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Geomorphology-Based, Automated Seismic Facies Analysis: Applied to 3-D Reservoir Mapping

Seismic facies analysis is a powerful, yet largely subjective methodology for hydrocarbon exploration and development. Determining how to automate the process to improve the consistency and reduce the 3-D cycle time has been a challenge. I present a geomorphology-based, automated seismic facies classifier that makes use of the large-scale geometry of depositional systems imaged from 3-D seismic data. In addition to seismic waveform and texture, geomorphology provides independent and useful information for high-resolution facies mapping and should be included in future technology and software development. The suggested procedure accomplishes five key goals: (1) to generate amplitude (or other attributes) stratal slices, (2) to characterize gray-tone shapes, (3) to calculate geomorphologic attributes, (4) to train a supervised, neural network classifier, and (5) to apply the classifier to seismic data for facies maps. Models show that a morphology-based neural network can classify depositional facies that are morphologically distinctive but identical or similar in amplitude and texture (e.g., bed-load, mixed-load, and suspended-load fluvial channels, or fluvial-, wave-, and tidal-dominated deltas). One test on the real seismic data for three types of fluvial channels (straight, meandering, and anastomosing) shows significant improvement over results from waveform classification. Another test successfully separates the incised-valley fill (IVF) sandstones—main reservoirs in the study area—from fluvial-channel sandstones and flood-plain shale in a 3-D volume, even though the IVF sandstones do not stand out as seismic amplitude, waveform, or texture anomalies.