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Application of converted-wave amplitude for fracture strike delineation - a physical model study

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The objective of this study is aiming on directing the fracture strike in a vertically aligned fracture reservoir using the seismic signature of the azimuthal dependence of C-wave amplitude (ADCA). A fractured reservoir has made itself as one of the most important productive zones in petroleum exploration. The existence of fractures not just provides the space for the residence of oils and gases but creates pathways for migration. In terms of seismic anisotropy, reservoirs that possess vertical fractures system (VFS) has its physical properties vary in azimuth and is often grouped as a horizontally transversely isotropy (HTI). Since fracture strike is the priori information in drilling engineering that has to be known to maximize production or to enhance oil recovery (EOR) from a VFS reservoir. Therefore, characterizing a fractured reservoir and orienting the fracture strike has attracted much attention by exploration geophysicists and drilling engineers. To validate our objective, a HTI model was designed to simulate a VFS reservoir. A spherical dome was caved at one side of the HTI model. In laboratory, a pair of S-type transducer was used to carry out our reflection experiments. And constant offset reflections were acquired along principal symmetry directions and diagonal direction of the HTI model at two different offset intervals. In all, two constant offset reflection data sets were obtained and each data set consists of three observations collected at different azimuths. In the acquired seismic profile, a mixture of P-wave, S-wave and C-wave events were recognized. In analyzing the variation of C-wave amplitude in azimuth in the HTI model, reflections that were originated from apex of the dome structure were sorted and displayed as a common-reflection-point (CRP) gather. Our laboratory data show C-wave amplitude decrease with azimuth varying from a strike direction toward a direction transverse to the strike in the HTI model. The phenomenon of ADCA that was demonstrated can be considered as a valuable seismic attribute to orient the fracture strike in a VFS reservoir. For C-wave comes from a mode conversion of P- and S-waves, it takes behavior of P- and S-waves, and can be acquired using multi-component seismic recording survey. In conjunction with the azimuthal velocity and amplitude variations of P-wave and azimuthal polarization of S-wave, our experimental results not just provide a prospect to explore fracture strike but confident the characterization a fractured reservoir using multi-component 3D seismic data.