OKLAHOMA 2008 DRILLING HIGHLIGHTS

by Dan T. Boyd, Oklahoma Geological Survey

This article is a summary of 2008 Oklahoma drilling activity and highlights results that became public by January 1, 2009. Significant results registered after this date will appear in next year's summary. Except where noted, all data were supplied online by Petroleum Information/Dwights LLC dba IHS Energy Group, all rights reserved. Without this excellent database this report could not have been completed. Cartography is by Russell Standridge of the Oklahoma Geological Survey.

General Activity

The working drilling rig number is a fundamental barometer of oil and gas activity in any area. The Baker Hughes Company has tracked monthly rotary drilling rig counts for many years and has compiled these into annual averages for regions all over the world. According to Baker Hughes (2009) the average number of active drilling rigs in Oklahoma for 2008 was 200; up from the 2007 average of 188. This increase in the annual average does not reflect the recent drop that has occurred due to dramatically lower energy prices. Since the Oklahoma rig count peaked at 219 in the week of September 5th, the number of working rigs has fallen 27% to 159. This decline will undoubtedly continue into 2009 and end a three-year run of increasing activity (Figure 1).

The price of natural gas is by far the most important factor controlling drilling activity in Oklahoma, with major price fluctuations having a close correlation with drilling activity (Figure 2). The average 2008 wellhead gas price in Oklahoma will be very close to $7.45 per thousand cubic feet (MCF) (Soltani, 2008), which is an all-time record. However, this is due to prices in the first half of the year. Since July, when Henry Hub prices peaked between $13 and $14 per MCF, the price of natural gas has fallen dramatically, with year-end prices hovering between $5 and $6 per MCF. It should be noted that wellhead prices in Oklahoma historically average $1.32 below those of Henry Hub (Soltani, 2008).

The long-term impact on drilling activity that this latest round of lower natural gas prices will have in Oklahoma is impossible to predict, but much will depend on the severity of winter weather. Of even greater concern than the number of active rigs is the fact that more than one quarter of the State's gas production comes from wells that are less than a year old (Boyd, 2005). This makes it likely that, in addition to a drop in drilling activity, 2009 will also see a significant decrease in gas production and associated gross production tax revenue.

Total completions in 2008 were 62% gas and 31% oil (Figure 3). Dry holes, which comprise all plugged and abandoned wells, including those junked for mechanical

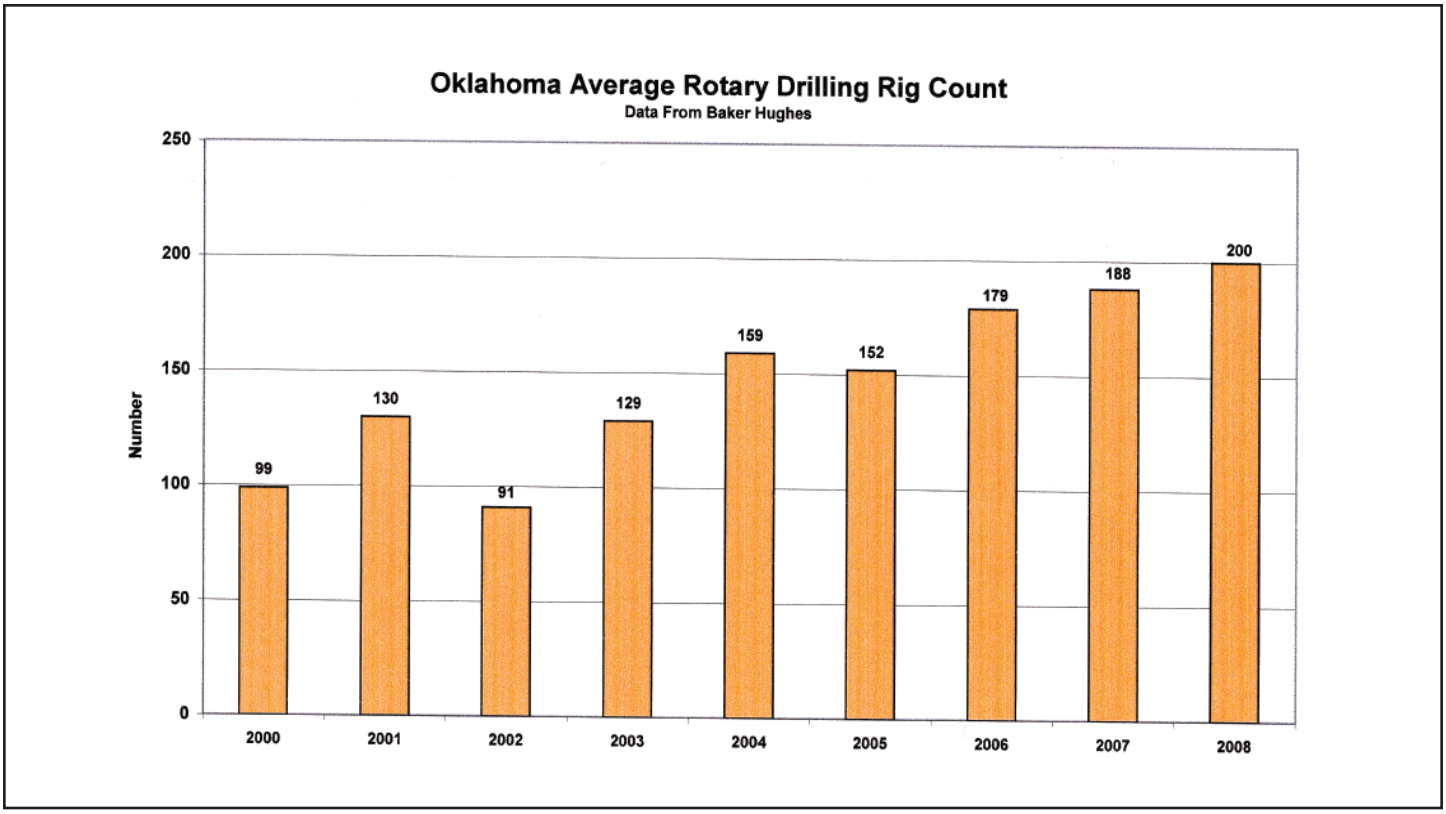

Figure 1. *Oklahoma Average Rotary Drilling Rig Count, from 2000 through 2008. Data from Baker Hughes, 2009.*

