T. 27 N., R. 10 E.

By Heath M. Robinson and R. V. A. Mills.

INTRODUCTION.

T. 27 N., R. 10 E., occupies a position in the northeastern part of the Osage Reservation that is precisely shown in figure 1 of this report. Bartlesville, the nearest and most accessible town having good railroad facilities, is about 12 miles east and 2 miles south from the southeast corner of the township. At the time of the field examination the Atchison, Topeka & Santa Fe Railway system was building a branch line from Caney, Kans., to Pawhuska, Okla., which traverses this township, as shown on Plate XLVI. When this road is completed it will place railroad facilities much closer to the developed properties in this township. Although the roads between the oil fields in this township and Bartlesville are rough, owing to the hauling of heavy loads to and from the oil fields, they are constantly used by automobiles, motor trucks, and other vehicles. Rock and Buck creeks supply most of the water used in the boilers connected with the oil industry. The township has a maximum relief of about 250 feet, and most of it is wooded. Rock Creek roughly bisects the township and, because of the rough topography along its course, presents a rather formidable barrier for transportation of heavy loads between the eastern and western parts of the township.

The field work on this township was done by R. V. A. Mills and Heath M. Robinson, geologists, assisted by Lewis Mosburg and Willard Miller, instrument men. The territory each geologist covered in the field is outlined in a sketch on Plate XLVI. All the office work on this report was done by Mr. Robinson, who is responsible for the statements and conclusions herein presented.

A telescopic alidade and a 15 by 15 inch plane table were used in mapping the structure of the township. The elevations used were controlled by a system of triangulation which was checked with the Government bench marks previously established by the United States Geological Survey in this township.

STRATIGRAPHY.

EXPOSED ROCKS.

GENERAL CHARACTER.

The rocks exposed in T. 27 N., R. 10 E., are of middle Pennsylvanian age and aggregate about 500 feet in thickness. Shale constitutes the greater part of the sediments, sandstone is next in volume, and the remainder of the section, a very minor amount, is made up of limestone. Although the limestones constitute only a small fraction of the total rocks exposed, they are to be classed as among the most important key beds used in mapping the structure of the township. Figure 44 shows three sections—a generalized section of the rocks exposed in the southern part of T. 27 N., R. 10 E.;

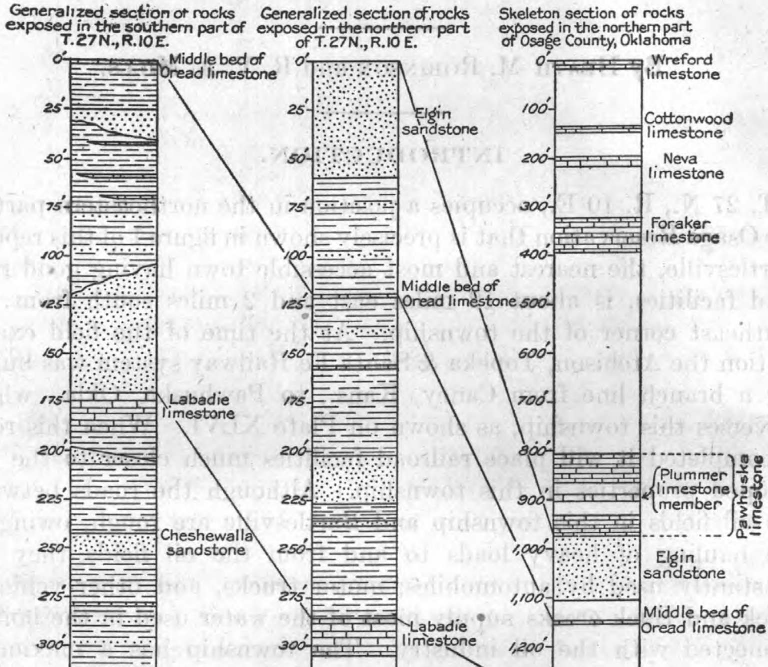


FIGURE 44.—Stratigraphic sections of rocks exposed in T. 27 N., R. 10 E.

a generalized section of the rocks exposed in the northern part of the township; and a generalized skeleton section of the rocks exposed in the northern part of the Osage Reservation, with correlation lines indicating the relative position of the exposed rocks in T. 27 N., R. 10 E., as compared with the larger section. As this report is strictly economic in character, the description of the stratigraphy will be confined to those beds which were found to be useful in mapping the structure of the township. These beds are called key beds, and if the geologist who later does field work here identifies these key beds, he will not only be able to establish his position in the stratigraphic column but will save time by using those beds which are the most persistent and can be most satisfactorily followed.

KEY BEDS.

Middle bed of the Oread limestone.—A bed regarded as the stratigraphic equivalent of the middle bed of the Oread limestone of Kansas is overlain by about 60 feet of shales interbedded with a few thin sandstones, which, in turn, are overlain by a thick series of sandstones called the Elgin sandstone. The outcrop of the middle bed of the Oread limestone is graphically shown on Plate XLVI. As its outcrop is generally unwooded and hence easily traceable, and as its peculiar characteristics make it easy to identify in the field, it was found to be one of the best key beds in the township. It rarely exceeds 2 feet and generally was found to be a little over 1 foot in thickness. It is interbedded with a blue-gray shale and in the southern part of the township is separated by about 25 feet of shale from a well-developed sandstone below it. The limestone is steel-gray on fresh surfaces but weathers to a dirty yellow. It is dense and fine grained, contains a few *Fusulina,* and is overlain in some places by a finely conglomeratic limestone which at first glance looks somewhat like an oolite. This conglomeratic limestone is very characteristic and is not likely to be confused with any other bed in the section.

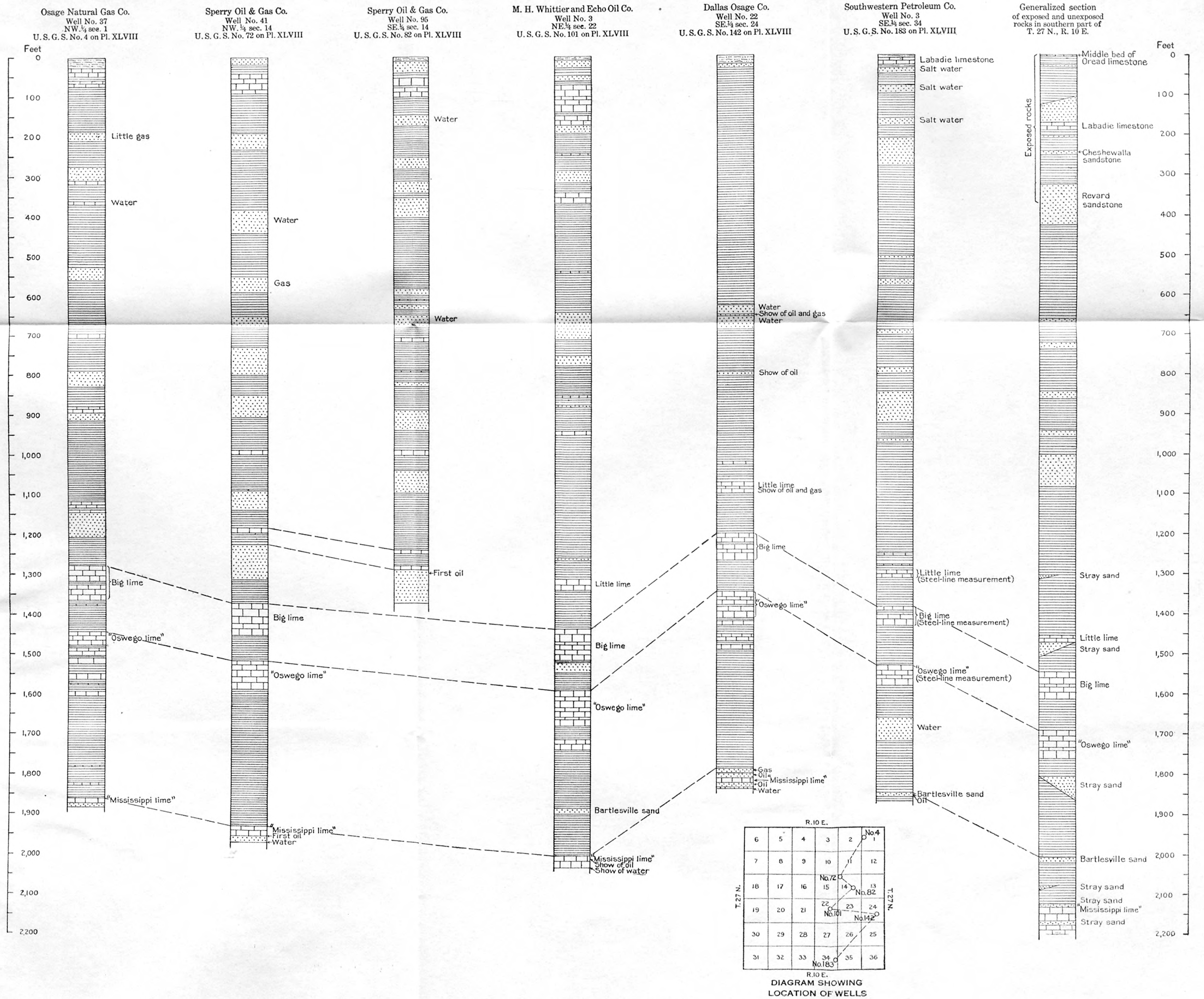
Labadie limestone.—The Labadie limestone is below the middle bed of the Oread limestone and is separated from it by about 170 feet of shales and sandstones. Figure 44 shows that the beds in this interval in the northern part of the township are different in character from the corresponding beds in the southern part. The outcrop of the Labadie limestone is graphically shown on Plate XLVI. In the northeastern part of the township this limestone is directly overlain by shale, the outcrop is unwooded, and it forms prominent ledges which can be very easily followed. In the south-central part, however, it is overlain by a thick massive sandstone, which also forms ledges and is wooded, and consequently the limestone is not so prominently exposed as in the northeastern area. The Labadie limestone is between 15 and 20 feet thick in most of the exposures in this township. The major body of the limestone is gray on fresh and weathered surfaces, but in some localities the weathered surface of the upper part has a rich cinnamon-brown color that is probably due to a high iron content. The limestone commonly weathers into large rectangular-shaped blocks a foot or so across and only a few inches thick. The bed is not abundantly fossiliferous, but in many outcrops fossils may be found.

