T. 26 N., RS. 9, 10, AND 11 E.

By FRANK R. CLARK.

INTRODUCTION.

The area described in this paper embraces T. 26 N., Rs. 9, 10, and 11 E., and lies in the eastern part of the Osage Reservation. (See fig. 1.) The country is sparsely settled, there being within this area few farms and only one small town, Okesa. The Missouri, Kansas & Texas Railway traverses the southeast corner of R. 10 E. and the central part of R. 11 E., and a new branch of the Atchison, Topeka & Santa Fe Railway (now under construction) traverses the east side of R. 9 E.

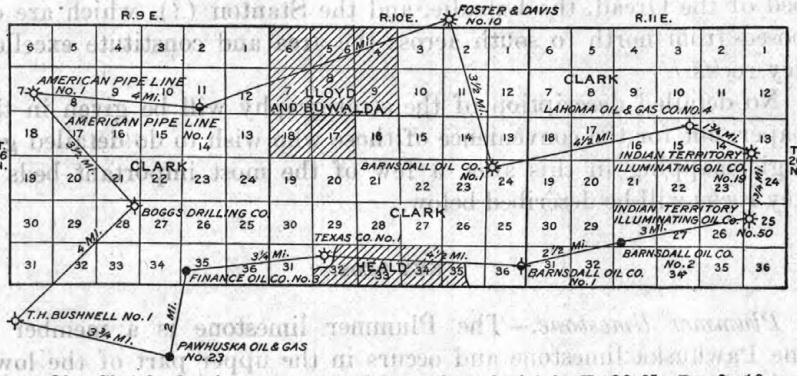


FIGURE 20.—Sketch showing area mapped by each geologist in T. 26 N., Rs. 9, 10, and 11 E., and location of wells shown in Plate XVII.

Field work in these townships was done for varying periods between August, 1917, and June, 1918, by K. C. Heald, W. A. English, E. R. Lloyd, J. P. Buwalda, P. V. Roundy, E. M. Spieker, and the writer, assisted by Lewis Mosburg, Earl Crandall, and R. L. Triplett, instrument men. The area mapped by each geologist is shown in figure 20. The writer, assisted by the men mentioned above, is responsible for the portion indicated without shading. The geology was mapped with plane table and telescopic alidade, but in some densely wooded areas work of this sort was supplemented by

barometer and compass traverse. The barometer work was carefully checked and the structure contours throughout represent the attitude of the surface rocks.

It will be found by comparing the maps of the townships covered by this report with those of the adjacent townships that the contours match exactly except along the boundary lines between Tps. 25 and 26 N., Rs. 10 and 11 E., and T. 26 N., Rs. 11 and 12 E. The failure to match here is due to convergences in one township between certain key beds which are not present in another township and to the presence of lenticular beds which are prominent only over small areas.

STRATIGRAPHY.

ROCKS EXPOSED.

GENERAL FEATURES.

The exposed rocks in this area belong to the middle Pennsylvanian. They consist of shales, sandstones, and limestones aggregating about 900 feet in thickness, and their character and succession are shown graphically on Plate XVI. Shales and sandstones form the major part of the exposed rocks, and the shales are the more abundant. The principal limestones are the Plummer, the Lecompton, the middle bed of the Oread, the Labadie, and the Stanton (?), which are exposed from north to south across the area and constitute excellent key rocks.

No detailed description of the stratigraphy will be given in this paper, but for the convenience of those who wish to do detailed geologic mapping in this area, a few of the most important beds or key rocks will be described below.

KEY BEDS.

Plummer limestone.—The Plummer limestone is a member of the Pawhuska limestone and occurs in the upper part of the lower half of this formation. It outcrops in the west two tiers of sections in T. 26 N., R. 9 E. (see Pl. XIII), and is well developed just east and north of Plummer's ranch house, in sec. 8. It is about 9 feet thick and consists of two benches each about 1 foot thick, separated by about 7 feet of shale. The upper bench, in many places concealed by float or slump from the overlying limestone, weathers in large rectangular blocks from 6 inches to 1 foot in thickness. The rock is dark steel-gray to brown on the weathered surface, but light gray to white on fresh fractures and is massive and crystalline. In physical character and thickness the lower bench is similar to the upper bench, but it differs in containing an abundance of *Fusulina*.

Lecompton limestone.—The Lecompton limestone, described by Heald,[1] is exposed near the top of the flat divide in sec. 21, T. 26 N., R. 9 E., and is well developed farther north in Little Sand Creek. It is about 8 feet thick. In some places it is exposed in two benches, each less than 2 feet thick, separated by about 5 feet of shale, but elsewhere the lower bench is not developed or is replaced by underlying Elgin sandstone. The Lecompton, which is also a member of the Pawhuska limestone, lies 30 to 35 feet below the top bench of the Plummer limestone. It contains *Fusulina* and is of a bright lemon color on weathered surfaces and dull russet-yellow on fresh fractures.