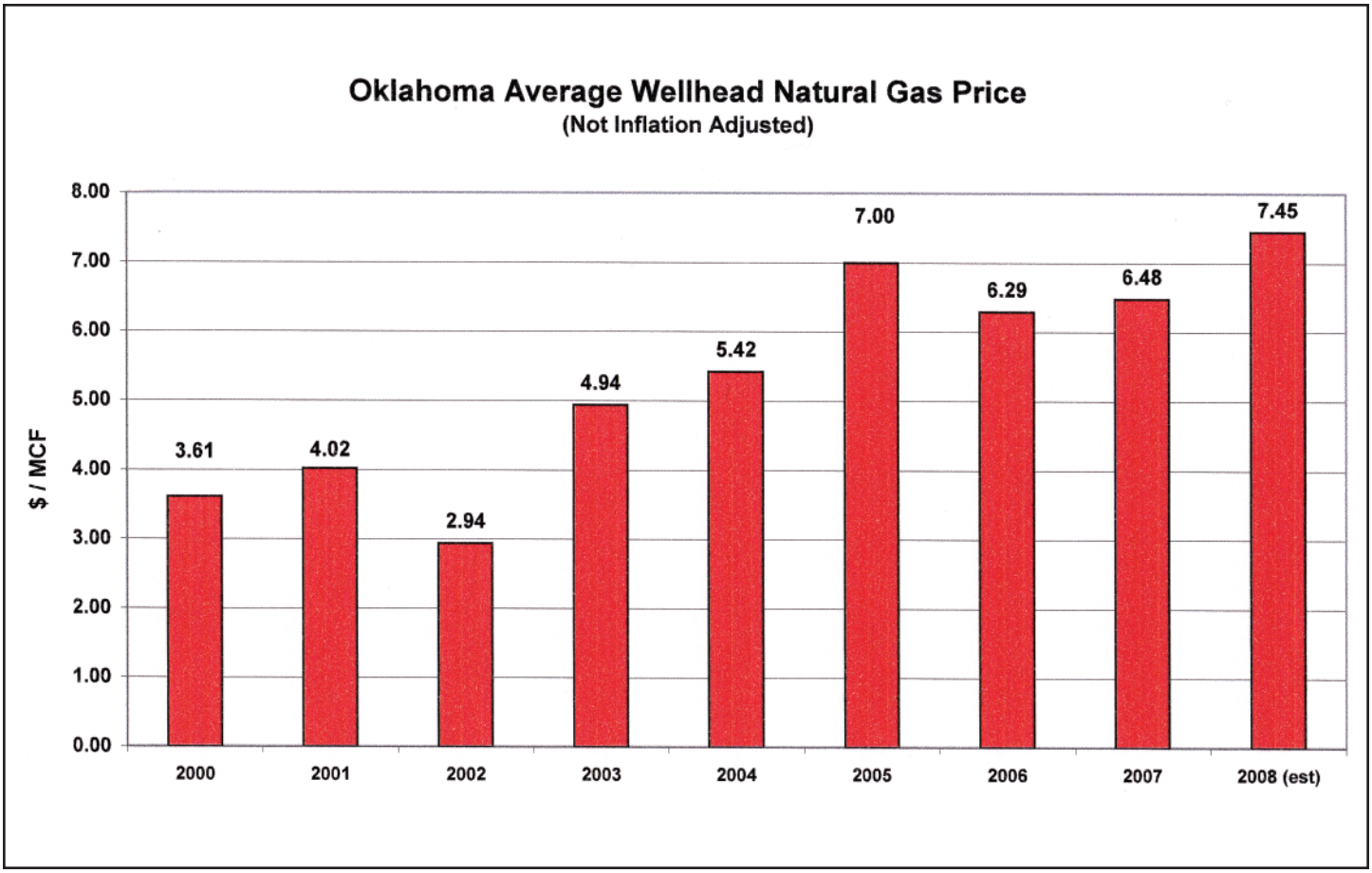

Figure 2. *Oklahoma Average Wellhead Natural Gas Price from 2000 through 2008 (not inflation adjusted). Data from Soltani (O.C.C.), 2008.*

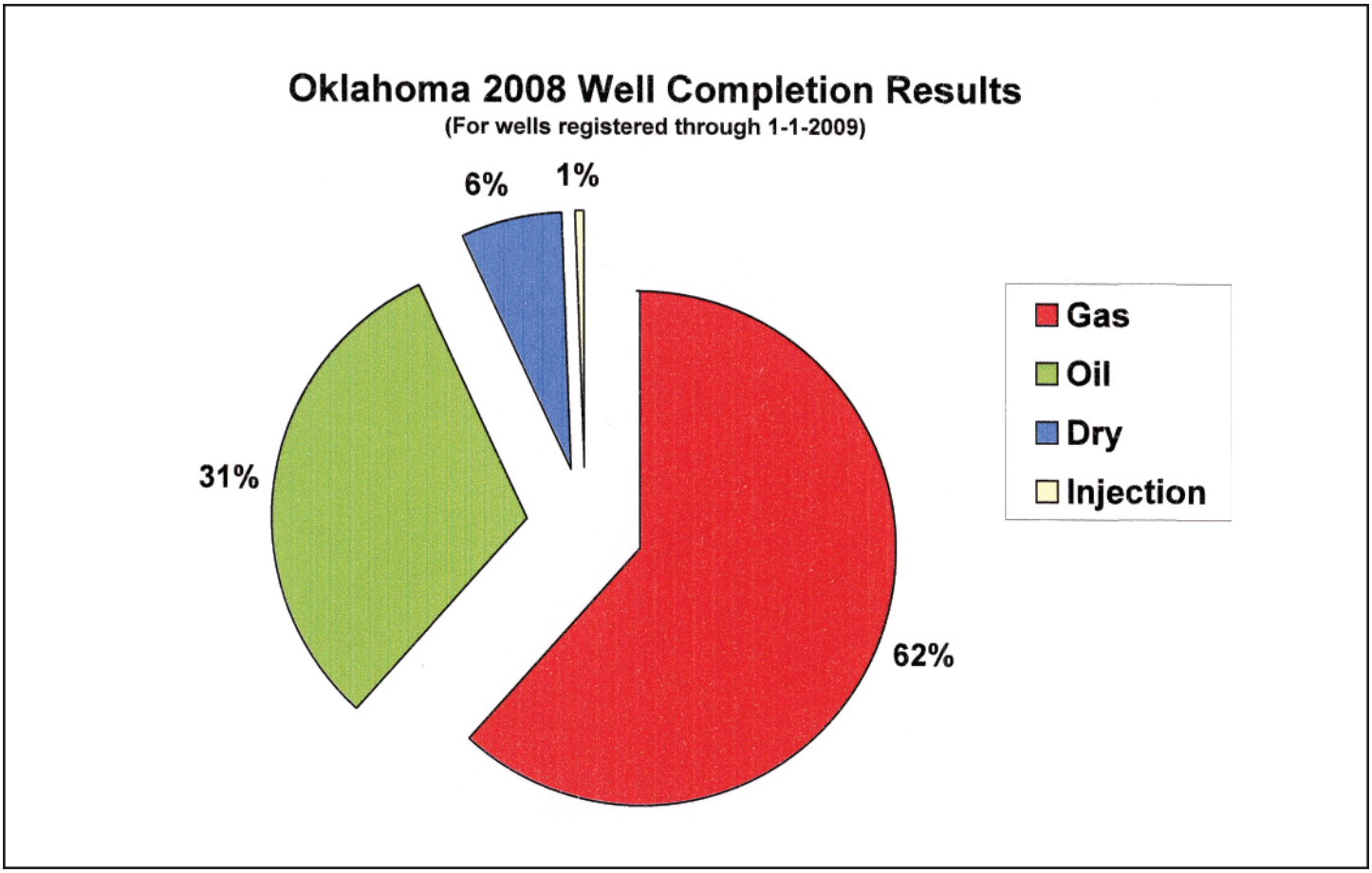

Figure 3. *Oklahoma 2008 Well Completion Results (for wells reported through January 1, 2009). Data from IHS Energy, 2009.*