Cheshewalla and Revard sandstones.—The outcrops of the Cheshewalla and Revard sandstones are confined to a small area in the southeastern part of this township, and consequently these beds were not found to be particularly useful in mapping the structure. However, the upper shale contact of both of these sandstones can be followed beyond the limits of this township, so it is known that they are somewhat persistent. Both of the sandstones are wooded where exposed at the surface, and in general they are very much alike in their physical characteristics.

ROCKS NOT EXPOSED.

Most of the information regarding the rocks below the surface in T. 27 N., R. 10 E., is derived from the records of the wells that have been drilled for oil and gas in this township. As the regional dip of the beds in this part of Oklahoma is toward the west, the more persistent beds described in the well logs crop out farther east, where they may be studied. About 130 well records were available in working up the table of well data given on pages 325-327, and a few of the more representative of these well records are shown on Plate XLVII. Plate XLVII also shows the relation of the subsurface beds to the exposed and unexposed rocks in the southern part of the township. The strata between the middle bed of the Oread limestone and the "Mississippi lime" have an aggregate thickness of about 2,150 feet, the upper 350 feet of which is exposed in this township. The rocks between the surface beds and the "Mississippi lime" are made up of shale, sandstone, and limestone; shale occupies about three-quarters of the section, sandstone about 15 per cent, and limestone about 10 per cent. As a rule these rocks do not "cave" enough to necessitate the use of a rotary drill, so it is a universal practice in this township to use cable tools in drilling for oil and gas. In most of the available well logs certain prominent beds are recorded, and on Plate XLVII the correlations of some of these beds, as shown in representative logs, are indicated by dashed lines. These principal subsurface beds are briefly described below.

A limestone called the Little lime is the first prominent limestone below the surface that is generally recognized by the drillers. In



TYPICAL LOGS OF WELLS IN T. 27 N., R. 10 E.

the southern part of the township it is about 1,450 feet below the middle bed of the Oread and about 1,280 feet below the top of the Labadie limestone. The rocks between the surface and the Little lime constitute a series of interbedded shales and sandstones, with shale constituting by far the greater part of the section. The average thickness for the Little lime given in the well logs from the southern part of the township is about 20 feet.

After drilling through the Little lime the bit usually encounters about 75 feet of shale, interbedded in some places with sandstone, before reaching the top of the so-called Big lime. The sandstone recorded in this 75-foot interval is in certain areas an important reservoir for oil and gas, but the bed is lenticular and is not recorded in many of the logs from the southern part of the township. The Big lime has an average thickness of about 70 feet, and in some records it is shown to have a shale parting 5 to 10 feet thick. It is tentatively correlated with the Oologah limestone, which crops out between 30 and 40 miles east of this township.

A limestone known as the "Oswego lime" lies below the Big lime and is separated from it by about 80 feet of shale. In some of the records a sandstone is shown interbedded with this shale member. The "Oswego lime" has an average thickness of about 70 feet, which includes, in some of the sections, partings of shale 5 to 10 feet thick. It is generally believed to be the stratigraphic equivalent of the Fort Scott limestone, which crops out about 50 miles east of this township.

A sandstone known by the drillers as the Bartlesville sand occupies a position in the stratigraphic section about 245 feet below the base of the "Oswego lime." The interval between the "Oswego lime" and the Bartlesville sand is made up largely of shale interbedded with an occasional lenticular sandstone. The importance of the Bartlesville sand lies in the fact that it is one of the most productive oil and gas reservoirs in the Mid-Continent oil and gas field. As shown in Plate XLVII, in the southern part of T. 27 N., R. 10 E., it has an average thickness of about 15 feet, and this figure probably represents a fair average for the remainder of the township. The area in which the Bartlesville sand is virtually proved productive is shown on Plate XLVIII. The fact that this sand is present over most of the part of the township that has been drilled but is productive over only a relatively small area probably means that the sandstone is too tightly cemented to serve as an oil or gas reservoir outside of the area indicated by shading on Plate XLVIII. The term Bartlesville has been applied to any sand found at about the stratigraphic position of this sand, as indicated on Plate XLVII. It is likely that these sands found at different localities in the Osage Reservation are approximately of the same age, but it is unlikely that they represent one continuous sand body.

The "Mississippi lime" is stratigraphically below the Bartlesville sand and is separated from it by about 105 feet of shale. Some of the well logs record a sandstone 10 to 20 feet thick just above the top of the "Mississippi lime," and other logs record a sandstone 20 to 30 feet below the top of the limestone. Both of these sandstones are classed by the drillers as part of the "Mississippi lime." The upper 70 feet of this formation is important commercially because a large number of the producing wells in T. 27 N., R. 10 E., derive their oil and gas from these beds. Well 153, Plate XLVIII, is reported to have been drilled to a depth of 2,245 feet and to have reached the top of the "Mississippi lime" at 1,895 feet. This is within about 15 feet of the position the "Mississippi lime" should occupy below the "Oswego lime" at this locality, if the average interval between the "Oswego lime" and "Mississippi lime" for the southern part of the township is applied here. Because of the economic importance of the beds below the top of the "Mississippi lime" the portion of the driller's record describing these beds is given below.

Log of lower part of well 153, in the NW. ¼ sec. 25, T. 27 N., R. 10 E.

	Depth.		Depth.
	Feet.		*Feet.*
Sandy lime; top of "Mississippi lime"	1,895-1,918	Light slate	2,170-2,200
White sand; smell of oil	1,918-1,927	White sand, show of gas (about 10,000 feet)	2,200-2,210
Black lime	1,927-1,985	Hard lime, light	2,210-2,240
Lime	1,985-2,060	Sand; little more gas, 100 barrels of salt water in 24 hours	2,240-2,245
White lime	2,060-2,120		
Black brick	2,120-2,170		

In brief, the upper 275 feet of the "Mississippi lime," which is made up principally of limestone, overlies a series of sandstones, shales, and limestones that aggregate at least 85 feet in thickness, and these sandstones are known to contain some gas. The "Mississippi lime" is tentatively correlated with the Boone chert, which crops out in the northeast corner of Oklahoma, but it is believed that the possibility of correlating the "Mississippi lime" with one of the limestones above the Boone chert should at least be considered. The Morrow and Pitkin limestones, which overlie the Boone chert, also crop out in eastern Oklahoma. The Pitkin is of Mississippian age, but the Morrow is Pennsylvanian. It is not impossible that the "Mississippi lime" recorded in some of the well logs is the stratigraphic equivalent of the Morrow and Pitkin, but as the matter stands now it is entirely an open question. The question is one of material economic importance, because of the possibility of finding deeper sands than those now known to produce oil and gas in this township. In this connection it is appropriate to consider means of distinguishing between the Boone chert and the younger Mississippian limestone. The Boone chert is more siliceous than the overlying limestones and it should cut the bit of the drill faster than a limestone that contains a smaller amount of silica. Whenever practicable fragments of drill cuttings or lumps of the material obtained after shooting the producing bed in the limestone should be examined for fossils and the amount of silica they contain should be noted.

CONVERGENCES OF THE SUBSURFACE BEDS.

