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Hydrogen diffusion in representative geological formations used for underground storage

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Underground hydrogen storage (UHS) commonly consider three main types of geological formations, including depleted natural gas/oil fields and saline aquifers of sedimentary rock formations, both overlaid with impermeable cap rock (such as shale and salt rock), as well as salt dome caverns and bedded salt formations. This work studies a total of seven representative rock samples from typical geological formations encountered at UHS, such as Berea sandstone, Crab Orchard sandstone (with smaller grain sizes and associated lower permeability than Berea sandstone), Guelph dolomite, and Indiana limestone (serving as examples of depleted sandstone or carbonate oil/gas reservoirs & saline aquifers) with Woodford claystone and Haynesville Shale as cap rocks, as well as Himalayan salt rock for UHS and as cap rock. 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 [1-2]. In conjuction with a set of complementary approaches for pore structure characterization, this work utilizes several custom designed apparatuses (e.g., gas diffusion) to provide the essential information of H_2 diffusivity and tortuosity of natural rocks, in the presence of other gases (CH_4, CO_2, and O_2), in assessing the effectiveness of UHS in typical gological formations [3].

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