

NEMAHA UPLIFT PROVINCE (055)

by Ronald R. Charpentier

INTRODUCTION

The Nemaha Uplift Province (055) extends from southeastern Nebraska to south-central Oklahoma. It consists of 23 counties; all boundaries of the province follow county boundaries. The province is about 450 mi long (north-south) by 110 mi wide (east-west) and has an area of 16,100 sq mi.

Petroleum exploration in the Nemaha Uplift Province (055) began before the turn of the century. Gas was discovered in Cowley County, Kans., as early as 1902. The first discovery larger than 1 MMBOE was in 1903 in Cowley County, Kans. (Dexter field). More than 45,000 wells have been drilled in the province and 194 fields larger than 1 MMBOE have been discovered. Discovered resources as of the end of 1990 have been more than 2.4 BBO and over 6.1 TCFG. Among the largest fields in the province are Oklahoma City field (more than 750 MMBO and more than 2.4 TCFG), in Cleveland and Oklahoma Counties, Okla.; El Dorado field (more than 300 MMBO), in Butler County, Kans.; and Crescent-Lovell field (more than 850 BCFG), in Kingfisher and Logan Counties, Okla.

The plays were erected for the Nemaha Uplift Province primarily by grouping the reservoir rocks by age. Thus, the reservoirs and prospects in the pre-Woodford Paleozoic rocks are in play 5501, except for those significantly below the top of the Arbuckle Group, which are in play 5507 (the Internal Arbuckle/Reagan Play). Woodford Shale reservoirs are part of a regional unconventional play, the Woodford/Chattanooga/Arkansas Novaculite of Midcontinent Play (5811), described under the Anadarko Basin Province (058). Mississippian reservoirs are assigned to Play 5503. The Pennsylvanian and Permian reservoirs are divided into two plays by primary trap type. Play 5504 includes Pennsylvanian or Permian reservoirs or prospects with structural or combination traps. Play 5505 includes Pennsylvanian, primarily but not exclusively Desmoinesian, reservoirs with stratigraphic traps. Another play assessed within the Nemaha Uplift Province is the Precambrian Midcontinent Rift System Play (5101), discussed under the Superior Province (051). Coal-bed gas resources were not assessed for this province.

ACKNOWLEDGMENTS

Scientists affiliated with the American Association of Petroleum Geologists and from various State geological surveys contributed significantly to play concepts and definitions. Their contributions are gratefully acknowledged.

CONVENTIONAL PLAYS

5501. PRE-WOODFORD PALEOZOIC PLAY

The Pre-Woodford Paleozoic Play is a confirmed, conventional play defined by being within the bounds of the Nemaha Uplift Province and by having reservoir rocks ranging from the top few tens of feet of the Arbuckle Group to the base of the Woodford Shale. A small portion of the Sedgwick Basin Province (059) is considered to be structurally similar to the Nemaha Uplift Province and is included in this play. The play is bounded geographically by similar Lower Paleozoic plays in the Forest City Basin, Sedgwick Basin, and Cherokee Platform Provinces (056, 059, and 060, respectively). It is underlain by the Internal Arbuckle/Reagan Play (5507) and overlain by the Woodford/Chattanooga/Arkansas Novaculite of Midcontinent Play (5811). The play excludes areas, particularly in the northern part of the province, where the sub-Woodford rocks are completely eroded. Most accumulations are in structural traps.

Reservoirs: There are five main reservoirs included. The uppermost Arbuckle Group (Lower Ordovician) consists of karstic dolomite reservoirs with an average of 17 ft net pay. The Middle to Upper Ordovician Simpson Group reservoirs are mostly sandstones with an average of 55 ft net pay. The Viola Limestone reservoirs (Upper Ordovician) average 17 ft of net pay. Hunton Group (Upper Ordovician to Lower Devonian) carbonate-rock reservoirs average 72 ft net pay. Misener Sandstone (Middle to Upper Devonian) reservoirs average 11 ft net pay.

Source rocks: The Ordovician Simpson Group and Decorah Formation shales are probably the most important sources. In the deeper parts of the Forest City Basin the Ordovician source rocks may have been mature in Late Pennsylvanian or Permian time. The Devonian-Mississippian Woodford Shale is also a likely contributor. In the northern part of the Nemaha Uplift, all these rocks are shallow and immature and migration from adjacent basins is likely. In the southern part of the Nemaha Uplift, depths are greater and some of the rocks on the uplift could provide local sources. There is evidence that oil migrated into some Nemaha Uplift structures (such as that of the Oklahoma City field) prior to mid-Pennsylvanian and was lost to surface leakage before a resealing by later Pennsylvanian shales.

