Quantifying Heterogeneity Preserved in Inverted Seismic Data: Implications for Reservoir Prediction and Geostatistical Modeling

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Abstract

The Upper Cretaceous Tres Pasos Formation, located adjacent to Laguna Figueroa in the Magallanes Basin of southern Chile, contains outcropping deep-water channel deposits. These deposits represent the products of sediment transfer across deep-water slopes. Digital outcrop and bed-to geobody-scale models of channel deposits in the Tres Pasos Formation reveal that channel element stacking patterns and internal architecture are not only coupled, but also strongly control connectivity. However, this scale of architecture is difficult to resolve in seismic-reflection profiles, and it is often problematic to tie interpretations back to bed- to geobody-scale architecture observed in outcrop or core. Forward seismic reflectivity modeling of digital outcrop models at varying frequencies provides insight into what heterogeneity is preserved in a filtered seismic response; however, such studies often stop short of an assessment of the link between underlying depositional architecture and seismic resolvability. In this study, we generate forward seismic models of a bed- to field-scale deep-water channel system outcrop model with variable: sandstone net-to-gross (NTG), proportion of mass transport deposits (MTDs), and stratigraphic hierarchy. The model results are inverted and analyzed for predicted rock properties and stratal surfaces, which are then compared with those of the underlying model. The goal of the study is to quantify what information is preserved in inverted seismic data for interpretation and modeling workflows and what the implications are of correct versus incorrect interpretation of stratal packages and

facies classification. Results show that probability of misclassification of stratal packages and facies from seismic attributes (i.e., near- and far-angle stack impedances) increases with decreasing frequency. Furthermore, hierarchical groupings (e.g., channel complexes) are more easily interpreted in systems characterized by higher NTG elements and a higher proportion of MTDs stratigraphically separating complexes. Finally, the probability of facies misclassification from seismic attributes predictably increases for laterally stacking patterns more than vertical stacking patterns. This investigation provides a fundamental understanding of what architectural information is preserved in inverted seismic data and how this data can (or cannot) be used directly for reservoir prediction.

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