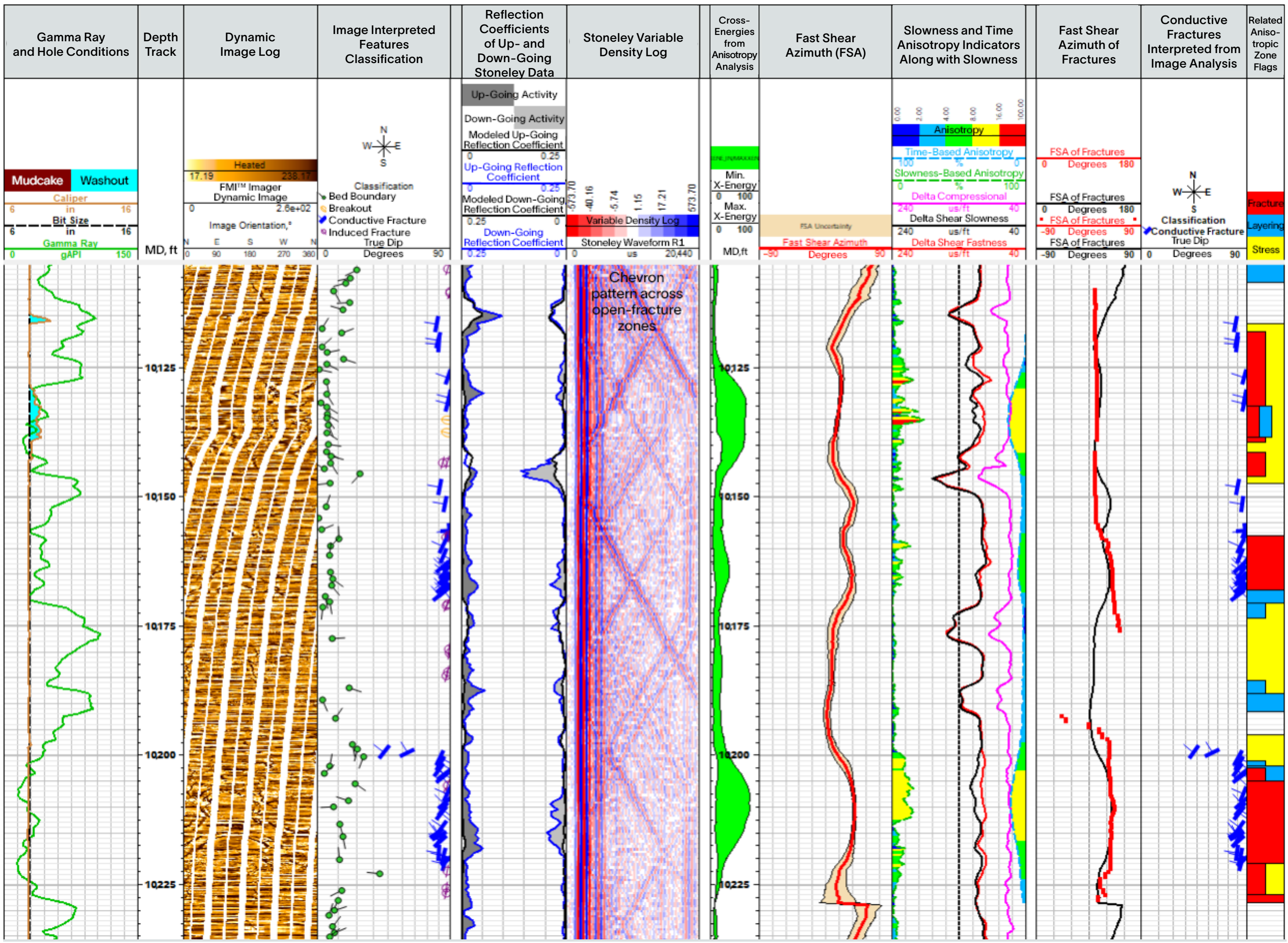
Integrated fracture characterization

Comprehensive fracture characterization using dipole anisotropy, Stoneley reflections and attenuation, and image interpretation



Integrated fracture characterization composite plot displaying extensive open-fracture zones.

Applications

Fractures act as the main conduits for hydrocarbon flow in reservoirs with low intrinsic porosity and permeability. The existing natural fracture network provides a drainage path for production in tight carbonates, clastics, and unconventional shale and basement resources. Identifying the presence of fractures in the caprock is important for assessing caprock integrity. The ability to discriminate between open fractures and closed ones and drilling-induced fractures from natural fractures is vital. The ability to identify discrete fracture networks is critical for efficient completion design in fractured reservoirs. To do this, the operator must do the following:

- → propagate hydraulic fractures in complex medium
- → determine producible fractures
- → differentiate between drilling-induced and open natural fractures
- → build discrete fracture networks
- → identify zones of major fluid losses while drilling
- → assess caprock integrity.

How it improves performance

- Evaluates naturally fractured environments, consistently using all available data
- Accelerates production using discrete producible fracture network
- Optimizes completions, resulting in enhanced production
- Improves hydrocarbon recovery in tight reservoirs
- Reduces nonproductive time by detecting zones of major fluid loss

Combines acoustics and borehole geology

The integrated fracture characterization solution combines acoustics and borehole geology data to provide a consistent evaluation of naturally fractured environments. The process uses all available relevant data to determine the location of extensive open fracture zones, which would more likely contribute to hydrocarbon flow.

Borehole image analysis gives a firsthand picture of the presence and density of natural fractures. Advanced image analysis provides information on fracture aperture, density, and porosity in the near wellbore. Reflection and transmission analysis of Stoneley data supplements information on the openness of the fractured intervals near the wellbore. The presence of an extensive open natural fracture network creates acoustic anisotropy in the formation. Detailed anisotropic analysis is further done to detect zones with intrinsic or stress-induced anisotropy. Fracture anisotropic modeling using a forward approach is then executed to interpret dipole sonic anisotropy related to the geologic features. This analysis significantly enhances the understanding of the cause of anisotropy, and thus can discriminate the depth zones that are influenced by natural fractures, stresses, or both. This workflow is applicable for near-vertical and deviated wells.

Inputs

- Processed image logs with dip interpretation
- Compressional, dipole shear anisotropy, and Stoneley waveforms
- Conventional openhole triple-combo logs

Takeaways

- Stoneley reflectivity and attenuation
- Dipole anisotropy (fast and slow shear, fast shear azimuth)
- Forward modeling of interpreted fractures from images with dipole anisotropy response
- Fracture aperture and porosity from borehole image logs

Learn more

Prioul, R., et al.: "Forward Modeling of Fracture-Induced Sonic Anisotropy Using a Combination of Borehole Image and Sonic Logs, Geophysics," Geophysics (2007) Vol 72, 4 https://doi.org/10.1190/1.2734546

Prioul, R. and Jocker, J.: "Identification of Elastic Anisotropy Mechanisms from a Joint Interpretation of Borehole Images and Sonic Logs," SPWLA 51st Annual Logging Symposium, Perth, Australia (June 2010) SPWLA-2010-52080

Velez, E., et al.: "Novel Approach for Fracture Characterization in Metamorphic Reservoirs," SPE, Peru (December 2010) SPE-138965-MS https://doi.org/10.2118/138965-MS