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The Role of Rock Physics in Unconventional Frontier Plays

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ABSTRACT

Rock physics is invaluable in exploring for hydrocarbons in unconventional plays in frontier areas, because it allows for the reservoir to be characterized in terms of its lithology (reservoir) and/or fluid (pay) potential. The wireline data can be used to forward model various expected seismic attribute responses. The subsequent inverted seismic data can then be transformed to various reservoir properties (i.e., porosity, volume of sand, saturation etc.) using the rock physics template (RPT) derived from the well data as a guide.

Two RPTs have been constructed to constrain two deterministic (pre-stack) inversions from two independent and geologically very different areas within the Kingdom of Saudi Arabia. The aim of the first template was to optimally characterize zones of higher porosities for a clastic, offshore, deep-water, exploration prospect (i.e., reservoir template), while the second template was used to guide the pre-stack seismic inversion to highlight remaining pay zones in a large onshore field currently in production (i.e., pay template).

A multi-attribute inversion feasibility analyses were carried out, prior to designing the RPTs, to investigate the sensitivity of various elastic attributes to porosity and pay for the two areas.

Firstly, for the reservoir template, although the offshore reservoir exhibits low porosity and permeability (tight) zones, the rock physics analysis showed that the reservoir sands could still be separated into zones of higher, intermediate and lower porosity units, then mapped using two pre-stack inversion attributes (LambaRho and MuRho). The rock physics analysis and seismic inversion were incorporated to successfully guide a proposed well side-track trajectory, targeting the higher porosity sands of another deep-water well in the area. Logging While Drilling (LWD) data was acquired in the new well and confirmed the occurrence of a high-porosity unit as predicted by the rock-physics-guided inversion.

Secondly, with the use of the pay template, the rock physics analysis was able to identify additional, geologically reasonable, remaining pay zones within the area. Moreover, the rock-physics-guided predicted pay matched the in situ pay zones in the existing wells really well and therefore increasing the confidence in the predicted results.

In future, both these rock physics templates will be utilized to guide seismic inversion volumes for all subsequent wells in the two areas.