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Integrated 3-D Reservoir Modeling Using Neural Networks: Weyburn Field, Williston Basin, Saskatchewan

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Weyburn Field is a 1.4 billion barrel OOIP oil field located along the northeastern flank of the Williston Basin, Saskatchewan, Canada. The operator, PanCanadian, is currently injecting CO2 into the first phase of a miscible flood of 19 patterns of horizontal wells, the first full scale CO2 flood of a shelf carbonate reservoir in Canada. Detailed reservoir modeling of Weyburn field is critical to (1) optimize sweep efficiency; (2) predict and monitor the advancement of the CO2 front; and (3) assess the long-term storage capacity of the reservoir for greenhouse gas sequestration. Weyburn Field is the subject of 3-D and 4-D multi-component seismic studies by PanCanadian Resources and the Reservoir Characterization project at the Colorado School of Mines. A 3-D reservoir model was constructed for flow simulation by linking seismic derived attributes from multi-component data to rock properties. The use of artificial neural networks (ANN), enabled better integration of seismic scale observations with sub-seismic scale rock properties from core and log data.

An initial geologic model, constructed from core data, described flow units within a sequence stratigraphic framework. Core and diagenetic studies provided excellent vertical resolution of porosity and permeability distribution in the reservoir, but indicated high lateral variation. Preliminary work indicates that ANN's give better results than multi variable regression analysis (MVR) to predict permeability and porosity variations throughout the reservoirs. It appears that, at least for our conditions, ANN's can cope better with non-linear and fuzzy relationships between rock properties and geophysical measurements.