TIME-LAPSE 3D VSP STUDY FOR CHARACTERIZING FRACTURES IN THE BARNETT SHALE

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ABSTRACT
The extraction of hydrocarbons from low permeability unconventional shale reservoirs depends highly on the presence of natural and induced fracture networks. Understanding how fractures affect surface- and subsurface-based geophysical signals is an important step in characterizing a reservoir. A time-lapse 3D vertical seismic profile (VSP) was collected in the Barnett Shale with the goal of characterizing fractures before and after hydraulic fracturing. Preliminary results show azimuthally varying seismic attributes in the baseline survey, consistent with the presence of the in situ naturally occurring fractures. An HTI model for the reservoir could be used to explain the travel-time observations. Three follow-up monitor surveys collected after hydraulic fracturing show changes in the degree of anisotropy in the reservoir. These results can be attributed to the addition of induced fractures with additional orientations. Subsequent work includes using digital rock physics models to invert for fracture parameters that take into account the microstructure of the reservoir.
Travel times as a function of azimuth for the vertical component of the baseline survey. Events indicate sinusoidal variations consistent with the in-situ fracture strike. Green lines have been drawn to highlight these variations.