Middle bed of Oread limestone.—The bed of the Oread limestone that is present in this area is regarded as the stratigraphic equivalent of the middle limestone bed of the Oread of Kansas. The interval between the Lecompton and Oread limestones is filled mainly with the Elgin sandstone (about 110 feet thick), and associated shales, aggregating about 205 feet in thickness. The Oread crops out in the east half of T. 26 N., R. 9 E. (see Pl. XIII), and is well developed in the Pawhuska-Bartlesville road on the west side of the big hill along the south line of sec. 36, T. 26 N., R. 9 E. In general appearance it resembles the Lecompton limestones, above described. Where well developed it rarely exceeds 2 feet in thickness, and in many places it is represented only by a thin band (1 to 3 inches) of chertlike nodules about the size of marbles. The characteristic blue-gray lime shale in which the Oread occurs and a red shale and white sandstone series about 20 to 25 feet below it render the correlation of the Oread certain and make it an excellent key rock.

Labadie limestone.—The Labadie limestone in this area occurs about 180 feet below the middle bed of the Oread, but farther south there is a strong convergence between them. Thus the distance between these beds in the southwest quarter of T. 25 N., R. 10 E., is only about 150 feet, whereas north of this area, in T. 27 N., R. 10 E., it is about 170 to 180 feet. The Labadie limestone crops out through the east-central portion of T. 26 N., R. 10 E. (see Pl. XIV), and is particularly well developed at Labadie Point, in sec. 9, and elsewhere on Rock Creek and Sand Creek. This limestone in this area is from 5 to 8 feet thick. The upper portion weathers cinnamon brown and the lower part gray brown, but on the fresh surface it is steel gray and crystalline. In many places it is highly siliceous, and where best developed it crops out in a vertical wall 5 feet or more high. It weathers out in large blocks and forms conspicuous topographic features. The bed does not contain many fossils, but in places they may be found. In T. 27 N. a still higher bench of gray to white color rests on the cinnamon-brown bed.

[1] Heald, K. C., U. S. Geol. Survey Bull. 691, pp. 67–68, 1918 (Bull. 691–C).

Revard sandstone.—The Revard sandstone, which occurs about 140 to 150 feet stratigraphically below the Labadie limestone, is well developed at Revard Point, in sec. 13, T. 26 N., R. 10 E., and elsewhere on Sand Creek in this vicinity. In several places 200 feet of nearly continuous sandstone is exposed from the top of the Revard downward, but the name is applied to the upper 30 to 40 feet, which is usually separated from the sandstone below by a thin shale that in places is bright red. The Revard is a massive, unevenly bedded quartzose sandstone. It is highly cross-bedded, and in some places the upper surface is ripple marked, but in others it is uneven, making a poor surface on which to interpret structure. In places it is overlain by a red shale containing a thin productoid-bearing sandstone, which lies from 7 to 10 feet above the top of the Revard. This thin sandstone aids in correlation and mapping and in the interpretation of the structure. Two prominent sandstones crop out between the Labadie limestone and the Revard sandstone. The upper one occurs about 15 to 25 feet below the top of the limestone. It is massive and ledge-making. The other sandstone, the Cheshewalla, described by Winchester and Heald,[1] closely resembles the Revard and occurs about 80 feet above it. This sandstone is 25 to 40 feet thick, is cross-bedded and massive, and is overlain by red shale and fossiliferous sandstone. Care must be used in mapping these sandstone beds, because the only basis for a distinction is their relative stratigraphic position.

Buck Point sandstone.—The Buck Point sandstone occurs 95 to 115 feet stratigraphically below the top of the Revard sandstone, described above. Together with the underlying shale it is well developed at Buck Point and elsewhere around the edges of the main divide between Sand and Buck creeks in T. 26 N., R. 11 E. On the north side of Buck Creek in secs. 2, 3, and 4 it is characterized by a thin productoid-bearing stratum at the top, which is easily traceable and insures definite correlations. The Buck Point sandstone is about 45 feet thick and forms a prominent bench with a vertical cliff below. It is easily traced in the field, but over the greater part of this area its only distinctive characteristic is the presence of a calcareous conglomeratic bed at or near the base, which at many places is associated with *Fusulina*-bearing sand. Except for a thin shale immediately overlying the Buck Point, the interval between the Revard and Buck Point sandstone is occupied principally by sandstone, and in a few places the entire interval is filled with sand. Below the Buck Point sandstone is a shale, which at Buck Point is about 75 feet thick and which occupies approximately the same stratigraphic position as the shale below the Bigheart sandstone, described

[1] Winchester, D. E., and Heald, K. C., report on T. 25 N., R. 10 E.: U. S. Geol. Survey Bull. 686–G, 1918.

by Hopkins.[1] The Buck Point and Bigheart are, however, not continuous and are probably not at exactly the same stratigraphic horizon. They are therefore given different names.

