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Adsorption Swelling and Anisotropic Characteristics of CO2 in Shale

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Abstract. Geologic sequestration of carbon dioxide (CO2) is one of the most significant technologies to combat climate change at present. Nevertheless, the CO2 injected into shale reservoirs can expand to affect the permeability and strength of the reservoirs, affecting the efficiency of injection and the safety of storage. In this work, the strain behavior of He (1300 psi) andCO2 (850 psi) on shale samples at constant hydrostatic pressure was investigated using a self-developed high temperature and high pressure gas adsorption and expansion apparatus measuring temperatures at 308 K. The results indicate that adsorption expansion of CO2 exists in shale samples. With increasing pressure, the swelling rate increases and then decreases, and the adsorption-induced swelling strain of shale shows a Langmuir-like relationship with pressure. The adsorptive deformation of shale is anisotropic, with deformation perpendicular to the direction of the laminae being greater than that parallel to the plane of the laminae. The asynchronous response of adsorptive swelling and mechanical compression produced by CO2 gas can lead to crack expansion in rocks and rock fracture. The amount of swelling is dependent on the CO2 concentration, and the swelling of shale is mainly determined by the partial pressures of the component gases.

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