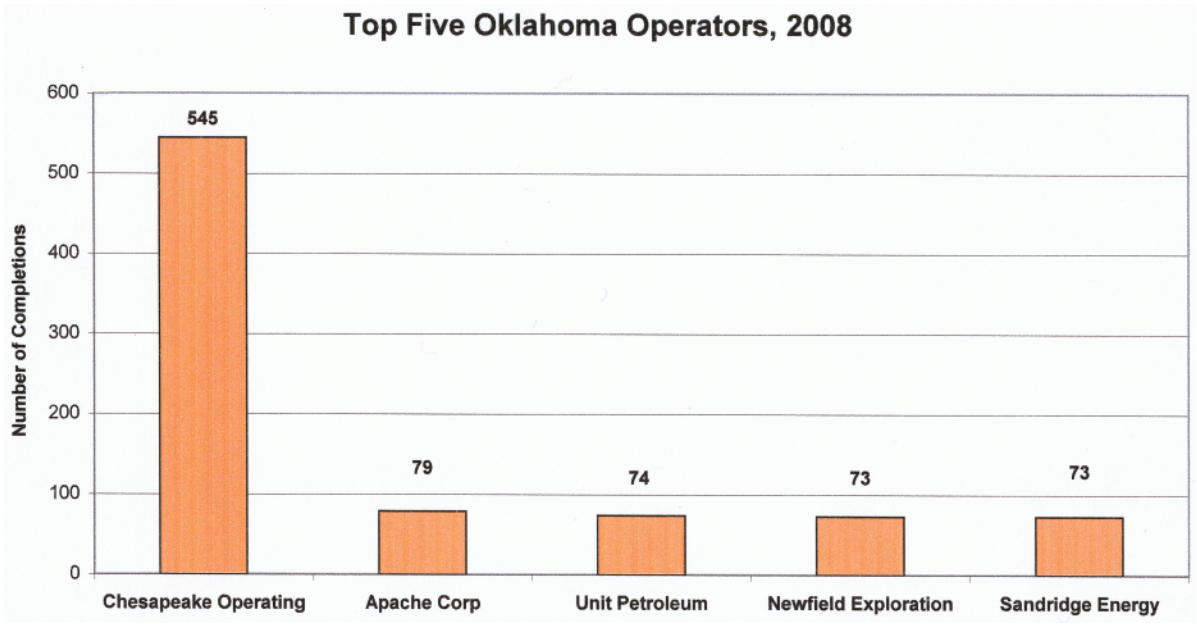

Figure 4. *Top 5 operators in Oklahoma in 2008, based on the number of completions registered through January 1, 2009. Data from IHS Energy, 2009.*

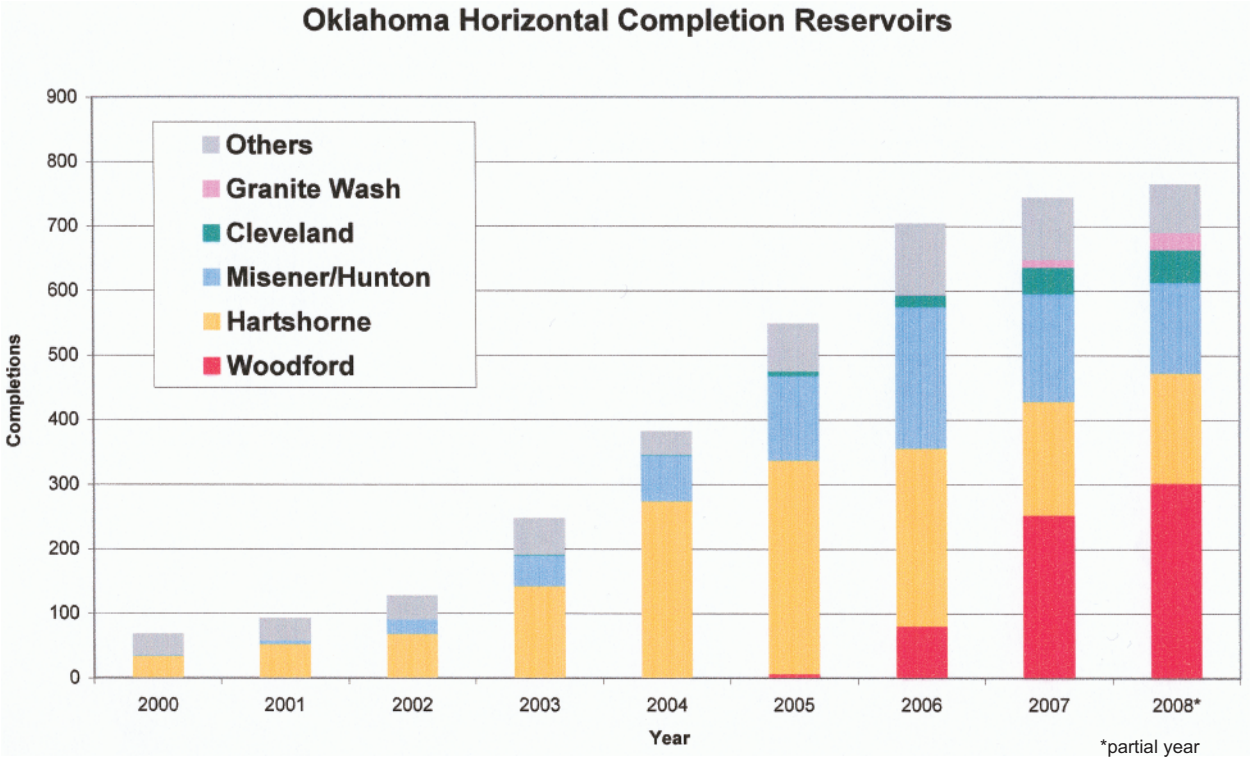

Figure 5. *Oklahoma Horizontal Completion Reservoirs from 2000 through 2008. Data from IHS Energy, 2009.*

reasons, accounted for only 6% of drilling in 2008. This overall 94% success rate shows that drilling for both oil and gas in Oklahoma continues to be overwhelmingly developmental. Although still far fewer than gas, oil completion numbers did increase over the last year due to record prices in the first part of the year. However, years of gas-focused drilling has brought a fundamental shift in hydrocarbon production in the State from oil to gas. This trend continues, with the barrel of oil equivalent production now standing at 82% natural gas.

Hundreds of companies drilled wells in 2008, but Chesapeake Operating continues to be by far the most active operator. Their dominance in Oklahoma is vividly illustrated in Figure 4. Based on completions registered through January 1, 2009, Chesapeake accounted for about 16% of all wells drilled. Their 545 completions are scattered through almost every region of the State, and are 7 times greater than the second-ranked operator - Apache.

