A NEW 3D SEISMIC DATA BASED AVAZ FRACTURE CHARACTERIZATION METHOD: CASE STUDY IN THE HAYNESVILLE SHALE

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ABSTRACT

The work presented here describes a novel fracture characterization technique that utilizes azimuthal amplitude variations (AVAZ) present in 3D seismic data to deduce subsurface fracturing characteristics. We apply this technique to both synthetic data and real data from the Haynesville Shale. The method we propose is able to unambiguously invert for fracture azimuth, and does not suffer from a 90-degree ambiguity that is present in similar AVAZ methods. When inverting for fracture density, we assume orthorhombic anisotropy, which is characteristic of fractured shale. Results from the fracture density inversion indicate spatially varying fracture density throughout the area, and we identify a distinct zone of higher fracture density in the northwestern corner of the area. This fracture density distribution is consistent with the analysis of production data and from considering FMI log data in surrounding wells. Results from the fracture azimuth inversion were largely consistent throughout the area analyzed, and indicate that the strike of the predominant fracture set is oriented at approximately 82 degrees relative to true north – i.e., an orientation rotated slightly counterclockwise of east-west. Expectations from a regional stress analysis and from examining fracturing in comparable formations agree well with this fracture orientation.
Comparison of fracture azimuth as determined from our proposed method and from using commercially available software. The upper image shows fracture azimuth results from our proposed method. The middle image shows fracture azimuth results from the Fourier coefficient method proposed by Downton et al. (2011), as implemented using commercial software. The lower image shows fracture azimuth results from the method based on the Rüger AVO equation (Rüger, 1995), as implemented using commercial software. Colorbars on all images range from 0 degrees to 180 degrees. The black arrows indicate the direction of north.