Okesa sandstone.—The Okesa sandstone, so called because it crops out near the railroad station and town of Okesa, forming the first prominent bench half a mile to the southeast, occurs 65 to 115 feet below the Buck Point sandstone. The maximum distance was measured at Buck Point and the minimum on Paula Creek south of Okesa, and there is thus a 50-foot convergence between these sandstones toward the south and west. The Okesa is 20 to 30 feet thick and is well developed on both sides of Sand Creek as far west as Okesa but passes below drainage level in the bed of Sand Creek at the Bartlesville-Pawhuska wagon road crossing half a mile north of Okesa. It is also well developed on both sides of Little Rock Creek, and the outcrop extends southward into T. 25 N., R. 11 E. In the vicinity of Okesa it is confined to one bed which contains numerous pelecypods and a few brachiopods, but in most places within this area two benches are developed, separated by shale. The lower bench is generally massive and forms a ledge, and its upper surface contains fossils. A thin nodular limestone crops out at many places about 5 feet above the lower bench. The upper bench, which is from 10 to 13 feet above the lower, is thinner and not so well exposed, but wherever seen it contains many pelecypods. A shale from 25 to 60 feet thick occurs below the Okesa and above the Torpedo sandstone.

Torpedo sandstone and Stanton (?) limestone.—The Torpedo sandstone, which crops out over a large area in the eastern part of T. 26 N., R. 11 E., occurs about 65 feet below the top of the Okesa sandstone, but in places the stratigraphic distance between these beds varies as much as 50 feet. The distance between the Okesa and Torpedo sandstones in the SE. ¼ sec. 7, T. 26 N., R. 12 E., is 75 feet, and near the center of sec. 1, T. 26 N., R. 11 E., it is not more than 25 feet, showing a convergence of 50 feet in a distance of less than 2 miles. Other convergences, though not so great, occur near Buck Point and to the southwest. The torpedo sandstone is 20 to 30 feet thick, is massive, and in general forms a ledge. In many places its upper surface is filled with tubelike openings. An impure siliceous limestone, probably the Stanton, occurs above the Torpedo sandstone. The limestone is generally separated from the sandstone by 2 to 9 feet of blue-gray limy shale, containing crinoid stems, but in a few places it rests directly on the sandstone. The limestone, though generally thin, is in some places several feet thick. It contains many crinoid stems and locally other fossils. It weathers lemon yellow, but on fresh fracture is steel gray. The Torpedo sandstone and the Stan-

[1] Hopkins, O. B., report on T. 25 N., Rs. 11 and 12 E.: U. S. Geol. Survey Bull. 686–H, 1918.

ton (?) limestone are well developed in the bluff on the north side of Sand Creek 1 mile northwest of Torpedo siding and also at many places on Little Rock Creek and along the Pawhuska-Bartlesville road on the north side of Sand Creek.

ROCKS NOT EXPOSED.

Records of wells in this area show that between the surface rocks and the Big lime occur shale, sandstone, and limestone, and that the shale aggregates a greater thickness than the sandstone and limestone combined. Between the Big lime and the "Mississippi lime" shale and limestone predominate, but there are a few prominent sandstones which yield oil and gas. The character of the rocks is clearly indicated in Plate XVII, in which is shown graphically the drillers' interpretation of the rocks penetrated in several selected wells in this area. These records are alined on the horizon of the middle bed of the Oread limestone as a datum.

The Big lime is the first key bed that the driller has attempted to recognize, and therefore his interpretation of the rocks above it is in many logs only roughly recorded and in many others unfortunately not recorded at all. Correlations of beds above the Big lime, from well logs now available, must be based on relative positions. The irregularities shown in the intervals between certain prominent sandstones or limestones may be in part true irregularities, due to variations in the conditions of deposition and in part simply the result of errors in measuring or recording the log. From a study of surface rocks it is known that prominent beds vary in thickness and that strong convergences exist between these beds, but many logs show impossible conditions. It is therefore suggested and urged that the utmost care be taken in future drilling to record the log accurately from the surface to the bottom of the hole, because such a record will materially aid the geologist and also the driller in the interpretation of these rocks and of their bearing on the production of oil. The driller has taken more pains to record the character of the rocks between the top of the Big lime and the "Mississippi lime," probably because most of the oil produced at present comes from that interval and also because these beds contain characteristics which he more easily recognizes.

