Quantifying fluids in porous media using neutron imaging

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Neutron imaging has been used for quantitative analysis of fluids in many applications such as fuel cells, roots of plants, and various porous media. Neutrons are ideally suited for the investigation of fluid (e.g., water, CO_2, brine) movement in natural and engineered porous media because they are strongly attenuated by hydrogen and relatively insensitive to other elements. In water-rich samples, however, there is also a greater probability for neutron scattering, which leads to additional noise in the detector. Imaging water-rich or thick samples using a polychromatic beam can also result in artifacts due to beam hardening. These effects cause deviations from the Beer-Lambert Law when quantifying fluid content. Empirical calibrations have successfully accounted for beam hardening and scattering effects in partially-saturated sand and sandstone samples at the High Flux Isotope Reactor (HFIR) imaging facility, Oak Ridge National Laboratory. We are utilizing this empirical calibration method combined with neutron tomography for mapping the three-dimensional distribution of multiphase fluid content in porous media at the McClellan Nuclear Research Center (MNRC), University of California, Davis. Fluid contents derived by this empirical calibration will be compared with neutron tomography data to provide constraints on the structure of porous media and three-dimensional spatial distribution of fluids. We aim to better understand the distribution and migration of multiphase fluid in geological formations (e.g., soil, evaporite, clastic and fractured formations) where pore geometry and connectivity are sensitive to moisture content, fluid composition, temperature, and lithostatic pressure – issues critically important in, for example, hydrocarbon recovery, carbon sequestration, and disposal of spent nuclear fuels and high-level waste in a geological repository.