

Nanogeochemistry: Nanostructures, emergent properties and their control on geochemical reactions and mass transfers

Abstract

Nanogeochemistry - a newly emerging research field - attempts to understand geochemical reactions and mass transfers at nanometer scales, especially with regards to the formation of nanostructures in geochemical systems, emergent properties of these structures, and their controls on geochemical processes. The research also includes use of nanotechnology to design new materials and engineering approaches for effective natural resource extraction and environmental management. At the core of this new research field is the concept that, as the size of a material is reduced to nanometers, novel physical or chemical properties of the material may emerge that can be drastically different from those of the corresponding bulk phase and the material properties then become size-dependent. Nanostructures, which frequently occur in geologic materials, may directly control mineral phase stability, mineral-water interface chemistry, geochemical reaction kinetics, geo-fluid migration and transport, and even global biogeochemical cycles as a whole. This presentation will focus on recent progress in nanogeochemical research, specifically on two general types of nanostructures - nano solid phases and nanopores (nanofluids) – with an emphasis on the occurrence of each nanostructure in natural environments, the associated emergent properties, and the potential geochemical implications. Stemming from an increasing interest in shale oil/gas research, a special discussion will be given to oil/gas disposition and migration in unconventional low-permeability reservoirs, wherein shale can be treated as a nanocomposite material.

Biographic Information

Dr. Yifeng Wang is a Distinguished Member of Technical Staff at Sandia. He obtained a Ph.D. in Geochemistry from Indiana University, MS from Nanjing University, and BS from Zhejiang University in China. He has extensive experience in environmental material development and the application of nanostructured materials to nuclear waste management. He did pioneer work on the geochemistry of nanopore confinement. In recent years, he is trying to use the nanogeochemistry concept to understand fluid interaction and transport in unconventional oil/gas reservoirs. He is the author or coauthor of more than 100 peer-reviewed publications; he holds 10 US patents. He was a recipient of 2014 Asian American Engineer of the Year (AAEOY).