OKLAHOMA GEOLOGICAL SURVEY
Chas. N. Gould, Director

Bulletin No. 40-V

OIL AND GAS IN OKLAHOMA

GEOLOGY OF WASHINGTON COUNTY

By
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NORMAN
JANUARY, 1928

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FOREWORD

In 1917 the Oklahoma Geological Survey issued Bulletin 19 part 2 entitled, "Petroleum and Natural Gas in Oklahoma." This volume was so popular that the supply was soon exhausted, and for several years copies have not been obtainable.

The present director has seen the need of a revision of this bulletin. On account of lack of appropriations he has not been able to employ sufficient help to compile the data, and has called on some twenty representative geologists throughout the state to aid in the preparation of reports on separate counties. These gentlemen, all busy men, have contributed freely of their time and information in the preparation of these reports.

It will be understood that the facts as set forth in the various reports represent the observation and opinion of the different men. The Oklahoma Geological Survey has every confidence in judgment of the various authors, but at the same time the Survey does not stand sponsor for all statements made or for all conclusions drawn. Reports of this kind are, at best, progress reports, representing the best information obtainable as of the date issued and doubtless new data will cause many changes in our present ideas.

Washington County was the scene of much of the early oil and gas development in the State. The area has been almost completely developed at the present time, and it is probable that, with the present price of oil, no further drilling is to be expected.

The present report by Mr. Everett Carpenter summarizes the geological conditions, both surface and subsurface. It will be found to be of value in case of future development or in the event of the application of increased recovery methods.

CHAS. N. GOULD
Director

January, 1928.

WASHINGTON COUNTY

By

Everett Carpenter

LOCATION

Washington County is located in the northeastern part of the State. It borders Kansas on the north and is about 65 miles west of the Oklahoma-Missouri line. It extends from T. 23 N., to T. 29 N., inclusive, and from a line about 1½ miles west of the east side of R. 12 E., to the middle of R. 14 E. It is about 10½ miles wide and 40 miles long and includes about 420 square miles. (See Fig. 1.)

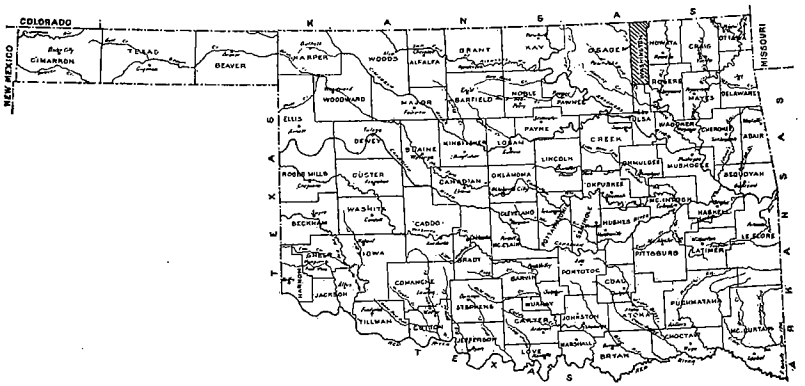


Fig. 1—Map of Oklahoma showing area covered by this report.

It is traversed from the north to south by the Atchison, Topeka and Santa Fe Railroad, and from northeast to southwest by the Missouri, Kansas, and Texas Railroad. Bartlesville, the county seat, is situated in the northern part of the county. It is a town of about 20,000 population and is the location of several important industries.

TOPOGRAPHY

The topography of Washington County may be classed as rolling. East of Caney River it is a prairie plain varying in altitude above sea level from 700 to 860 feet. The lowest point is on the Caney River in the southeastern part of the county in sec. 28, T. 23 N., R. 14 E., where the elevation is 590 feet. The highest point is in the northeastern part of the county in sec. 6, T. 29 N., R. 14 E., where an elevation of 960 feet is reached. West of Caney River the topography is more hilly. Along the western border of the county, an escarpment

ranging from 150 to 200 feet in height, rises conspicuously above the plain.

The county is drained by tributaries of the Arkansas River, the largest of which is Caney River which flows in a southeasterly direction. It has cut a broad alluvial filled valley which contains excellent agricultural land.

GEOLOGY

Surface Formations

The rocks exposed at the surface in Washington County are of Pennsylvanian age. They occur about the middle of that system and consist of sandstone, shales, and limestone. The subdivisions[1] from oldest to youngest are Coffeyville formation, Hogshooter limestone, Nellie Bly formation, Dewey limestone, Ochelata formation, and Nelogony formation. (See Plate II.)

COFFEYVILLE FORMATION

The oldest and lowest formation occurring in Washington County is the Coffeyville. It outcrops in the southeastern part of the county, where it has an exposed width of about ten miles. The lowest portion of the formation consists of bluish to greenish homogenous shale containing a calcareous member near the base, known as the Checkerboard limestone. The upper portion is sandy with numerous exposures of pure sandstone. The thickness of the formation as a whole is about 370 feet, not all of which is exposed in Washington County.

