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Seismic Attribute-Based Characterization of Coalbed Methane Reservoirs: An Example from the Fruitland Formation, San Juan Basin

The Fruitland Coal of the San Juan Basin is the world's largest producer of coalbed methane. Production variations from the Fruitland, on a basin-wide and local scale, reflect various influences, including differences coal thickness and fracture (cleat) density. In this study, we examine a thick, continuous coal seam in lower part of the Fruitland Formation (Rosa Unit, north-central part of the San Juan Basin) using well logs and p-wave 3-D seismic data. Our objective was to use 3-D seismic data to predict coal thickness, and the distribution and orientation of subtle structures that may be associated with enhanced permeability zones. Using a multiattribute-based analysis, we derived an empirical expression that predicts coal thickness as a function of 3 attributes (maximum absolute amplitude, integrated trace and total energy). We validated the result by evaluating its statistical, geophysical, and geological significance, in addition to comparing the empirical results with results derived from forward modeling. By using multiple attributes, we better captured subtle variations in waveform than could have been achieved with any single attribute (e.g., composite amplitude). We then used curvature attributes to delineate subtle structural features not easily observed on vertical transects or seismic horizons through the data volume. By integrating curvature lineaments with predicted thickness map, we can define post-depositional and syn-depositional structural features. Moreover, analysis of production trends revealed a strong association between thick accumulation of coal, proximity to subtle structures, and high productivity. Therefore, the incorporation of production data added robustness to our attribute-based interpretation.