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Analysis of azimuthal anisotropy for multiple walkaround VSPs in an unconventional field in Saudi Arabia: A Case study

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ABSTRACT

An unconventional field in an important limestone reservoir in southeastern Saudi Arabia had shown, through conventional attribute analysis, an anisotropy trend suggesting the presence of fractures. Information from different geoscience disciplines is required to validate the presence of fractures in this field.

Using surface seismic data to identify the possible causes of these anisotropy trends at the reservoir level is a major challenge. Seismic anisotropy in multi-azimuth surveys has long been studied and used as a geophysical tool for fracture characterization (Crampin 1985; Queen and Rizer 1990; Lynn 1996; Li 1999; Gaiser 2000; Gray and Head
2000; Hall and Kendall 2003; Maultzsch 2009).

In this paper, we describe how shear wave splitting analysis was applied for azimuthal anisotropy on a multiple walkaround VSP dataset, to characterize fractures in the Tuwaiq Mountain Formation. The downgoing and upgoing shear waves were separated into the horizontal components and were used to identify shear wave splitting intervals. Also, the transverse-component of common receiver gathers was analyzed to investigate polarity reversals and shear wave travel time variations to identify the symmetry axes and the fast shear direction. Shear wave splitting analysis was performed on each of the two VSPs in this study. The walkaround VSPs were acquired with a source-to-well radius offset of 8,200 feet, at 9-degree spacing, and with a dense array of receivers at 25-foot spacing, to provide the highest resolution at the reservoir level.

The case study analysis performed and presented here shows that walkaround VSPs identified the presence of shear wave splitting in the Jubaila and Tuwaiq Mountain formations. Due to the lack of evidence of fractures, as observed with different tools such as surface seismic, image logs and dispersion slowness analysis, we conclude that while shear wave splitting is present in this unconventional field it is related more to stress than to major fracture trends.

This analysis shows that the fast-direction azimuth of the found anisotropy trend is E-W and is in agreement with the maximum stress trend observed in image logs.