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Reservoir Heterogeneity of Turbite Channel/Levee and Submarine Fan Facies in a Lower Devonian Chert and Siliceous Carbonate Reservoir: University Waddell Field, West Texas

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ABSTRACT

University Waddell Field, in northeast Crane County, West Texas, has yielded more than 19.5 million barrels of oil from Lower Devonian Thirtyone Formation deep water cherts and siliceous limestones. Oil production is on the decline, and current recovery represents only 30 percent of the original oil-in-place. The low recovery efficiency, despite 50 years of primary and secondary recovery (gas injection, waterflood) and a partially-completed 20-acre infill well pattern, chiefly reflects reservoir heterogeneity induced by complex facies relationships in a basinal turbidite channel/levee complex and submarine fan depositional setting.

Analysis and interpretation of core and log data from University Waddell field permits subdivision of the approximately 900 ft thick Lower Devonian reservoir interval into four regionally mappable stratigraphic units that define three large-scale (> 100 ft thick) distal-to-proximal successions. Major field production is from porous cherts and siliceous limestones in the lowermost sequence. Reservoir bodies are composed of silt-size to fine-grained, siliceous skeletal packstones/grainstones derived from the platform margin/slope and transported up to 50 mi basinward by turbidity currents. These porous, relatively well-sorted facies represent episodic, high-energy deposition in turbidite channel/levee to proximal submarine fan complexes. Mapping of individual facies bodies indicates lobate to channel-form geometries that generally trend north to northwest, parallel with the regional depositional axis. Reservoir facies grade laterally and are interbedded with nonporous facies that represent slow accumulation of mud-rich sediments in an overbank and distal submarine fan setting and background hemipelagic sedimentation.

Although fault-induced compartmentalization occurs in updip Thirtyone Formation reservoirs, the role of faults and fractures is poorly defined for University Waddell Field. The complex anticlinal structure in the southern portion of the field requires 3-D seismic data to adequately resolve. Significant (50-100 ft vertical offset) normal and reverse faults are recognized from log correlation, although the current well spacing precludes mapping of these steeply dipping fault planes. Although open fractures are common in core, existing data are inadequate to determine their spacing and orientation. High-resolution resistivity image logs from future wells are essential for evaluating the influence of fractures on reservoir behavior.

An estimated 17 million barrels of remaining mobile oil make this reservoir a significant target for enhanced recovery efforts. The highly heterogeneous facies-induced reservoir architecture accounts for many of the production anomalies, poor communication between injection wells and flanking producers, and undrained reservoir regions due to inadequate production completions and inefficient waterflood sweep. To access part of this remaining oil, nearly 40 recompletion opportunities were defined in existing production and injection wells. Five geologically targeted infill drilling locations were defined, the most favorable site coincides with an undrilled structural high.