HOGSHOOTER LIMESTONE

The Hogshooter limestone rests conformably upon the Coffeyville formation. It is a single bed of massive gray lime and has a thickness of 6 to 8 feet, in T. 26 N., R. 14 E. However, it becomes thin bedded and argillaceous and thins to about 4 feet at Ramona and Vera. Along Hogshooter Creek it is exposed over a wide area but the breadth of its outcrop gradually narrows southward to Ochelata, where it becomes less conspicuous and must be indicated on the map by a single line.

NELLIE BLY FORMATION

The Nellie Bly formation consists of alternating shales and hard sandstones, the latter ranging from a few inches to several feet. This formation is about 15 feet thick at the Kansas line but thickens southward to 200 feet in southeastern Osage County. Throughout its exposure in Washington County, it averages about 75 feet.

1. The data for the nomenclature used in this report has been taken from Bulletin No. 35, Oklahoma Geological Survey. The data for the geologic map have been compiled from information furnished by the Oklahoma Geological Survey and several oil companies and consulting geologists. Among those whose contributions have been of assistance are; Foster Petroleum Co., Wood Brothers, Gypsy Oil Co., Phillips Petroleum Co., Robert E. Garrett, Prairie Oil and Gas Co., and The Wolverine Oil Co.

DEWEY LIMESTONE

The Dewey limestone, which rests upon the Nellie Bly is bluish gray in color, semi-crystalline, and often shaly, although it is not infrequently massive. It is three feet thick at Wann, but thickens southward until it is 20 feet thick east of Dewey, where it has its greatest areal extent. It thins slightly toward the south.

OCHELATA FORMATION

The Ochelata is essentially a shale formation containing several sandstone and limestone members. The Avant limestone member, a ferruginous limestone 5 to 57 feet thick, occurs in the south end of the county about 200 feet above its base. It is about 400 feet thick and outcrops in a band about 12 miles wide. The Stanton limestone member is exposed in the north end of the county. It is hard and white and is about ten feet thick, but thins rapidly to the south. It is the Piqua limestone in the Independence quadrangle of Kansas.

NELOGONY FORMATION

Only the basal part of the Nelogony formation is exposed in Washington County. It occupies the tops of the hills northwest of Bartlesville, and attains its greatest thickness in the northwest corner of the county, where its exposures are chiefly shales interstratified with sandstone.

Subsurface Formations

East of Washington County, older Pennsylvanian strata outcrop. These formations contain the sands from which the oil and gas of this area are obtained. From oldest to youngest they are: Cherokee shales, Ft. Scott limestone, Labette shale, Pawnee limestone, Bandera shale, Altamont limestone, Oologah limestone, and Nowata shale. East of northern Washington County the Lenepah limestone occurs between the Nowata shale and the Coffeyville formation.

Subsurface formations in Washington County.

Formation	Outcrop Thickness (in feet)		
Cherokee shale	450	to	960
Ft. Scott limestone		50	
Labette shale	100	to	120
Pawnee limestone		40	
Bandera shale[3]	0	to	100
Altamont limestone		60	
Nowata shale		130	
Boone chert		450	
Chattanooga shale	5	to	40
Arbuckle limestone (Siliceous lime)	25	to	1,500 (?)

3. The Bandera shale thins from the Kansas line southward until it permits the Pawnee and Altamont limestones to unite forming one formation known as the Oologah limestone.

The last three formations are of older age and sometimes yield oil and gas.

The following well logs penetrated all formations from the surface to the granite.

Log of Empire Gas & Fuel Co's. Maggie Thompson No. 1, sec. 22, T. 29 N., R. 13 E.

Formation	Top	Bottom	Formation	Top	Bottom
lime	0	50	slate	955	960
sand	50	110	lime	960	975
lime	110	125	slate	975	995
shale	125	200	lime	995	1002
sand	200	210	shale	1002	1085
lime	210	310	sand	1085	1135
sand	310	340	shale	1135	1263
slate	340	345	sand	1263	1269
lime	345	565	shale	1269	1398
slate	565	638	sand	1398	1453
lime	638	685	Mississippi lime	1453	1815
slate	685	705	sand	1815	2475
lime	705	710	lime	2475	2500
slate	710	900	granite T. D.	2500	3175
lime	900	955			

Log of Barnsdall Oil Co's., Wm. Rigdon No. 7, SW.¼ sec. 30, T. 28 N., R. 13 E.