The distance between the horizon of the middle bed of the Oread limestone and the Big lime ranges from 1,350 feet in sec. 7, T. 26 N., R. 9 E., to about 1,580 feet in sec. 25, T. 26 N., R. 11 E., and averages about 1,500 feet for the logs shown in Plate XVII.

Below the Big lime is a sandstone and shale series aggregating 65 to 110 feet, followed by a limestone (the Fort Scott) 60 to 100 feet thick, usually called "Oswego lime" by the drillers. The Peru sand, normally present between the Big lime and the "Oswego

lime," is either absent in several of the wells whose logs are shown in Plate XVII or the drillers failed to recognize it. The Peru sand in places in Osage County is productive of oil. The "Oswego lime" is usually separated into several benches by partings of black shale, a characteristic which aids the driller in recognizing this key bed. Showings of gas are reported from this bed, but no big yield is known in this vicinity. Below the "Oswego lime" and above the "Mississippi lime" is a series of shale, sandstone, and thin limestone from 250 to 375 feet in thickness in which the shale aggregates many times the amount of sandstone and limestone. The productive oil and gas sands in this interval are the Squirrel and Bartlesville. The Squirrel sand ranges from 10 to 138 feet in thickness and, according to most of the logs studied, is separated from the "Oswego lime" by shale, but in several places the lime rests directly on the sand. The beds between the Squirrel and the Bartlesville consist mainly of shale with a number of thin limestones, one of which is the so-called Pink lime, which in some parts of Osage County is easily recognized by the driller. Between the Pink lime and the "Mississippi lime" is a series of sandstone interbedded with shale. Any productive sand in this interval is called Bartlesville by the drillers, and in this region the Bartlesville embraces the basal portion of the Cherokee—that is, of the Pennsylvanian. Several wells in this area have gone below the Bartlesville and associated sands and reached a limestone commonly called the "Mississippi lime," which probably represents the Boone limestone of northeastern Oklahoma and Kansas, but the correlation is not at present absolutely certain. Its thickness is not known, because it has not been completely penetrated, but at several places in Osage County beds below the top of this lime have yielded oil and gas in commercial quantities. It should be tested to a depth of 300 feet in areas of distinctly promising structure.

A study of the logs of wells drilled in this area shows many irregularities in the thickness and character of the rocks between certain recognizable key beds but reveals a very significant fact, namely, that between the surface beds and the "Mississippi lime" there is a strong divergence toward the south and east. The well logs are so chosen (see fig. 20) that by combining certain logs profile sections may be had in almost any direction. As they are arranged in Plate XVII they show roughly north-south and east-west profiles. The "Mississippi lime" is stratigraphically more than 400 feet deeper at the southeast corner of T. 26 N., R. 11 E., than it is at the northwest corner of T. 26 N., R. 9 E. The few available detailed well logs show variations in the position of the "Mississippi lime," but as a whole the logs shown in Plate XVII are convincing and are sufficient to establish the existence of this strong divergence.

STRUCTURE.

AREAS OF FAVORABLE STRUCTURE.

