Shale Gas Reservoir Characterization and Sweet Spot Prediction

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ABSTRACT

An integrated study of the well Zhao-104 and surrounding wide-azimuth 3D seismic volume within the shale gas reservoir in South China has been conducted with the objective of generating shale formation properties related to fracture orientation and intensity in the area and deriving such reservoir rock properties as data quality allows. The inversion for P and S impedance and derivative attributes produced volumes that relate to rock properties such as brittleness and rigidity that are likely to impact fracturing. Seismic attribute analysis of anisotropy from elliptical velocity inversion indicates that anisotropy varies horizontally and vertically, and that it is dominantly controlled by stress azimuth, which conforms to the current day stress field as independently determined from borehole break-outs. Seismic attribute analysis of anisotropy from elliptical velocity inversion indicates that anisotropy varies horizontally and vertically, and that it is dominantly controlled by stress azimuth, which conforms to the current day stress field as independently determined from borehole break-outs. The inversion produced volumes that relate to rock properties such as brittleness and rigidity that are likely to impact fracturing. For the reservoir, it appears that the modern–day SH (N40E) orientation approximates the conjugate fracture orientation of a wrench-faulted tectonic regime; this map pattern suggests a clockwise net rotation of the stress field from time of deposition to the present-day by 40°. Very large strike-slip faults (cutting the survey) have low anisotropy. Intermediate strike-slip faults cutting the entire shale section may exhibit larger anisotropy. Structural depressions formed by transtension act as TOC-rich sinks and likewise feature large anisotropy vectors. Relative paleo-sea-level change influenced mineral assemblages and elastic properties of systems tracts. Of several interpreted transgressions, only the first transgressive phase is associated with significant TOC-deposition. At the end, the multi-attribute data fusion process to integrate all “sweet spot” parameters, such as shale formation depth, thickness, fault and fracture zone intensity and distribution, TOC and its thickness distribution, local stress field and its orientation, formation brittleness, pressure coefficient, impedance, Passion's ratio, Young's modules, porosity distribution, was used to predict “sweet spot” for shale gas reservoir exploration and production.