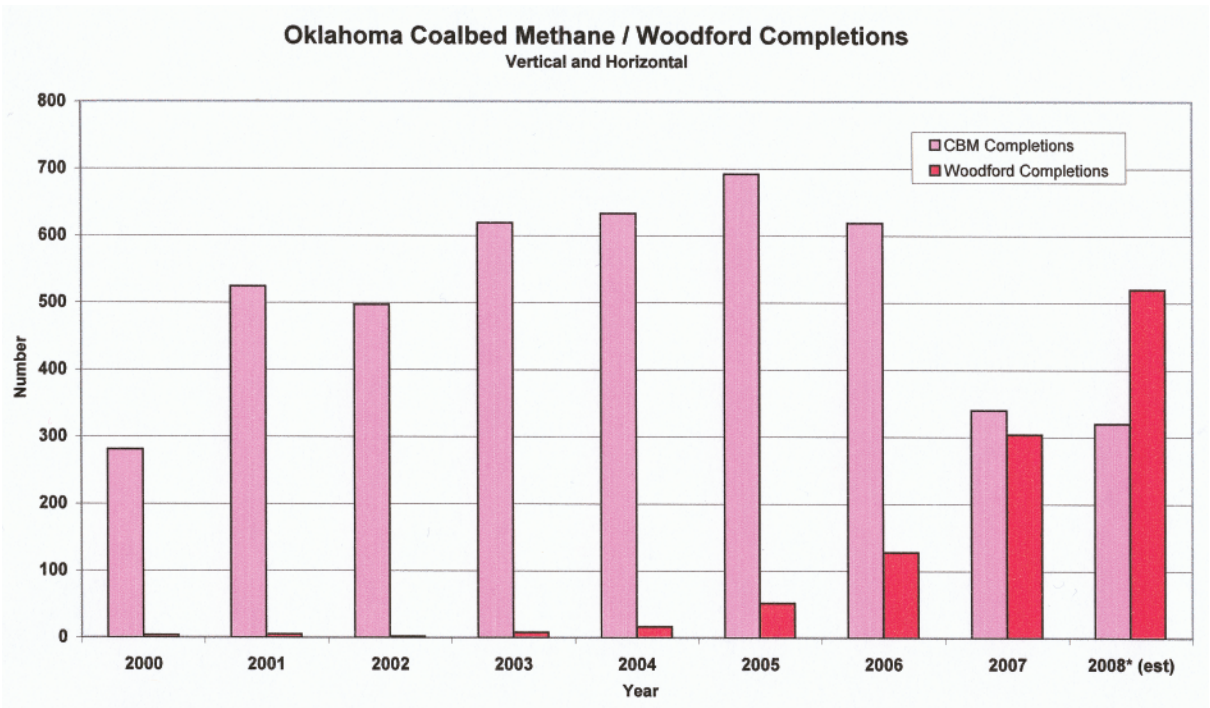

Figure 6. *Oklahoma Coalbed Methane and Woodford Completions from 2000 through 2008. Data from IHS Energy, 2009.*

In 2008 Chesapeake drilled more wells in Oklahoma than the next eight operators combined.

Coal and shale gas drilling in 2008 were most significant in the eastern part of the State, while conventional reservoirs were more concentrated in the western part. Horizontal drilling is by far the most important drilling/completion technique to be recently applied in Oklahoma. Its use has made formerly unproductive areas and reservoirs profitable and revitalized reservoirs that have been producing for decades. It now represents 22% of State drilling activity and is a common thread running through many of the notable wells listed here. In addition to increased wellbore exposure to low permeability reservoirs, horizontal drilling is useful in dewatering dual porosity oil reservoirs. Dewatering is the process by which reservoir pressure is reduced in fields with natural water support through aggressive water production. This production triggers associated gas expansion in poorer (unswept) parts of the reservoir, forcing oil into the natural and/or induced fracture system and ultimately into the wellbore.

Because of reporting delays, the 2008 horizontal drilling shown in Figure 5 is grossly under-represented, with the final annual completion total, mostly driven by the Woodford, likely to go off the vertical scale. Other active horizontal plays include the Hartshorne coalbed methane in the Arkoma Basin, where El Paso E & P was the most active, and the Misener/Hunton, which is scattered throughout the State. Hunton horizontal drilling tends to be focused on de-watering in and around Lincoln County, and here New Dominion was the most active operator. Activity in both of these horizontal plays waned in 2008, despite high oil and gas prices through most of the year. However, the Cleveland horizontal play (see Well #2), which is located mostly in Ellis County, and the Des Moines Granite Wash horizontal play (see Well #3), in the deep Anadarko Basin in Washita County, both picked up pace in 2008. The Cleveland play has many operators, but the Granite Wash is being lead by Chesapeake, who completed 25 of the 27 wells registered thus far for 2008.

Coalbed Methane

Last year's most active play, which is now in second place behind the Woodford, is coalbed methane (CBM) (Figure 6). To contrast these top two plays, their drilling activity and production will be shown together. CBM wells in Oklahoma are located in two geologic regions: the Arkoma Basin and the Cherokee Platform (Figure 7). About 2/3rds of CBM drilling in 2008 targeted the Hartshorne coal in the Arkoma Basin as horizontal wells. A variety of coals produce on the Cherokee Platform, but the most popular in 2008 were the Mulky and Riverton. These coals are completed in vertical wells, and in this area CEP Midcontinent and Canaan Resources were the most active operators (IHS Energy, 2009).

There are now about 6,000 completed CBM wells in Oklahoma, of which 289 have been registered thus far for 2008 (IHS Energy, 2009). The nearly 50% drop in CBM activity that was seen between 2006 and 2007 seems to have been arrested, with 2008 CBM drilling projected to be equal or only slightly below that of 2007 (Figure 6). As in

