

Reservoir Evaluation of Channelized Paleozoic Reservoirs Using Seismic Chronostratigraphy, Spectral Decomposition and Log-Based Facies Classification – North Ghawar, Saudi Arabia

Stanley R. Wharton¹ and Harianto Soepriatna¹

¹Saudi Aramco, Dhahran, Saudi Arabia.

ABSTRACT

Paleozoic reservoirs in the north Ghawar area represent productive exploration targets located in combined structural/stratigraphic traps. Large scale uplift and erosion during the Hercynian Orogeny, along with glaciation, generated deep paleovalleys into which were periodically deposited stacked glacio-fluvial sediments. To characterize the Unayzah reservoirs, the main challenge is defining their vertical and lateral distribution on the Ghawar structure. A 3D seismic dataset was subjected to aggressive de-noising routines and flattened on a Permian Khuff reservoir seismic pick to focus the deeper structural configuration and image the stratigraphy. Using this dataset, a seismic chronostratigraphy model was built to stack a dense set of seismic horizons within the model. Horizons are sequentially investigated in relative geological time to elucidate basin structure and definition of the Unayzah sequences from underlying formations. Key well picks, including the Pre-Unayzah (PUZU) unconformity are integral in identifying the Unayzah. The approach proved beneficial as selected horizons tied to a spectrally enhanced seismic dataset were analyzed using Spectral Decomposition. The technique employs a Red, Green and Blue (RGB) blending of seismic frequencies to reveal channelized delta systems. Channel flow is roughly northwest to southeast with visualization of individual channels constrained by multi-storied channel systems. Well core data descriptions provided the “ground truth” for interpreting the depositional systems. Well log analysis results and a gross thickness map of the Unayzah reservoirs corroborated with reservoir limits and reveal local depocenters spread across the study area. A log-based Heterogeneous Rock Analysis technique was applied to the Unayzah and Jauf reservoirs to map reservoir distribution and depositional environments. The facies classification technique employs use of elastic and petrophysical properties from logs using compressional to shear wave velocity ratios (V_p/V_s) and Acoustic Impedance (AI) crossplots to select log facies. Geobody rendering using Spectral Decomposition results from a low frequency, and a high resolution seismic dataset reveals the distribution of channel systems corroborated with the gross reservoir thickness. This integrated approach is considered beneficial towards understanding the basin configuration and reservoir heterogeneity within the complex Paleozoic reservoirs in north Ghawar.