Seismic Signatures of Faults in the Appalachian Basin of NYS, and the Effect of These Faults on Devonian Black Shales: An Update

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In 2002 the Appalachian Basin in NYS was proposed to be riddled by literally hundreds of faults, based primarily on EarthSat's (1997) Landsat lineaments integrated with gravity and magnetics and in western NYS, surface geology and soil gas. This report summarizes advances the UB Rock Fracture Group and associated partners have made in fault understanding since 2002, based principally on extensive 3D seismic, as well as integration with field studies of fracture systems in the black shales.

The spider web of interconnected fault strands can be separated into fault systems with common orientations and tectonic histories. Many of the major northerly-striking fault systems, such as the Clarendon-Linden Fault System, are reactivated intra-Grenvillian suture systems. The northerly-trending faults influenced deposition rates (and facies) for much of the Paleozoic rock record, and show that the faults commonly reversed motion during orogenies. The arcuate fault pattern across PA and NY (in map view) began as Iapetan-opening related faults (IOFs) and outlines the Laurentian margin as the Pennsylvanian Salient and NY Promontory. Cambrian inversion of the IOF basins is common. The IOFs were reactivated with the most significant offset primarily in Taconic times, but were reactivated in all the Appalachian orogenies. Taconic fault block interactions between the arcuate IOFs and intersecting northerly-trending faults are typical. Taconic slip on the IOFs in the arcuate pattern was oblique, and most likely reversed during late Taconic convergence. The arcuate fault set controlled the development of many of the TBr fields. NNE-striking "Taconic" faults in the Mohawk Valley region may be reactivated IOFs and experienced oblique slip consistent with E-W Laurentian convergence (present coordinates). N-striking "neo-Taconic" faults display only down dip motion indicators in outcrop. Both fault systems controlled Utica thickness variations; they were reactivated in the Silurian when they controlled 0-lines and facies development at the edge of the Salinic basin. NW-striking faults in western NY and PA, and WNW-striking faults in eastern NY were transfer zones between segments of the IOFs. They were reactivated during the Taconic as oblique slip, and reversed motion in late Taconic, and were reactivated in later orogenies. These faults also controlled development of some TBr fields.

In the Devonian Geneseo black shale in the Finger Lakes region, N- and ENE-striking Fracture Intensification Domains (FIDs) are coincident with similarly-striking faults proposed on the basis of stratigraphic offsets and seismic data. Also in eastern NYS, some Marcellus outcrops exhibit anomalous fracture systems, related to coincident fault systems, and do not display the typical J1/J2.

Steep gradients in thermal maturity (indicated by CAI contours, Weary et al., 2001) in the Utica have been shown to coincide with fault systems such as the Keuka Lake Fault System (Jacobi, 2007). Although less compelling in the Devonian shales, observed steep gradients between CAI of 2 to 3.5 would be an equivalent of ~5,000 m offset, significantly more than is possible along faults in central NYS. We therefore suggest that the steep gradients are influenced by relatively hot fluid migration along fault systems. Thus, the local thermal maturity index may *not* be simply measuring a *simple burial history*.