Lithofacies and Pore-structure Characterization of the Mid-continent Mississippian Limestone, Grant Count, Oklahoma

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ABSTRACT

The Mid-continent Mississippian Limestone is an unconventional carbonate reservoir with different scales of mineralogical, lithological, and petrophysical heterogeneity. A complex depositional and diagenetic history of the Mississippian Limestone has resulted in a variety of lithofacies and a pore system with different shapes, pore sizes, and pore-size distribution. The heterogeneous lithofacies and pore-system properties play a significant role in controlling reservoir distribution, fluid storage, connectivity of the pores, and fluid flow in a reservoir. Despite its scientific and economical potential, little information on lithofacies and pore-structure characteristics of the Mid-continent Mississippian Limestone in the state of Oklahoma is currently available.

This study focuses on lithofacies and pore-structure analysis of the Mid-continent Mississippian Limestone from integrated core and digital-image analysis. The Mississippian Limestone represents a distally-steepened ramp where seventeen (17) lithofacies ranging from mud-dominated to grain dominated and chert breccia lithofacies were deposited. Multi-scale 2-D pore-structure characterization using digital-image analysis (DIA) reveals that the majority of pores in the Mississippian Limestone are within the nanopore (1 nm2 < A < 62.5 μm2) to micropore (62.5 μm2 < A < 500 μm2) classification size. General pore types consist of interparticle and intraparticle, vuggy, channel, matrix, and microfracture pores. DIA-porosity quantification yields a reliable result to predict porosity in several lithofacies. However, for mud-dominated lithofacies, DIA-porosity quantification results in a relatively higher porosity as compare to core-measured porosity. Relationships among several pore parameters such as pore shape, pore size, circularity, convexity, and solidity with the petrophysical properties are also investigated in the Mississippian unconventional carbonate reservoir.