Assessment of Stratigraphic Traps in Arab Formation Reservoirs Using Seismic Reservoir Characterization and Associated QSI Fluid Substitution Techniques, Rimthan Arch, Saudi Arabia

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ABSTRACT

Stratigraphic play definition for hydrocarbons in Arab Formation reservoirs presents a challenge for successful exploration on the Rimthan Arch. Exploration success of the Jurassic Arab A, B, C and D reservoirs shows wide variability owing to the indiscriminate distribution of high quality grainstone reservoirs. Depositional environments range from tidal to grainstone shoals, and into basin deposits. To identify the nature of stratigraphic trap plays, an integrated reservoir characterization approach was applied using 3D seismic data and well logs to better characterize the reservoirs. The approach was three-fold: to define the basin depositional framework, to apply reservoir heterogeneity log facies assessments to well data based on elastic and petrophysical properties cross plots, and to apply Quantitative Seismic Interpretation (QSI) techniques, mainly fluid substitution, to Arab A reservoirs. Results were encouraging. A seismic stratigraphy assessment shows the prograding Arab sequences downlapping onto the underlying post-Hanifa sequences. Each Arab sequence progrades towards the Gotnia intrashelf basin where beds change lithologically to alternating salt and anhydrite beds. A neural network-based unsupervised seismic facies evaluation using complex seismic attributes identifies lateral distribution of facies that corroborates prograding depositional trends. A log-based Heterogeneous Rock Analysis facies clustering technique highlights the vertical and lateral distribution of the grainstone and packstone reservoirs within the Arab. Compressional to shear wave velocity (Vp/Vs) versus Acoustic Impedance (AI) crossplots support the definition of at least 5 log facies classes linked to grainstone, packstone, muddy packstone, wackestone and anhydrite tied to core data. A dip correlation panel of eight wells demonstrates the reservoir lithology variations from a tidal, to shoal, to deeper water deposition where reservoir quality degrades basin-ward. Local variations in lithology suggest enhancement for increased lateral seal potential. Fluid Substitution analysis, using 100% brine, 80% oil and 90% gas, reveals positive responses of the rock properties to pore fluid changes. Reservoir charge correlated positively to specific rock facies using Vp/Vs and AI assessments. The integrated approach incorporating quantitative and qualitative seismic interpretation and log analysis proved useful in defining the stratigraphic trap potential for the Arab reservoirs.