Commenced 7-24-20; Completed 12-20-20

Formation	Top	Bottom	Formation	Top	Bottom
soil	0	10	lime	1070	1075
sand	10	30	sandy shale	1075	1100
lime	30	40	shale	1100	1239
shale	40	60	Bartlesville sand	1239	1245
sand	60	75	shale	1245	1300
shale	75	250	lime	1300	1302
lime	250	275	shale	1302	1400
sand	275	300	lime	1400	1402
shale	300	415	shale	1402	1450
lime	415	431	sand	1450	1485
shale	431	670	Mississippi lime (Boone)	1485	1520
lime	670	700	sand	1520	1525
shale	700	735	lime	1525	2542
lime	735	795	sandy shale	2542	2548
shale	795	880	pink granite T. D.	2548	2560
lime	880	955			
shale	955	1070			

Log of Link Oil Co's. Whiteturkey No. 1 NE.¼ NE.¼ SW.¼ sec. 17, T. 26 N., R. 13 E.

Commenced 10-17-24; Completed 12-28-24

Formation	Top	Bottom	Formation	Top	Bottom
shale	0	46	shale	135	313
lime	46	87	lime	313	319
shale	87	135	shale	319	361

(Continued on page 9)

(Continued from page 8)

Formation	Top	Bottom	Formation	Top	Bottom
lime	361	364	lime sandy	949	950
shale	364	371	sand	950	957
lime	371	375	shale	957	980
shale	375	390	lime	980	983
sand	390	415	shale	983	1005
shale	415	445	lime	1005	1007
sand	445	480	shale	1007	1149
lime	480	492	Bartlesville sand	1149	1220
shale	492	553	lime	1220	1224
lime	553	590	shale	1224	1242
shale	590	600	lime	1242	1250
lime	600	622	shale	1250	1343
shale	622	634	lime	1343	1353
Peru sand	634	659	sand	1353	1412
shale	659	751	lime	1412	1636
lime	751	785	shale	1636	1667
shale	785	794	sand	1667	1701
lime	794	811	lime	1701	1712
shale	811	821	sand	1712	1760½
lime	821	840	flint	1760½	1775
shale	840	855	granite	1775	1805½
sand	855	949			

Log of R. A. Crowe & Co's. McElmore No. 3, 1,720' fr. N. line; 1,720' fr. E. line, sec. 25, T. 25 N., R. 12 E.

