Diagenetic Controls on Reservoir Quality in Deep Upper Wilcox Sandstones of the Rio Grande Delta System, South Texas

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GCAGS Explore & Discover Article #00109*
http://www.gcags.org/exploreanddiscover/2016/00109_dutton_et_al.pdf
Posted September 13, 2016.

*Abstract extracted from a full paper published in the *GCAGS Journal* (see footnote reference below), which is available as part of the entire 2016 *GCAGS Journal* volume via the GCAGS Bookstore at the Bureau of Economic Geology (www.beg.utexas.edu) or as an individual open-access document via www.gcags.org, and delivered as an oral presentation at the 66th Annual GCAGS Convention and 63rd Annual GCSSEPM Meeting in Corpus Christi, Texas, September 18–20, 2016.

ABSTRACT

Upper Wilcox sandstones in far South Texas were deposited in the Rio Grande Delta system. Petrographic analysis of these Eocene sandstones was conducted on reservoirs from Fandango Field in Zapata County, Texas, which produces gas from Wilcox sandstones at depths of 14,800 to 18,000 ft (4.5 to 5.6 km). The goal of the study was to determine the influence of detrital composition, texture, and diagenesis on reservoir quality. Study of reservoir quality in these sandstones is pertinent to predicting reservoir quality of upper Wilcox sandstones in the Perdido Fold Belt area in the deep Gulf of Mexico along the boundary between U.S. and Mexican waters.

Wilcox sandstones in Fandango Field are mostly sublitharenites, feldspathic litharenites, and litharenites, having an average composition of 71.9% quartz, 8.5% feldspar, and 19.6% rock fragments. Mean grain size ranges from lower to upper very fine sandstone. Quartz is the most abundant authigenic mineral (average whole-rock volume = 9.5%), followed by chlorite (4.5%) and carbonates (calcite, Fe–calcite, and ankerite = 3.0%). Some sandstone intervals in Fandango Field retain anomalously high porosity (≥20%) and permeability (≥10 md) at temperatures >400°F (>204°C) because extensive, continuous chlorite coats inhibited later quartz cementation. Other sandstones at the same depth and temperature are tightly cemented by quartz. Chlorite cement is more abundant in coarser grained sandstones, and there is a statistically significant correlation between chlorite-cement volume and permeability.

Wilcox sandstones in the Texas Gulf Coast show a clear trend of decreasing average and maximum permeability with increasing temperature. Upper Wilcox sandstones from Fandango Field, however, have permeability that is significantly higher than the regional trend as a result of the chlorite coats. Different provenance is interpreted as the reason for the formation of greater volumes of chlorite cement in Fandango Field than in other Wilcox sandstones. We interpret that the weathering of volcanic rock fragments and other iron-bearing minerals in the source area contributed iron to the Rio Grande fluvial system, which then transported the iron to the shallow-marine setting. Clay precursors formed where amorphous iron hydroxides carried in river water flocculated when mixed with seawater. Precursor clay flakes developed parallel to detrital grains by

Originally published as: Dutton, S. P., W. A. Ambrose, and R. G. Loucks, 2016, Diagenetic controls on reservoir quality in deep Upper Wilcox sandstones of the Rio Grande Delta system, South Texas: Gulf Coast Association of Geological Societies Journal, v. 5, p. 95–110.

mechanical accretion as grains were rolled around by currents. The parallel-aligned clays provided a substrate for later precipitation of chlorite crystals oriented perpendicular to the grains. It is the presence of abundant, continuous chlorite coats that results in anomalously high porosity and permeability in some Fandango Field sandstones.

This study of detrital mineral composition and diagenesis of upper Wilcox sandstones in Fandango Field may provide insight into reservoir quality of Wilcox sandstones in the deepwater Gulf of Mexico. The Eocene Rio Grande system was a possible source of sand deposited in deepwater turbidites in the Perdido Fold Belt area. The iron-rich source area for the sediments might have led to development of chlorite coats in these deepwater sandstones and contributed to reservoir-quality preservation.