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Seismic Azimuthal Anisotropy of the Lower Paleozoic Shales in Northern Poland: can we reliably detect it?

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Analysis of the azimuthal anisotropy is an important aspect of characterization the Lower Paleozoic shale play in northern Poland, since it can be used to map pre-existing fracture networks or help in optimal placement of the horizontal wells. Previous studies employed Velocity versus Azimuth (VVAz) method and found that this anisotropy is weak – on the order of 1-2%, only locally – close to major fault zones – being higher (ca. 7%). This is consistent with the recent re-interpretation of the cross-dipole sonic data, which indicates average shear wave anisotropy of 1%. The problem with the VVAz method is that it requires good definition of the interval, for which the analysis is made and it should be minimum 100 ms thick. In our case, the target intervals are thin – upper reservoir (Lower Silurian Jantar formation) is 15 m thick, lower reservoir (Upper Ordovician Sasino formation) is 25 m thick. Therefore, we prefer to use the Amplitude vs Azimuth (AVAz) method, which can be applied on a single horizon (e.g. the base of the reservoir). However, the AVAz method depends critically on the quality of the seismic data and preservation of amplitudes during processing. On top of the above mentioned issues, physical properties of the Lower Paleozoic shales from Poland seem to be unfavourable for detecting azimuthal anisotropy. For example, for both target formations, parameter g=(Vs/Vp)2 is close to 0.32, which implies that the anisotropy expressed by the anisotropic gradient in the dry (i.e. gas-filled fractures) case is close to zero. In case of e.g. the Bakken Shale, g is much higher (0.38-0.4), leading to a detectable anisotropic signature even in the dry case. Modelling of the synthetic AVAz response performed using available well data suggested that anisotropic gradient in the wet (fluid-filled) case should be detectable even in case of the weak anisotropy (1-2%). This scenario is consistent with the observation, that the studied area is located in the liquid/condensate window. Promising results of the synthetic modelling allowed us to perform analysis on the real data: a subset (52.8 km2) of a large modern wide-azimuth 3D seismic survey from northern Poland. The seismic data were pre-stack depth migrated using full-azimuth non-sectored type migration algorithm, providing excellent input for AVAz. We perform both the classical Ruger and Fourier Coefficients AVAz. Results of the AVAz analysis of the real data correlate to some extent with the earlier VVAz results, both in terms of the anisotropy magnitude and orientation. Despite the weak anisotropy, obtained orientations are more or less consistent with the available image (XRMI) logs from the vertical wells.

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