Developing a Hydrocarbon Exploration Tool in the Arkoma Basin, Oklahoma

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ABSTRACT

My colleagues, graduate students, and I started constructing balanced structural cross-sections and conducting petrophysical work in the Arkoma Basin in the mid-1990s. We plotted different sandstone sedimentary facies of the Spiro Sandstone on the cross-sections to locate the extent of the porous zones likely to have hydrocarbon reservoirs. Preservation of primary porosity occurs in all chamositic sandstones and therefore structural traps produce better when they involve the chamosite-rich facies. By the turn of the millennia, our worked evolved into compartmentalization and fault sealing problems. The thrust faults in the horses of the duplex structures are overpressured and thrust faults act as a permeability barrier.

Later, 3D seismic data gave us a chance to refine our structural cross-sections. We found out that duplexes in the basin do not only contain break-forward hinterland dipping thrust faults, but also contain foreland-dipping backthrusts that cause structural thickening and provide much thicker reservoirs in many wells, previously attributed to sedimentary facies changes. Recently, we have been using seismic attributes to define the relationship between reservoir porosity and seismic impedance. The areas of tighter anticlinal folds correlated reasonably well with the lower acoustic impedance values in thick sandstone reservoirs, such as Spiro. When there is a facies change the acoustic impedance value is also a good predictor of porosity. However, we have not found a very reliable correlation between the porosity and acoustic impedance in thin sandstone reservoirs such as the Brazil and Red Oak because of the tuning thickness of intervals.

Our two decades-long research in the Arkoma Basin suggest that a successful gas well in the Arkoma Basin should be drilled into the hanging wall of the folded sandstone reservoirs in the duplex structure, where porosity is controlled by sedimentary facies and fault act as seals. Backthrusts in the horses may cause structural thickening and can enhance reservoir thickness. Seismic impedance values can also be used to determine the porous zone if the sandstone reservoir is recognizable by the tuning thickness intervals.

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