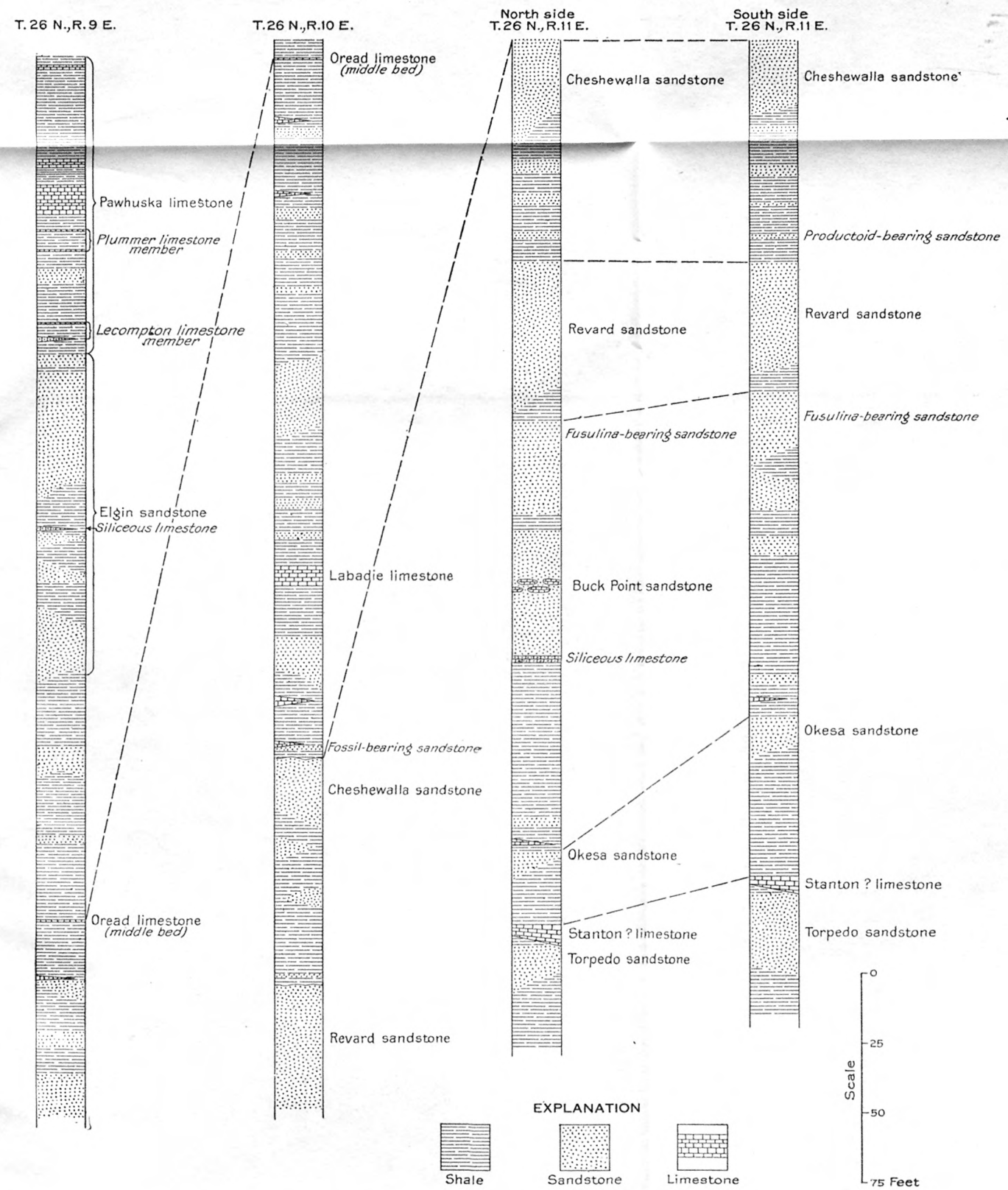
GENERAL FEATURES.

The area covered by this report is a portion of a much larger region in which the general dip of the rocks is to the west and northwest. The presence of an east dip is therefore significant, because it indicates an upfold that may yield commercial quantities of oil and gas.

A study of the trend of oil production in many developed fields in Osage County indicates that in general the oil occurs in areas of anticlinal structure and that it has migrated up the dip from the west. There appears to have been little migration of oil along the strike of the rocks, even in small folds, because in many of the folds commercial production is confined largely to the west flank unless the uplift is large and there is considerable gathering ground in other directions. In testing the oil possibilities of any fold one or even two dry holes which are structurally favorably located should not condemn the fold, because a "tight sand" may prevent the accumulation of oil in one part, whereas in another part an "open sand" may yield a good quantity of oil. No well favorably located structurally should be considered a failure until it has penetrated the "Mississippi lime" at least 300 to 400 feet. Sites for test holes are indicated on the accompanying maps (Pls. XIII–XV). These sites are chosen with reference to structure and may be shifted slightly if necessary to obtain favorable topographic positions.

The rocks in the west half of T. 26 N., R. 9 E., and the central, northwestern, and southeastern parts of T. 26 N., R. 10 E., dip gently to the west, with few marked irregularities, in conformity with the regional structure. The rocks in the east half of T. 26 N., R. 9 E., the southwest and northeast corners of T. 26 N., R. 10 E., and all of T. 26 N., R. 11 E., are more closely folded, producing many uplifts which are favorable for the occurrence of oil and gas. There are few faults in this area, the principal ones being confined to the east half of R. 9 E., although a few are found elsewhere. The structure is shown by means of contours on the maps. These contours are based solely on surface data and are drawn on a theoretical bed 560 feet below the top bench of the Plummer limestone.

For convenience in description the folds that are favorable for oil will be described from west to east, beginning with the Myers dome, in the northwest corner of T. 26 N., R. 9 E. (See fig. 21.)



GENERALIZED SECTIONS OF ROCKS EXPOSED IN T. 26 N., RS. 9, 10, AND 11 E.

