Quantifying the Probability of Occurrence of Shallow Gas as a Geohazard

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Seismic anomalies of strong negative amplitude are usually associated with porous sands and are interpreted as potential regions of fluid/gas saturation. Thus, amplitude anomaly extraction in the near-surface interval has been shown to be a proxy for shallow gas during geohazards assessment. Quantification of the degree of gas hazard can be accomplished using two interpretation methodologies: amplitude versus offset (AVO) and spectral decomposition.

The variation in amplitude of a seismic reflection with angle of incidence is often used as a hydrocarbon gas indicator, because gas generally increases amplitude with increasing incident angle. The variation is determined by a ratio of far-angle to near-angle stack. After calibration with rock properties from well data, this variation is exported as a shallow-gas probability volume.

Spectral decomposition is based on the concept that a thin bed reflection has a unique spectral response in the frequency domain. Seismic reflection data is transformed to different frequency domains, and a series of amplitude slices are generated at different frequencies. By examining individual amplitude slices at various frequencies and combining different frequencies of amplitude images together, subtle events and anomalies can be identified. Spectral decomposition combines two or three frequency slices into a single display, assigning different colors to different frequencies, and then animate a series of spectral images through depth to capture anomalies. Multi-frequency spectral decomposition with RGB color co-rendering is crucial to reveal the 3-dimensional nature of possible shallow-gas hazards and assists in refining stratigraphic interpretation of complex channel-levee systems.

Geohazards assessment using quantitative AVO analysis provides the probability of encountering shallow-gas hazards for planning drilling strategies with greater confidence; while spectral decomposition technique has helped interpreters better understand the relationship between amplitude anomalies and geology in complex settings. Incorporation of AVO, spectral decomposition, and conventional amplitude anomaly extractions has improved our ability to find safe drilling locations in areas that may have previously been considered too dangerous to drill.