Characterization and Modeling Using Macrofacies and Microfacies Intervals of the Midale and Rival "Nesson" Beds in the Mississippian Madison Group, Burke County, North Dakota

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The Plains CO_2 Reduction Partnership, led by the Energy & Environmental Research Center, has selected the Rival field area as one of its Phase III regional characterization sites examining promising oil fields with potential for carbon dioxide (CO_2) enhanced oil recovery (EOR). The Rival acid gas disposal field is located alongside the Rival field where acid gas is collected at the Bear Paw Gas Plant and injected in the permeable horizons below the Rival's lower sealing formation. Acid gas has been injected into the Rival acid gas field since 2002 at a rate of 0.5 Mcf/day.

The Midale beds are at the base of the Charles Formation in the Ratcliffe Interval and conformably overlie the Rival beds of the Mission Canyon Formation in the Frobisher-Alida Interval. Together, they represent a traditional near-shore marine and Sabkha sequence that has been locally productive in the Rival, Black Slough, Portal, and Lignite oil fields in Burke County, North Dakota. The Frobisher-Alida Interval was deposited during rapid carbonate progradation representing a shallowing-upward carbonate to evaporite sequence during the Osagian Stage. Progradation ceased, and a subtle transgressive sequence began to flood the shoreline, depositing the Upper Rival and Midale beds. Sulfate-rich brines heavily cemented the inner portions of the shoreline to the east and formed an up-dip seal for the reservoirs.

Characterization efforts incorporate 120 normalized and correlated wells that penetrate the Midale/Rival beds and have been calibrated to core data, which is present in 80 wells. Local stratigraphy of the Midale/Rival beds is represented by ten petrophysical zones combining for a true vertical thickness (TVT) of 45-70 feet. Further petrophysical and core analysis show a prominent skeletal shale zone with a TVT of 2-9 feet, capping the Upper Rival and restricting hydrocarbon movement between the Midale and Rival beds.

North/south striking intertidal buildups are being modeled with three-dimensional Truncated Gaussian Simulation with trends. This facies modeling technique provides an interactive component where trends and interfingering effects can be altered to honor facies transitions, relationships, well data, and the progradation to transgressive sequences. Geologic and numerical modeling will assess total pore volume and flow rates applicable to CO_2 storage, revised original oil in place, and history matching the acid gas injection. Previous miscibility lab tests show favorable results for CO_2-EOR. Predictions will be made as to the potential success of an acid gas-CO_2 EOR scheme in the Rival field.