ANTICLINES IN T. 26 N., R. 9 E.

MYERS DOME.

The Myers dome is a nearly symmetrical dome with a small crown situated near the center of sec. 12, T. 26 N., R. 8 E. It has a closure of more than 70 feet, and the lowest closed contour incloses about 3 square miles, of which about half a square mile lies in the W. ½ sec. 7, T. 26 N., R. 9 E. A shallow sand is now yielding gas from this dome, but oil and gas sands deeper than 1,000 feet have not been tested.

The only deep well near the dome is in the SW. ¼ NE. ¼ sec. 7 (American Pipe Line No. 1). It was drilled to a depth of 2,250 feet and probably reached the "Mississippi lime" at 2,180 feet, although the lime in the bottom of the hole may be about the horizon of the Pink lime. Even if the drill reached the "Mississippi lime," this hole does not test the oil and gas possibilities of the deeper sands, be-

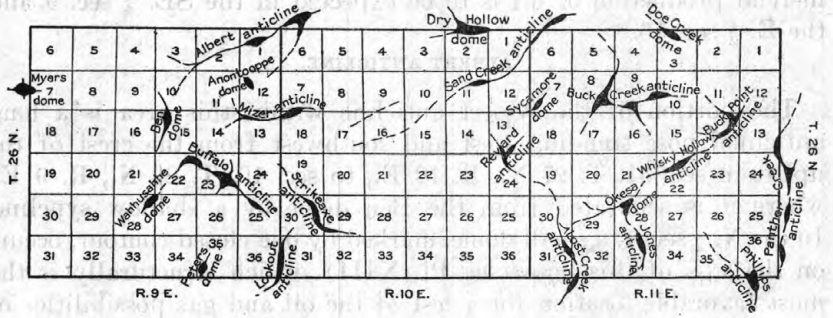


FIGURE 21.—Sketch showing roughly the position of anticlinal axes in T. 26 N., Rs. 9, 10, and 11 E., shaded to indicate the crests of folds.

cause the well is off the productive area and in the bordering syncline. The proper location for a test well for that part of the Myers dome situated in this area is shown on Plate XIII.

The Myers dome is the only pronounced uplift in the west half of T. 26 N., R. 9 E., but there is a considerable area that may yield oil or gas. The rocks in the west two tiers of sections are comparatively flat, but there are possibly three areas in which they may be slightly bowed up—(1) the NE. ¼ sec. 8; (2) the SW. ¼ sec. 17 and NW. ¼ sec. 20, and (3) the NW. ¼ sec. 19. Structurally these areas are low, flat terraces or possibly slight upwarps and may catch and hold some gas and possibly oil. A striking northwest fault cuts the surface rocks in secs. 19 and 29. The greatest displacement, 10 feet, is in the SE. ¼ sec. 19, and the downthrow is on the east.

A belt of steeply dipping rocks extends from north to south through the middle of T. 26 N., R. 9 E. This belt is considered

fairly favorable for the accumulation of oil, and test wells should be drilled near the top of the steeply dipping zone. The "Mississippi lime" will probably be reached within 2,200 feet.

BEN DOME.

The crown of the Ben dome is in the NW. ¼ sec. 15, T. 26 N., R. 9 E. It has a closure of less than 20 feet, and the lowest closed contour incloses an area of about a quarter of a square mile. This dome has an ample gathering area and is structurally very favorable for the accumulation of oil. The crown probably contains gas, and tests for oil should therefore be drilled on the west flank at locations shown on the map (Pl. XIII).

