Fault Geometries and Origins in Western Pennsylvania and Northern West Virginia

Robert Jacobi[1], Joel Starr, Craig Eckert, and Travis Warner

[1]EQT Production

Abstract

Ongoing acquisition of outstanding imaging in 3D and 2D seismic data reveals details of the complicated geometries and timing of structural elements in the western part of the PA/northern WV Appalachian Plateau. Some of these structures are consistent with Late Devonian extension/sliding/slumping of the Upper Silurian/Devonian section easterly toward the basin paleo-axis. Normal faults separate prominent back-rotated blocks over locally downslope flow-thickened Silurian units. These fault blocks and easterly verging thrusts that are structurally above the normal faults have variable timing, but all initiated in Late Devonian, based primarily on growth fault geometries. Upper Devonian Elk and Bradford sands onlap and infill drape-synclines ("collapse synclines") above zones-of-removal where parts of the Silurian Vernon and D-salt section were removed during downslope slumping. Further motion occurred on a number of faults during Alleghanian.

The Acadian faults developed before the Devonian sediments entered the oil window. Subsidence models suggest the faulted areas entered the oil window in late (Neo) Acadian, and the gas window in early Alleghanian. Near the faults J1 trajectories rotate into orthogonality with the fault strike, indicating these particular faults were "open" when J1 developed; the J1 fractures would have delivered gas to these faults, which in turn may have provided hydrocarbon migration pathways to the Elk and Bradford sands, as well as paleo-surface seeps.

3D surveys indicate the normal faults adjacent to the zones of removal ("collapse synclines or "keystone grabens") have step-overs where lateral ramps occur. Ramps in the same 3D have variable ages. Down-slope (SE) from some of the zones of removal are slide-thickened, Vernon/Lower Salina (D-Salt) sections that exhibit spectacular box folds, kink folds, and disharmonic folds indicating multiple decollement and thrust ramps. Although the thick Salina F-salt section does not display significant thinning or thickening in the zone of removal or in the slide-thickened area of the back-rotated blocks, thrust fault-associated anticlines have F-salt and Vernon thickening. Reactivation of Rome-Trough basement faults influenced paleoslope changes and influenced the location and trends of the slumping.

South of the Silurian salt basin, salt/Vernon-tectonic related structures are not observed, and most of the Devonian section folding appears to be related to Rome Trough fault-block inversions during Alleghanian horizontal-directed compression of the basement fault blocks.