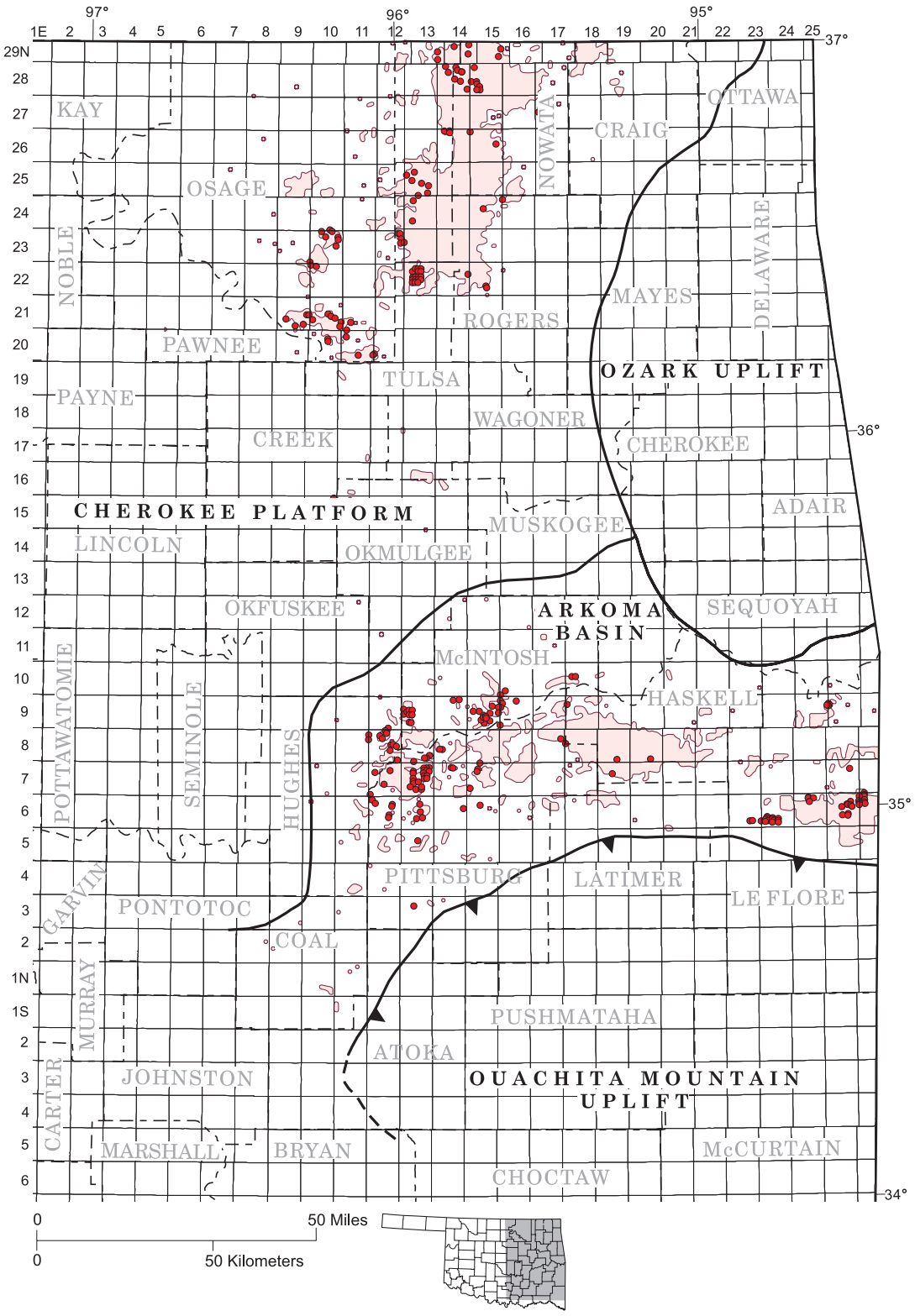

Figure 7. *Map of 2008 Oklahoma Coalbed Methane Activity. Map shows geologic provinces and areas of previous coalbed methane completions overlain by 2008 completions. Areas and activity are from IHS Energy, 2009. Major geologic province boundaries are modified from Northcutt and Campbell, 1995.*

past years, the bulk of 2008 activity is contained within well-established areas of CBM production in Pittsburg, McIntosh, Le Flore, Osage, Washington, and Tulsa Counties (Figure 7).

Cumulative Statewide CBM production now stands at about 500 billion cubic feet (BCF), with its 150 million cubic feet (MMCF) of daily production representing about 4% of all gas produced. The average CBM well in Oklahoma

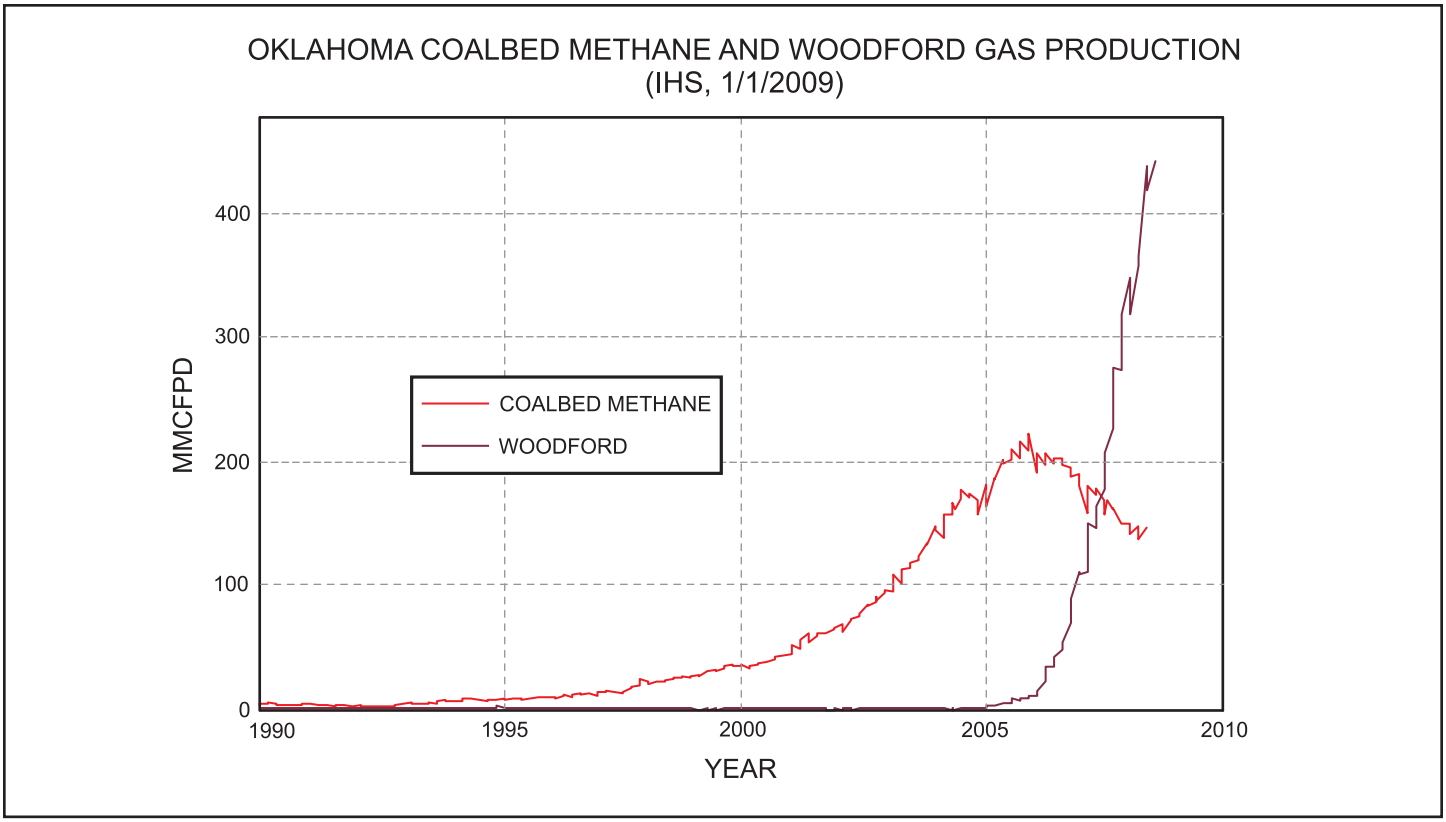

Figure 8. *Oklahoma Coalbed Methane and Woodford Gas Production from 1990 through 2008. Data from IHS Energy, 2009.*

now produces about 40 MCFPD (IHS Energy, 2009). Coalbed methane peaked in both drilling and production in 2005, with October 2005 production reaching about 225 MMCFPD. The steep decline in production over the last three years has been symmetrical with the incline. However, this should flatten as fewer wells are drilled and natural reservoir depletion becomes the primary force driving the long-term decline (Figure 8).