By averaging the measurements between certain key beds in the wells listed in the table of well data (pp. 325–327), it is possible to arrive at certain conclusions relative to the intervals in different parts of the township between individual subsurface beds and also between these beds and those at the surface. In general the beds converge toward the north; or, in other words, the interval between two particular beds in the southern part of the township is greater than the measured distance between these same two beds in the northern part. The economic application of this difference is evident, for wells drilled in the southern part of the township will have to go deeper than wells drilled in the northern part to reach the same sand, if the wells are started on the same surface bed. The stratigraphic interval between the surface beds and the top of the "Oswego lime" is greater by 30 feet in the southern part of sec. 36 than it is in the center of sec. 13, and greater by 100 feet in the southern part of sec. 36 than it is in the northern part of sec. 1. The interval between the top of the "Oswego lime" and the top of the "Mississippi lime" in the southeast corner of sec. 36 is greater by about 30 feet than the interval between these same beds in the center of sec. 13. It appears that the direction and amount of the convergence between the surface beds and the "Oswego lime" are approximately the same as between the "Oswego lime" and the "Mississippi lime." A few examples will give an idea of the depth necessary to drill in order to reach the "Mississippi lime" at a number of points on the surface of the township. A well drilled in the SE. ¼ sec. 36, starting at the top of the Labadie limestone at the surface, should reach the "Mississippi lime" at a depth of 1,985 feet; a well drilled in the center of sec. 34, at the same surface horizon, should reach the "Mississippi lime" at a depth of 1,955 feet; a well starting on the same surface bed in the center of sec. 13 should reach the lime at a depth of about 1,935 feet; and in sec. 1 the drill, after going through the Labadie limestone, would still have to penetrate about 1,835 feet of strata before reaching the top of the "Mississippi lime."

STRUCTURAL FEATURES.

GENERAL DESCRIPTION.

The structure of T. 27 N., R. 10 E., is graphically shown on Plate XLVI by means of structure contours that have an interval of 10 feet. These contours are based entirely on the structure of the surface rocks and are so drawn as to show the elevation above sea level, in feet, of a theoretical bed 560 feet below the top of the Plummer limestone member of the Pawhuska limestone. Where the field evidence is sound, the contours are drawn with solid lines, but where the correlations are doubtful or the exposures poor, the contour lines are broken to indicate the lack of conclusive evidence. It will be noted that the highest structure contour shown on Plate XLVI (the 870-foot contour) is in the extreme southeast corner of the township, and the lowest structure contour (the 610-foot contour) is confined to the western edge of the township. The general dip across the township, then, is in a westerly direction and is between 30 and 40 feet to the mile, agreeing very well in direction and amount with the general or normal dip of the Pennsylvanian rocks in northern Oklahoma.

The approximate position of the anticlinal axes in T. 27 N., R. 10 E., is graphically shown in figure 45. As it is generally conceded that such structural features as domes, anticlines, and terraces offer greater promise for oil and gas accumulation than unfolded areas, it is appropriate here to describe the salient points of these structural features.

ANTICLINES AND DOMES.

Dry Hollow dome.—The approximate position of the axis of the Dry Hollow dome is shown in figure 45 to lie in the southern part of sec. 35, and although the trend is not very pronounced, it seems to have a general direction of northwest and southeast. Only the northern flank of this dome is shown on Plate XLVI, but comparison with the structure map of T. 26 N., R. 10 E.,[1] shows that this dome has a closure of about 20 feet. The Dry Hollow dome is characterized by a relatively steep dip on its western flank and moderate but well-developed dips on the other flanks.

Whitetail anticline.—The axis of the Whitetail anticline, which has a northeasterly trend, cuts diagonally across the SE. ¼ sec. 31. It is continuous with the Albert anticline, described by F. R. Clark,[2] and is a part of the same fold. The crest of the anticline is cut off sharply to the east by a fault with a northwesterly trend, which has caused a vertical displacement of more than 30 feet. The rocks immediately east of the fault and in line with the anticlinal axis to

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[1] Clark, F. R., U. S. Geol. Survey Bull. 686–I, pl. 14, 1918. [2] Idem, p. 100.

the west have been depressed into a syncline, which is also cut off sharply by the fault. The northern flank of the Whitetail anticline is also cut by a small fault that is approximately parallel to the one described above. The western part of the crest of the anticline grades into a flat terrace-like feature, with a rather irregular outline. A nose extends southwestward into sec. 1, T. 24 N., R. 9 W.

Bellieu dome.—The axis of the Bellieu dome has a northwesterly trend and intersects the northwest corner of sec. 26. (See fig. 45.)

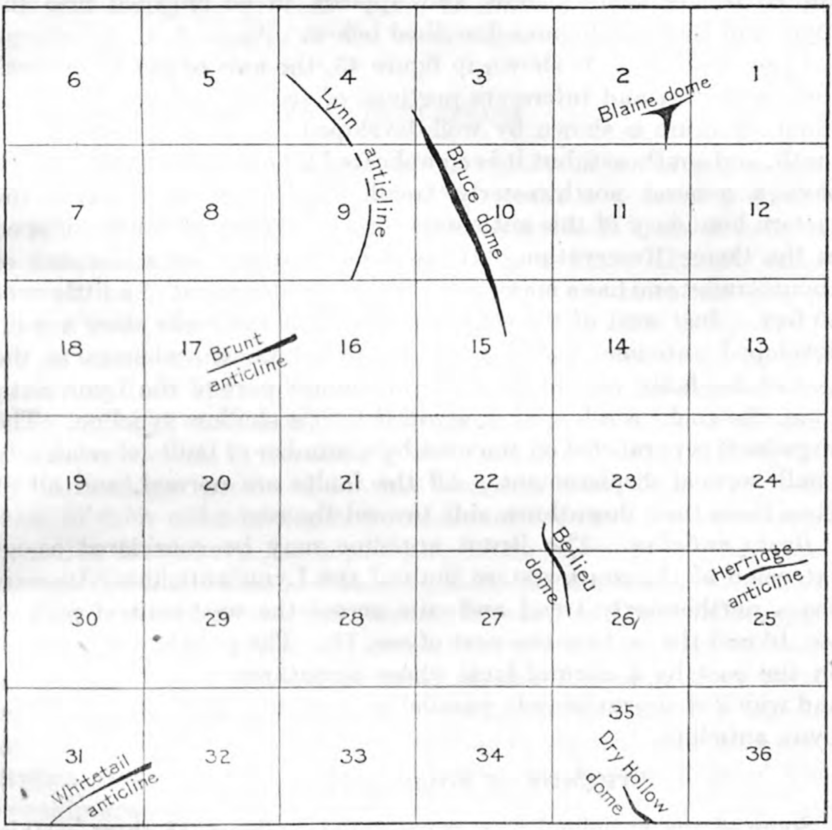

FIGURE 45.—Diagram showing approximate positions of anticlinal axes in T. 27 N., R. 10 E.

This dome has a closure of about 20 feet and is separated from the Dry Hollow dome by a shallow structural saddle. The steepest dips on this dome are on its northern flank.

Herridge anticline.—The axis of the Herridge anticline is shown in figure 45 to have a general northeasterly trend and to cut across the N. ½ sec. 25. East of sec. 25 the Herridge anticline merges into a structural terrace. In secs. 24 and 25 it has well-developed north, south, and west dips.

Blaine dome.—The Blaine dome covers a large part of sec. 2 and fractions of secs. 1, 12, and 11. As shown on Plate XLVI, it has a closure of about 30 feet.

Bruce dome.—The Bruce dome is a relatively large, elongated dome with a closure of about 60 feet. As shown in figure 45, its axis has a northwesterly trend and cuts across the extreme southwest corner of sec. 3, intersects sec. 10 diagonally, and extends into the north-central part of sec. 15. As shown on Plate XLVI, the Bruce dome is faulted on its western flank and appears to be crowded into the Lynn and Brunt anticlines described below.

Lynn anticline.—As shown in figure 45, the axis of the Lynn anticline is curved and intersects portions of secs. 4 and 9. The anticlinal structure is shown by well-developed dips to the north, west, south, and southeast, but it is complicated by a series of faults, which have a general northwesterly trend. The fault that forms the eastern boundary of this anticline is one of the largest faults mapped in the Osage Reservation. It has been mapped for a distance of about 2 miles and has a maximum vertical displacement of a little over 60 feet. Just west of the center of this fault the rocks show a well-developed anticlinal structure, as described above, whereas to the east of the fault, east of the crest or highest part of the Lynn anticline, the rocks are bowed downward into a shallow syncline. The large fault is paralleled on the west by a number of faults of relatively small vertical displacement. All the faults are normal, and all of them have their downthrow side toward the east.

Brunt anticline.—The Brunt anticline may be considered as an extension of the southwestern limb of the Lynn anticline. Its axis has a northeasterly trend and cuts across the west-central part of sec. 16 and the east-central part of sec. 17. The anticline is bounded on the east by a normal fault whose downthrow is on the east side and which is approximately parallel to the faults associated with the Lynn anticline.

TRENDS OF FOLDS AND FAULTS.

Some of the anticlinal axes represented in figure 45 show certain general alinements. Probably the best example of this is the northwest-southeast line made by the axes of the Bruce dome, the Bellieu dome, and the Dry Hollow dome. Inspection of Plate XLVI shows that there is an almost continuous synclinal depression which extends from a point near the center of sec. 12 through the southwest corner of sec. 14 and the southwest corner of sec. 21 and across the NW. ¼ sec. 31. It thus seems that there are at least two general lines of folding in this township that are nearly at right angles to each other. The Bruce dome, the Lynn anticline, and the Brunt anticline appear to form a part of a general upfolded area that has been more or less broken up by parallel normal faults. It is noteworthy that all of the faults are normal; that they are more or less parallel, and that the downthrow in each is on the east side of the fault plane. As described above, a few of the faults in this township are bordered on the east by a syncline and on the west by an anticline. It seems that the strata have undergone tangential stresses and that relief from these stresses has been accomplished by a flexing of the rocks in some places and by rupture or faulting in others. The location of the folds and faults has probably been determined, at least in part, by the rigidity and weight of the rock segments operating with the tangential stresses.

