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Shear Wave Splitting analysis of borehole microseismic reveals weak azimuthal anisotropy hidden behind strong VTI fabric of Lower Paleozoic shales in northern Poland

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Azimuthal anisotropy plays a key-role in hydraulic fracturing experiments, since it provides information on stress orientation and pre-existing fracture system presence. The Lower Paleozoic shale plays in northern Poland are characterized by a strong (15-18%) Vertical Transverse Isotropy (VTI) fabric which dominates weak azimuthal anisotropy being of order of 1-2%. A shear wave travelling in the subsurface after entering an anisotropic medium splits into two orthogonally polarized waves travelling with different velocities. Splitting parameters which can be assessed using a microseismic array are polarization of the fast shear wave and time delay between two modes. Polarization of the fast wave characterizes the anisotropic system on the wave path while the time delay is proportional to the magnitude of anisotropy. We employ Shear Wave Splitting (SWS) technique using a borehole microseismic dataset collected during a hydraulic stimulation treatment located in northern Poland, to image fracture strike masked by a strong VTI signature. During the inversion part, the VTI background parameters were kept constant using information from 3D seismic (VTI model used for pre-stack depth migration). Obtained fracture azimuths averaged over fracturing stages are consistent with the available XRMI imager logs from the nearby vertical well, however they are different from the large-scale maximum stress direction (by 40-45 degrees). Inverted Hudson's crack density (ca. 2%) are compatible with the low shear-wave anisotropy observed in the cross-dipole sonic logs (1-2%).

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