

FOREST CITY BASIN PROVINCE (056)

By Ronald R. Charpentier

With a discussion of coalbed methane by Dudley D. Rice and Tom Finn

INTRODUCTION

The Forest City Basin Province (056), extends from southwestern Iowa and northeastern Kansas to central Missouri. It consists of 58 counties; the boundaries of this province all follow county boundaries. The province is 240 mi long (north-south) by 195 mi wide (east-west) and has an area of 32,000 sq mi.

Petroleum exploration in the Forest City Basin Province began in 1860 with drilling in Miami County, Kans., and discovery of oil near Paola. The first discovery larger than 1 MMBOE was in 1882, also in Miami County, Kans. (Paola-Rantoul field). More than 10,000 wells have been drilled in the province, and 21 fields larger than 1 MMBOE have been discovered. Discovered resources as of the end of 1990 total more than 100 MMBO and over 15 BCFG. Among the largest fields in the province are Paola-Rantoul field (more than 41 MMBO), in Franklin, Johnson, and Miami Counties, Kansas; and Falls City field (more than 5 MMBO), in Richardson County, Nebraska

The plays for the Forest City Basin Province were erected primarily by grouping the accumulations by the age of the reservoir rocks. Thus, the reservoirs and prospects in the pre-Woodford Paleozoic rocks are in Pre-Woodford Paleozoic Play (5601). Mississippian reservoirs are assigned to Mississippian Play (5602) and Pennsylvanian reservoirs to Pennsylvanian Play (5603). One coalbed methane play was assessed and described by Dudley D. Rice. Additional discussion of coalbed gas plays is included in a chapter by Dudley D. Rice elsewhere in this CD-ROM. Another play which occurs in the Forest City Basin Province is the Precambrian Midcontinent Rift System Play (5101), discussed in the section for the Superior Province (051).

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CONVENTIONAL PLAYS

5601. PRE-WOODFORD PALEOZOIC PLAY

The Pre-Woodford Paleozoic Play is a confirmed, conventional play defined by being in the bounds of the Forest City Basin Province and by having reservoir rocks ranging from the base of the Paleozoic section to the base of the Woodford Shale. The play is bounded geographically by similar Lower Paleozoic plays in the Nemaha Uplift and Cherokee Platform Provinces (055 and 060, respectively). It is overlain by the Mississippian Play (5602). 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 three main reservoirs included in the pre-Woodford Paleozoic Play. The Arbuckle Group (Upper Cambrian to Lower Ordovician) reservoirs consist of karstic dolomite with an average of 9 ft net pay. The Middle to Upper Ordovician Simpson Group reservoirs are mostly sandstone with an average of 10 ft net pay. Hunton Group (Upper Ordovician to Lower Devonian) limestone and dolomite reservoirs average 23 ft net pay.

Source rocks: Shales of the Ordovician Simpson Group and Decorah Formation are probably the most important source. In the deeper parts of the Forest City basin these Ordovician source rocks may have been mature in Late Pennsylvanian or Permian time. The Devonian-Mississippian Woodford Shale is another likely source, by long-range migration from deeper parts of the Anadarko or Arkoma Basins.

Traps: Traps are primarily structural. Stratigraphic components are also involved in the trapping in some of the carbonate-rock reservoirs. Depths of current production are 1,900-3,200 ft and undiscovered accumulations are expected to be at similar depths.

Exploration status: Hydrocarbon exploration began in this play before 1890. The first significant discovery was the Bradfield field in Lyon County, Kans., in 1921. Since then, 5 oil and no nonassociated gas accumulations larger than 1 MMBOE have been discovered. The largest accumulation is in Falls City field (more than 5 MMBO), in Richardson County, Nebr.

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. When compared with how heavily the area has been drilled, there is little expectation for large numbers of accumulations larger than 1 MMBOE. Accumulations smaller than that size are still likely to occur, however.

5602. MISSISSIPPIAN PLAY

The Mississippian Play is a confirmed conventional play defined by being in the bounds of the Forest City Basin Province and by having reservoirs and prospects in Mississippian rocks. The play is bounded geographically by similar Mississippian plays in the Nemaha Uplift and Cherokee Platform Provinces (055 and 060, respectively). 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 Pre-Woodford Paleozoic Play (5601) and overlain by the Pennsylvanian Play (5603). 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.

Source rocks: Shales of the Ordovician Simpson Group and Decorah Formation are probably the most important source rocks, and, 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 another likely source, by long-range migration from deeper parts of the Anadarko or Arkoma Basins.

Traps: Traps are primarily combination. Depths of current production are about 1,000-2,000 ft and undiscovered accumulations are expected to be at similar depths.

Exploration status : Hydrocarbon exploration began in this play by 1890. Since then no accumulations larger than 1 MMBOE have been discovered.

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 and when compared with how heavily the area has been drilled, there is little expectation for accumulations larger than 1 MMBOE. Accumulations smaller than that size are still likely to occur, however.

5603. PENNSYLVANIAN PLAY

The Pennsylvanian Play is a confirmed conventional play defined by being within the bounds of the Forest City Basin Province and by having reservoirs and prospects within Pennsylvanian rocks. The play is bounded geographically by similar Pennsylvanian plays in the Nemaha Uplift and Cherokee Platform Provinces (055 and 060, respectively). It is underlain by the Mississippian Play (5602).

Reservoirs: The main reservoirs are sandstones of Pennsylvanian age. Most significant are fluvial-deltaic sandstones of Desmoinesian age. Net pay averages 18 ft.

