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Dynamic Reservoir Characterization of a Complex Carbonate Reservoir at Weyburn Field, Saskatchewan

Weyburn Field produces from a complex carbonate reservoir (Mississippian Midale Unit) with a high degree of heterogeneity, and is currently the subject of a high-volume CO2 miscible flood program. A representative group of cores, reflecting the range in depositional environments and textures, were studied to construct a detailed sequence stratigraphic model and reservoir paragenesis, which formed the basis for a reservoir model. Critical heterogeneities (those which affect sweep efficiency) and their distribution were identified and preserved in the upscaling process for dynamic reservoir simulation.

Zones of critical heterogeneity were identified through petrophysical, stratigraphic, and diagenetic analysis. Modified Lorenz plots indicate that the reservoir consists of four main flow units that correspond to three principal stratigraphic sequences. Further zonation of flow units reflects the critical heterogeneities that have an effect on flood advancement. Pore throat analysis, using a Winland R35 technique, indicates that critical heterogeneities relate to variations in diagenetic overprinting.

Factors identified that were important to critical heterogeneity were: (1) high permeability zones (five times above average permeability for the flow unit), (2) pore throat configuration, and (3) vertical and horizontal stacking and distribution of high flow capacity rocks. The influence of these critical heterogeneities on the efficiency of sweep will be tested under dynamic simulation by integrating the reservoir model with 4D (repeat) seismic surveys currently underway. The ultimate test is whether adding critical heterogeneities into the up-scaled reservoir simulation model creates a closer match between fluid flow simulation response and the interpreted 4D seismic CO2 front.