Quantitative Seismic Characterization of the Spraberry-Wolfcamp in the Midland Basin: Reservoir and Geomechanical Properties

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ABSTRACT

Quantitative seismic interpretation can be an integral part of the conventional workflow for the characterization and development of unconventional reservoirs. We present a methodology of estimating elastic properties, TOC, and porosity in the Spraberry-Wolfcamp interval in the Midland Basin by integrating the results from 3D seismic inversion, joint petrophysical inversion, and machine learning (ML). We generate several 3D cubes of elastic and reservoir properties of the zone of interest. Data from 15 wells and 3D post-stack seismic data are available for this study. We use a neural network approach to estimate velocity logs from other conventional logs in a few wells, lacking such information. First, we compute standard elastic properties from wireline logs, such as Young's modulus and Poisson's ratio. Then, these results are integrated with petrophysical probabilistic-solver-based volumes (quartz, clay, carbonate, and kerogen) to understand the relations between minerals and rock properties. Because no pre-stack 3D seismic data were available, we use a combination of acoustic impedance (from inversion), RMS amplitude, instantaneous frequency, and phase attributes as input to a neural network model to predict Young's Modulus and Poisson's Ratio using 3D seismic data. We compared the seismic-based elastic and reservoir properties with a blind-test well to reduce the uncertainty in ML–based results. Our predicted properties match reasonably well with the original log data. The relation between Young's modulus and Poisson's ratio helped to delineate brittle versus ductile units in the Spraberry-Wolfcamp interval. Multiple brittle zones can be observed in the Lower Spraberry and across the Wolfcamp. These zones also change laterally because of the variability of the mudstone facies. Combining the brittleness index, TOC, and porosity cubes by color blending (red-green-blue) into a composite image, we could highlight potential sweetspots in the study area.

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