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Value Added to Exploration Teams by Integrating Basin Modeling, Rock Physics, and Quantitative Seismic Interpretation

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ABSTRACT

Predicting the lithologic composition of both known and potential reservoir rocks is challenging in areas where well penetrations are limited. We present a new method that combines basin modeling with rock physics and quantitative seismic interpretation to predict the composition-sandstone or shale-away from well control. Traditionally, this basin modeling part of the workflow was missing. In this study, we first use basin modeling to predict thermal and pressure history across a basin. Effective stress and temperature from the basin model are then used to calculate seismic velocity and density, which in turn are used to determine impedance across the study area. This impedance solution forms the basis for honoring spatial trends of impedances into the background model (or initial guess) used to invert for impedances from seismic data. Also, the impedance solution extends the training data (or well data) beyond well control to preserve spatial trends. The final step is lithofacies classification from the final inverted impedance volume. This methodology is applied to three scenarios. The base case is the reference scenario in which data from two wells are used to determine acoustic and elastic impedances. Scenario 1 uses data from just a single well and follows the traditional method of predicting lithofacies (i.e., without basin modeling). Scenario 2 uses that same well but uses the new workflow with basin modeling predictions of impedances at the location of the second well. The relative proportions of sandstone and shale are nearly indistinguishable between the base case and Scenario 2, whereas Scenario 1 significantly underestimates the amount of sandstone. This new methodology, demonstrated in a salt withdrawal mini-basin in the Gulf of Mexico, can be applied to all potential reservoir intervals in a study area, thus allowing the determination of stacked pay.