Combining Sequence Stratigraphy with Artificial Neural Networks to Enhance Regional Correlation and Determination of Reservoir Quality in the "Mississippian Limestone" of the Mid-Continent, USA

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ABSTRACT

The "Mississippian Limestone" of the U.S. Mid-Continent region is a complex, highly variable, mixed carbonate and siliciclastic system that serves as an important unconventional hydrocarbon reservoir. Recent studies have focused on developing and applying a sequence stratigraphic framework to enhance the understanding of depositional facies and reservoir architecture, and to enhance regional and sub-regional correlation. Throughout the region, the system is characterized by a 3-fold hierarchy of probable 2nd, 3rd and 4th order sequences and high frequency sequences. The third order sequences have proven to be the most reliable for correlation purposes due to distinct wireline log signatures that have been confirmed by ground-truthing the logs to multiple cores and tying to facies stacking patterns.

An integrated approach utilizing well logs, sequence stratigraphy, core analysis, and 2D modeling is used to correlate and assess the reservoir quality of the "Mississippian Limestone" at both regional and sub-regional scales. Nine cored wells are used to create an artificial neural network (ANN) which is tested with k-means clustering methods to create a lithofacies log. The ANN is tested and trained to determine the lithofacies present based on well log signatures alone, in an attempt to pick up small scale changes in this heterogeneous carbonate system. This lithofacies log is applied to non-cored wells throughout the study area, which spans several counties, in order to predict the lithofacies in areas without core data. 2D geostatistical models are created from this data in order to correlate sequence stratigraphic frameworks, facies changes, and reservoir distribution in the Mississippian Limestone across the region.