning transmission electron microscopy (AC-STEM) is used for visualizing 3D connectivity and structure of the <10-nm pore population in gas shales (~ 1nm resolution) and energy dispersive X-ray spectrometry (EDS) is used to identify the distribution of chemical composition of pore-lining phases. Data obtained from topological and chemical analysis can be mapped together to reconstruct three-dimensional (3-D) pore structures with different phases. Reconstructed 3-D pore will be used as an input for gas transport simulations in shale gas rocks to improve our understanding of enhanced diffusion processes (e.g, Knudson diffusion, slippage) in nano-pores and impact of chemical, mechanical, and textural characteristics on shale gas transport and poro-elastic behavior. In this talk, we will also highlight in-situ neutron diffraction experiments of CO_2 interaction with clay and creep experiments under in-situ conditions of the core together with newly upgraded capabilities at Geomechanics Laboratory at Sandia.
Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Biography:
Dr. Hongkyu Yoon is a technical staff in the Geoscience Research and Applications Group at Sandia National Laboratories, Albuquerque, NM. His research areas include hydrogeology and reactive transport experiments and modeling, digital rock physics of geomaterials, chemo-mechanical coupling, reservoir characterization and simulations, and high-fidelity inverse modeling and uncertainty quantification. His research involves building and implementing a framework to analyze well-characterized laboratory experiments and field-scale observation data coupled with single- and multi-phase flow and reactive transport modeling across scales (e.g., pore to field) to develop the predictive model at a large-scale from smaller scales. His current projects focus on multiscale multiphase flow and reactive transport with applications to geological carbon sequestration and unconventional resources recovery, shale geomaterial characterization, and high-fidelity inverse modeling and uncertainty quantification. Dr. Yoon obtained a Ph.D degree in Environmental Engineering in Civil Engineering from the University of Illinois at Urbana-Champaign in 2005 and has ~30 peer-reviewed publications.

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