Extract More Information from the Full Seismic Wavefield in the Local Angle Domain

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ABSTRACT

The industry has seen vast improvements in acquiring and processing seismic data in order to deliver a better subsurface image. Operators have moved towards full azimuth surveys to better characterize their reservoirs. While the full wavefield is the sum of specular and diffraction energy, the industry is mainly focused on retrieving the specular (continuous) image for seismic interpretation. However, it is the diffracted energy that captures the discontinuities that define feature edges and fractures that are often lost when using conventional seismic processing and imaging methods. Additionally, the capture and decomposition of the full seismic wavefield also provides a path way to discriminate primary from multiple energy, even for interbed multiples.

The local angle domain offers a new world of sub-surface information for geoscientists as it maximizes the information that can be extracted from recorded seismic data. True-amplitude 5D angle gathers enable better subsurface imaging, reservoir characterization and interpretation, to help operators secure new acreages with more confidence, discover, recover and produce more energy. The full-azimuth angle domain is used to image, analyze, characterize, visualize and interpret the total seismic wavefield in all directions.

The wealth of recorded seismic is decomposed into full- azimuth, angle-dependent reflectivities and directional data components. These components can be selectively sampled, creatively combined, dynamically visualized, and further processed to secure images of the subsurface. Imaging in the local angle domain has been demonstrated to provide depth imaging and processing experts, as well as interpretation specialists, the ability to derive accurate subsurface velocity models, structural attributes, medium properties, and reservoir characteristics. With angle gathers it is possible to construct accurate kinematic and dynamic subsurface images from recorded surface seismic data, using the full seismic wavefield. It provides high-resolution images, which lead to the detection of faults, fractures, and small vertical displacements in reservoirs, especially important in unconventional shale plays. The 5D parameterization of data allows model builders to incorporate optimal velocity and structural information for anisotropic tomographic updates as well as full azimuth reflectivities for fracture and stress determination.

With this 5D decomposition in the local angle domain, we can bypass the approximations associated with surface azimuthal sectoring. Continuous azimuthal sampling reduces seismic velocity non-uniqueness and provides a more precise determination of fracture and stress determination using the seismic method...

To image the subsurface in the presence of poor signal to noise, the method allows for specular weighting to enhance structure continuity, or specular attenuation (diffraction imaging) to enhance discontinuous objects such as small faults and fracture systems. In this domain we can also gain broader insight into elastic properties and boundaries of target reservoirs to achieve reservoir geophysics objectives for seismic inversion and 4D analyses.