Exploring Jurassic Carbonate Stratigraphic Traps by Integrating Sequence Stratigraphy, Petrophysical Characterization, and 3-D Seismic Facies Modeling, Northern Saudi Arabia

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The Jurassic contains world class source rocks and significant oil reservoirs in the Kingdom of Saudi Arabia. The exploration for Jurassic oils over the past few decades has primarily been focused on structural plays, however, considerable oil resources are believed to be contained in stratigraphic traps. Over the last few years, Saudi Aramco has pursued rigorous geological and geophysical studies to lay the foundations for exploring stratigaphic traps. This paper presents a workflow for exploring Jurassic carbonate stratigraphic traps through an integration of sequence stratigraphic framework, core-based rock typing and well-log electrofacies prediction, and calibrated seismic facies modeling of 3D seismic volumes.

This workflow transforms core, well-log, petrophysical, and seismic data into 3D models. The workflow involves: 1) Unraveling the stratigraphic framework and reservoir architecture by integrating core, well-log correlations, and regional 3D seismic interpretations; 2) Core-based rock typing for selected Jurassic carbonate reservoir formations by integrating core descriptions, thin-section petrography, core plug porosity/permeability, and capillary pressure data; 3) Construction of electrofacies prediction models for selected "Reference Wells" that are extensively cored and representative of the Jurassic stratigraphy in the area. These electrofacies prediction models were rigorously tested by validating predicted electrofacies using core-derived rock types. The optimized model was used to predict electrofacies that represent rock types of varying reservoir quality and seal facies for all the "Application Wells"; and 4) The derived electrofacies from all the wells were upscaled to a seismically detectable level, and then output as numerical codes into the calibrated seismic facies modeling of 3D seismic volumes using state-of-the-art technologies for seismic facies classification, modeling and seismic attributes analysis.

The generated calibrated seismic facies, rock types and porosity models allow accurate prediction of lateral and vertical facies changes of reservoirs and seals within 3D volumes, revealing potential stratigraphic traps. The Middle and Upper Jurassic Arab-D and Upper Fadhili reservoirs have been taken as examples for the above approach. The results from this study have demonstrated that existing stratigraphic trap analogue and potential new stratigraphic traps can be successfully predicted.