SAND CONDITIONS.

In an area that has produced oil and gas it is important to consider the productive beds and to outline as far as possible the areas in which they are productive. An attempt has been made to indicate these areas for the east side of the township in Plate XLVIII, which shows, in addition to the development work in the township (the oil and gas wells, the dry holes, and the abandoned wells), the probable area in which the Bartlesville sand is essentially proved to be productive, and an approximate outline of the known productive area of the principal stray sand. The wells are numbered to agree with the numbered wells in the table of well data at the end of this report. The oil and gas produced in this township come from five beds, which in their order of depth from the surface are (1) a stray sand about 150 feet above the top of the Little lime, (2) a stray sand between the Little lime and the Big lime, (3) the Bartlesville sand, (4) a stray sand between the Bartlesville sand and the "Mississippi lime," and (5) the sands in and associated with the top of the "Mississippi lime." It is noteworthy that in this township there is no record of oil or gas production of importance from the Big lime or the "Oswego lime" or from the Peru sand, which should be found between these two limes The principal productive beds of the township are briefly described below.

Stray sand above the Little lime.—There is only one well in this township that is reported to have produced oil or gas from a sand above the Little lime. Well 3, in the NW. ¼ sec. 1, is reported to have had an initial production of 2,000,000 cubic feet of gas a day, presumably from a sand between 894 and 961 feet below the surface and about 150 feet above the top of the Little lime. As "offset" wells to well 3 have been drilled to deeper sands without recording production from this stray sand, the conclusion seems justified that the productive area of this sand is very small and it is unlikely that the sand will supply any large amount of oil or gas in this township.

Stray sand between the Little lime and the Big lime.—The approximate area within which the sand between the Little lime and the Big lime is essentially proved to be productive in the eastern part of the township is graphically shown in Plate XLVIII. The probable productive area of the sand includes appreciable parts of secs. 11, 12, 13, 14, 15, and 23. It should be noted that the boundary of this productive area is not indicated by a clean-cut line, for it is impossible to outline precisely the productive area of any sand ahead of the drill. This estimate of prospective oil and gas territory may be regarded as a conservative one. The maximum thickness recorded for this stray sand is 96 feet, and an average thickness over the productive area is about 40 feet. The average initial production of the wells from this sand is about 40 barrels of oil a day. From the available records it appears to be a common practice to shoot this sand with rather large shots (200 to 300 quarts of nitroglycerin are not uncommon), which would seem to indicate that the sand is rather tightly cemented and that thorough breaking up is necessary to increase the production of oil and gas.

Stray sand between the "Oswego lime" and the Bartlesville sand.—A sand about 70 feet below the base of the "Oswego lime" is reported to have produced initially about 2,750,000 cubic feet of gas daily from well 177, in the NE. ¼ sec. 34, and what is probably the same sand is reported to have produced gas in well 206, in the SE. ¼ sec. 35. The probable productive area of this sand may be indicated on the map as that area embraced by a line connecting wells 177, 205, 206, and 202. The maximum thickness recorded for this sand is 61 feet.

Bartlesville sand.—The area in which the Bartlesville sand is practically proved to be productive in this township is graphically shown in Plate XLVIII. It covers substantial parts of secs. 34, 35, and 36. This does not mean, however, that the sand is not present outside of the area indicated by shading in Plate XLVIII. On the contrary, the records of a large number of the wells drilled in many parts of the township outside of that area have proved that the Bartlesville sand is present over most of the township where the drill has gone deep enough to test that sand. It is likely, however, that over much of the region outside of the area indicated by shading the sand is too tightly cemented to serve as a good oil and gas reservoir. In this connection it is noteworthy that a few wells outside of the probable productive area are reported to have produced oil from the Bartlesville sand, although "offset" wells were drilled through the sand without getting commercial quantities of oil or gas. Concrete examples of this may be found in well 116, in the SE. ¼ sec. 23; well 102, in the NE. ¼ sec. 22; and well 5, in the SW. ¼ sec. 1. In a few of the wells the Bartlesville sand was recorded

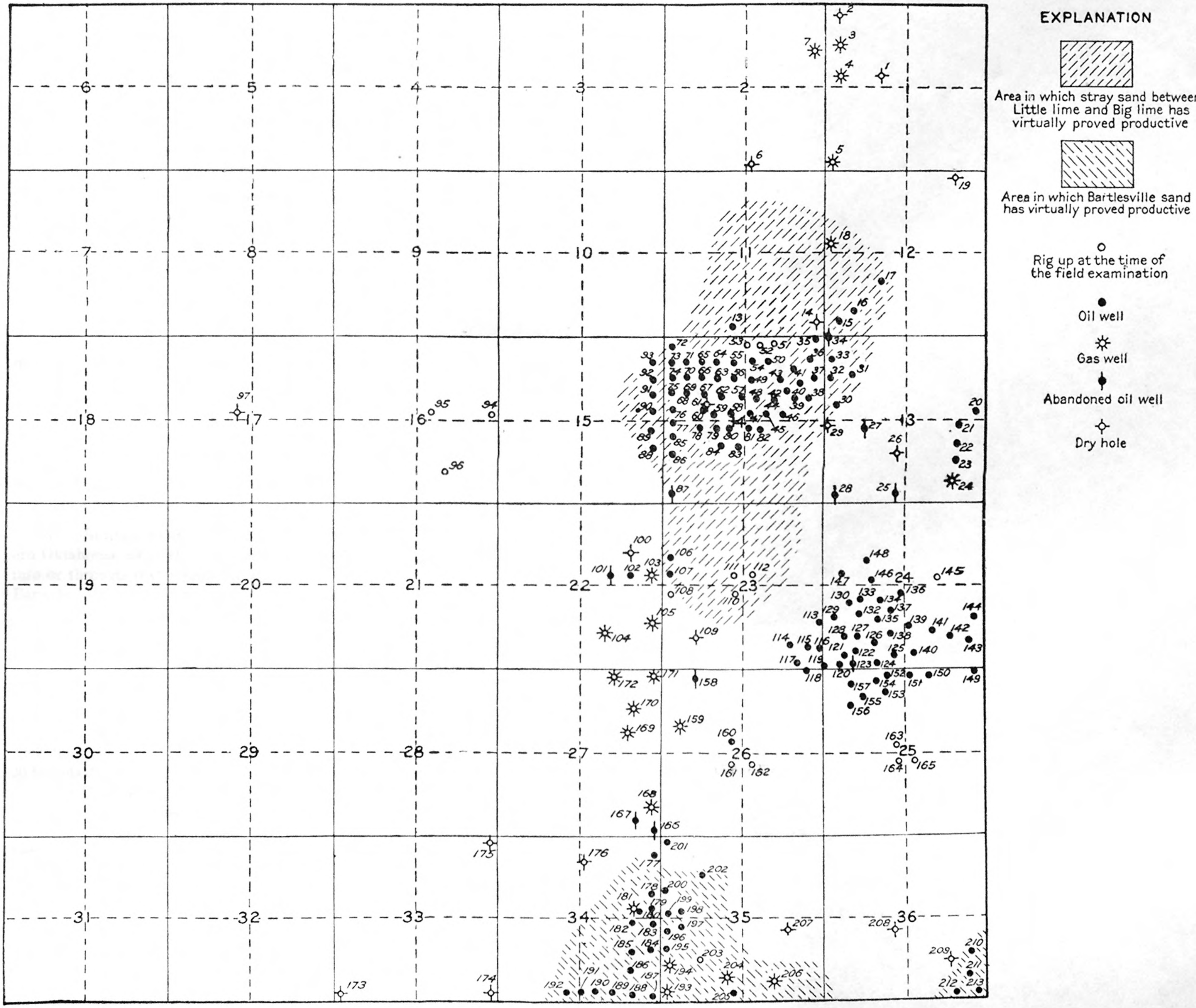

DIAGRAM SHOWING DEVELOPMENT AND ESSENTIALLY PROVED AREAS OF SOME OF THE SANDS IN T. 27 N., R. 10 E.

as being as thick as 30 feet; in others the sand appears to be absent; and an average thickness of the sand as recorded in the available logs is about 16 feet. The initial daily production of a few of the wells in the Bartlesville sand exceeded 100 barrels of oil, but the average initial production from this sand amounted to about 55 barrels.

"Mississippi lime."—The oil and gas obtained from the "Mississippi lime" comes from the upper 50 feet of the formation. In some places the oil comes from a sand immediately above the lime; in others it is reported from the lime itself; and in still others it is from a sandstone 20 to 30 feet below the top of the lime. The area in which the "Mississippi lime" is productive does not seem to be determined by the condition of the sand or rock that acts as reservoir but is apparently defined in large part by the structural features of the township, which are discussed in a later part of this report. The average initial production of the wells in this township that produce oil from the "Mississippi lime" is between 20 and 25 barrels of oil a day. Wells that produce more than 50 barrels of oil a day are exceptional.

