An Integrated Seal Analysis for CO2 Sequestration in Southwest Kansas

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Abstract

Carbon capture, unitization, and storage (CCUS) can play a critical role in reducing greenhouse gas emissions to the atmosphere in a manner that is safe, economical, and acceptable to the public. There are multiple geological complexes in Southwest Kansas that can serve as potential commercial-scale carbon storage sites. Recent studies have suggested that more than 50 million tonnes of CO2 storage potential exists in a set of stacked, saline reservoirs in the Patterson Oil Field, including the Cambrian-Ordovician Arbuckle, Ordovician Viola, and Mississippian Osage reservoirs. They are sealed by continuous shale and nonporous limestone of the Simpson, Kinderhook, and Meramec-Cherokee Groups. This research is part of an effort to understand the geological setting for future commercial CCUS projects and is funded through U.S. Department of Energy CarbonSAFE program (Phase II). An ideal CO2 storage site should have little or no risk of gas migration beyond the boundaries of the storage complex. We present an integrated study that combines caprock, structural, and reservoir geomechanical analyses to evaluate the seal integrity, to provide maximum storage permanence for this CCUS project. Geological models of the storage complex have been updated with the new appraisal wells and a new 3D seismic survey over the field to avoid poorly cemented formations and fractured zones that could present migration pathways. Reservoir geomechanical analyses have been performed by combining stress analysis, laboratory rock mechanical tests, and numerical modeling to establish sealing properties and identify maximum injection pressure during the sequestration. Preliminary results show that the Morrow Shale forms the top-seal for the Upper Morrow oil accumulation and also is the principal confining unit for CO2 storage. Numerous shale units in the Atoka and Cherokee Groups provide secondary confining units to ensure the containment of

injected CO2. Faults in the Patterson Field area are not interrupt the Morrow Formation primary seal and upper strata. Geomechanical lab tests indicate that candidate reservoirs are covered by competent caprocks will be able to arrest fracture propagation from pressure changes induced by injection.