Woodford Shale

The Woodford Shale in 2008 eclipsed coalbed methane as the most active play in Oklahoma (Figure 6). Operators increased the size of the main fairway in the western Arkoma Basin, expanded three significant satellite areas in the Anadarko and Ardmore Basins and on the Cherokee Platform, and tested the Woodford in a variety of outlying areas. The areas of prior Woodford production and the 2008 completions that have been registered to date are shown in Figure 9.

Most Woodford activity in 2008 was centered in and around the main fairway, where Newfield Exploration is the most active operator (see Well #10). This area lies in the western Arkoma Basin in a broad trend extending from north-central Pittsburg and Hughes Counties through western Atoka County. Major satellite areas were also developed. In Wagoner County, adjacent to the western margin of the Ozark uplift, over 90 wells were drilled with Coronado Great Plains LLC the dominant operator (see Well #13). Along the northern edge of the Ardmore Basin more than two dozen wells were drilled by a variety of operators. Most significant here is a series of four horizontal Woodford oil wells that were completed by Walter Oil and Gas (see Well #8). The last significant satellite area marks the western limit of 2008 Woodford drilling activity, and is located in the eastern Anadarko Basin. Located in northwestern Canadian County, Devon Energy and Cimarex Energy are the primary operators (see Well #5) (Figure 9).

Since 2005 about 1,000 Woodford wells have been put on production, with over half of these drilled in 2008 (Figure 6). During this time production has gone from negligible to about 450 MMCFPD in the last reported month. With 718 active wells producing from the Woodford, this yields an average per-well rate of about 625 MCFPD. Cumulative Woodford production stands at about 250 BCF, but again half of this gas is from 2008 alone (Figure 8). Although true of all plays, because of its especially high initial declines, the direction that Woodford production takes from here will be entirely dependent on drilling activity, which in turn is dependent on the price of natural gas.

Significant Wells in 2008

The following is a list of what are, or may become, significant wells for 2008 in Oklahoma. It is based on a weekly review of wells described in the IHS Energy Energy News on Demand Midcontinent activity reports that were

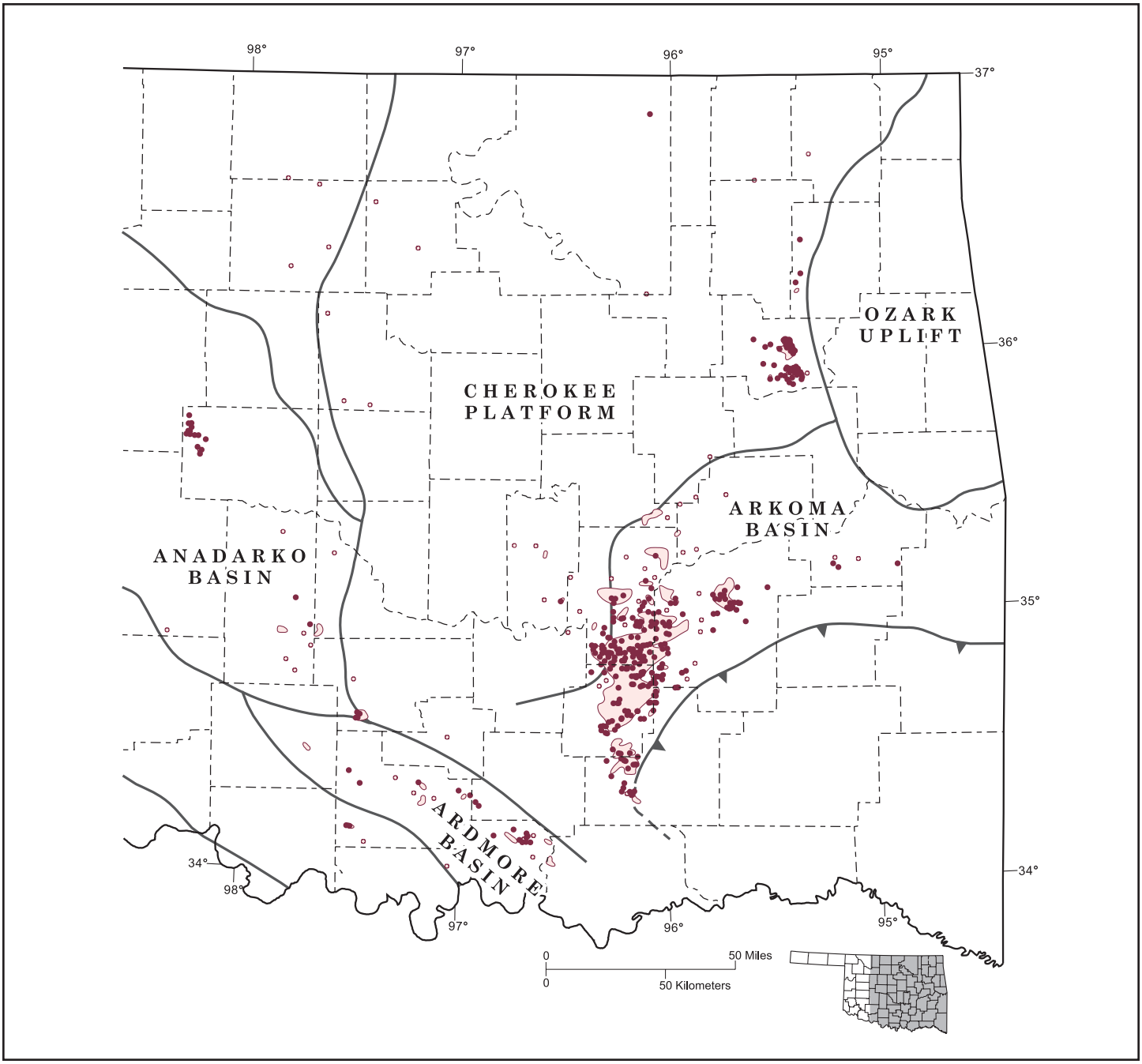

Figure 9. *Map of 2008 Oklahoma Woodford Drilling Activity. Map shows geologic provinces and areas of previous Woodford completions overlain by 2008 completions. Areas and activity are from IHS Energy, 2009. Major geologic province boundaries are modified from Northcutt and Campbell, 1995.*

released online throughout 2008. An initial list of 135 possibilities compiled from these publications was distilled to a total of 13 potentially significant wells. Such a listing is necessarily subjective, and may miss wells that could eventually become noteworthy. Due to confidentiality issues, wells that may be notable for technical reasons will probably be missed. For instance, those that confirm some new type of trapping style or proved the benefit of a new completion technique will be difficult to identify until information is disseminated years later.

The wells shown here are of two general classes; those that establish significant production more than one mile from existing production in the same reservoir, which is the standard to be considered a discovery, and those that are notable for other reasons. The latter include rank wildcats, major play expansions, or new production types and/or completion techniques. The following are wells reported as completed in 2008 that are considered significant (Figure 10).

