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Performance Forecasting and Characterization of Carbonate Reservoirs Using Data-Driven Models

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ABSTRACT

The pace of operations in the oil industry keeps increasing with higher volumes of data becoming available in shorter periods with newer technologies and processes. This requires industry professionals to analyze the data at the same pace, and make quick and reliable decisions to manage assets better and create value. Unconventional modeling approaches are necessary to extract more information from limited data for optimum utilization of hydrocarbon resources so that development projects would not be affected from volatile oil prices. In this study, a data-driven modeling approach utilizing neural networks is followed to better understand reservoir characteristics and flow dynamics from limited data in carbonate reservoirs. Two case studies are considered to test the proposed methodology: 1) Estimation of infill well performance in an oil reservoir with waterflooding patterns, 2) Estimation of resistivity logs from surface-seismic attributes. Models are developed using seismic attributes, historical production/injection data, well logs and derived reservoir properties. For the infill-well-performance model, two key types of information presented for model-training are: 1) oil/water rate data from offset wells, 2) estimated ultimate drainage area that is calculated using Voronoi grids for each well to account for interference effects. Developed model was able to accurately predict oil production rates and water cuts for the existing wells with correlation coefficients greater than 0.80, capturing the fluid-flow dynamics within the reservoir and demonstrating the potential to estimate the performance of new development wells. For the reservoir characterization model, 39 surface seismic attributes, well locations and depth are used as inputs to predict induction conductivity, induction resistivity and short-normal resistivity logs. Using 14 wells for training, logs of 3 wells in the testing set were predicted with a correlation coefficient of 0.83. The study shows that neural-network based data-driven models can be used to estimate well performance and well logs accurately using field data. The workflow presented is very efficient in terms of manpower and computational-time requirements when either high-fidelity models or computational resources are not available. Using only real data reduces the risks related to potential uncertainties in reservoir modeling and interpretations for unexplored locations.