Theory and Methodology for Seismic Texture Analysis: Implications for Seismic Facies Visualization and Interpretation

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ABSTRACT

"Texture" is a general terminology that has different definitions and implications in different areas of science. Basically, texture is defined by spatial variations and distribution patterns of constituents of a feature at a given scale in a specific domain. In seismic stratigraphy, seismic texture refers to lateral and vertical variations in reflection amplitude and waveform at a specific sample location in 3-D seismic domain. It is an acoustic expression of lateral and vertical variations in rugosity, lithology, and thickness of beds and thin beds in 3-D stratigraphic domain. Physically, seismic texture is linked to stratigraphy via a wavelet convolution, and such a physical link between seismic texture and stratigraphy holds the key and potential to characterize and quantify depositional facies from reflection seismic data.

To quantify seismic texture analysis, this study applies a texture model regression method that directly transforms a regular amplitude volume into a seismic texture classification volume. The algorithm first designs a seismic texture model using a full wavelength of trigonometric cosine function with a specific amplitude and frequency. Then it compares actual seismic texture at each sample location with the model by calculating regression gradient based on a least-squares linear regression analysis. To minimize the impact of phase of wiggle traces on facies visualization, the model is defined dynamically using adaptive phase as it moves from sample to sample along each trace throughout the seismic input volume, thereby creating a new regression gradient volume. The resulting regression gradient represents texture similarity relative to the model that is interpreted to be possible facies indicator. Case studies and comparative analysis indicate that the new seismic texture theory and methodology provides an effective means for interactive and robust seismic facies discrimination, visualization, and interpretation.