Enhancing Predictability of Electrofacies Using Sequence Stratigraphy in a Middle Eastern Carbonate Reservoir

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Abstract

This study aims to enhance the electrofacies prediction results in a Middle Jurassic shallow-marine carbonate reservoir in the Middle East. This study uses an integration of a sequence stratigraphy framework from core data and an artificial neural network method to enhance the prediction results. The final results were used to produce a populated 3D grid for better petrophysical property modeling and field development decisions. Sedimentological analysis of the studied reservoir showed five lithofacies arranged from proximal to distal; laminated peloidal skeletal mud to grain-dominated packstone, bioturbated skeletal grain-dominated packstone, peloidal skeletal bioturbated mud-dominated/packstone, wispy laminated wackestone and laminated calcareous mud to wackestone deposited in mid-ramp settings below fair weather wave base. By recognizing the 1D stacking pattern of the lithofacies, four shallowing-upward cycles are identified where each cycle represents a 4th order high-frequency sequence arranged from base to top (UF1, UF2, UF3 and UF4). The sequence stratigraphy framework was used to define rock intervals across the wells for the prediction process. It improved the prediction results by 9% compared to other interval methods based on lithostratigraphy. In addition, the stacking pattern in the predicted results is preserved better using the sequence stratigraphy method. The supervised approach based on lithofacies from core data and selected log packages was used to apply the electrofacies prediction to uncored wells. The lateral distribution and continuity of lithofacies are best described in the 3D facies model. The model uses all core lithofacies and predicted electrofacies from cored and uncored wells. A stochastic modeling approach by sequential indicator simulation algorithm was used to populate the lithofacies. This method produced results that honor well data with constraints that were obtained from sedimentological analyses. The 3D facies model can be used to improve porosity modeling, especially when a porosity-facies relationship is established. In addition, the model can be used to ensure better well planning and placement.