Possible productive sands below the "Mississippi lime."—Oil in commercial quantities is reported to have been found in sands more than 200 feet below the top of the "Mississippi lime" in several localities in Oklahoma. According to R. H. Wood,[1]

> The oil limitations are not reached at the top of the "Mississippi lime" in northeastern Oklahoma, as production has been obtained in a number of localities by drilling into or through that formation some 300 feet. Concrete examples may be found in Barnsdall Oil Co.'s wells 374 and 407, in sec. 8, T. 20 N., R. 12 E. In well 374 the "Mississippi lime" was reached at 1,850 feet and the top of a sand at 2,125 feet, which continued to 2,178 feet. This is 275 feet below the top of the lime. This deep sand produced initially, according to the superintendent, 1,000,000 feet of gas and 312 barrels of oil a day. Farther west, in sec. 14, T. 22 N., R. 8 E., the Red Bank Oil Co. has within the last two weeks completed a "Mississippi lime" well, but no data are available except those appearing in the trade journals. It is reported that the "Mississippi lime" was found at 2,545 feet and some oil at 2,579 feet. A sand was found at 2,850 feet, and drilling continued to 2,886 feet. The well is now said to be producing 30 barrels daily, presumably from the deep sand. In T. 20 N., R. 11 E., the Phoenix Refining Co. has drilled a number of wells near Sand Springs, some 300 feet below the top of the "Mississippi lime," and obtained production there. The first of these wells was reported to produce initially 1,500 barrels daily. This oil is of very high grade. Between Sapulpa and Tulsa and nearly east of Sapulpa some wells have been drilled several hundred feet into the "Mississippi lime" and found to yield high-grade oil. With only meager data in hand it is impossible to determine in every instance whether the "Mississippi lime" is Boone or Morrow and Pitkin.

In sec. 25 of the township under discussion, well 153 is reported to have obtained over 1,000,000 cubic feet of gas a day from a sand more than 300 feet below the top of the "Mississippi lime." In

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[1] Informal communication, Jan. 25, 1918.

view of the evidence above set forth, the statement seems justified that no area in T. 27 N., R. 10 E., should be considered completely tested until a depth of 400 feet below the top of the "Mississippi lime" is reached.

AREAS OF FAVORABLE STRUCTURE FOR THE ACCUMULATION OF OIL AND GAS.

GENERAL RELATIONS.

Although not enough work has been done at the date of this writing to permit the formulation of definite conclusions regarding the relation between surface structure and oil and gas production in the Osage Reservation, it is believed that certain generalizations may be made from a study of the structure contour maps of different parts of the reservation on which the producing oil and gas wells are plotted. It is fully demonstrated that areas occupied by anticlines, domes, and terraces are more promising prospective oil and gas territory than areas in which the strata are not so folded, provided, of course, that sand conditions and other factors are equal. It seems to be generally true also that the crests of the anticlines and domes in the Osage Reservation are more likely to be productive of gas than of oil, and that the western flanks, particularly the northwestern portions, of the anticlines and domes are more productive than the eastern flanks, and the productive area extends farther down structurally from the crests of the folds on the west than on the east. These generalizations form the basis for most of the recommendations made below in outlining the areas that seem to be well located structurally, but the known and probable productive areas of the sands associated with the anticlines and domes are also discussed.

Because the generalizations given above can not be laid down as definite rules, and because of the impossibility of forecasting the nature of a sand with certainty ahead of the drill, it is emphasized that the recommendations here made do not constitute a guaranty that oil or gas will be found in the areas outlined. They do represent, however, the best estimates the writers can make, and it is believed that losses by futile drilling will be materially reduced if the areas are tested in accordance with these recommendations.

DRY HOLLOW DOME.

Stray sands above the Bartlesville sand.—The table of well data at the end of this report gives records of three wells that have produced oil and gas from sands above the Bartlesville in the area covered by the Dry Hollow dome. Well 177, in the NE. ¼ sec. 34, is reported to have produced initially about 2,750,000 cubic feet of gas a day from a sand about 70 feet below the base of the "Oswego lime." Well 205, in the SW. ¼ sec. 35, is reported to yield a small quantity of oil from a sand that is estimated to be between 1,420 and 1,430 feet from the surface. Well 206, in the SE. ¼ sec. 35, is reported to have produced gas from a sand between 1,606 and 1,627 feet from the surface, which is about the same stratigraphic position as the sand in well 177, mentioned above. Other records from sec. 35 without exact locations indicate production from a sand between the "Oswego lime" and the Bartlesville sand, probably the equivalent in age to the sand in well 177. The productive area of this sand is probably limited to a narrow strip along the northeastern flank of the anticline, which may be roughly outlined on the map as embracing the area surrounded by a line connecting wells 177, 205, 206, and 202.

Bartlesville sand.—The area in which the Bartlesville sand is probably productive in the Dry Hollow dome is outlined in Plate XLVIII and as shown there covers parts of secs. 34 and 35. The average initial daily production of the wells from the Bartlesville sand in the area so outlined is between 70 and 75 barrels of oil. The average thickness of the sand over the productive area is between 15 and 20 feet.

"Mississippi lime."—As oil or gas in commercial quantities is obtained above the "Mississippi lime" in most of the wells drilled on the Dry Hollow dome, very few of the wells are deep enough to test the "Mississippi lime." Well 201, in the extreme northwest corner of sec. 35, is reported to have had an initial daily production of 6 barrels of oil from the "Mississippi lime." Inasmuch as this bed is widely productive in this and adjacent townships it seems reasonable to assume that there is a very good chance of finding oil and gas in it on the Dry Hollow dome when the wells that now tap the Bartlesville sand are deepened or when new wells are drilled deep enough to test the lime. The area that may be classed as a prospective source of oil or gas from the "Mississippi lime" may be roughly outlined as embracing the territory indicated by shading on Plate XLVIII as favorable area for the Bartlesville sand on the Dry Hollow dome, plus enough territory to the north to include well 201. The area so outlined includes a good part of the SE. ¼ sec. 35, all of the SW. ¼ sec. 35, the major part of the NW. ¼ sec. 35, approximately the southeast half of the NE. ¼ sec. 34, all of the SE. ¼ sec. 34, and a strip along the east side of the SW. ¼ sec. 34. As stated in the discussion of the sand conditions, the average initial production of the wells in this township from the "Mississippi lime" is between 20 and 25 barrels of oil a day, and until the area is proved by the drill this figure may be taken as the probable average initial production of the wells that may in the future produce from the "Mississippi lime."

WHITETAIL ANTICLINE.

The Whitetail anticline has not been tested by the drill for oil or gas, and consequently it is difficult to say much about the sand conditions on it. Productive sands above the Bartlesville may be encountered in this anticline, but there is no possible way of predicting this in advance of the drill. The Bartlesville sand is likely to be productive in the southern tier of sections in T. 27 N., R. 11 E., and the eastern part of T. 27 N., R. 10 E. The "Mississippi lime" should probably be classed as the most promising source of oil and gas in the Whitetail anticline, although the average initial production from the "Mississippi lime" in wells in this township is only about 20 or 25 barrels of oil a day. The upper part of the lime is known to yield oil or gas in most of the wells in this township that are favorably located in regard to structure.

The part of the Whitetail anticline which should receive a higher rating as prospective oil and gas territory than the adjacent area may be outlined (see Pl. XLVI) as that part of sec. 32 which lies southwest of the fault and within the 650-foot contour in the SW. ¼ and that part of sec. 31 which lies southwest of the fault that cuts the eastern boundary of the section and which is partly surrounded by the 650-foot contour.

BELLIEU DOME.

Stray sand.—As shown in Plate XLVIII the essentially proved productive area of the stray sand which is found between the Little lime and the Big lime covers a part of the northeastern flank of the Bellieu dome. It is likely that the productive area of this sand will be found to extend to the north beyond the area covered by the Bellieu dome, or beyond the central and northern parts of sec. 23. Well 106 is credited with an initial production of 20 barrels of oil a day after being shot, and well 107 with an initial production of 30 barrels. Both of these wells found the sand at a depth of about 1,295 feet.

Bartlesville sand.—Well 102 is reported to have had an initial production from the Bartlesville sand of 40 barrels of oil a day, although the "offset" wells around it are not credited with producing from this sand. Presumably the Bartlesville sand over most of the area covered by the Bellieu dome is too tightly cemented to serve as an oil or gas reservoir, but in an occasional well the sand is found to be open and productive. The Bartlesville sand can not, however, be considered an important source of oil or gas here, and no attempt is made to outline its probable productive area on the Bellieu dome, but if a good show of oil is found in this sand in any of the wells drilled here the sand should be shot in order to test it thoroughly for oil or gas.

"*Mississippi lime.*"—The "Mississippi lime" is the most important oil and gas reservoir in the area covered by the Bellieu dome. The crest of the dome has been proved to be gas territory by wells credited with initial yields between 1,000,000 and 4,500,000 cubic feet of gas a day. This gas territory may be described as including the area encircled by lines connecting wells 103, 104, 172, 169, 168, 159, 158, and 103. It is not unlikely that oil will be found on the western flank of the Bellieu dome. The 740-foot contour may be taken as the northern and western limit of the probable oil territory in sec. 22, and a line connecting the point where this contour crosses the southern boundary of sec. 22 with well 201 may be considered tentatively as the southwestern boundary of the probable oil territory on the Bellieu dome.

