Regional Assessment of Reservoir Properties and Waste Disposal Modeling for Arbuckle Formation in South Central and Southwestern Kansas

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Abstract

The Arbuckle Group is a 600-1,000 ft. thick and more than 3,500 ft. deep carbonate saline aquifer, making it a good candidate for various waste disposal operations, such as oil field brine and chemical plant waste disposal, and CO2 geological storage. Recent developments in unconventional resources and research initiatives in CO2 geological storage have brought more focus and attention to the Arbuckle Group in southern Kansas. Despite the commercial interest, essential information about reservoir properties and structural elements is limited.
As a part of a DOE-NETL-funded initiative, the Kansas Geological Survey collected, compiled, and analyzed available data, including well logs, core data, step rate tests, drill stem tests, 2D and 3D seismic data, water level measurements, and others types of data. Several exploratory wells were also drilled and core was collected and modern suites of logs were analyzed. Reservoir properties were populated into several site specific geological models of Kansas fields (e.g., Wellington, Bemis-Shuts, and Cutter fields). In addition, a regional-scale geological model was developed and used to determine simulation-based estimates of CO2 storage.

The geological models illustrate the highly heterogeneous nature of the Arbuckle Group. Vertical and horizontal variability results in several distinct hydrostratigraphic units that are the results of both depositional and diagenetic processes, with the latter including both development of meteoric karst and late-stage dissolution by hydrothermal fluids. Small-scale faults and fractures also add complexity to the reservoir. To understand fluid flow in these complex carbonate reservoirs, numerical simulations were performed with several fluid phases defined as potential or actual waste disposal fluids. Results of these simulations could help to site wells for waste disposal, improve estimates of available storage capacity, and improve and refine locations of remaining oil. For example, regional simulations estimated that the Arbuckle Group aquifer could store more than 4 billion metric tons of carbon dioxide over 50 years, on the lower end of previous estimates based on pore volume. However, reservoir pressure management techniques would need to be applied in order to accomplish storage on such a scale.