Traps: Traps are primarily structural and are related to formation of the Nemaha Uplift during early Pennsylvanian time, with some further post-Permian movement. Some stratigraphic component is also involved in the trapping in some of the carbonate-rock

reservoirs. Depths of current production are 1,800–12,500 ft and undiscovered accumulations are expected to be at similar depths.

Exploration status: Hydrocarbon exploration began in this play before 1900 and increased significantly in 1914 with the discovery of pre-Pennsylvanian reservoirs in the Augusta field, Butler County, Kans. Since then, 90 oil and 3 nonassociated gas accumulations larger than 1 MMBOE have been discovered. The largest oil accumulation (more than 650 MMBO) is in Oklahoma City field, in Cleveland and Oklahoma Counties, Okla. The largest nonassociated gas accumulation (more than 45 BCFG) is in Elk Horn, Northeast field in Garfield, Logan, and Noble Counties, Okla.

Resource potential: The play is very mature with few accumulations larger than 1 MMBO or 6 BCFG expected. The number of discoveries per amount of wildcat drilling is decreasing as is the size of the discoveries. Because the area has been heavily drilled, there is little expectation for large numbers of accumulations larger than 1 MMBOE. Large numbers of accumulations smaller than that size are still likely to occur, however.

5503. MISSISSIPPIAN PLAY

The Mississippian Play is a confirmed conventional play defined by being within the bounds of the Nemaha Uplift Province and by having reservoirs and prospects within Mississippian rocks. A small portion of the Sedgwick Basin Province (059) is considered to be structurally similar to the Nemaha Uplift Province and is included in this play. The play is bounded geographically by similar Mississippian plays in the Forest City Basin, Sedgwick Basin, and Cherokee Platform Provinces (056, 059, and 060). The play excludes areas, particularly in the northern part of the province, where the Mississippian rocks are completely eroded. The play is underlain by the Woodford/Chattanooga/Arkansas Novaculite of Midcontinent Play (5811) and overlain by the Pennsylvanian-Permian Structural and Pennsylvanian Stratigraphic Plays (5504 and 5505). Most accumulations are in combination traps.

Reservoirs: The main reservoirs are limestones and cherts of Mississippian age. The "Mississippian chat", actually a residual deposit of Mississippian-age chert fragments deposited at the base of the Pennsylvanian, is included in this play. Net pay averages 34 ft.

Source rocks: Hydrocarbon sources are probably similar to those for the Pre-Woodford Paleozoic Play (5501). The Devonian-Mississippian Woodford Shale is probably the most important source, partially by long-range migration from deeper parts of the

Anadarko Basin. The Ordovician Simpson Group and Decorah Formation shales are possible sources for vertical migration. The dark, marine shales of the Pennsylvanian (especially Desmoinesian) cyclothems may provide hydrocarbons from adjacent basins. In the northern part of the Nemaha Uplift, all these rocks are shallow and immature and migration from adjacent basins is likely. In the southern part of the Nemaha Uplift, depths are greater and some of the rocks on the uplift could provide local sources.

Traps: Traps are primarily combination. The structural component is related to formation of the Nemaha Uplift during early Pennsylvanian time, with some further post-Permian movement. Depths of current production are 2,400–5,700 ft and undiscovered accumulations are expected to be at similar depths.

Exploration status: Hydrocarbon exploration began in this play prior to 1900. Since then 30 oil and 1 nonassociated gas accumulations larger than 1 MMBOE have been discovered. The largest oil accumulation (more than 15 MMBO) is in Ponca City field, in Kay County, Okla. The largest nonassociated gas accumulation (more than 200 BCFG) is in Crescent-Lovell field in Kingfisher and Logan Counties, Okla.

Resource potential: The play is very mature with few accumulations larger than 1 MMBO or 6 BCFG expected. The number of discoveries per amount of wildcat drilling is decreasing as is the size of the discoveries. Because the area has been heavily drilled, there is little expectation for large numbers of accumulations larger than 1 MMBOE. Large numbers of accumulations smaller than that size are still likely to occur, however.

5504. PENNSYLVANIAN-PERMIAN STRUCTURAL PLAY

The Pennsylvanian-Permian Structural Play is a confirmed conventional play defined by being within the bounds of the Nemaha Uplift Province, by having reservoirs and prospects within Pennsylvanian and Permian rocks, and by having a primarily structural or combination trap type. A small portion of the Sedgwick Basin Province (059) is considered to be structurally similar to the Nemaha Uplift Province and is included in this play. The play is bounded geographically by similar Pennsylvanian plays in the Forest City Basin, Sedgwick Basin, and Cherokee Platform Provinces (056, 059, and 060). It is underlain by the Mississippian Play (5503).