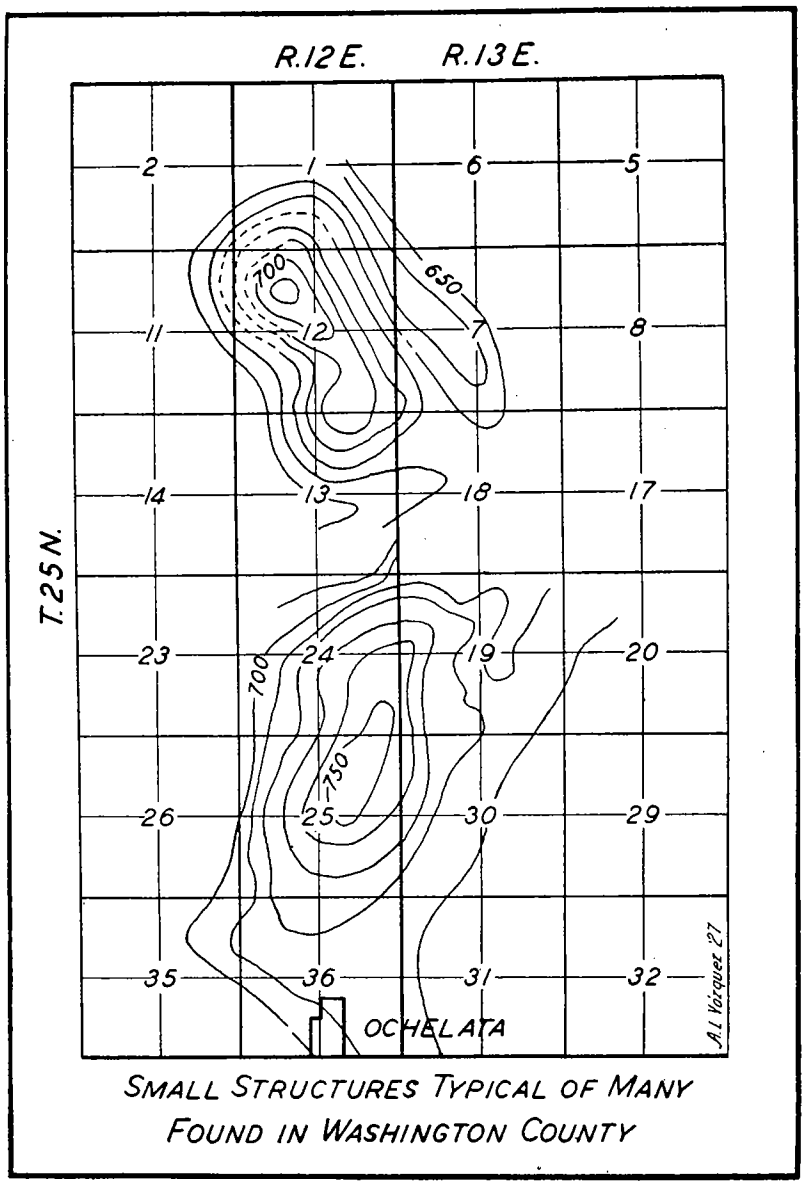
Commenced 9-18-16; Completed 2-11-17

Formation	Thickness	Bottom	Formation	Thickness	Bottom
clay	40	40	shale	25	1010
shale	140	180	slate	10	1020
sand	35	215	lime	5	1025
slate	265	480	slate	295	1320
lime	10	490	Bartlesville sand	30	1350
slate	175	665	slate	136	1486
lime	35	700	Mississippi lime	300	1786
shale	10	710	sand	8	1794
lime	40	750	water sand	14	1810
slate	23	773	lime	530	2340
sand	20	793	granite T. D.	28	2368
slate	125	918			
lime	67	985			

Producing Sands

Sands producing oil and gas in Washington County.

Name	Product	Thickness	Stratigraphic Position
McEwin	Oil	30	125 feet below Oologah in Nowata shale.
Peru	Oil	20	Below Pawnee limestone in Labett shale.
Squirrel	Oil	20	100 feet below Ft. Scott limestone in Cherokee shale.
Bartlesville	Oil-Gas	25-60	350 feet below Ft. Scott limestone in Cherokee shale.
Burgess	Gas		500 feet below Ft. Scott limestone in Cherokee shale, and immediately above Boone (Mississippi Lime).
Siliceous lime	Gas	10+	Top of Arbuckle lime.



SMALL STRUCTURES TYPICAL OF MANY FOUND IN WASHINGTON COUNTY

Figure 2.

The position of these sands is shown graphically in Fig. 4, which illustrates the columnar section encountered in drilling.

STRUCTURE

The strata of Washington County have a northeast-southwest strike and a northwest dip of 20 to 25 feet per mile. The geologic map (Plate II.) shows the strike and outcrop belts of the formations exposed at the surface. The normal structure is in general a northwestward dipping monocline, but the normal westward inclination of the strata is interrupted in places to form local anticlines, terraces, and "noses."

Anticlinal folding is generally associated with the accumulations of oil and gas, although it is not always the only controlling factor in such accumulations. The producing sands are more or less lenticular. In places these lenticular bodies of sand furnish all the requirements for accumulation that are provided by closed anticlines, so that pools are sometimes found that are not on structures.

DEVELOPMENT

Owing to its relationship to the producing fields of Kansas where oil and gas were first developed in the Mid-Continent field, what is now Washington County received early attention from the oil producers. The Cudahy Oil Co. obtained leases in the vicinity of Bartlesville and drilled a well in 1897. The location of this well is now in Johnstone Park within the city limits of Bartlesville. It was the first commercial oil well drilled in the county and is still producing. (See Plate I).

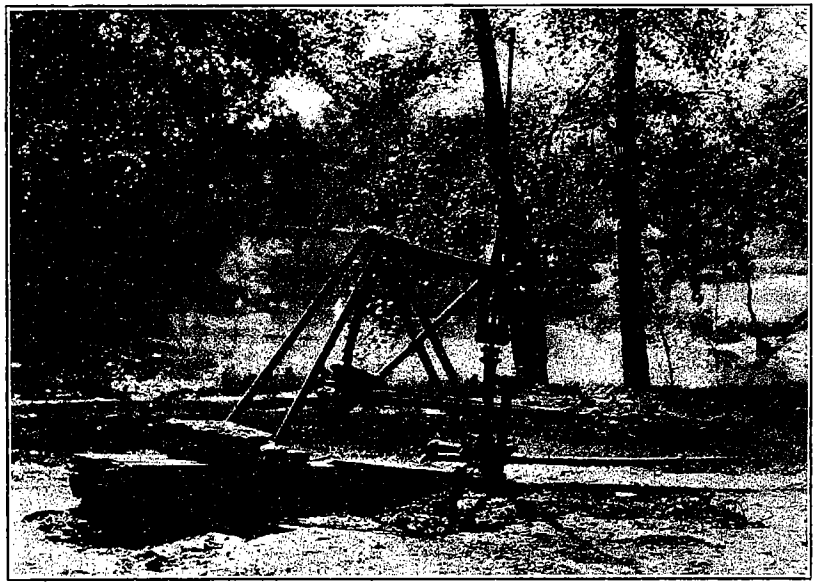
Active development was retarded until 1904 on account of the necessity of obtaining the approval of the Secretary of the Interior for Indian alloted leases. The period of years between 1904 and 1907 saw the most active development. Most of the pools of the county were discovered and drilled during those years. Wells with an initial production as high as 1,000 barrels of oil and 75 million cubic feet of gas per day were drilled. The peak of production was reached in 1906, from which date there has been a slow but steady decline, until at present (1927) the average per well per day is probably not more than one barrel.