1) Sec. 28-17N-25W (Roger Mills): GHK completed the first in a 7-well program of horizontal Tonkawa tests in Grand South Field with their Bachmann #1-28. This well had an initial flowing potential of 150 barrels of oil (BO) + 436 MCFPD with no water reported, but has yet to go on production. Although lateral displacement is over 3,000', only 1,300' of reservoir was completed from a true vertical depth (TVD) of 8,156'. This multi-well program is located 12 miles northeast of the nearest horizontal

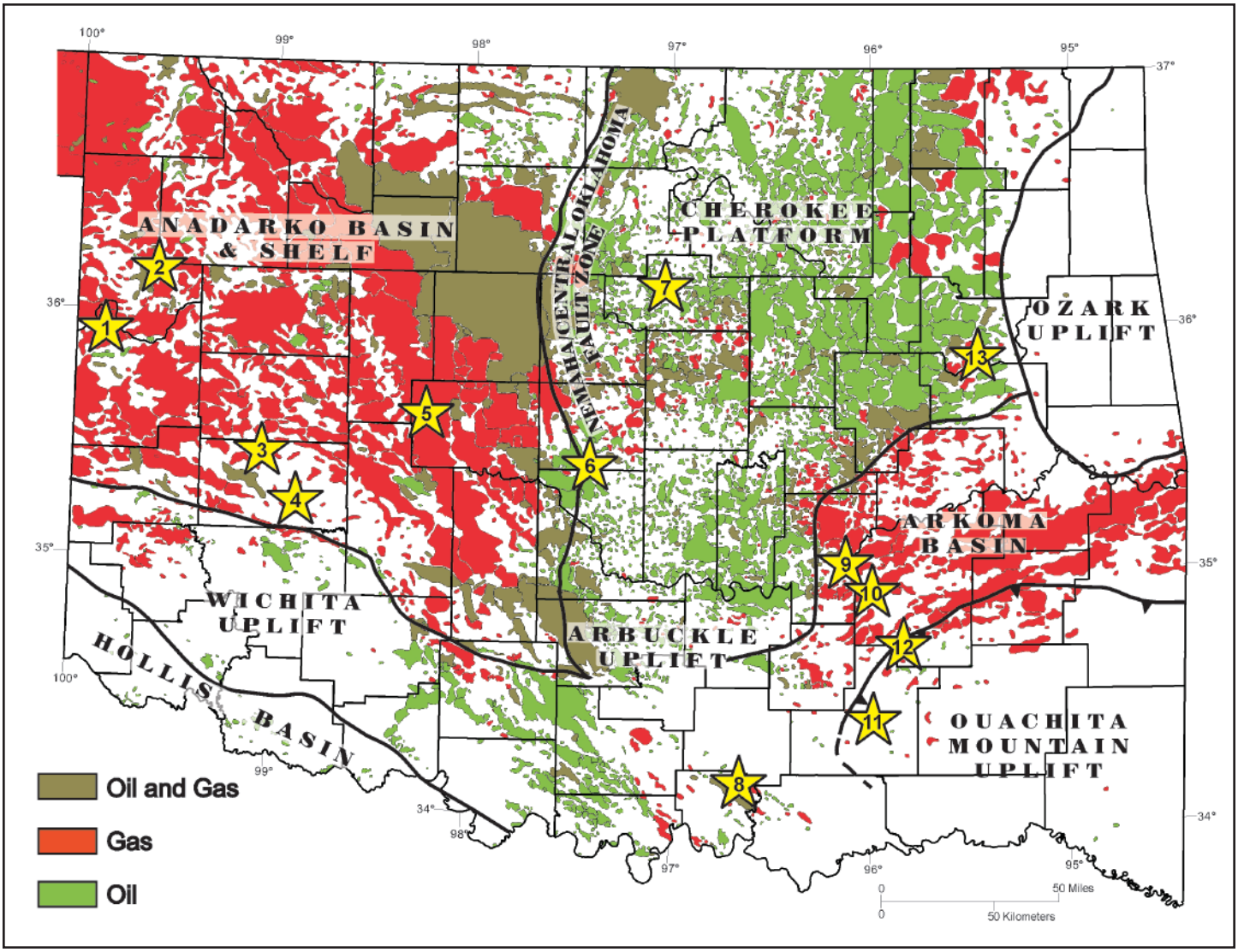

Figure 10. *Map of Oklahoma oil and gas fields, distinguished by GOR, showing location of significant wells reported for 2008. Modified from Boyd (2002). Major geologic provinces boundaries modified from Northcutt and Campbell (1995).*

Tonkawa production located in Reydon Field.

2) Sec. 6-19N-22W (Ellis County): The horizontal Cleveland play in far western Oklahoma continued strongly with Panther Energy drilling the well with the best initial potential in 2008. The Ruger # 6-4H, which was drilled to measured depth (MD) of 11,223' (TVD 8,714'), registered an initial potential of 708 BO + 568 MCF + 188 barrels of water (BW) per day. About 2,000' of reservoir was opened, and this was fracture stimulated with about one half-million pounds of sand. The well has not yet been put on production.

3) Sec. 13-11N-18W (Washita County): The Chesapeake Wise #1-13H is the best of the horizontal Granite Wash wells drilled in this play, which began in 2007. Drilled to a measured depth of 17,100' and TVD of 12,633', the 4,300' of open lateral in the Wise well flowed on test 10,654 MCF + 766 barrels of condensate (BC) + 117 BWPD with a flowing tubing pressure (FTP) of 4,338 pounds per square inch (psi). In its first 8 months of production it has produced 1.9 BCF + 109 MBC. This play has been largely restricted to three townships (11N 17-19W) in northern Washita County, although wells are now being drilled in Custer County. Based on reported initial tests, about half of the wells produce dry gas and the other half wet gas with a 30 to 70 BC/MMCF initial condensate yield. Wellbore paths are dominantly north – south.

4) Sec. 16-9N-16W (Washita County): Chesapeake made what appears to be an excellent Springer (Cunningham) discovery 7 miles northwest of the nearest production from Rocky Field. Only the second productive well ever drilled in this township, the South Fork #1-16 was drilled to 22,820' and completed in the Cunningham Sandstone at 21,536-544'. This 8' interval was given a 2-stage 200,000-lb fracture stimulation and then flowed 6,604 MCF + 7 BWPD with a FTP of 15,700 lbs. This well has yet to be put on production, but Chesapeake is now drilling an appraisal well nearby in section 15.

5) Sec. 11-13N-10W (Canadian County): The Devon Energy Ratliff # 1-11H was the best Woodford completion in the most active area of Woodford drilling in the

Anadarko Basin. This area in northwestern Canadian County, which was discovered by Devon the previous year with their Hancock discovery well drilled in sec. 36-13N-10W (see last year's report), saw 14 wells completed in 2008. The Ratliff was drilled to a TVD of 12,826', and with about 3,700' of Woodford open, had an initial potential of 6,601 MCF + 105 BO + 466 BW per day after a four-stage 1.4 million pound fracture stimulation. In its first four months of production the well produced about 500 MMCF and 7,500 BO.

6) Sec. 30-11N-2W (Oklahoma County): In their ongoing dewatering project of the Arbuckle in Oklahoma City Field, in 2008 New Dominion completed 4 new wells. With up to 8 laterals drilled from a single surface location, the best initial potential this year came from the 3-30H Oklahoma City, which pumped on test 202 BO + 1,843 MCF + 14,166 BW per day. In its first full month this well produced 35,688 BO + 138 MMCF. Arbuckle production in the field is rising steeply, with the last complete published month averaging a rate of about 1,700 BO + 10 MMCF per day. Incremental production from New Dominion's dewatering operation stands at about 1.1 million barrels (MMBO) + 5.5 BCF, with water production/injection at about 130,000 barrels per day.

