

Site Assessment Update at Weyburn-Midale CO₂ Sequestration Project, Saskatchewan, Canada: New Results at an Active CO₂ Sequestration Site

Gavin Jensen*

Saskatchewan Ministry of Energy and Resources, Regina, Saskatchewan, Canada

gavin.jensen@gov.sk.ca

and

Erik Nickel

Saskatchewan Ministry of Energy and Resources, Regina, Saskatchewan, Canada

and

Ben Rostron

University of Alberta, Earth and Atmospheric Sciences, Edmonton, Alberta, Canada

Abstract

The Weyburn Field, operated by Cenovus Energy, currently contains the largest amount of anthropogenic CO₂ injected and geologically stored in the world, with over 16 million tonnes of CO₂ sequestered as of June 2010. The IEA GHG Weyburn-Midale CO₂ Monitoring and Storage Project is in its Final Stage of research and is focussed on building on the results developed in Phase 1 of this study to provide a further understanding of parameters required to develop, implement and regulate carbon storage sites.

One aspect of geological characterization of the storage site in this phase of research is to further develop the geological model used in Phase 1 by adding more wells and including several geological units not incorporated into the geological model of Phase 1. Additionally, improvements into the quantification of regional flow directions in and around the active CO₂ injection site by using hydrologic data (pressure tests and hydrochemistry analyses) not included in the original model. These stratigraphic, pressure, hydrochemical and temperature data of flow units in a 1865 km² area around the Weyburn Field will better define fluid movement in the injection site and assist with long-term modeling of the fate of injected CO₂.

Stratigraphic data from more than 900 wells are included in the current geological model including 200 newly picked wells. The Final Phase geological model includes: 1) an “altered zone” of anhydrite and dolostone at the up dip edge of the Weyburn-Midale reservoir that forms the caprock to the reservoir subjacent the regional seal formed by the Watrous Formation; 2) the Frobisher Evaporite, a variably thick anhydrite unit present at the base of the reservoir beneath the northern portion of the field; and 3) the Oungre Evaporite, an anhydrite/dolomite unit within the Ratcliffe beds present above the majority of the reservoir, all of which were not included in the Phase 1 model. Adding these units into the model required closely delineating the zero edges using isopach values, and then stacking the isopach thicknesses to proportionately fill the 3D grid while maintaining their complex morphology and accurately representing the hydrogeological flow units above and below the Midale aquifer. Core derived porosity and permeability was included in the model for the Midale and Frobisher aquifer units only as beyond these beds very little core exist.

Pressure and hydrochemistry maps for the targeted aquifers (Midale, Frobisher and Ratcliffe) contain straddle tests and new wells drilled since Phase I was completed. Hydrogeological results from this study include; 1) Hydrochemistry maps which indicate large variations in total dissolved solids (TDS) within the target aquifers. The observed chemical and density variations have an influence on fluid movement; 2) Hydrochemical cross-sections provide insight into lateral variations in hydrochemistry across the injection area; 3) Pressure depth profiles which include pre-CO₂ injection pressure and current pressure from a recently completed DST.

This presentation will demonstrate the utility of integrating a high resolution geocellular model with hydrogeological pressure, chemistry, and temperature to determine fluid movement in CO₂-EOR operations post injection.