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# Petrophysical properties of representative geological rocks encountered in effective carbon storage and utilization

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Under studies for nearly 20 years, several different kinds of subsurface lithologies, such as deep saline aquifers, depleted oil and gas reservoirs, non-minable coal seams, geothermal reservoirs, organic-rich shale, and basalt, can be candidates for permanent $CO_2$ geological storage processes, in a broad context of carbon capture, utilization, and storage (CCUS). These systems commonly need effective reservoirs (sandstones, carbonates) for large-volume storage (e.g., effective porosity) and impermeable cap rock (mudrocks and salt rock) for containment (e.g., permeability, diffusivity). This work studies 10+ representative rock samples from typical geological formations encountered at CCUS, such as Berea sandstone, Crab Orchard sandstone, Guelph dolomite, and Indiana limestone (as depleted sandstone or carbonate oil/gas reservoirs & saline aquifers) with Woodford claystone and Himalayan salt rock as cap rocks. Haynesville Shale, Sihe coal, Texas basalt, and Sierra white granite were also used to study the storage and utilization in shales, coal seams, and basalt formations, as well as enhanced geothermal systems. The important petrophysical attributes (properties of rocks and fluids, as well as fluid-rock interactions) for this wide range of geological rocks are not available or sufficiently studied with respect to different methodologies, vast lithological difference, and sample scale effect, with a particular focus on how microscopic pore structure (especially pore connectivity) influences macroscopic fluid flow and chemical transport [1]. In conjuction with a set of complementary approaches for pore structure characterization (such as small angle neutron/X-ray scattering), this work utilizes several custom designed apparatuses (e.g., gas diffusion) to provide the essential information of $CO_2$ diffusivity and tortuosity of natural rocks, in the presence of other gases ($CH_4$, $H_2$, and $O_2$), in assessing the effectiveness of CCUS in typical gological formations [2].

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