

Integrated regional tectonic and petrophysical investigation of the Williston Basin sediments in and around the Weyburn CO₂ sequestration reservoir

Sandor Sule, Zoltan Hajnal, Bhaskar Pandit, Jeff Closson
Department of Geological Sciences, University of Saskatchewan, Canada

2005 CSEG National Convention



This study is part of the International Energy Agency (IEA) Weyburn CO₂ Monitoring and Storage Project. The Seismic Laboratory of the Department of Geological Sciences (University of Saskatchewan) is a participant of the program and has conducted a regional seismic reflection/well-log study over an area of around 100 km radius of the storage reservoir. The operator (EnCana Corporation) produces oil from the Mississippian Midale fractured carbonate reservoir using CO₂ injection, and will subsequently sequester about 20 million tonnes of CO₂ through the process of enhanced oil recovery. Injection of CO₂ is expected to increase the oil recovery by 40% over water flooding and hence raise the production to 130 million bbl of oil.

The critical question to be answered is: Do the tectonic, petrophysical and rheological properties of the sedimentary fill guarantee the permanent storage of CO₂ in the region? To address this question, a comprehensive geological/geophysical/geochemical program was initiated to develop an overall model which extends from the Precambrian basement to the surface.

The specific objective of our investigation was to define the structural framework around the reservoir, recognize 10-13 regionally traceable seismic horizons, the fault systems and regional structural trends from the Precambrian basement (1500-3500 m below sea level) to the Cretaceous sediments, correlate these to borehole markers and investigate the petrophysical properties of the stratigraphy between these seismically mappable horizons. The input data include 2000 km of 2D seismic lines, a 3D seismic volume in the Weyburn field, and more than 7000 well log curves from 1000 boreholes. For the structural analysis, besides the seismic/borehole data, the High Resolution AeroMagnetic (HRAM) and gravity data were also taken into consideration. The synthesis of the regional petrophysical data was undertaken by neural network analysis and inversion of the seismic and well log data.

Conclusions of the present study are as follows:

1. In the investigated area no large scale regional tectonic elements intersect in the vicinity of the Weyburn field.
2. The Lower Watrous seal, which is a complex 40 m thick siltstone-sandstone sequence interbedded with nodular anhydrite and anhydritic claystones, is a regional seal to most of the Mississippian strata.
3. Small scale faults (i.e. fault with small offsets) have been identified in the Weyburn field. It is not known whether these faults that extend through the regional seal are potential migration pathways or not.

Knowledge of the geometry (derived from the seismic data) and the physical/geochemical rock properties (derived from the well logs and core data) will allow determination of an appropriate petrophysical model. This is expected to be carried out in a subsequent 2nd phase of the project.