Regional Stratigraphy and Proximal to Distal Variation of Lithology and Porosity Within a Mixed Carbonate-Siliciclastic System, Meramec and Osage Series (Mississippian), North-Central Oklahoma

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ABSTRACT

The Mississippian carbonate and silica-rich deposits of northern Oklahoma formed on a regionally extensive carbonate ramp to basin setting and formed the petroleum reservoirs of the "Mississippi Lime" and STACK plays in north-central Oklahoma. The stratigraphy, lithology, and porosity characteristics of the Mississippian Meramec and Osage series vary significantly from proximal ramp carbonates to more distal carbonate and silt-rich deposits into the Anadarko Basin. Porosity is, in part, related to shoaling-upward lithofacies successions that stack to form high-frequency, transgressive-regressive cycles. The degree of calcite cementation is also a controlling factor on porosity. Core samples reveal that the more proximal lithofacies are commonly tripolitic chert-breccias, skeletal grainstones, bioturbated packstones-grainstones and wackestone-packstone fabrics. More distal lithofacies include bioturbated to laminated argillaceous siltstones, and calcareous siltstones, and skeletal packstones to grainstones.

The stratigraphy and spatial variability of Mississippian reservoir properties were evaluated using 56 wells with wireline logs with raster images. Core descriptions from 9 of the wells show variations in lithology, sedimentary structures, grain types and bioturbation. The data was evaluated along a structural-dip transect through Grant, Garfield, Kingfisher, and Blaine counties extending from the "Mississippi Lime" Play southward into the STACK Play. To relate core observations to log properties certain classification methods, including artificial-neural network (ANN) and k-means clustering are evaluated for their ability to distinguish lithologies and lithofacies (rock types). Rock types were predicted using both methods and evaluated in terms of overall accuracy. Core data and wireline logs are used to train and test the classification techniques. Lithology logs are created for non-cored wells throughout the study area from these classification methods. The lithology logs are used to create a regional cross section and 2-D reservoir model framework, displaying lithologic variations within interpreted third-order depositional cycles. Lithology and petrophysical property models illustrate the relationship between shallowing-upward cycles, lithologies, and reservoir quality along the Mississippian ramp structural-dip profile.