Numerical simulation of carbon sequestration in the Sylvania Sandstone

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The feasibility of carbon sequestration in the Devonian Sylvania Sandstone and Bois Blanc Formation was studied in the central Michigan Basin, USA. The Sylvania Sandstone is an important carbon capture and sequestration (CCS) target because it is present throughout a region with high CO2 emissions (>~20 Mmt/year). This unit has proven reservoir quality as demonstrated by historic liquid waste disposal activities and an overlying suitable cap rock. The Sylvania Sandstone is a geologically complex and heterogeneous formation. There is reworked, aeolian, quartzose littoral sandstone of the Sylvania intermingled with siliceous, shallow shelf carbonates of the Bois Blanc. The Sylvania occurs in three main shallowing, shoaling upward parasequences that compartmentalize the reservoir. Core analyses indicate that the sandstone lithofacies have moderate to good porosity (Ø), high permeability (K), and are excellent injection targets. Tripolitic chert lithofacies have high Ø, low to moderate K and questionable injection potential. All other carbonate lithofacies have low Ø and K. Detailed reservoir characterization determined that approximately 730 million metric tons could be stored in the Sylvania Sandstone in central lower Michigan, albeit with a high degree of regional variability.

Numerical simulations of supercritical carbon dioxide CO2 injection were conducted using a DOE simulator named STOMP. Models were run at several known well locations within the Sylvania, showing substantial variation in injection rates, plume radius and stored volumes over the 10 year injection period and 20 year relaxation period. Multiple locations had an injectivity of at least 1000 mt /day . The crucial importance of detailed geologic characterization of potential injection sites could be seen in. the varying CO2 plumes and the migration response of the brines as well as the difference in injection rates resulting from heterogeneous rock mechanical and hydraulic properties.