Source rocks: The dark, marine shales of the Pennsylvanian (especially Desmoinesian) cyclothem are probably an important source. The Devonian-Mississippian Woodford Shale is likely another important source, by long-range migration from deeper parts of the Anadarko or Arkoma Basins. Shales of the

Ordovician Simpson Group and Decorah Formation are also possible sources. In the deeper parts of the Forest City basin the Ordovician source rocks may have been mature in Late Pennsylvanian or Permian time.

Traps: Traps are structural and combination types. Depths of current production are from 150-1,500 ft and undiscovered accumulations are expected to be at similar depths.

Exploration status: Hydrocarbon exploration began in this play in 1860 in Miami County, Kans. The first discovery larger than 1 MMBOE (Paola-Rantoul field) was in 1882, also in Miami County, Kans. Since then, 13 oil and 1 nonassociated gas accumulations larger than 1 MMBOE have been discovered. The largest accumulation is in Paola-Rantoul field (more than 41 MMBO), in Franklin, Johnson, and Miami Counties, Kans.

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. When compared with how heavily the area has been drilled, there is little expectation for accumulations larger than 1 MMBOE. Accumulations smaller than that size are still likely to occur, however.

UNCONVENTIONAL PLAYS

Coalbed Gas Plays

By Dudley D. Rice

One play, the Forest City Basin–Central Basin Play (5650) is identified in the Forest City Basin Province (056).

The coalbed gas potential of the Forest City Basin of Iowa, Kansas, Missouri, and Nebraska is described by Tedesco (1992) and Bostic and others (1993a, b). Deep coal resources of Kansas are assessed by Brady (1990). In general, information to fully evaluate potential coalbed gas reserves in the basin is limited.

In the Forest City Basin, coal-bearing strata are present in the Pennsylvanian Atokan and Desmoinesian Series. In all four States, the coals are assigned to the Riverton Formation and the Cherokee, Marmaton, and Pleasanton Groups. The coal-bearing units are cyclothems made up of shale, sandstone, limestone, and coal. More than 40 individual beds have been identified, and many have been mined for more than 100 years, both underground and on the surface. Some of the important coal beds, in ascending order, which correlate across State boundaries, are Riverton, Weir-Pittsburg, Mineral, Scammon, Fleming, Tebo, Croweburg, Bevier, Summit, Mulky, Mystic, and Mulberry. The coal beds are relatively widespread and commonly too deep to mine. As a result, many parts of the basin are underlain by multiple, unmined coal beds. Drill holes indicate that the cumulative coal thickness may be as much as 22 ft, and individual beds may be as thick as 10 ft. However, many of the beds are less than 2 ft thick, and multiple-seam completions may be required for commercial production. The coal-bearing section is as much as 1,600 ft deep along the axis of the basin in southwestern Iowa.

The rank of Pennsylvanian coals ranges from high-volatile C to A bituminous. Rank increases with depth and apparently to the west where greater depths of burial exist. In addition, higher heat flow in the west might have been associated with structural movements along the Nemaha Uplift. Maximum burial occurred in late Paleozoic or early Mesozoic time. The coal ranks are marginal with respect to significant thermogenic hydrocarbon generation.

Desorbed gas samples consist mostly of methane (72 to 93 percent). Other significant components are ethane and CO₂. The isotopic composition of the gases indicates that at least some of the gas, which was probably formed relatively recently in association with groundwater flow, may be of biogenic origin. The high amounts of ethane are probably the result of fractionation during the desorption process.

The Forest City is a structural basin of Pennsylvanian age and, based on existing data, appears to be relatively undeformed. A series of northwest-southeast trending folds and faults has been documented in Missouri. In addition, recurrent movement has taken place on the Nemaha Uplift, which forms the

western border, and the Thurman-Redfield Structural Zone in Iowa, which might have locally enhanced permeability.

Gas content information is limited in the Forest City Basin. Measurements from one well in Kansas ranged from 21 to 94 Scf/t over the depth interval of 757–1158 ft. These values are relatively low, and more measurements are needed to properly evaluate the coalbed gas potential. An interesting fact is that excessive amounts of methane and associated explosions were reported in underground mines of Missouri from 1881 to 1905. Coal-bed gas resources have not been estimated for the basin.

Large amounts of coal were produced along the eastern and northern flanks of the basin in the past, particularly during World Wars I and II. At present, limited surface mining is being done in Iowa, Kansas, and Nebraska.

Since 1990, more than 10 wells have been drilled for coalbed gas in the Kansas and Missouri parts of the basin. Data are not available from these wells, and production has not been established. In addition, some other wells may have coalbed gas commingled with gas produced from other zones in the Cherokee Group. The northeastern part of the basin, particularly in Kansas, is underlain by shallow, low-pressure oil and gas fields. As a result, some infrastructure is in place for the development of coalbed gas, both from new wells and recompletions in old wells.

5650. FOREST CITY BASIN-CENTRAL BASIN PLAY (HYPOTHETICAL)

On the basis of limited data, one hypothetical coalbed gas play is recognized in the Forest City Basin, the Forest City Basin–Central Basin play (5650). The play terminates at the Nemaha Uplift on the west and the Bourbon Arch on the south. On the east and north flanks of the basin, the play outline is defined by the 300 ft depth of burial for the coal-bearing strata. The potential for reserves of coalbed gas in this play is graded as fair to poor, with low rank associated with low gas contents as the main limiting factors.

REFERENCES

(References for coalbed gas are shown in Rice, D.D., Geologic framework and description of coalbed gas plays, this CD-ROM)

- 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.
- Carlson, Marvin, 1989, Oil in Nebraska: Nebraska Geological Survey Resource Report 11, 86 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.
- 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.

