Integration of Multiple Seismic Tools to Identify Thin Tight Carbonate Reservoir in Northern Kuwait Field

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Abstract

Thin tight carbonate reservoir posed huge challenge to explore and delineate within Middle Minagish Formation interval in northern Kuwait field, although the oil presence proven in an adjacent field. This reservoir is one of the prolific producer among the carbonate reservoirs within the southern and western part of Kuwait fields. This thick and porous excellent reservoir of south and west deteriorated towards north due to possible change of depositional settings, diagenesis and tectonics. Thickness of the reservoir varies within 5 to 15 feet and maximum porosity of the reservoir varies between 8 to 10 porosity units. Seismic based reservoir characterization immensely impacted due to the sub-seismic resolution of the strata. Thus, a seismic attribute based geophysical and geological integration approach adapted to identify the presence of reservoir and its probable demarcation. The seismic spectral decomposition attribute analysis is an indispensable tool to identify seismically thin bed reservoir. Its lateral facies variation adapted through Short Window Discrete Fourier Transform (SWDFT) method. It effectively proved in identification of thin tight carbonate in one of the north Kuwait field. The state of the art seismic tools like the waveform inversion, geostatistical waveform classification and machine learning based tools like the probabilistic fault-likelihood and thin-likelihood assisted to identify this thin tight reservoir and encompassed its areal extent. The seismic waveforms classified in ten unsupervised classes and two classes encompass on the possible reservoir facies area. The distribution of the waveform facies further verified through quantitative seismic inversion approach. A robust inversion carried out utilizing the conditioned wireline logs and the post-stack seismic volume to generate P-impedance volume for reservoir property identification. The seismic P-impedance attribute calculated and mapped using the 12 ms interval. The P-impedance range 45,500 - 47,500 (g/cc*ft/s) used in extracting the horizon attributes. The available drilled wells information and petrophysical interpretation indicated the presence of thin tight reservoir with oil.