Imaging Anisotropic Symmetry Using Prestack Converted-Wave Seismic Data for Fracture Analysis

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In an effort to extend practices developed for land 9C data to the marine environment, where we are limited to the use of converted waves for purposes of anisotropy analysis and characterization of rock properties, imaging of anisotropic symmetry for fracture analysis was made using prestack, converted wave seismic data. Models and real data were used in the investigation. Models included transverse isotropy with a horizontal axis of symmetry (HTI) commonly associated with vertical fractures, and tilted transverse isotropy (TTI) commonly associated with dipping fractures. The multi-layer models included varying degrees of anisotropy and dip. It was found that by using layer stripping techniques modified from those designed for poststack seismic data, that the anisotropic symmetry could be imaged using both amplitudes, and time differences resulting from shear-wave birefringence. When applied to two real data sets, one in the Gulf of Mexico and one in the Williston Basin in North America, the technique was able to image anisotropy in areas of high data coverage. In the Gulf of Mexico, depositional fabric was interpreted as the dominant factor in creating the anisotropy, and in the Williston Basin – open fracture direction and intensity were interpreted and compared to previous analysis using other techniques – including well log analysis, vertical seismic profiling and direct shear-wave surface seismic. We determine that the inclusion of azimuth and offset variations in the analysis is an important and necessary part of anisotropy analysis, which demands the use of prestack seismic data analysis and processing techniques. We also examine the effects of limited azimuthal coverage on such analysis and investigate possible corrections applicable in the data processing phase.