Reservoirs: The main reservoirs are sandstones of Pennsylvanian and Permian age. The most significant of these are Desmoinesian fluvial-deltaic sandstones. Net pay averages 37 ft.

Source rocks: The same three sources for the hydrocarbons are likely. The Devonian-Mississippian Woodford Shale is probably the most important source, partially by long-range migration from deeper parts of the Anadarko Basin. The Ordovician Simpson Group and Decorah Formation shales are probable sources for vertical migration. The dark, marine shales of the Pennsylvanian (especially Desmoinesian) cyclothems are likely local sources. In the northern part of the Nemaha Uplift, all these rocks are shallow and immature and migration from adjacent basins is likely. In the southern part of the Nemaha uplift, depths are greater and some of the rocks on the uplift could provide local sources.

Traps: Traps are structural and combination types. The structural component is related to formation of the Nemaha Uplift during early Pennsylvanian time, with some post-Permian movement. Depths of current production are 500–7,900 feet and undiscovered accumulations are expected to be at similar depths.

Exploration status: Hydrocarbon exploration began in this play before 1900. The first significant discovery was the Blackwell-Newkirk gas area in Kay County, Okla. in 1909. Since then 57 oil and 10 nonassociated gas accumulations larger than 1 MMBOE have been discovered. The largest oil accumulation (more than 100 MMBO) is in El Dorado field, in Butler County, Kans. The largest nonassociated gas accumulation (more than 1.7 TCFG) is in Oklahoma City field, in Cleveland and Oklahoma Counties, Okla.

Resource potential: The play is very mature with few accumulations larger than 1 MMBO or 6 BCFG expected. The number of discoveries per amount of wildcat drilling is decreasing as is the size of the discoveries. Because the area has been heavily drilled, there is little expectation for large numbers of accumulations larger than 1 MMBOE. Large numbers of accumulations smaller than that size are still likely to occur, however.

5505. PENNSYLVANIAN STRATIGRAPHIC PLAY

The Pennsylvanian Stratigraphic Play is a confirmed conventional play defined by being within the bounds of the Nemaha Uplift Province, by having reservoirs and prospects within Pennsylvanian rocks, and by having a primarily stratigraphic trap type. A small portion of the Sedgwick Basin Province (province 059) is considered to be structurally similar to the Nemaha Uplift Province and is included in this play. The play is bounded geographically by similar Pennsylvanian Plays in the Forest City Basin, Sedgwick Basin, and Cherokee Platform Provinces (056, 059, 060, respectively). It is underlain by the Mississippian Play (5503).

Reservoirs: The main reservoirs are sandstones of Pennsylvanian age. Most of these are fluvial-deltaic sandstones of Desmoinesian age, but some other Pennsylvanian-age sandstones are also included. Net pay averages 21 ft.

Source rocks: The same three sources for the hydrocarbons are likely. The Devonian-Mississippian Woodford Shale is probably the most important source, partially by long-range migration from deeper parts of the Anadarko Basin. The Ordovician Simpson Group and Decorah Formation shales are probable sources for vertical migration. The dark, marine shales of the Pennsylvanian (especially Desmoinesian) cyclothems are likely local sources. In the northern part of the Nemaha Uplift, all these rocks are shallow and immature and migration from adjacent basins is likely. In the southern part of the Nemaha uplift, depths are greater and some of the rocks on the uplift could provide local sources.

Traps: Traps are primarily stratigraphic. Depths of current production are 1,800–7,000 ft and undiscovered accumulations are expected to be at similar depths.

Exploration status: Hydrocarbon exploration began in this play before 1900. The first significant discovery was Rock field, Cowley County, Kans., in 1914. Since then 27 oil and 1 nonassociated gas accumulations larger than 1 MMBOE have been discovered. The largest oil accumulation (more than 27 MMBO) is in Fox-Bush-Couch field, in Butler and Cowley Counties, Kans. The largest nonassociated gas accumulation (more than 11 BCFG) is in Red Rock, West field in Noble County, Okla.

Resource potential: The play is very mature with few accumulations larger than 1 MMBO or 6 BCFG expected. The number of discoveries per amount of wildcat drilling is decreasing as is the size of the discoveries. Because the area has been heavily drilled, there is little expectation for large numbers of accumulations larger than 1 MMBOE. Large numbers of accumulations smaller than that size are still likely to occur, however.