7) Sec. 14-19N-2E (Payne County): In a clever use of horizontal drilling technology, EEC Inc. drilled an otherwise inaccessible Skinner Sandstone prospect under the Oklahoma State University campus. The Stillwater #1-14H became the first horizontal Skinner completion in Oklahoma, with a TVD of 4,037' and a MD of 7,256'. With about 2,700' of lateral open the well had an initial potential of 450 barrels of 34 API gravity crude, 230 MCF and no water. EEC is now drilling a second well in the same section.

8) Sec. 14-5S-6E (Marshall County): Drilled in 2007, but not registering until 2008, Walter O&G extended Ardmore Basin Woodford production to the eastern edge of Marshall County with the drilling of their Porter #1-14. With a drilled depth of 7,975' and a TVD of 5,067', the well initially tested, from a 2,400' lateral in the Woodford, 1,110 MCF + 36 BO + 150 BW per day. In its first 11 months it produced 307 MMCF + 10 MBO, and in its last month averaged 500 MCF + 7 BO per day. Since the drilling of the Porter, 5 additional horizontal Woodford wells have been drilled within 2 miles.

9) Sec. 1-6N-11E (Hughes County): Continental Resources registered the second highest initial potential for a Woodford gas well with the completion of their Blevins #1-1H. This well flowed 10,755 MCF + 2,284 BW per day on test with an FTP of 1,450 psi. Drilled to a depth of 10,640' (TVD: 6,103') its 3,747' lateral was given an 8-stage fracture stimulation in which over 2.5 million pounds of sand were used. Behind only the Newfield Sherman Ellis #4H-22, which had an initial potential of 11.2 MMCFPD and is the best well in the play thus far with over 3 BCF of production, the Blevins has not yet been put on production.

10) Sec. 9-5N-12E (Pittsburg County): Newfield Exploration remains the most active operator and driller of horizontal Woodford wells. Their three Elms wells (#2H4, #3H4, and #4H4), which have bottom-hole locations in section 4 to the north, demonstrate the technique of drilling multiple wells from a single surface location. Each of these wells had initial potentials that ranged from 3 to 4 MMCFPD coming from 3,900 to 4,500' laterals. Each was completed with 8-stage fracture stimulations. At the end of 2008 Newfield was producing 209 Woodford wells, which are almost all within the main fairway located in the western part of the Arkoma Basin. In their last full month of production these were making about 167 MMCFPD, which is an average rate of about 800 MCFPD per well.

11) Sec. 18-2S-13E (Atoka County): Longfellow Energy completed their Thompson #1-18 as a discovery in the Big Fork chert. This rank wildcat is 11 miles from the nearest Big Fork production and 4.5 miles from uneconomic oil production from an unnamed 400' reservoir in Potapo Creek Field. The Thompson is an 1,800' deepening of a 7,656' dry hole drilled by Arco in 1992. Three Big Fork intervals were perforated and fracture stimulated between 7,446' to 8,800'. These had initial potentials of 2,100 MCF, 5,045 MCF, and 1,600 MCF per day. Longfellow has already drilled two offsets in sections 7 and 8 in the same township, and at last report both were waiting to be completed.

12) Sec. 32-3N-14E (Pittsburg County): Samson Resources completed the first in a program of three horizontal wells targeting the Wapanucka about 30 miles northeast of the nearest horizontal Wapanucka. The Gladys Rose # 1H-5 was drilled to a total depth of 13,100' (10,388' TVD) and after a 340,000-lb fracture stimulation tested 1.95 MMCF +17 BW per day from a lateral extending about 2,000' into the adjoining section (5-2N-14E). This well produced an average rate of 2.2 MMCFPD in its first month. At last report Samson was drilling an appraisal well to the southwest in section 7-2N-14E.

13) Sec. 20-16N-18E (Wagoner County): In a major expansion of the Woodford gas play, Coronado Great Plains LLC completed 58 shallow (~1,100') vertical wells in eastern Wagoner County. Based on its initial potential, their Glass #20-2 is the best to date. On test this well pumped 526 MCF + 50 BWPD from a perforated interval extending from 1048-74'. Coronado does not appear to fracture stimulate any of these wells, only cleaning perforations with a light acid job. The average initial potential for the wells drilled thus far is less than 100 MCFPD, and none have yet been put on production.

ABOUT THE AUTHOR

DAN BOYD

Dan Boyd is a petroleum geologist with the Oklahoma Geological Survey, where he has been employed since 2001. Dan received his Master of Science degree in geology from the University of Arizona in 1978. He spent the first 22 years of his career as an exploration and development geologist in the petroleum industry. From 1978 through 1991 he worked on a variety of areas in the United States from Houston, Dallas, and Oklahoma City for Mobil Oil and Union Texas Petroleum. In 1991 he moved overseas, working in Karachi Pakistan for four years and Jakarta Indonesia for the following four. He returned with his family to the U.S. in 1999 with Arco (the successor to Union Texas) where, until Arco's sale to BP, he worked the offshore Philippines from Plano, Texas.

Since joining the OGS staff Dan has presented and published several reports on the history, status, and future outlook of the oil and gas industry in Oklahoma. He chaired the 2002 Symposium on Cherokee Reservoirs in the Southern Midcontinent (OGS Circular 108), and prepared and presented a workshop on the Booch gas play in southeastern Oklahoma (Special Publication 2005-1). His most recent study of oil reservoirs and recovery efficiencies (Shale Shaker May/June, 2008) demonstrates that large volumes of producible oil remain in the ground and that a major barrier to finding and producing this oil is shortcomings in State oil and gas data. Dan serves on the board of Energy Libraries Online (ELO) from a conviction that the long term success of the Oklahoma industry depends on improving both the completeness and accessibility of State oil and gas data.

REFERENCES CITED

(The Oklahoma City Geological Society (OCGS), and the Shale Shaker Editorial Board, are not responsible for omissions of references cited in the text.)

Baker Hughes, 2009, 2008 Average Rotary Drilling Rig Count, Accessed at: http://www.bakerhughes.com/investor/rig/rig_na.htm

Boyd, D.T., 2002, Map of Oklahoma oil and gas fields (distinguished by GOR and conventional gas vs. coalbed methane: Oklahoma Geological Survey Map GM-36.

Boyd, D. T., 2005, Oklahoma oil and gas production: Its components and long-term outlook: Oklahoma Geology Notes, v. 65, no. 1, p. 4-23.

IHS Energy, 2009, Well Data supplied by Petroleum Information/Dwights LLC dba IHS Energy Group, January 1, 2009. all rights reserved.

Northcutt, R. A.; and Campbell, J. A., 1995, Geologic provinces of Oklahoma: Oklahoma Geological Survey Open-File Report 5-95.

Soltani, Cameron, 2008 Oklahoma Corporation Commission, Oil and gas information: Oklahoma Corporation Commission: 2006 Report on Crude Oil and Natural Gas Activity within the State of Oklahoma; accessed at: http://www.occ.state.ok.us/Divisions/OG/AnnualReports/2005%20OIL%20AND%20GAS%20REPORT.pdf, partial 2008 data from personal communication, December 16, 2008.