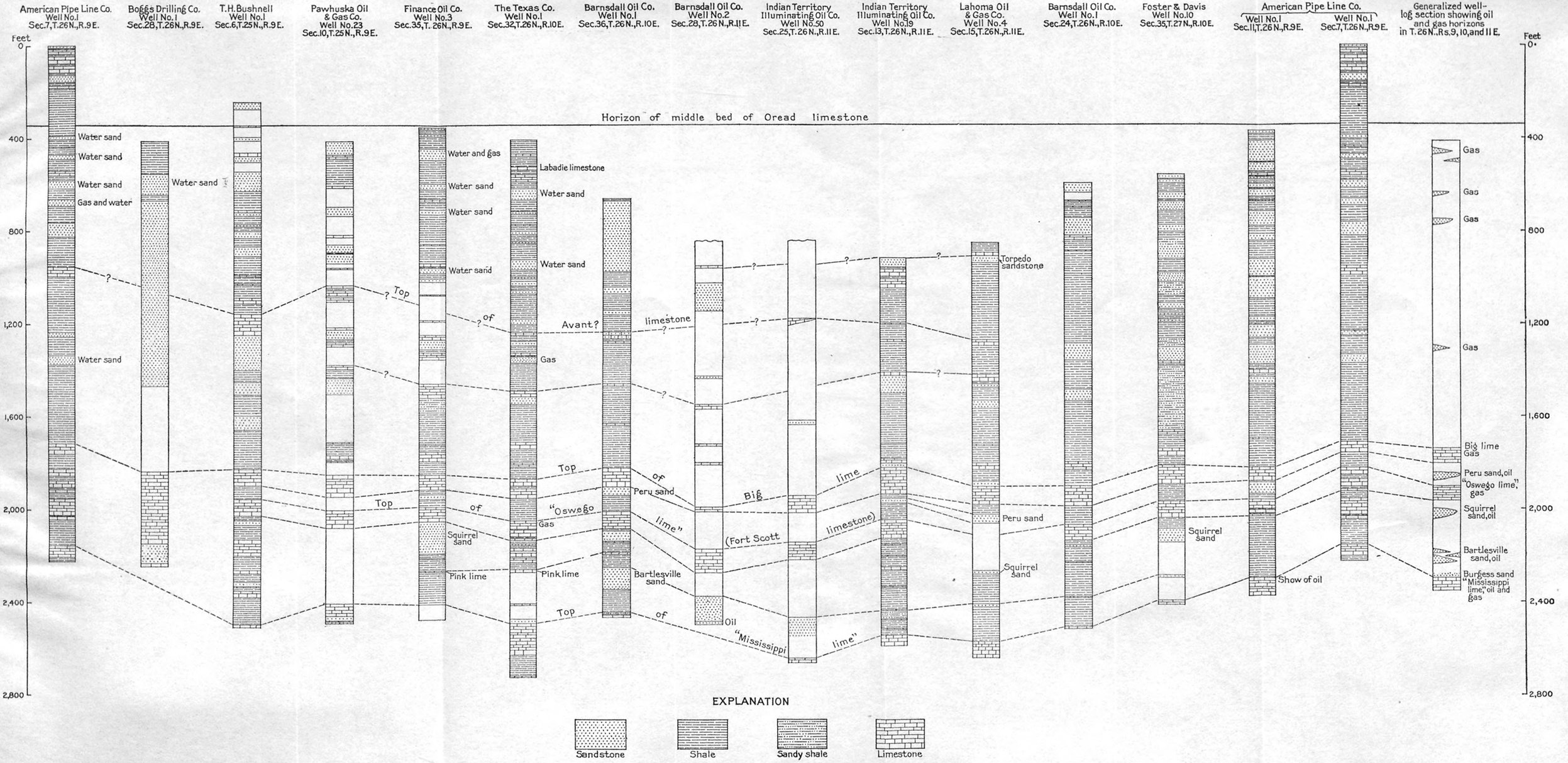
Of these the most promising is that in the NE. ¼ sec. 16, where the "Mississippi lime" will probably be reached within 2,200 feet, but the well at this site should be drilled to a depth of 2,500 feet to constitute a thorough test. If the test wells prove successful commercial production of oil is to be expected in the SE. ¼ sec. 9 and the E. ½ sec. 16.

ALBERT ANTICLINE.

The portion of the Albert anticline within this area is a long anticlinal nose trending west and southwest from the crest of the uplift in sec. 31, T. 27 N., R. 10 E., to sec. 10, T. 26 N., R. 9 E., where it is separated from the Ben dome by a shallow syncline. In the N. ½ sec. 1, a small dome, marked by one closed contour, occurs on the axis of this nose (see Pl. XIII), which structurally is the most favorable location for a test of the oil and gas possibilities of the Albert anticline in this great area, but a site on the main crest of the uplift in sec. 31, T. 27 N., R. 10 E., is the most favorable for a test hole. The "Misissippi lime" in the test hole indicated on Plate XIII is believed to lie at a depth of 2,050 to 2,100 feet, but the test well in the NW. ¼ sec. 1 should be drilled at least 2,400 feet. If this test proves successful, oil in commercial amounts may be expected in each direction, especially westward. The anticlinal nose, which extends through sec. 2 and into sec. 10 structurally, also has fair possibilities for the accumulation of oil, especially in the SW. ¼ sec. 2, where the gently dipping strata pitch westward into the steeply dipping monocline.

ANONTOOPPE DOME.

