Improvements in imaging faults and flexures – multispectral coherence and aberrancy

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ABSTRACT

One of the key takes of a seismic interpreter is to map lateral changes in surfaces, including not only faults, folds, and flexures, but also incisements, diapirism, and dissolution features. Volumetrically, coherence provides rapid visualization of faults while curvature provides rapid visualization of folds and flexures.

In general, one wishes to interpret the most broadband data possible. However, because of the thickness tuning effects, certain spectral components often better illuminate a given feature with higher signal-to-noise ratio than others. Clear images of channels and other stratigraphic features that may be buried in the broad-band data may “light up” at certain spectral components. For the same, coherence attributes computed from spectral voice components (equivalent to a filter bank) also often provide sharper images, with the “best” component being a function of tuning thickness and reflector alignment across faults. While one can co-render three coherence images using RGB blending, display of the information contained in more than three volumes in a single image is difficult. We address this problem by summing a suite of structure-oriented covariance matrices computed from spectral voices resulting in a “multi-spectral” coherence algorithm.

Aberrancy measures the lateral change (or gradient) of curvature along a picked or inferred surface. Aberrancy is complementary to curvature and coherence. In normally faulted terrains, the aberrancy anomaly will track the coherence anomaly and fall between the most-positive curvature anomalies defining the footwall and the most-negative curvature anomalies defining the hanging wall. Aberrancy can delineate faults whose throw falls below seismic resolution, or is distributed across a suite of smallr conjugate faults, which do not exhibit a coherence anomaly. Previously limited to horizon computations, we extend aberrancy to uninterpreted seismic data volumes.

To demonstrate the “uplift” of these new algorithms over more well-established workflows, we apply our volumetric aberrancy calculation to a megamerge data volume acquired over the Oklahoma STACK play and to a more modern survey acquired over the Barnett Shale gas reservoir of the Fort Worth Basin, Texas. Multispectral coherence provides images that are both sharper and less noisy than conventional coherence computed from the broadband data, while also illuminating Red Fork channel edges that were previously not seen. Aberrancy delineates small karst features, which are in many places too smoothly varying to be detected by coherence. Equally important, aberrancy provides the azimuthal orientation of the flexure anomalies allowing them to be processed to be evaluated as potential fracture sets.