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3-D seismic analysis of Atoka Formation sandstone reservoirs, Vacuum Field vicinity, Lea County, New Mexico

Atoka Formation (lower Pennsylvanian) sandstone natural gas reservoirs in the Delaware
Basin of southeastern New Mexico are unpredictable exploration targets when mapped using well logs only as control. Integrating geology, petrophysics and seismic interpretation, more effective exploration is possible in T17S, R 35 E where more than 4 billion cubic feet of natural gas has been produced from the formation. The data available for this study included a proprietary 109 mi^2 3-D reflection seismic volume and related well logs. Time-depth conversion using synthetic seismograms, and constraint of the interpretation by a geology-based seismic model yields clues to the structure, tectonic development, and potential distribution of reservoirs. The thickness of sand bodies (>20 ft) makes them seismically resolvable. Coherency analysis proved useful for delineating channels.

In the area studied, the Atoka Formation is primarily clastic, sandwiched between overlying Strawn Formation limestone and underlying Morrow Formation limestone. It is subdivided into lower Atoka fluvial deposits, and upper Atoka deltaic to marine strata. The upper Atoka Formation is marked by cyclic upward-coarsening, clastic sequences that represent delta progradation following episodic marine flooding events that are marked by black organic shale and limestone. The lower Atoka Formation consists of stacked, vertically-aggraded, fining-upward, fluvial depositional sequences, and can be divided into the "upper sand" and "lower sand". Only the lower sand has demonstrated reservoir characteristics. It was deposited in meandering fluvial channels confined to two incised channel belts, whereas the upper sand's northeast-trending meandering channels were unconfined and free to migrate across a broader floodplain from southeast to northwest, with migration reflecting local tectonic tilting.