Geophysical Research Abstracts
Vol. 19, EGU2017-3678, 2017
EGU General Assembly 2017

Behaviors of azimuthal offset-dependent of converted wave amplitude in a vertically fractured reservoir

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Fractures play very important role in hydrocarbon exploration. It is because the existence of natural fractures not just impacts reservoir performance but also subsurface flow. In reflection seismology, directional variation and Amplitude Versus Offset in aZimuth (AVOZ) of the compressional wave velocity and the phenomenon of shear wave splitting are popular seismic signatures those are often used to characterize a fractured reservoir. According to the origin, a converted (C-) wave is initiated by a downward traveling P-wave and converted on reflection to up-coming S-waves. Hence, a C-wave takes behaviors of P- and S-wave. Making use the characteristics of the origins of C-waves, the objective of this study aims on exploring the responses of Amplitude Versus Offset of C-wave in aZimuth (AVOCZ) using scaled physical model. In laboratory manipulation, a Horizontally Transversely Isotropic (HTI) model is created to simulate a reservoir of vertically aligned fractures. Seven end-on shooting experiments were directionally carried out on the orthogonal plane of the HTI model. In the acquired profiles, the mixed mode of P-, S1-, C1- and C2-waves were identified. Taking the behaviors of S-wave in a Transversely Isotropic Medium (TIM), the phenomenon of C-wave splitting was clearly observed in the direction of layering strike and no longer observed in the direction of layering normal. To demonstrate the direction variation of amplitudes, the detected P-, C1- and C2-waves reflections were Hilbert Transformed to obtain the reflection strengths of relative events. In the results, the variations of AVO signatures lead by the existence of vertically aligned fractured were demonstrated by the reflection strengths analysis. Both of AVOZ and AVOCZ decrease with azimuth varying from a strike direction toward a direction transverse to the fractures. However, the AVOCZ exhibits more sensitive to the azimuth then that of AVOZ. Results of our laboratory work thus propose that in conjunction with AVOZ, AVOCZ and C-wave splitting, the fracture orientation can be characterized with more confidence.