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Coupled petrophysical and geochemical studies 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, Guelph dolomite, and Indiana limestone as depleted sandstone or carbonate oil/gas reservoirs & saline aquifers, along with Woodford claystone and Himalayan salt rock as cap rocks. Haynesville Shale, Sihe coal, and Texas basalt were also used to study the storage and utilization in shales, coal seams, and basalt formations. In addition, nummulitic limestones of El Gueria Formation in Tunisia are also studies as a leading candiate for CCUS projects. is the most productive reservoir of hydrocarbon in Tunisia The important petrophysical attributes for this wide range of geological rocks are assessed with a particular focus on how microscopic pore structure influences macroscopic fluid flow and chemical transport [1]. Such pore accessibility issues is examined with CO_2 flooding experiments using a customly-designed appratus with cm-sized rock samples of various lithologies and pore connectivity. 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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