As a whole, the area has been productive. Probably a greater proportion of the acreage within the county has produced either oil or gas than any like area in the Mid-Continent field. Every township in the county has had some production although T. 23 N., Rs. 11-13 E., have had very little.

BARTLESVILLE—DEWEY POOL

The Bartlesville-Dewey pool occupies an area extending across the county from the north line of T. 27 N., to, and including, the north tier of sections in T. 25 N. It was formerly thought that the oil in this area lay in separate pools, but many former pools have since been

PLATE I.



EARLY OKLAHOMA OIL WELL
Well drilled by the Cudahy Oil Co. in what is now Johnstone Park, Bartlesville, 1897.

united. There are many nonproductive spots in this area but only a few sections which do not have some producing wells.

Perhaps the most prominent structure is known as the Bartlesville anticline. The apex of this structure is in sec. 17, T. 26 N., R. 13 E., but it plunges westward under Bartlesville and into Osage County. The structure of this anticline is shown in Figs. 4 and 5, which show the structure of the Dewey, Peru, and Bartlesville sands and the Mississippi lime.

Data are not available to show the structural conditions obtaining in all parts of the county. Most of the pools were discovered and drilled before geologists were commonly employed in exploration work for the oil companies. This area has not been subjected to that intensive study that many other oil producing areas have been.

The Bartlesville-Dewey pool was the earliest discovery in the county. Development was very active during 1904, 1905, and 1906. Some of the wells drilled during this period had an initial production of 1,000 barrels per day. In 1906 the average initial production per well was about 73.2 barrels. This average gradually decreased from that time and in 1914 it was only 10.4 barrels. At the close of

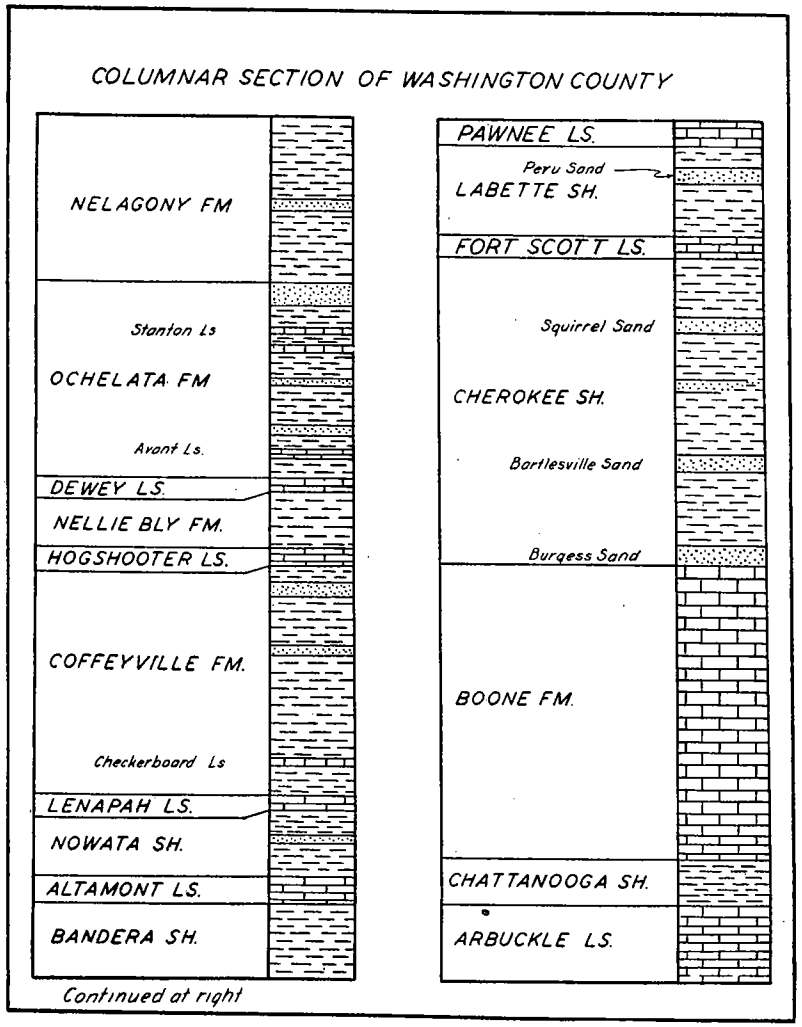


Figure 3.

