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Regional Tectonic and Petrophysical Study in and around the Weyburn Oil Field, Southern Saskatchewan, Canada

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As a part of Phase I of the International Weyburn CO_2 Sequestration Project, regional seismic investigations have been conducted around a 100 km radius of the reservoir in Southern Saskatchewan. The objective is to answer the following question: Do the tectonic, petrophysical and rheological properties of the sedimentary fill guarantee the permanent storage ($\sim$10000 years) of CO_2 in the region ?

To achieve this goal, 2000 km of industry-donated seismic reflection data and over 1000 boreholes and related wireline information, as well as a 15 km^2 3D seismic coverage of the reservoir were analyzed.

Eleven seismically recognizable geologic (structural) horizons were mapped from top of the Cretaceous to the basement unconformity. These are: 2nd White Specs, Lower Colorado, Manville, Upper Watrous, Lower Watrous top, Lower Watrous bottom /top of Midale/, Bakken, Prairie Evaporite, Winnipegosis, Winnipeg, Deadwood and Precambrian.

An integrated analysis of these structural horizons over 100 seismic sections was used to map the regional structural setting of the sedimentary fill and the top of the Precambrian. By establishing a correlation between the basement structures and the disturbances in the sedimentary column, the influences of deep epirogenic movements on the development of the investigated part of the basin has been determined.

To date, the integration of seismic and borehole data has led to a better delineation of a number of prominent regional geologic structures (e.g. Roncott Anticlinorium, Missouri Coteau, Elbow-Hummingbird Monoclinal Flexure, Brockton-Froid-Fromberg

Fault zone and the Nesson Arch. Furthermore this effort also yielded enhanced images of previously known and some newly identified ringfaults.

The resolution of the ages of the epirogenic movements in the region, which generated the mappable structures, is an important issue. A number of faults and their temporal extent were recognized on the seismic sections. All the faults recognized to date and the time period through which they were active will be illustrated.

Moreover, within an area designated as a 'Risk Assessment area' in the immediate vicinity of the reservoir, two previously unknown fault zones were identified on the 3D seismic data set.

In the investigated area no large scale regional tectonic elements intersect the Weyburn field. There are, however, recognizable structural disturbances present; their properties and historical influences on the reservoir and its vicinity are under investigation.

Further analyses were done to set up a 3 dimensional volumetric model for the Lower Watrous reservoir seal. The Lower Watrous is a complex 40 m thick siltstone-sandstone sequence interbedded with nodular anhydrite and anhydritic claystones. Porosity and shale content mappings of this critical unit above the reservoir were carried out on a combined borehole/wireline and seismic datasets. The different stochastic geostatistical models which can be set up for the Lower Watrous are also included in the study.

Although many small scale structural disturbances (i.e. fault with small offsets/local flexures) have been identified above the reservoir in the Weyburn field, it is presently not possible to know with certainty, if these faults extend through the regional seal, act as a potential migration path way for CO_2.

The knowledge of the geometry (derived from integrated analysis of the seismic and the borehole data) and the physical/geochemical properties of the rock volume (derived from the well logs and core data) will be required to resolve the above stated uncertainties.

Comment: Some other details of the investigation will be presented at the oral session.