Multi-Trace Seismic Attributes for Fracture Detection

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ABSTRACT

Identifying and mapping the distribution of natural fractures and faults systems is important in understanding fluid flow and hydrocarbon accumulation. Although such features are not usually identifiable using conventional 3-D seismic data, their orientation and intensity can be inferred using seismic attributes. In pursuing my goal of developing fracture detection technology, I addressed four areas: 1) improved edge detection algorithm, 2) edge protection smoothing filtering, 3)spectral analysis of curvature, and 4) interazimuth coherence.

All seismic data contains a mixture of signal and noise. Unfortunately, modern edge preserving smoothing algorithms are unable to preserve small, thin lineaments that are only one trace wide. For this reason, I have developed a suite of crack-preserving smoothing algorithms that preserve such lineaments but suppress more random noise.

One of the most accepted geologic models is the relation between reflector curvature and the presence of open and closed fractures. Depending on the tectonic regime, structural geologists link open fractures to either Gaussian curvature or to curvature in the dip or strike directions. Reflector curvature is fractal in nature, with different tectonic and lithologic effects being illuminated at the 50 m and 1000 m scales. Until now, such curvature estimates have been limited to the analysis of picked horizons. I have developed to my knowledge the first volumetric estimates of reflector curvature that can be examined at various spatial scales.

3-D surface seismic data can image fractures and faults more effectively if the seismic data are sorted into common azimuth bins and analyzed separately for each azimuth. Based on this fact, I have developed a new algorithm to detect sub-seismic

faults and fractures by calculating the similarity between prestack limited azimuth seismic data. The new algorithm calculates coherence *between* rather than *within* prestack azimuth-sorted cubes.