1914 there were 4,816 producing oil wells in this field. The high price paid for oil in 1915, stimulated development to such an extent that most of the inside and edge locations were drilled. Many wells were operated profitably that were abandoned when the price of oil declined. The initial daily production ranged from a few barrels to about 60 barrels, the average being about 20 barrels.

This pool has developed a number of prolific gas wells. The Burgess sand encountered at a depth of 1,400 to 1,500 feet was the chief gas sand. The gas lay near Bartlesville, though a narrow belt extended toward the northeast, to and beyond Dewey. Some wells were brought in with an average initial open flow volume of 15 million cubic feet per day, and an average rock pressure of 464 pounds. In most cases wells of such capacity were among the first wells drilled in the field. By the latter part of 1911 the pressure on these wells had declined to 219 pounds, and the open flow to about 9 million cubic feet.

Drilling record and initial production of wells in the Dewey-Bartlesville pool, 1906-1915.

Year	WELLS COMPLETED				INITIAL PRODUCTION (Oil)	
	Total	Oil	Dry	Gas	Total Barrels	Average per. well, Bar'ls
1906	790	606	123	61	44,367	73.2
1909	415	390	19	6	16,540	37.8
1910	443	420	14	9	16,269	38.1
1911	493	455	30	8	12,513	28.1
1912	1,120	980	71	69	24,022	24.6
1913	(a) 948	829	75	44	19,412	28.4
1914	(a) 520	441	55	24	4,573	10.4
1915	90	80	9	1	1,120	14.0
Total	4,819	4,201	396	222	148,816	31.8

(a) Includes Hogshooter.

Future Drilling

In early drilling no attention was paid to the shallower horizons, because of greater yield from deeper sands. The smaller wells at shallower depths will, as the deep sands are drained and the price of oil advances, become more and more important. It seems probable that as oil becomes scarce, shallow drilling will offer the best inducement in this region and that the life of the pool will be extended a number of years by such work.

COPAN POOL

Location and Extent

The Copan pool is located in T. 28 N., Rs. 12-13 E., and occupies an area of about 8 square miles. It is almost continuous with the

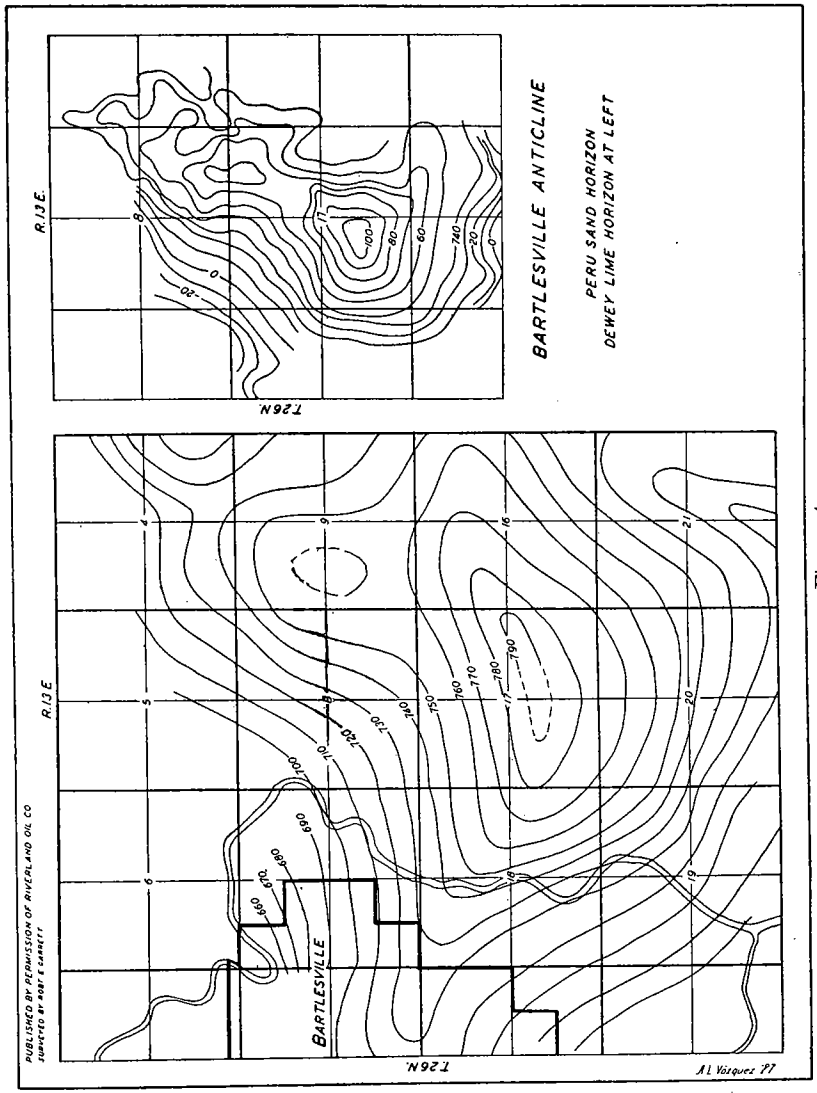


Figure 4.

