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Please fill in your abstract title.	VSP Inversion of Azimuthal Velocity Variations for Seismic Anisotropy	
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Abstract

Objective/Scope:

Natural fractures play a key role in production of hydrocarbons in form of increased porosity and permeability for unconventional reservoirs. Thus, knowledge related to fracture orientation and intensity is vital for the development of unconventional reservoirs. A set of two orthogonal walkaway VSPs and a walkaround VSP is acquired in Eastern Saudi Arabia, and the objective of this paper is to identify the intensity and direction of fracture-induced seismic anisotropy using Velocity Variations with Azimuth (VVAZ).

Method, Procedures, Process:

A technique for VVAZ inversion, based on the elliptical NMO equation for Horizontal Transverse Isotropy (HTI) media for surface seismic data is extended to offset, walkaway, workaround, and 3D VSPs. For this method, irregular topography and near-surface effects are accounted for prior to the inversion for fast, slow RMS velocities, and their directions. The fast direction most likely indicates the fracture direction, while the ratio of the fast and slow velocities indicates the anisotropy intensity. In such a way, the cumulative influence up to a target including overburden is estimated. Then, Dix-type interval properties are estimated for every layer or interval.

Results, Observations, Conclusions:

A set of two walkaway VSPs and a walkaround VSP data from Eastern Saudi Arabia are used to estimate the magnitude and direction of seismic azimuthal anisotropy. It was assumed that the detected anisotropy is fracture-induced and that there is only one major fracture direction. The inverted log of anisotropy symmetry plane orientation obtained by VVAZ of all VSP data is correlated to image log and drilling borehole breakout caliper data. The major trend was found to be an east to west trend of maximum horizontal stress direction within the target reservoir. A strong mode-converted PS wave produced at the top of the fractured reservoir is observed and utilized to estimate possible orientations of symmetry plane using the walkaround VSP data. Finally, cumulative and interval anisotropy magnitude logs are obtained by VVAZ using all VSP data.

Novel/Additive Information:

In this paper, a VVAZ technique for offset, workaround, walkaway, and 3D VSP data based on the elliptical NMO equation of surface seismic data, is developed to estimate intensity and orientation logs of azimuthal seismic anisotropy.