HERRIDGE ANTICLINE.

Stray sands above the Bartlesville sand.—A number of wells have been drilled on the Herridge anticline, but no oil or gas of commercial importance from sands above the Bartlesville is recorded in the available well logs. In view of this fact, there seems to be little promise of obtaining oil or gas in commercial quantities from these sands.

Bartlesville sand.—Of the available well logs there is one record, that of well 116, that reports oil from the Bartlesville sand in the area covered by the Herridge anticline. In this log the sand is reported to be 12 feet thick and it is credited with an initial production of 10 barrels of oil a day. This well is surrounded by wells that produce oil from the "Mississippi lime" and that consequently must have been drilled through the Bartlesville sand without getting enough oil or gas to make paying wells. The conclusion seems warranted that the Bartlesville sand in the area of the Herridge anticline is irregularly cemented, and although oil or gas may be obtained from it in occasional wells it can not be counted upon as an important reservoir.

"Mississippi lime."—East of the Herridge anticline the strata flatten out into what is called in T. 27 N., R. 11 E., the Levelette terrace. The Levelette terrace merges into the Bacon Rind anticline toward the north so that these three structural features—the Herridge anticline, in T. 27 N., R. 10 E., and the Levelette terrace and Bacon Rind anticline in T. 27 N., R. 11 E.—influence the accumulation of oil and gas in the area discussed below.

A glance at Plate XLVI shows that over 50 wells have been drilled on or near the Herridge anticline. Almost all these wells produce oil from the "Mississippi lime," and their average initial production was about 20 barrels of oil a day. The probable productive area associated with these structural features may be outlined as embracing the territory in sec. 13 southeast of the 790-foot structure contour (see Pl. XLVI), all of sec. 24 except that part northwest of the 790-foot contour, that part of the SE. ¼ sec. 23 that lies southeast of the 780-foot contour, approximately the E. ½ NE. ¼ sec. 26, a small part of the NE. ¼ SE. ¼ sec. 26, and the N. ½ sec. 25.

BLAINE DOME.

Stray sand above the Bartlesville sand.—Well 3, in the NW. ¼ sec. 1, is reported to have had an initial daily production of 2,000,000 cubic feet of gas, presumably from a sand between 894 and 961 feet below the surface. The top of this sand is about 215 feet above the top of the Little lime, and according to the well data available this is the only well in the township that produces oil or gas from a sand at this horizon. As the logs of "offset" wells to well 3 drilled through this sand did not report production from it, the conclusion seems warranted that the productive area of the sand is very small, and no attempt is made to predict its extension beyond the area drained by well 3.

Bartlesville sand.—Well 5, in the extreme southwest corner of sec. 1, is reported as a gas well from the Bartlesville sand. As described earlier in this report, the Bartlesville sand has not been found to be productive outside of the area indicated by shading on Plate XLVIII, except in a few scattered wells, most of which are partly surrounded by deeper wells that are not credited with production from that sand. It seems rather unlikely that the Bartlesville sand will supply any great amount of oil or gas in the area covered by the Blaine dome, but if a good show of oil is encountered in this sand the sand should be shot before it is cased off.

"*Mississippi lime.*"—Some of the walls on the Blaine dome have been drilled deep enough to test the "Mississippi lime," and those which were located near the crest of the dome are reported as gas wells. The southeastern and southern boundaries of the probable productive area on the southern and southeastern flanks of the Blaine dome may coincide with the 780-foot structure contour (Pl. XLVI). The productive area on the northwestern flank may be limited by the 760-foot contour. The crest of the dome should be classed as gas territory, and the area well down on the northwestern flank of the dome, within the area outlined as probable productive territory, has a chance for oil.

BRUCE DOME, LYNN ANTICLINE, AND BRUNT ANTICLINE.

The Brunt and Lynn anticlines are very closely associated with the Bruce dome, and it is difficult to separate the discussions of the probable productive area of these structural features. Therefore they are treated as a structural group and their probable productive area is outlined as a single unit.

Stray sands above the Bartlesville sand.—As indicated in Plate XLVIII, the stray sand that is found stratigraphically between the Little and Big limes has been proved productive in the E. ½ sec. 15 and the greater part of sec. 14. This area embraces a part of the southeastern flank of the Bruce dome. The maximum initial daily production from the wells on this flank is recorded as about 80 barrels of oil from well 63, in which the sand is at 1,242 to 1,272 feet below the surface.

A gas well has been reported, through the press, in the SW. ¼ SE. ¼ sec. 10, which produces from the "Mississippi lime," the sand between the Little and Big limes presumably being dry. It has also been reported through the press that a hole has been drilled in the NE. ¼ sec. 10 to a depth of 1,300 feet without obtaining oil or gas in commercial quantities from the sand between the Little and Big limes. It seems possible, therefore, that the western limit of the productive area of this stray sand lies to the east of these two wells.

Two gas wells in the NW. ¼ sec. 4 have been reported, through the trade journals and the press. These two wells are said to have had initial daily yields of 4,000,000 and 5,000,000 cubic feet of gas, respectively, from a sand between 1,200 and 1,300 feet below the surface. Although logs of these wells are not at hand at the time of writing, it is not unlikely that this sand is equivalent in age to the stray sand. The two wells in sec. 10 may, however, be interpreted as indicating a separation of the gas territory in the NW. ¼ sec. 4 from the proved area in sec. 14 and adjacent territory.

Bartlesville sand.—Very little can be said about the Bartlesville sand in the area covered by the Bruce dome and the Lynn and Brunt anticlines. No commercial production of either oil or gas has been recorded from the sand in this area, but the area is large and has been tested at only three localities—well 72, in the northwest corner of sec. 14; well 97, near the center of sec. 17; and a well recently drilled in the NW. ¼ sec. 9, the exact location of which is not known to the writers. None of these wells produced either oil or gas in commercial quantities from the Bartlesville sand. The essentially proved area of the Bartlesville sand, as outlined on Plate XLVIII, lies several miles south of the area under discussion. All things considered, the outlook for important production from this sand in this area is not very promising, but if a good show of oil is found the sand should be shot before drilling deeper.

"*Mississippi lime.*"—Only a few wells have been drilled deep enough to test the "Mississippi lime" in the area covered by the Bruce dome and the Lynn and Brunt anticlines. Well 72, in the extreme northwest corner of sec. 14, is reported to have reached the "Mississippi lime" at a depth of 1,932 feet and there obtained an initial production of 20 barrels of oil a day. A well in the SW. ¼

SE. ¼ sec. 10 has been reported through the press to have had an initial production of 1,500,000 cubic feet of gas a day from a sand between 1,965 and 1,983 feet from the surface, which is about the right depth for the "Mississippi lime" at this locality. The well reported to have been drilled in the NE. ¼ sec. 10 was not deep enough to test the "Mississippi lime." A well is reported, through the press, to have been drilled in the NW. ¼ sec. 9, near the center of the north line of the quarter section. The sand is reported to have been found between 1,991 and 2,018 feet below the surface and this is probably the "Mississippi lime." The initial production is said to have been about 7 barrels of oil a day. At locality 97 a dry hole has been drilled to a reported depth of 2,070 feet, which was deep enough to test the "Mississippi lime."

The portion of the area covered by the Bruce dome and the Lynn and Brunt anticlines which is believed to have a relatively higher rating as prospective oil or gas territory, if the top of the "Mississippi lime" is regarded as the pay sand, than the adjacent country may be outlined in a general way as follows: The eastern and northeastern boundary of this probable productive area is tentatively limited by the 780-foot contour on the eastern and northeastern flanks of the Bruce dome. (See Pl. XLVI.) The area may extend down from the crest of the Bruce dome to a line made by the 770-foot contour on the southern flank of the dome. The southwestern flank of the Bruce dome and the southern flank of the Lynn anticline may be considered as probable productive territory as far down from their crests as the 760-foot contour. The probable productive area of the Brunt anticline may be roughly outlined as embracing the territory that is partly encircled by the 760-foot contour, which includes a substantial part of the E. ½ sec. 17 and extends into sec. 16 and there merges into the territory described above as the probable productive part of the south flank of the Lynn anticline. The western flank of the Lynn anticline may be considered as probably productive as far down from its crest as the 760-foot contour, and the north flank of both this anticline and the Bruce dome may be found to be productive as far down from their crests as the 770-foot contour. As outlined above, the area that will probably be found to carry oil or gas in the "Mississippi lime" in the area covered by the Bruce dome, the Lynn anticline, and the Brunt anticline embraces a substantial part of the SW. ¼ sec. 3; all of sec. 10 except a portion of the NE. ¼; a relatively small fraction of the SW. ¼ sec. 11; a small fraction of the NW. ¼ sec. 14; the N. ½ and a part of the S. ½ sec. 15; the NE. ¼ and a substantial part of the W. ½ sec. 16; the greater part of the E. ½ sec. 17; all of sec. 9 except a strip about a quarter of a mile wide (east to west) and a mile long (north to south) in the western part of the section; all of sec. 4 except very small fractions of the southwest and northwest corners and a relatively larger fraction in the northeast corner; and a relatively small area in the eastern part of sec. 5.