Bartlesville-Dewey field to the south, and extends into Osage County to the west.

Development

The Copan field was opened in 1907 and development soon became very active. The average initial production of the wells in 1907 was 54.4 barrels and in 1910 it was 33.7 barrels. This average gradually decreased from that time. A few small oil and gas wells were the result of development in 1915.

Drilling record and initial production of wells in the Copan pool, 1909-1915.

Year	WELLS COMPLETED				INITIAL PRODUCTION (Barrels of Oil)	
	Oil	Dry	Gas	Total	Average Per Well	Total
1909	45	17	35	95	54.4	2,340
1910	121	22	65	208	33.7	4,082
1911	216	45	21	282	27.3	5,890
1912	482	50	41	573	22.8	10,972
1913	393	50	26	469	16.1	6,309
1914	294	80	76	450	29.7	8,729
1915	76	10	19	105	12.2	926
Total	1,625	274	283	2,182	28.0	39,248

(a) Includes also Wann and Canary pools.

The gas wells which originally had a rock pressure of 450 to 530 pounds had been depleted so that during the fall of 1911 the pressure was not more than 25 pounds, mainly because the sand was coarse and the drain rapid. Probably the maximum capacity of the field was about 300 million cubic feet per day. In 1914 the capacity of the field was probably not more than 50 to 75 million cubic feet. The table above gives the development from 1909 to 1915.

Sands

The wells begin in the Ochelata formation, a shallow sand which is encountered at 700 to 800 feet and is probably the Peru sand. The Bartlesville sand, which has a thickness of 29 feet, occurs at a depth of about 1,300 feet and is oil producing. The interval between it and the top of the Ft. Scott limestone is about 350 feet. The Burgess sand produces gas and occurs at a depth of about 1,500 feet. On page 18 is a log which is thought to be typical of this region.

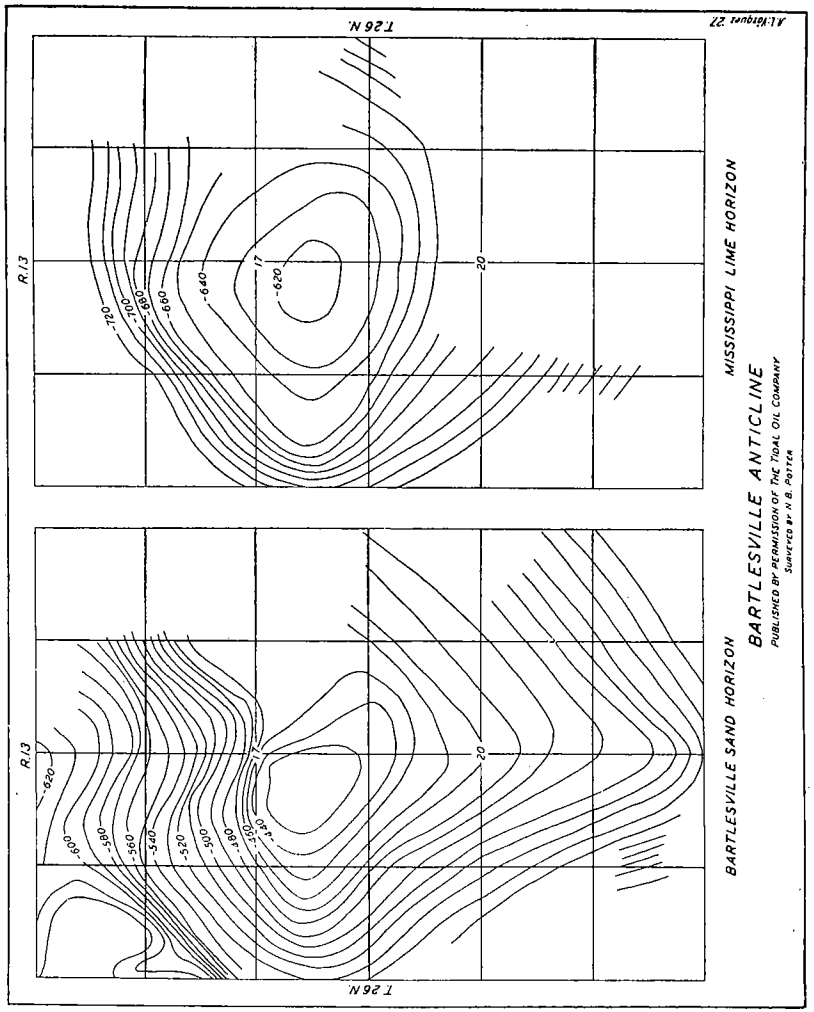


Figure 5.

