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Experimental investigations of H2, He, CH4 and CO2 adsorption, wettability and geomechanics on kerogen at geo-storage conditions

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Kerogen is the most abundant form of organic matter in the subsurface and its properties of adsorption, wettability and geomechanics affect gas (H2, He, CH4 and CO2) geo-storage (GGS) capacity and leakage risk. However, a systematically experimental investigation of these three properties at in-situ GGS conditions is lacking and thus large uncertainties exists in evaluating the impact of kerogen content on GGS integrity. Therefore herein, kerogen properties were investigated experimentally at GGS conditions, based on isothermal adsorption, contact angle, and nanoindentation measurements. It is demonstrated that 1) the maximum adsorption capacity for H2, CH4 and CO2 is 0.3789 mol/kg, 3.5360 mol/kg, and 5.2625 mol/kg respectively (occurring at various thermophysical conditions), thus following the order H2 < CH4 < CO2; 2) kerogen wettability ranges from weakly water-wet to gas-wet with its affinity to gases following the order He < CO2 < H2 < CH4; and 3) after exposure to H2, He, CH4, liquid CO2 and H2O for 3 –5 mins, the Young's modulus of kerogen decreases by 45%, 32%, 1%, 70%, and 50% respectively, while the kerogen pellet disintegrates after exposure to supercritical CO2 for 3 mins. This study provides key data for evaluating GGS, an important pathway for accelerating the energy transition, promoting the advanced technology development, balancing the energy supply and demand, and mitigating the carbon emissions.

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References

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