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Defining the Supercritical Carbon Dioxide Window for Coalbed Methane Reservoirs in the Black Warrior Basin: Implications for Carbon Sequestration and Enhanced Coalbed Methane Recovery

Sorption of gas onto coal is sensitive to temperature and pressure, and carbon dioxide can potentially become a supercritical fluid that reacts with coal under reservoir conditions. More than 4,000 coalbed methane wells have been drilled in the Black Warrior basin, and hydrologic and geothermic information from these wells were used to identify regions where carbon dioxide may become a supercritical fluid.

Geothermal gradients within the coalbed methane fields are high enough that reservoirs never cross the gas-liquid condensation line for carbon dioxide. However, reservoirs have potential for supercritical fluid conditions where reservoir pressure exceeds 1,074 psi, which is equivalent to a depth of 2,480 feet under a normal freshwater hydrostatic gradient. All target coal beds are subcritically pressured in the northeastern half of the coalbed methane production fairway, whereas those same beds had supercritical pressure in the southwestern gas fields prior to production.

Coal can contain carbon dioxide under supercritical conditions, which may redevelop as reservoirs equilibrate by hydrologic recharge after abandonment. But supercritical isotherms indicate non-Langmiur conditions under which some carbon dioxide may remain mobile in coal or may react with formation fluid, organic matter, or minerals. Hence, carbon sequestration and enhanced coalbed methane recovery show great promise in subcritical reservoirs, and additional research is required to assess the behavior of carbon dioxide in coal under supercritical conditions where additional sequestration capacity may exist.