Can Machine Learning Help Predict Channel Stacking Patterns in Deep-Water Systems?

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Abstract

Deep-water slope channel systems represent potential hydrocarbon reservoirs that are of great economic importance to the petroleum industry. Characterizing these reservoirs is critical because temporal and spatial variations in channel body stacking patterns impact reservoir connectivity; however, stratigraphic architecture can be difficult to interpret in exploration-scale seismic data. The use of outcrop studies as analogs can help to improve our understanding of facies distribution and heterogeneity with bed- to geobody-scale field observations and measurements not commonly available in subsurface data. A wealth of quantitative data and statistics can be extracted from outcrop analogs and used to test and guide subsurface interpretation workflows. In this study, we utilize an outcrop database of a deep-water slope channel system to test the efficacy of unsupervised and supervised machine learning algorithms in adequately predicting deep-water stacking patterns from 1-D borehole data. The database contains over 3,400 meters of measured section data from deep-water slope channel strata in the Tres Pasos Formation at Laguna Figueroa in the Magallanes Basin, Chile. The measured section data includes grain size, bed thickness, and sedimentary structure information, which were used to interpret facies associations and stratal packages within the upper and lower channel complex sets at Laguna Figueroa. From these measurements and interpretations, statistics including net-to-gross, channel thickness, facies proportions, and amalgamation ratio were calculated for individual channel bodies. Both supervised and unsupervised algorithms were used to analyze statistics and generate classifications of position—axis, off-axis, or margin—for two different interpreted facies models: two positions (axis/margin) and three positions (axis/off-axis/margin). The results show: 1) the supervised and unsupervised learning algorithms were more successful when classifying channel bodies for only two positions, 2) the supervised learning algorithms were overall more successful for classifying channel body position than the unsupervised learning algorithms for both facies models. The classification results, and the uncertainty associated with them, are then used to generate a prediction of near-wellbore channel body stacking patterns.

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