

A Comprehensive Facies Prediction Workflow for a Heterogeneous Carbonate Reservoir, Saudi Arabia

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ABSTRACT

Detailed sedimentological descriptions of cores integrated with wireline log data has enabled facies predictions for heterogeneous carbonate reservoirs at the wellbore scale for non-cored wells using a neural network system. These facies predictions, along with the core data, are the main input for a 3D geological and integrated simulation modelling study. The cored wells across the reservoir intervals were fully described, interpreted and digitized. Core-to-wireline log calibrations were performed at a higher resolution. A sequence stratigraphic framework was developed and several stratigraphic intervals were defined. A comprehensive workflow was implemented for the facies prediction that includes (1) data management, (2) data preparation, (3) data learning and calibration, and (4) facies population to the non-cored wells using advanced neural network software. The wire-line log data for the cored wells were quality controlled, cleaned, and normalized. Different combinations of wire-line logs were tested for facies prediction; however, the best results were obtained from the combination of gamma ray, sonic, neutron-density, porosity and multi-mineralogy volumes. After the learning and calibration process for each stratigraphic interval, the predicted facies were populated to a cored well as a blind test of the predictions. The results ranged from 55% to 80% agreement between predictions and core data, which is considered a good ratio in such a heterogeneous carbonate reservoir. Based on these results, the prediction was extended to all non-cored wells for all the stratigraphic intervals. The facies prediction of these non-cored wells was effectively implemented in the core-based sequence stratigraphic framework, and extended the understanding of facies distribution, specifically the best reservoir quality. After the successful results of the facies prediction in this study, the workflow is being implemented for all the other fields in Saudi Arabia.