Adequate Geologic Characterization of Sand Bodies for Geological CO_2 Sequestration Simulations: A Case Study of the Broom Creek Formation in North Dakota

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Abstract

Detailed characterization of the subsurface is essential when developing geologic models used to estimate storage capacity of carbon dioxide (CO_2) in the subsurface. CO_2 plume migration and morphology are highly dependent on subtle, localized heterogeneities in rocks that may be considered to be relatively homogeneous at the regional scale. The Permian–Pennsylvanian Broom Creek Formation in the North Dakota portion of the Williston Basin appears to be a good candidate for geosequestration of CO_2 and is the subject of an extensive characterization and simulation study being conducted by the Plains CO_2 Reduction (PCOR) Partnership to predict the long-term fate of a 1 million-ton/year CO_2 injection over a 50-year time period. The Broom Creek Formation is a brine-saturated formation consisting primarily of sandstone with local "tight" anhydritic dolomite and shale. Initially, these tight zones appeared to be randomly distributed throughout the rock column; however, upon further investigation, it appeared that many of these zones could be correlated from petrophysical well logs, indicating that the zones are beds with inconsistent lateral distribution. The result of these correlations was a series of thin "baffles" that not only affected the CO_2 plume migration pathway and morphology but also the redistribution of pressure from the injection which, in turn, limited injectivity.

The properties used in the model were generated based on data collected from petrophysical well logs, core samples, core analysis, and previous literature. The simulation tool used is a commercial black oil simulator used extensively in the oil and gas industry (1). In these simulation studies, two fluid phases exist in the reservoir, a gas phase into which the properties of CO_2 were entered and an oil phase where the properties of the formation brine were entered. This model was used to allow the CO_2 to go into solution with the formation brine to more accurately determine plume migration and extent.

Keywords: Geologic CO_2 Sequestration, CO_2 Solubility, Injection Simulations

(1) Schlumberger, 2007, ECLIPSE Reservoir Simulation Software 2007.