Matthew J. Pranter, University of Colorado, Boulder, Colorado
Neil F. Hurley, Thomas L. Davis, Colorado School of Mines, Golden, Colorado

Identification of Subtle Faults Using 3-D Seismic and Multilateral Horizontal Well Characterization

Structural and stratigraphic compartments within a platform carbonate reservoir were identified and exploited through horizontal well development and characterization. Compartments bounded by subtle faults (25 feet vertical displacement or less) and bypassed pay associated with thinly stratified flow units were targeted using a dual-lateral, medium-radius horizontal well within a mature field. Anomalies on multicomponent and compressional-wave seismic continuity volumes were utilized to identify discontinuities associated with faulting and karstification. Dual-lateral horizontal wells were drilled to take advantage of inferred undrained fault compartments.

The reservoir interval consists of stacked, shallowing-upward cycles, forming parasequences of subtidal, shallow subtidal to intertidal, and supratidal dolomites within a shelf-margin setting. Extensive dolomitization and karstification have significantly altered the primary depositional fabric, resulting in a variable distribution of intercrystalline, interparticle, bimoldic, and fracture porosity types. In addition, pervasive anhydrite cement occurs within brecciated and fractured zones and reduces lateral and vertical permeability. Basinward-dipping and counter-regional normal faults present along the platform margin are sites of potential compartments that have not been effectively drained by surrounding vertical wells.

To identify structural discontinuities encountered by the dual-lateral horizontal well, well logs were converted to true vertical depth (TVD) for direct correlation to adjacent vertical wells. Stratamodel software was used to visualize the structural setting along the shelf margin in three dimensions and as an aid in detecting the minor discontinuities. Since the horizontal leg of each lateral had deviations that at times exceeded 90 degrees, well logs were separated into intervals and TVD logs were constructed for each interval. Given the close proximity of the vertical wells (20-acre spacing) and relatively minor variations in stratigraphic thickness, individual zones could be correlated with confidence. Faulted intervals identified on the logs of the horizontal well were characterized by zones of missing section bounded above and below by zones that were correlative between the horizontal and vertical wells. Decline curves from the horizontal and adjacent vertical wells show a significant increase in production from the horizontal wells and no interference with production from offset vertical wells.