

The Impact of Rock Physics Guided Seismic Property Forward Modeling on Stratigraphic Traps

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Abstract

The fundamentals of applied rock physics models are to associate reservoir properties with elastic properties. Therefore, rock physics forward modeling could play a major role in decreasing the risks of drilling dry wells. This requires a careful analysis of the quality of wells, petrophysical, and seismic data to build forward models that are designed to assess the accuracy of the prospect integrity. In our study, we evaluated the extension of a Devonian clastic reservoir and its seismic response pertinent to possible trapped hydrocarbons. The study was initiated to enhance the seismic interpretation, especially around key exploration wells to understand the trap and reservoir definition of the prospect. We used data from three wells, well-A, well-B, and well-C, that targeted the Devonian clastic reservoir. Both core and stratigraphic data analysis showed that the reservoir exists only in well-A, and perhaps in well-B. In addition, the top of the reservoir is an unconformity surface that is difficult to detect with seismic data only. To enhance the reservoir characterization study, we performed a rock physics feasibility analysis. We cross-plotted different elastic properties to discriminate between reservoir and non-reservoir facies among the three wells. To validate our rock physics analysis, we generated rock physics seismic properties forward models, which allowed us to confirm the reservoir existence and its relative pinch out by tracking the amplitude on the modelled synthetic seismic. From a resolution perspective, we developed a wedge model to determine the tuning thickness and the detectability of the reservoir from seismic amplitudes. The separation between reservoir and non-reservoir facies was based on the cutoffs in elastic attributes, mainly AI and Vp/Vs. We demonstrated the presence of the reservoir in Well-B and the pinch out between wells B and C. In addition, we calculated the reservoir detectability for the current seismic data quality. We were able to prove that the top reservoir amplitude variations are due to the unconformity that is caused by in the interfaces from the different lithologies. However, the base of the reservoir had a consistent amplitude confirming that it is a conformable surface. Based on the rock physics guided seismic property forward modeling, we were able to define the reservoir and the trap in the Devonian zone. Consequently, this analysis has helped with the placement of another delineation well.