Structure and Petroleum System of the Pennsylvanian wrench-related Cuervo graben, northwestern Tucumcari Basin, New Mexico

Brian S. Brister
Gunn Oil Company

Cuervo Hill-Pennsylvanian Gas Pool was established in 2010 in Guadalupe County, New Mexico. The discovery resulted from a five well program by SWEPI, LP (Shell). This project originated from an exploration effort designed after a successful analog, the Broken Bone graben of Cottle County, Texas (Brister, et al., January 2002, AAPG Bulletin). Similarities in basin type, tectonic and deposition histories, and potential petroleum systems between the Texas example and sub-basins of the Tucumcari Basin (publications of Broadhead, New Mexico Bureau of Geology and Mineral Resources) encouraged exploratory reflection seismic and drilling efforts by a joint venture of small independents to establish the sources of abundant oil and gas shows in the northwestern part of the Tucumcari Basin. Results of these efforts attracted major-company capital and technology which led to the new field discovery.

In 2005 an existing proprietary 2-D seismic dataset was extended with new data to image an approximate 200 square mile area in the northwestern part of the Tucumcari Basin. The 2-D grid aided in delineating much of two sub-basins and an intervening horst long known as the "Newkirk" anticline (horst, arch, high, etc.). An exploratory drilling program was undertaken in 2006, in part to drill deep stratigraphic tests in each of the sub-basins to determine the presence and characteristics of source rocks. The Cuervo graben, southernmost of the two sub-basins studied, is a northeast-trending pull-apart basin, 15 mi long by 6 miles wide. The basin axis is asymmetrical, positioned nearest the northwestern basin flank. As the basin subsided it was filled with Pennsylvanian (Atokan-Missourian) clastic shale and sandstone (lesser carbonates) with provenance closely linked to the uplifted basin flanks: granite from the Sierra Grande uplift to

the Northwest, and metasediment from the Newkirk horst to the north and east. The basal Pennsylvanian unconformity lies at approximately 14,000' in its deepest structural position in the basin.

Source rocks in the Atokan (?) to Desmoinesian strata buried deep in the Cuervo graben are dominated by gas prone kerogen with dry gas window thermal maturity. From limited data, these source rocks are apparently lean and potentially "spent". Reservoir sandstone beds have low porosity and permeability with low water saturations where productive (suggestive of "permeability jail") and are interbedded with the terrestrially-derived source rock shale. Residual wet gas shows (suggesting gas has "leaked") are common in shallower sandstone beds (Missourian?) with higher porosity, higher water saturations, and interbedded with shale of mixed-terrestrial/ marine origin. Thus, conventional, shallower traps could be associated with the Cuervo graben's flanks.

There are other Pennsylvanian sub-basins beneath the broader Permian extent of the Tucumcari Basin. The key to exploration is to delineate these sub-basins and determine the discreet petroleum system(s) related to each. Targets range from gas in deep-centered tight sandstone to basin-flank stratigraphic traps, and flanking uplift conventional structural traps of migrated gas and oil.