Regional Trends in Diagenesis and Reservoir Quality of Jurassic Cotton Valley Sandstones, Northern Gulf of Mexico Basin

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ABSTRACT

Jurassic Cotton Valley sandstones in East Texas, Louisiana, and Mississippi were deposited in shallow-marine and fluvial depositional environments in the northern Gulf of Mexico Basin. Reservoir quality of onshore Cotton Valley sandstones varies significantly across this area, increasing from west to east, despite greater eastern burial depths. Petrographic analysis was conducted to determine the influence of detrital composition, texture, and diagenesis on reservoir quality. The objective of this study was to determine the controls on reservoir quality in onshore Cotton Valley sandstones from East Texas to Mississippi.

Cotton Valley sandstones are mostly subarkoses and sublitharenites and have an average composition of 85.5% quartz, 8.5% feldspar, and 6.0% rock fragments ($Q_{85.5}F_{8.5}R_{6.0}$). Metamorphic rock fragments are the most common lithic grains. Sandstones in East Texas contain fewer rock fragments ($Q_{88.1}F_{9.9}R_{2.0}$) compared with Mississippi ($Q_{77.0}F_{10.5}R_{12.5}$). Cotton Valley average grain size increases from west to east.

Total volume of cements and replacement minerals ranges between 0 and 48.0% in the Cotton Valley sandstones analyzed. Chlorite and illite form partial to complete clay rims around some detrital grains in Cotton Valley sandstones. In shallow-marine sandstones from East Texas and Louisiana, clay rims are discontinuous and cover only a small percentage of the grains. Abundant quartz cement precipitated where clay-rim coverage was low. Some Cotton Valley sandstones from Mississippi contain continuous clay rims that inhibited later quartz cementation and preserved intergranular porosity in fluvial and shallow-marine sandstones. Average porosity is higher in Cotton Valley sandstones from Mississippi (15.7%) than it is in East Texas (5.7%) or Louisiana (4.4%). Geometric mean permeability is also higher in Cotton Valley sandstones from Mississippi (7.3 md) than it is in sandstones from East Texas (0.02 md) or Louisiana (0.06 md). Unconfined compressive strength (UCS) of Cotton Valley sandstones and mudstones was estimated using a rebound hammer. There is a statistically significant correlation between total volume of cement in Cotton Valley samples and UCS.

Vitrinite reflectance equivalent (R_{oe}), an estimate of thermal maturity, was calculated by burial-history modeling. R_{oe} is lowest for onshore Cotton Valley sandstones in

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Mississippi (1.05%) and increases westward to 1.2% in Louisiana and 1.4% in East Texas. Cotton Valley sandstones in Mississippi are buried to greater depths than those in Texas and Louisiana, but because the geothermal gradient is lower in Mississippi, thermal maturity is less than in Texas and Louisiana.

Reservoir quality of onshore Mississippi Cotton Valley sandstones is superior to that of Texas and Louisiana as a result of several factors: coarser grain size, more continuous clay rims on detrital grains, and lower geothermal gradient. This study of diagenesis of onshore Cotton Valley sandstones provides insight into reservoir quality of Cotton Valley sandstones in the northeastern Gulf of Mexico. Low porosity and high thermal maturity in offshore Cotton Valley sandstones in the northeastern Gulf of Mexico indicate that generally poor reservoir quality exists in this area.

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