Sedimentological and Structural Controls on the Pennsylvanian Spiro Sandstone Gas Reservoirs in the Arkoma Foreland Basin, Oklahoma

Ibrahim Cemen
University of Alabama

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Abstract

Located in Southeastern Oklahoma and Eastern Arkansas, the Arkoma Foreland Basin is one of the most productive gas producing basins in the USA. Estimates of remaining reserves range from 4 Tcf to 7 Tcf. Although there is recent unconventional production from the Devonian to Early Mississipian Woodford shale, the production has been traditionally from the Pennsylvanian Sandstone reservoirs. Within the last two decades, my colleagues, graduate students, and I have been studying sedimentological and structural controls on the Atokan Spiro sandstone gas reservoirs which have been producing in the Hartshorne, Wilburton and Red Oak gas fields. We found out that preservation of primary porosity occurs in all Chamositic Spiro sandstone facies. The Chamosite facies is restricted to very shallow marine to tidal flat sedimentary environment during the Spiro deposition and provides sedimentological control on primary porosity. Based on our interpretation of available 2D and 3D reflection seismic data and available wire-line logs, we have constructed over 30 N-S balanced structural cross-sections along the Ouachita Mountains-Arkoma Basin transition zone where a duplex structure floored by the Woodford Detachment and roofed by the Lower Atokon Detachment is present. The duplex structure in the basin do not only contain break-forward hinterland dipping thrust faults but also contain foreland dipping backthrusts which cause structural thickening. Structural traps are located on the hanging wall anticlines of the hinterland dipping thrusts of the horse structures within the duplex. This

geometry provides compartmentalized reservoirs. We plotted different sandstone sedimentary facies of the Spiro sandstone on our structural cross-sections to locate the extent of the porous zones likely to have hydrocarbon reservoirs. This suggest to us that a successful gas well in the Arkoma Basin is usually drilled into the hanging wall of the folded sandstone reservoirs in the duplex structures where porosity is controlled by chamositic sandstone facies and faults act as seals. In some areas, backthrusts in the horses have caused structural thickening of the reservoirs. We also used seismic impedance values to determine the porous zones when the sandstone reservoirs are recognizable by the tuning thickness intervals.