Subsurface and Experimental Analyses of Fractures and Curvature

Evan Staples, Kurt Marfurt, and Ze'ev Reches
ConocoPhillips School of Geology and Geophysics, University of Oklahoma, Norman, OK

The Hunton Group (Late Ordovician to Early Devonian) is an important hydrocarbon reservoir throughout Oklahoma as it is present in the Anadarko, Ardmore, Marietta, and Arkoma Basins and the southwestern part of the Cherokee Platform. Hunton Group reservoirs include highly fractured zones, collapse features, stratigraphic traps, and structural traps.

Layer curvature is often used as a proxy for fracture intensity (FI) in subsurface-seismic analyses of fractured reservoirs. Theoretical beam-bending calculations suggest a linear relationship between curvature and strain (assumed fracture intensity). Clay models, horizontal-borehole-image logs, and 3D-seismic data provide a database to view curvature and fracturing at multiple scales and stages of deformation. Compression (thrust faulting) and extension (normal faulting) were modeled in clay experiments and showed strong linear relationships between fracture intensities (total fracture length/area) and curvature. Curvature and fracture calculations from 3D-seismic data in a nine-mi2 area in central Oklahoma and image logs of seven horizontal wells drilled into the Hunton Group in the same area indicated a linear relationship between fracturing and curvature. Curvature calculated from bedding-planes seen on horizontal-borehole-image logs follows similar trends as curvature calculated from 3D-seismic reflectors on wells with bedding-plane measurements. Relative fracture density (number of fractures per length) as determined in the horizontal-borehole-image logs showed correlations with azimuthally-limited curvature measures computed from 3D-seismic data consistent with the hypothesis that high fracture densities are located in areas of high curvature. Results from 3D-seismic data and the clay model experiments support the use of layer curvature as an indicator for FI in subsurface analysis.