5507. INTERNAL ARBUCKLE/REAGAN PLAY (HYPOTHETICAL)

The Internal Arbuckle/Reagan Play is a hypothetical conventional play defined as prospects within the Arbuckle Group, Reagan Sandstone, and equivalents within the bounds of the Nemaha Uplift Province. A small portion of the Sedgwick Basin Province (059) is considered to be structurally similar to the Nemaha Uplift Province and is included in this play. The play is bounded geographically by similar Internal Arbuckle/Reagan Plays in the Anadarko Basin and Cherokee Platform Provinces (058, and 060, respectively). The play excludes areas, particularly in the northern part of the

province, where the Arbuckle and Reagan are completely eroded. The play is overlain by the Pre-Woodford Paleozoic Play (5501).

Reservoirs: The potential reservoirs are carbonate rocks, especially dolomites, of the Upper Cambrian to Lower Ordovician Arbuckle Group. The Arbuckle Group ranges in thickness from completely eroded in northern parts of the province to 5,000 ft at the southern edge of the province. Other possible reservoirs are sandstones of the Upper Cambrian Reagan Sandstone and equivalents.

Source rocks: Hypothesized source rocks are organic-rich limestones and dolomites within the Arbuckle Group. Little is known about Arbuckle source-rock potential, but any mature sources would likely lie within the oil window. Younger sources (Woodford Shale or Simpson Group shales) could possibly contribute by lateral migration.

Traps: Traps would be lateral and vertical variations in permeability in the carbonate rocks within the Arbuckle Group. These would likely have resulted from either subaerial weathering or dolomitization processes.

Exploration status: Relatively little drilling has taken place in this province below the top few tens of feet of the Arbuckle Group. A very large volume of rock is thus unexplored, making this a very immature play.

Resource potential: Risk is high for this play, especially because of a low probability for good source rocks and seals. If good source rocks do exist within the Arbuckle Group, there is potential for large accumulations.

UNCONVENTIONAL PLAYS

There are no unconventional plays described in this province report. However, unconventional plays listed in the surrounding provinces may include parts of this province. Individual unconventional plays are usually discussed under the province in which the play is principally located.

REFERENCES

- Bebout, D.G., White, W.A., Hentz, T.F., and Grasmick, M.K., eds., 1993, Atlas of major midcontinent gas reservoirs: Gas Research Institute, Bureau of Economic Geology-The University of Texas at Austin, Arkansas Geological Commission, Oklahoma Geological Survey, Kansas Geological Survey, 85 p.
- Burchfield, M.R., 1985, Map of Oklahoma oil and gas fields: Oklahoma Geological Survey Map GM-28, scale 1:500,000.
- Franks, K.A., 1980, The Oklahoma petroleum industry: Norman, Oklahoma, University of Oklahoma Press, 284 p.
- Harrison, W.E., and Routh, D.L., 1981, Reservoir and fluid characteristics of selected oil fields in Oklahoma: Oklahoma Geological Survey Special Publication 81-1, 317 p.
- Hyne, N.J., ed., Pennsylvanian sandstones of the mid-continent: Tulsa Geological Society Special Publication 1, 360 p.
- Jewett, J.M., 1954, Oil and gas in eastern Kansas: Kansas Geological Survey Bulletin 104, 397 p. [with a 25-year update by M.O. Oros, 1979]
- Kansas Geological Survey, 1989, Oil and gas fields Manhattan Quadrangle in Kansas: Kansas Geological Survey Map M-18-3, scale 1:250,000.
- Kansas Geological Survey, 1989, Oil and gas fields Kansas City Quadrangle in Kansas: Kansas Geological Survey Map M-18-4, scale 1:250,000.
- Kansas Geological Survey, 1989, Oil and gas fields Lawrence Quadrangle in Kansas: Kansas Geological Survey Map M-18-5, scale 1:250,000.
- Kansas Geological Survey, 1989, Oil and gas fields Hutchinson Quadrangle in Kansas: Kansas Geological Survey Map M-18-6, scale 1:250,000.
- Kansas Geological Survey, 1989, Oil and gas fields Wichita Quadrangle in Kansas: Kansas Geological Survey Map M-18-11, scale 1:250,000.
- Miner, H.C., The fire in the rock--a history of the oil and gas industry in Kansas 1855-1976: North Newton, Kansas, Mennonite Press, 110 p.
- Newell, K.D., Watney, W.L., Cheng, S.W.L., and Brownrigg, R.L., 1987, Stratigraphic and spatial distribution of oil and gas production in Kansas: Kansas Geological Survey Subsurface Geology Series 9, 86 p.

Rascoe, Bailey, Jr., and Hyne, N.J., eds., [1988], Petroleum geology of the mid-continent:
Tulsa Geological Society Special Publication 3, 162 p.