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Basin Modeling in the Aid of Seismic Reservoir Characterization

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ABSTRACT

In this study, we utilize basin and petroleum system modeling (BPSM) to assess differences in elastic rock properties across the reservoir zone, in order to better understand their seismic signatures. BPSM models sedimentation, erosion, subsidence and uplift through geologic history and simulates the corresponding pressure and thermal histories (Hanstschel and Kauerauf, 2009 ; Peters, 2009). Seismic characterization of the distribution of reservoir lithofacies using quantitative seismic interpretation (QSI) requires prior understanding of the spatial trends of elastic properties changes in the reservoir (Avseth et al., 2005). QSI builds training data of elastic properties invertible from seismic volumes based on well-log data. Then, lithofacies are predicted by combining the training data with the inverted elastic properties cubes through a classification scheme. This QSI workflow is sensitive to how well the training data represents the subsurface distributions of elastic properties, and the quality of the inverted elastic properties volumes. Insights from BPSM about pressure and thermal histories can improve our understanding of the elastic property changes across the reservoir and hence the boost the quality of QSI.

We focus on characterizing the lithofacies of three reservoir intervals in the Thunder Horse mini-basin of the Gulf of Mexico using QSI. The Thunder Horse turtle structure is a result of inversion of a salt withdrawal mini-basin (Lapinski et al., 2004). It includes both Thunder Horse and Thunder Horse North fields. We build 1D basin models to estimate the pressure and thermal histories of the reservoir intervals in both fields. Then, we carried forward the 1D basin modeling pressure and thermal histories insights when building the training data from the wells and when inverting the seismic volumes into impedance cubes. In this workflow, we explored the value of the basin modeling insight in terms of improving the representation of the training data and the quality of the inversion results.