Time-lapse seismic AVAz inversion in the Stocker Field

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ABSTRACT

Organic rich Murdock reservoirs require hydraulic stimulation to be economically productive. Zones of high fracture density are desired due to the increase in permeability they would have. Thus, fracture characterization is an essential part of production planning in unconventional reservoirs. Amplitude Variation with Offset and Azimuth (AVAz) methodologies can help us determine parameters related to fractures. Here we employ two different methodologies, namely, Rüger's method and Fourier Coefficients decomposition method, to address this problem using seismic data targeting the Barnett formation. Rüger's method uses a linearized version of the full reflection coefficient for HTI media. Fourier Coefficients decomposition relies upon the fact that P-wave reflectivity can be described by a Fourier series and the components of the series can be linked to different properties related to fracture parameters. Both methodologies solve the inverse problem through Iterative Reweighted Least Squares (IRLS) and Cauchy-Gauss method for the calculation of the weights. Using 4D seismic data from the Stocker field, we compute the variation of the AVAz response before and after the hydraulic fracturing treatment and production from the area of interest. The results clearly demonstrate how the seismic response changes after these processes are performed and that can be interpreted in terms of fracture attributes. Anisotropic gradient B_{ani}, and second Fourier coefficient r2, both proxies for fracture density, are used with fracture azimuth φ_{sym} to estimate fracture orientation. With the absence of core data and FMI logs, regional stress information is used to constrain the estimates of fracture orientation. These estimates yield as result the primary orientation of the fractures in the area is NE-SW.

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