Workshop explores the possibilities

Seismic Sets Sights on Sweet Spots in Shale

By KEN MILAM, EXPLORER Correspondent

Shale plays may be changing the face of the petroleum industry, but they are a relatively new phenomenon as a viable resource – and their unique nature presents challenges to exploration and production.

Identifying "sweet spots" requires a number of measurements, and seismic data is a particularly valuable asset, according to AAPG member Joanne Wang of Paradigm.

In a presentation at a recent AAPG workshop, "Revisiting Reservoir Quality Issues in Unconventional and Conventional Resources: Techniques, Technologies and Case Studies," Wang discussed her company's experience in the Eagle Ford and Barnett shales.

Wang said experience shows that properly processed, imaged, analyzed and interpreted seismic data can be vital for success in shale plays.

"Seismic data provides valuable information for all stages of shale play exploration and production since it carries signatures related to lithology, fluid and in-situ stress. To transform the seismic data into the much needed reservoir quality information requires a support of a number of technologies and workflows," she said.


WANG

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Three major determining factors for identifying sweet spots are total organic carbon, shale brittle/ductile quality and in-situ stress, she said.

In-situ stress.

In-situ stress is one of the key factors that determine a successful drilling program. The challenge is how to accurately estimate the stress intensity and its orientation using surface recorded seismic data. Seismic data responds to stress. This can be observed as the azimuthal dependent behavior of the seismic amplitude and the seismic velocity, Wang said.

The AVAZ approach measures the changes in amplitude variation with reflection angle and azimuth affected by the anisotropic media.

Horizontal transverse isotropic media is assumed for the Eagle Ford shale given that the structural change is mild, the layer is relatively flat, and the shale is preferentially stressed in the studied area. Typical AVAZ attributes inverted by the HTI AVAZ inversion includes anisotropic gradient, stress intensity and azimuth of symmetry axis. Interpretation and visualization techniques are critical to extract and map the stress intensity and its orientation, she said.

Brittle/ductile quality.

Shale brittle/ductile quality can be estimated using the mechanical attributes such as Poisson's ratio and Young's modulus. Relatively, low Poisson's ratio and high Young's modulus correlate to brittle shale zones and high Poisson's ratio and low Young's modulus correlate with ductile shale zones. Seismic inversion procedures are used to invert seismic data amplitudes sampled by reflection angle to secure attributes sensitive to lithology and fluid changes. P and S impedances are layer properties directly related to rock properties such as bulk modulus, shear modulus, Young's modulus and Poisson's ratio, for example from which shale brittleness can be estimated.

Total organic carbon.

Presence and volume of TOC in the shale formation affect acoustic properties such as p wave velocity, density and AVO behavior. As such AVO attributes together with P impedance can be used to identify the zones with relative high TOC.

Winding up.

"The key point is to identify sweet spots in shale formation where the production rate and recovery rate are at the highest," Wang said.

"We have been working on different shale plays in the U.S., such as Barnett shale and Eagle Ford shale," she said. "We'll need the future drilling to confirm our observations in these particular cases."