The crests of the Bruce dome, the Lynn anticline, and the Brunt anticline are more likely to yield gas than oil, and the western flanks of these structural features should in part, at least, produce some oil. It is believed that the faults shown on Plate XLVI that cut the Lynn and Brunt anticlines do not materially lower the rating of the prospective oil and gas value of the area covered by these folds. There is no surface evidence of oil or gas seepages, and if there has been no leakage of oil or gas along the fault planes it is likely that the faults have served to aid in trapping the oil and gas.

OTHER PROBABLE PRODUCTIVE AREAS.

On Plate XLVIII a part of the SE. ¼ sec. 36 is indicated as productive territory of the Bartlesville sand. The same area may be also classed as probable productive territory of the "Mississippi lime," although the wells within the area indicated by shading have not been drilled deep enough to test the upper part of the "Mississippi lime." This area occupies a part of the western flank of the Sand Creek anticline, which lies in sec. 31, T. 27 N., R. 11 E.; sec. 6, T. 26 N., R. 11 E.; and secs. 1, 12, and 11, T. 26 N., R. 10 E. The initial production of the oil wells in the SE. ¼ sec. 36 of the township under discussion ranges from 2 to 40 barrels of oil a day, from the Bartlesville sand. The Bartlesville sand is 18 feet thick in the SE. ¼ sec. 36, according to the available well records. The sands above the Bartlesville have been adequately tested in this area, but no commercial quantities of oil or gas have been found in them.

As indicated in Plate XLVIII, the sand between the Little and Big limes, which is usually found between 1,200 and 1,300 feet below the surface, is expected to be productive over a large portion of the central and southeastern parts of sec. 11, a substantial portion of the southwestern part of sec. 12, a relatively small fraction of the NW. ¼ sec. 13, practically all of sec. 14, a part of the E. ½ sec. 15, and a large portion of the central and northern parts of sec. 23. It should be noted that this area is not located favorably in regard to geologic structure, but on the contrary it occupies the most pronounced structural depression in the township. The explanation is that the oil and gas production here is controlled not by geologic structure but by the character of the sand body. The average thickness of the sand in the producing wells is about 41 feet, and the maximum thickness recorded is 96 feet, in well 93, in the NE. ¼ sec. 15. The average initial daily production of the oil wells within the area indicated by shading on Plate XLVIII is about 45 barrels. It is believed that the productive area is controlled more by the cementation of the sand than by its thickness. Well 93, in which the maximum thickness is recorded, is credited with an initial production of only 5 barrels of oil a day. It seems to be the practice here to use relatively large shots of nitroglycerin (not uncommonly 200 to 300 quarts) to break up the sand in these wells, and this practice suggests that even where the sand is productive it is more or less tightly cemented and that its yield is increased by thoroughly breaking it up.

QUALITY OF THE OIL.

Discussion of analyses of the oil in T. 27 N., R. 10 E., is reserved for the final report on the Pawhuska quadrangle. For the benefit of the reader who is entirely unfamiliar with this field it may be stated that the oil is relatively rich in the lighter hydrocarbons and is classed in price with the oil found in the Bartlesville and Cushing fields. An average specific gravity of the oil measured by the Baumé scale at 60° F. approximates 34.

GENERAL RECOMMENDATIONS.

It is believed that the importance of testing the sands below the "Mississippi lime" is worthy of a second emphasis in this report. The test should first be made on the top of some well-developed anticline or dome, such as the Bruce dome, and if unsuccessful either the Dry Hollow or the Bellieu dome should be tested. Such test wells should be drilled to a depth of 400 feet below the top of the "Mississippi lime."

One of the features shown on Plate XLVI that immediately attracts the eye of the geologist is the large number of oil wells in the most pronounced structural depression in the township, in sec. 14. As explained in another part of this report the production in that area is controlled by the condition of the sand. Because it is impossible to tell in advance of drilling the condition of the sands below the surface, no part of this township is positively condemned for oil or gas. If the sand conditions are uniform the oil in a sand body will be trapped in those places where the geologic structure is favorable, and therefore, if the areas that are located favorably in regard to structure are first tested the risk of failure is greatly lowered. To reduce the risk of failure and to direct the most efficient testing of this township is the prime object of this report.

WELL DATA.

Data on wells in T. 27 N., R. 10 E.

Well No.	Section.	Quarter.	Depth to top of Big lime.	Depth to top of "Oswego lime."	Bartlesville sand.		Depth to top of "Mississippi lime."	Total depth.	Depth of pay sand.	Thickness of pay sand.	Type of well.	Initial daily production.
					Depth to top.	Thickness.						
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*		
2	1	NW. ¼	1,300	1,480	1,779	10	1,926	1,954			Dry	
3	1	NW. ¼	1,270					1,295	894-961 (stray)	67	Gas	2,00,00 cubic feet.
4	1	NW. ¼	1,280	1,445			1,864	1,886	"Mississippi"	22	do	1,510,860 cubic feet.
5	1	SW. ¼		1,505	1,821	17		1,966	Bartlesville	17	do	
6	2	SE. ¼			1,838	11	1,967	2,011			Dry	
13	11	SW. ¼						1,286	1,240-1,276 (stray)	36	Oil	15 barrels.
18	12	NW. ¼						1,269	1,234-1,263 (stray)	29	Gas	450,000 cubic feet.
20	13	NE. ¼	1,315	1,420			1,900	1,925	"Mississippi"	15	Oil	25 barrels.
21	13	SE. ¼	1,335	1,485	1,807	22	1,935	1,969	do	34	do	40 barrels.
22	13	SE. ¼					1,899	1,921	do	22	do	
23	13	SE. ¼					1,898	1,928	do	30	do	
24	13	SE. ¼	1,278	1,430	1,725	20	1,854	1,870	do	16	Gas	5,000,000 cubic feet.
26	13	SW. ¼		1,425			1,865	1,901			Dry	
35	14	NE. ¼						1,270	1,245-1,270 (stray)	25	Oil	50 barrels.
36	14	NE. ¼						1,254	1,220-1,250 (stray)	30	do	35 barrels.
37	14	NE. ¼						1,251	1,208-1,238 (stray)	30	do	50 barrels.
38	14	NE. ¼						1,298	1,258-1,288 (stray)	30	do	35 barrels.
39	14	NE. ¼						1,298	1,260-1,290 (stray)	30	do	Do.
40	14	NE. ¼						1,251	1,214-1,238 (stray)	24	do	60 barrels.
41	14	NE. ¼						1,238	1,212-1,230 (stray)	18	do	40 barrels.
42	14	NE. ¼						1,250	1,214-1,244 (stray)	30	do	
44	14	NE. ¼						1,264	1,225-1,264 (stray)	39	do	20 barrels.
45	14	NE. ¼						1,296	1,252-1,296 (stray)	34	do	85 barrels.
46	14	NE. ¼						1,283	1,243-1,283 (stray)	40	do	15 barrels.
47	14	NE. ¼						1,297	1,246-1,297 (stray)	51	do	110 barrels.
49	14	NE. ¼						1,306	1,272-1,304 (stray)	32	do	30 barrels.
50	14	NE. ¼						1,340	1,259-1,330 (stray)	71	do	85 barrels.
52	14	NE. ¼						1,272	1,210-1,256 (stray)	46	do	60 barrels.
53	14	NE. ¼						1,266	1,223-1,260 (stray)	27	do	30 barrels.
54	14	NE. ¼						1,288	1,246-1,280 (stray)	34	do	60 barrels.
55	14	NW. ¼						1,283	1,247-1,280 (stray)	33	do	20 barrels.
56	14	NW. ¼						1,284	1,249-1,284 (stray)	35	do	40 barrels.
57	14	NW. ¼						1,318	1,261-1,318 (stray)	57	do	Do.
58	14	NW. ¼						1,283	1,231-1,283 (stray)	52	do	60 barrels.
59	14	NW. ¼						1,341	1,307-1,334 (stray)	27	do	15 barrels.
60	14	NW. ¼						1,359	1,274-1,318 (stray)	44	do	Do.
63	14	NW. ¼						1,274	1,242-1,272 (stray)	30	do	80 barrels.
64	14	NW. ¼						1,281	1,247-1,279 (stray)	32	do	15 barrels.
65	14	NW. ¼						1,287	1,254-1,287 (stray)	33	do	35 barrels.
66	14	NW. ¼						1,277	1,241-1,273 (stray)	32	do	65 barrels.

Data on wells in T. 27 N., R. 10 E.—Continued.