Log of William Miller No. 5, sec. 2, T. 28 N., R. 13 E.

Formation	Top	Bottom	Formation	Top	Bottom
soil	0	30	lime	720	822
slate	30	130	shale	822	930
sand	130	180	lime Ft. Scott	930	1010
shale	180	220	shale	1010	1020
lime	220	260	sand	1020	1040
shale	260	378	shale	1040	1130
lime	378	400	slate	1130	1220
slate	400	500	shale	1220	1265
shale	500	570	gas sand	1265	1300
lime	570	610	oil	1300	1343
shale	610	720			

CANARY POOL

Location and Extent

The Canary pool lies in the extreme northeastern part of the county in T. 29 N., Rs. 13-14 E. The productive area was formerly approximately 10 miles square, with the long axis extending northeast-southwest. In as much as the gas has been exhausted the pool is now limited to the oil producing area.

Sands

The wells in this area start in the Ochelata formation. The productive horizons are the Bartlesville at 1,175 feet and the Burgess at 1,450 feet. The Bartlesville sand which is about 50 feet thick, is productive of oil and some gas. The Burgess was a prolific gas sand.

Development

The northeast part of the field is principally oil producing, with a few scattered gas wells. The reverse is true farther southwest. The average initial production per well is given by the United States Geological Survey as 54.4 barrels for 1909, and 33.7 barrels for 1910.

WANN POOL

The Wann pool produces from two small areas in the west side of T. 28 N., R. 14 E. The larger of the two areas is immediately west of Wann and the other about 4 miles southwest of Wann.

The general conditions of the pool are similar to the Canary and Copan pools. The wells start near the base of the Ochelata formation. The Bartlesville sand, which is the chief oil producing sand, is found at a depth of about 1,000 feet and the Burgess sand at about 1,200 feet.

HOGSHOOTER POOL

Location and Extent

The Hogshooter pool is located in Ts. 24-26 N., R. 14 E., and lies on both sides of Hogshooter Creek in the southeastern part of Washington County. The developed area includes a strip of about 12 miles

long from south to north, and from a fraction of a mile to about 4 miles in width. It is contiguous to the Dewey-Bartlesville field on the north.

The wells on the east side of Hogshooter Creek and south of Oglesby begin on, or near, the horizon of the Coffeyville formation. The wells on the west side of this creek begin near the horizon of the Hogshooter limestone.

Development

The Hogshooter pool was opened in 1907 and during that year development was very active. Some of the larger wells had an initial production as high as 500 barrels per day, and the gas wells ranged from 5,000,000 to 15,000,000 cubic feet per day.

The Hogshooter pool was one of the important gas areas of its time. Although it was not large in comparison with some of the later discoveries, it led to the construction of several large gas lines. The gas was transported as far as Hutchinson, Kansas, St. Joseph and Joplin, Missouri, and was used in the industries at Bartlesville, Dewey and Miami. The demands of these lines were greatly increased by the depletion of the Kansas fields, so that the field had a rapid decline. It is no longer a factor in the gas business for the amount now produced hardly meets the demands of the powers on the oil leases.

Sands

The sands in this pool are encountered at the following depths: the highest sand, the Peru sand, is about 40 feet below the "Big Lime" —the Pawnee; the Bixler sand which is just below the Ft. Scott limestone, occurs at about 710 feet; a productive oil sand, the Squirrel, is found 200 feet below the Ft. Scott, or at a depth of 880 feet; the Bartlesville, which is the main producing oil sand of this pool, lies about 400 feet below the Ft. Scott, or at a depth of 1,080 feet; the Burgess is encountered at a depth of 1,160 feet.

VERA POOL

The Vera oil and gas pool is located in the extreme southeastern corner of Washington County. The principal producing area lies near the corner of Tps. 22 and 23 N., Rs. 13 and 14 E. It was discovered in 1915 and had its principal development in 1915 and 1916. The production is both oil and gas. The initial production of the oil wells ranged from a few barrels to 350 barrels, and the gas wells from 2 to 18 million cubic feet per day.

The geologic conditions encountered are quite similar to those obtaining in the Hogshooter pool. The Bartlesville sand is the main producing horizon.

SUMMARY

Washington County is in completely developed oil and gas territory. The surface rocks are Pennsylvanian and generally dip to the

west at a low angle. The oil and gas accumulations are largely associated with folding, but some pools produce from lenticular sands. The county includes several important oil and gas pools. Development began early and has continued intermittently up to the present time. The production of all of the fields has declined until the average production per well per day, is probably not over one barrel, but more oil remains in the sand than has ever been removed. New and improved methods of extracting the oil still remaining in the sand will provide several years of production. Considerable territory has been developed, but there are still areas which have not had a test well drilled. The productive horizons are fairly shallow, ranging from 500 to 1,700 feet.