FRONTIER AND UNDEREXPLORED BASINS OF NEW MEXICO

BOTTOM LINE

Concentrated exploration efforts are justified in New Mexico basins, as there are many conditions favoring discovery of significant oil and gas accumulations. In addition, many existing fields drilled on structural anomalies may have substantial untapped reserves in stratigraphic components that have not yet been identified.

PROBLEM ADDRESSED

Relatively speaking, New Mexico's basins are under-explored as operators have pursued opportunities in other basins with more proven reputations. Little is known about the Paleozoic sections in these basins, most of which have thick Tertiary sedimentary cover. However, all of the key components that would suggest a significant oil province are present.

KEY WORDS:
Basin Evaluation
Gravity Surveys
Aeromagnetic Surveys
Seismic Surveys
Source Rocks
Exploration

TECHNOLOGY OVERVIEW

While less than some other states, New Mexico has an established oil and gas production history. In recent years, oil and gas revenues have contributed about 23% of the state government's revenues. Additional exploration success in New Mexico's under-explored basins would further increase the impact of the oil and gas industry on New Mexico's economy.

In the San Juan Basin in northwest New Mexico, gravity and magnetic highs correspond to uplifts, while such lows correspond to thick metasedimentary sequences. In the Four-Corners Platform on the northwest rim of the basin, over 21,000 wells in six plays were producing by 1990, cumulatively totaling 17 trillion cubic feet (tcf) of natural gas and 13 million (mm) barrels of oil and condensate.

According to stratigraphic analogy, the Paleozoic (Pennsylvanian) section in the San Juan Basin could be as prolific as the Paradox Basin in Utah. Source rocks are of sufficient maturity and flowing gas has been recovered on drill stem tests from the Paleozoic section.

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Exploration continues to grow in the San Juan Basin, as evidenced by the risk-sharing partnerships being formed. In one recent year, tens of thousands of square miles of high-resolution aeromagnetic data were produced (in addition to 350 miles of 2-D regional seismic surveys, 150 miles of 2-D prospect seismic surveys, and over 60 square miles of 3-D prospect seismic surveys). Two non-commercial exploratory tests were drilled in 1997.

The Tucumcari, Estancia, Vaughn, and Carrizozo basins are developed along the flanks of the Pedernal and Sierra Grande Uplifts that run just east of the Rio Grande Rift. These basins developed with strike-slip faulting as the uplifts formed in Early Pennsylvanian through Permian time.

Sedimentation is mostly shallow shelf. Small slivers associated with the bounding faults, however, underwent rapid and extensive subsidence. The process formed "elevator basins" that contain deep-water sandstones and shales, some with dark gray shales containing up to 9% total organic carbon. These source rocks have been buried deep enough to generate hydrocarbons, which may now be in associated sandstones. However, they probably could be found in shallow-shelf sediments next to the bounding faults (which served as migration pathways). In the Cuervo Trough, a deeper "elevator" part of the Tucumcari Basin, PreCambrian basement was encountered in a well at more than 9,000 ft. This sub-basin is about 75 miles long and has good potential reservoirs in granite wash pinchouts, associated reefs, and various anticlinal structures.

The Rio Grande Rift is one of the state's least-explored areas, but possibly the one with the greatest hydrocarbon potential. It is an area of extreme geologic complexity, with later Tertiary rifting overprinted on Laramide thrusting, which is in turn overprinted on earlier Paleozoic and PreCambrian structural trends. Only in the last few decades has the presence of significant Mesozoic and Paleozoic section been established. Mesozoic source rocks have been identified, but none have been documented as yet in the Paleozoic. Oil production from the rift was established in 1986. Only a few wells, with depth limited to the Mesozoic section, have been drilled since then.

Some potential undoubtedly exists to extend production beyond the productive reservoirs in the Permian Basin, moving further to the west and northwest into New Mexico. Understanding migration pathways and complex reservoir structures will be essential. Potential also lies within the earlier Paleozoic formations of southeast New Mexico (i.e., in pre-Permian formations, especially in Siluro-Devonian sediments). Exploration for these reservoirs has been very limited, partly because the stratigraphy is complex and not yet resolvable using 3-D seismic technology.

LESSONS LEARNED

In exploring frontier areas, drilling practices must be optimized to obtain the most useful information. Air drilling reduces circulation problems, allows continuous open-hole testing of potential producing formations, and results in faster penetration.

However, the advantages of air drilling are more than offset by some inherent disadvantages. Hole problems result from too rapid penetration. Cuttings returns are often inadequate to establish the needed stratigraphic framework for regional exploration, or to recognize the current position of the bit. Coring is seldom successful. There is a general lack of control on zones of fluid entry and the expense of intermediate casing is a definite economic consideration. Casing programs should, however, always consider the protection of freshwater aquifers.

Poor wireline logs are obtained when they are run in holes that are out-of-gauge, air-filled, or cased. Good borehole quality also ensures reliable testing and minimized formation damage. Balanced drilling is preferred to the overbalanced drilling, which has been traditional in many New Mexico basins. Some granite wash reservoirs may be pH-sensitive and require potassium chloride (KCl) in frac fluids.

FIELD RESULTS

In southeast New Mexico, more than 400 oil fields from the same Pennsylvanian and Permian carbonates that are productive in the Permian Basin of west Texas have produced more than 490 million barrels of oil and 3.2 tcf of gas.

A recent review revealed that 16 of the fields had been seriously underdeveloped at some point. Redevelopment accounted for 65% of total field reserves and was accompanied by a five- to 10-fold increase in productive acreage and number of wells. These fields, initially developed on structural anomalies, were found to have substantial off-structure stratigraphic components. Nearly all southeast New Mexico production is associated with small structural anomalies targeted during exploration (84% of fields have less than 10 wells, and 57% have less than three wells). Therefore, careful study of facies and depositional settings should substantially increase the potential of many fields.

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