Well No.	Section No.	Quarter.	Depth to top of Big lime.	Depth to top of "Oswego lime."	Bartlesville sand.		Depth to top of "Mississippi lime."	Total depth.	Depth of pay sand.	Thickness of pay sand.	Type of well.	Initial daily production.
					Depth to top.	Thickness.						
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*		
67	14	NW. ¼						1,324	1,241–1,307 (stray)	66	Oil	60 barrels.
69	14	NW. ¼						1,297	1,246–1,287 (stray)	41	do	40 barrels.
70	14	NW. ¼						1,281	1,244–1,276 (stray)	32	do	202 barrels. (?)
71	14	NW. ¼						1,297	1,245–1,291 (stray)	46	do	25 barrels.
72	14	NW. ¼						1,971	Mississippi, 1955	19	do	20 barrels.
73	14	NW. ¼						1,304	1,255–1,294 (stray)	39	do	10 barrels.
74	14	NW. ¼						1,315	1,250–1,304 (stray)	54	do	65 barrels.
75	14	NW. ¼						1,294	1,254–1,294 (stray)	40	do	40 barrels.
76	14	NW. ¼						1,329	1,277–1,324 (stray)	47	do	60 barrels.
77	14	SW. ¼						1,375	1,321–1,371 (stray)	50	do	65 barrels.
80	14	SW. ¼						1,309	1,281–1,307 (stray)	26	do	60 barrels.
81	14	SE. ¼						1,349	1,283–1,341 (stray)	58	do	30 barrels.
82	14	SE. ¼						1,372	1,295–1,372 (stray)	77	do	35 barrels.
85	14	SW. ¼						1,369			do	10 barrels.
86	14	SW. ¼						1,379	1,325–1,379 (stray)	54	do	35 barrels.
87	14	SW. ¼	1,430	1,585	1,855	45	2,005	2,125			Dry	
88	15	SE. ¼						1,382	1,324–1,382 (stray)	58	Oil	10 barrels.
89	15	SE. ¼						1,378	1,322–1,368 (stray)	46	do	15 barrels.
90	15	NE. ¼						1,355	1,321–1,340 (stray)	19	do	25 barrels
91	14	NE. ¼						1,353	1,282–1,348 (stray)	66	do	50 barrels.
92	15	NE. ¼						1,329	1,269–1,323 (stray)	54	do	25 barrels.
93	15	NE. ¼						1,361	1,265–1,361 (stray)	96	do	5 barrels.
97	17	NW. ¼						2,070			Dry	
100	22	NE. ¼	1,465	1,611	1,925	10	2,037	2,078			do	
101	22	NE. ¼	1,435	1,592	1,886	15	2,005	2,035			do	
102	22	NE. ¼	1,435	1,589	1,892	16		1,921	Bartlesville		Oil	40 barrels.
103	22	NE. ¼	1,448	1,589	1,900	15	2,016	2,038	2,025–2,038 ("Mississippi")	13	do	35 barrels.
105	22	SE. ¼	1,412	1,562			1,977	2,004	"Mississippi"	27	Gas	4,000,000 cubic feet.
106	23	NW. ¼						1,325	1,294–1,325 (stray)	31	Oil	20 barrels.
107	23	NW. ¼						1,312	1,295–1,310 (stray)	15	do	30 barrels.
108	23	SW. ¼	1,400	1,509			1,975	2,033	"Mississippi"		Gas	
109	23	SW. ¼	1,380	1,531			1,948	1,978	do	30	do	1,000,000 cubic feet.
113	23	SE. ¼	1,325	1,464			1,893	1,938	1,904–1,925 ("Mississippi")	21	Oil	20 barrels.
114	23	SE. ¼	1,345	1,478			1,886	1,934	"Mississippi"		do	5 barrels.
115	23	SE. ¼	1,270	1,330			1,857	1,895	do	38	do	
116	23	SE. ¼	1,267	1,422	1,728	12		1,874	Bartlesville	12	do	
117	23	SE. ¼	1,360	1,510	1,820	20		1,912				
118	26	NE. ¼	1,300	1,450			1,884	1,919	"Mississippi"	35	Oil	
119	24	SW. ¼	1,250	1,395			1,857	1,941	do		do	3 barrels.
121	24	SW. ¼	1,265	1,410			1,863	1,889	1873–1885 ("Mississippi")	12	do	365 barrels (?).
124	24	SW. ¼	1,275	1,435			1,859	1,909	1884–1905 ("Mississippi")	21	do	
125	24	SW. ¼	1,270	1,365			1,855		"Mississippi"		Gas	

126...	24	SW. ¼					1,813	1,853	"Mississippi"	40	Oil	
127...	24	SW. ¼	1,280	1,435			1,848	1,913	do		do	8 barrels.
130...	24	SW. ¼	1,275	1,430			1,864	1,919	1884–1900 ("Mississippi")	16	do	
133...	24	SW. ¼	1,275	1,420			1,845	1,884	1856–1876 ("Mississippi)	20	do	25 barrels.
134...	24	SW. ¼	1,230	1,360			1,871	1,908	1,871–1,880 ("Mississippi)	9	do	
135...	24	SW. ¼					1,828	1,866	"Mississippi"	38	do	
136...	24	SW. ¼	1,235	1,375			1,809	1,854	do	15	do	
137...	24	SW. ¼					1,804	1,854	do	50	do	
138...	24	SW. ¼					1,807	1,857	do	50	do	
139...	24	SE. ¼					1,789	1,839	do	50	do	
140...	24	SE. ¼	1,295	1,450			1,872	1,931	1,910–1,922 ("Mississippi")	12	do	
141...	24	SE. ¼	1,257	1,405			1,798	1,819	"Mississippi"			
142...	24	SE. ¼	1,195	1,341			1,786	1,833	do	14	Oil	Do.
143...	24	SE. ¼					1,808	1,826	do	5	do	
144...	24	SE. ¼	1,100	1,255			1,788	1,831	do	10	do	
146...	24	NW. ¼	1,175	1,400			1,875	1,918	1,875–1,883 ("Mississippi')	8	do	
147...	24	NW. ¼	1,345	1,500			1,907	1,977	"Mississippi"		do	10 barrels.
148...	24	NW. ¼	1,352	1,510			1,943	2,003	do	32	do	50 barrels.
149...	25	NE. ¼							1,779–1,829 (stray)	50	do	
150...	25	NE. ¼	1,250	1,410			1,855	1,896	"Mississippi"	6	do	10 barrels.
151...	25	NE. ¼	1,295	1,455	1,775	15	1,917	1,938	do	12	do	
152...	25	NW. ¼	1,322	1,476			1,908	1,936	do	30	do	
153...	25	NW. ¼	1,303	1,476			1,895	2,245	2,210–2,215 ("Mississippi")	5	Gas	1,500,000 cubic feet.
154...	25	NW. ¼	1,190	1,370			1,881	1,917	"Mississippi")	18	Oil	
155...	25	NW. ¼	1,275	1,430			1,859	1,910	do		do	
156...	25	NW. ¼	1,260	1,415			1,849	1,888	do		do	
157...	25	NW. ¼	1,250	1,400			1,844	1,868	do	14	do	
158...	26	NW. ¼	1,384	1,528			1,956	1,976	do	20	Gas	4,500,000 cubic feet.
159...	26	NW. ¼	1,410	1,550	1,858	10	1,970	1,990	do		do	3,000,000 cubic feet.
160...	26	NW. ¼	1,380	1,520	1,835	5	2,005	2,027			Oil	
177...	34	NE. ¼	1,390	1,510				1,676	1,615–1,676 (stray)	61	Gas	2,750,000 cubic feet.
179...	34	NE. ¼		1,505	1,837	31		1,868	Bartlesville	31	Oil	35 barrels.
183...	34	SE. ¼	1,381	1,528	1,844	13		1,865	do	13	do	135 barrels.
184...	34	SE. ¼	1,372	1,514	1,834	14		1,852	do	14	do	70 barrels.
186...	34	SE. ¼	1,368	1,520	1,835	14		1,859	do	14	do	50 barrels.
187...	34	SE. ¼		1,476	1,790	16		1,812	do	16	do	55 barrels.
188...	34	SE. ¼		1,513	1,819	21		1,861	do	21	do	100 barrels.
189...	34	SE. ¼	1,360	1,515	1,829	17		1,850	do	17	do	90 barrels.
190...	34	SE. ¼	1,360	1,511	1,830	10		1,850	do	10	do	125 barrels.
191...	34	SE. ¼	1,400	1,525	1,849	17		1,868	do	17	do	75 barrels.
192...	34	SW. ¼	1,330	1,520	1,848	10		1,860	do	10	do	40 barrels.
197...	35	SW. ¼	1,340	1,510	1,839	12		1,863	do	12	do	70 barrels.
199...	35	NW. ¼		1,510	1,845	30		1,875	do	30	do	27 barrels.
201...	35	NW. ¼		1,585			2,020	2,039	"Mississippi"	10	do	6 barrels.
206...	35	SE. ¼						1,627	1,606–1,627 (stray)	21	Gas	
207...	35	SE. ¼						1,970			Dry	
208...	36	SW. ¼			1,842						do	
210...	36	SE. ¼						1,813	Bartlesville	18	Oil	2 barrels.
211...	36	SE. ¼						1,810	do	18	do	40 barrels.
212...	36	SE. ¼						1,812	do	18	do	10 barrels.
213...	36	SE. ¼						1,910	do	18	do	40 barrels.