Integrating Basin Modeling and Seismic Imaging for Joint Uncertainty Reduction

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ABSTRACT

A critical input to any basin-modeling endeavor are the present-day geometries of geologic horizons interpreted using seismic data. However, the depths and spatial locations of the horizons as observed in the seismic image are highly dependent on the P–wave velocity model used for seismic imaging. On the other hand, seismic imaging itself is strongly controlled by the geo-history of the basin because factors such as compaction and overpressuring will affect rock velocities. Thus, it is desirable to ensure that basin modeling and seismic imaging workflows integrate these mutual constraints. We present an integrated workflow in which we link outputs of basin modeling such as present-day models of porosity, pore pressure, smectite-illite volume fractions to P–wave velocity through rock physics models. We propose a Bayesian framework for the workflow which facilities accounting for uncertainties associated with the workflow. We demonstrate our methodology on a 2D depth section in the northern Gulf of Mexico. We define prior probability distributions on uncertain modeling parameters related to lithologies and boundary conditions. We use well and seismic data to achieve joint uncertainty reduction on basin modeling parameters and velocity models. We perform seismic imaging with the basin modeling derived velocity models and demonstrate that velocity models lead to well-focused seismic images which are consistent with the geo-history of the basin.

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