The Anontooppe (a-non-to-op'pe) is a small flat-topped dome having a closure of less than 20 feet and an inclosured circular area of about 100 acres. It is limited on the south by a broad, shallow syncline and on the east by a faulted syncline. The fault trends northwest and has a maximum downthrow of about 20 feet on the



DRILLERS' RECORDS OF SELECTED WELLS IN TPS. 25, 26, AND 27 N., RS. 9, 10, AND 11 E.

west. The dome has a good gathering area to the west, and so far as its structure is concerned may be expected to yield considerable oil, although it is probable that the crown will yield gas. The best location for a test is shown on Plate XIII. The "Mississippi lime" should be reached here at a depth of about 2,050 to 2,100 feet, but the dome should not be condemned by an unsuccessful well less than 2,400 feet deep.

BUFFALO ANTICLINE.

The Buffalo anticline is the most pronounced uplift in T. 26 N., R. 9 E. It affects the attitude of the rocks over several square miles. The axis of the anticline, on which there are three domes separated by shallow structural saddles, is roughly crescent shaped and trends southeastward through secs. 22, 23, 24, and 25. (See Pl. XIII and fig. 21.) The uplift is limited on the south and east by deep synclines which are accentuated by faulting, but on the west a long monocline extends for several miles. The normal attitude of the rocks affected by the uplift in the SE. ¼, T. 26 N., R. 9 E., has been distorted at several places by northwestward-trending faults. This complexly faulted area is part of a larger northeastward-trending zone of weakness across the Pawhuska quadrangle, in Osage County, in which the rocks are displaced and shattered. Three faults cut the rocks in the E. ½ sec. 22. The vertical displacement of each is less than 10 feet, and therefore, unless they are accentuated in the vicinity of possible oil-bearing sands, they have had little effect on the migration or accumulation of oil. Two other faults, about 500 to 1,000 feet apart, cut the rocks on the south side of this fold in secs. 26 and 36 and greatly alter the trend and shape of the bordering syncline. The maximum vertical displacement of these faults appears near the northeast corner of sec. 35, where the west block of the west fault has been dropped about 10 feet and the east block of the east fault has been dropped about 30 feet. The maximum displacement of these faults, if it continues to the possible oil-bearing sands, is thought to be sufficient to retard the migration of oil and perhaps to offset oil or gas sands completely, so that an accumulation of oil might result. Three other faults in secs. 24, 25, and 36 limit or cut off the anticline on the east and convert the normal east flank of the uplift into a syncline. The west block of the west fault has a maximum downthrow of 10 feet near the center of the SE. ¼ sec. 25. The middle fault is the largest and is of the scissors type. The hinge or point of zero throw is in the SE. ¼ sec. 25, near the axis of the syncline that separates the Buffalo and Lookout anticlines. North of this point the maximum displacement is in the SW. ¼ sec. 24, where the east block has been dropped 50 feet; south of the hinge point the maximum displacement is in the SE. ¼ sec. 25, where the west block

has been dropped 10 feet. The east fault has its maximum throw near the line between secs. 13 and 24, where the east block has been dropped 25 feet. The throw of each of the three faults above described diminishes rapidly in either direction, and each fault passes into a flexure within less than a mile from the point of maximum displacement. If the displacement of the rocks due to the faults continues to the oil sands, it is sufficient to retard migration up the bordering syncline on the north, and would result in a small accumulation of oil on the northeast flank of the highest dome of the Buffalo anticline.

The center and highest dome of the Buffalo anticline, in the SE. ¼ sec. 23, has a closure of nearly 40 feet and an inclosed area of about half a square mile. Its axis trends southwest, or transverse to that of the main uplift, and pitches in either direction, terminating in bordering synclines. The long monocline on the northwest and southwest flanks affords ample gathering ground for a considerable accumulation of petroleum. The crown of this dome has been drilled, and several gas sands are reported—at 317 to 328 feet, yielding 5,000,000 cubic feet; at 420 feet, 2,000,000 cubic feet; and at 2,105 feet, 5,000,000 cubic feet. The deep producing sand is the upper part of the "Mississippi lime" of the drillers. As the crown of the dome yields gas, it is very probable that the flanks will be oil bearing, but just where the line between the oil and gas may be is difficult to predict. Locations for test oil wells are shown on the map (Pl. XIII). The more favorable of these two is that in the SW. ¼ sec. 23, where the "Mississippi lime" is believed to lie at about 2,075 feet, but the well should be drilled to a depth of at least 2,400 feet to constitute a thorough test. It seems probable that oil may be expected in the NE. ¼ and the W. ½ sec. 23 and in the NW. ¼ sec. 26.

The dome at the northwest end of the axis of the Buffalo anticline is considered favorable oil and gas territory. It has a closure of nearly 20 feet and a pear-shaped inclosed area of about 40 acres. Three faults have slightly displaced the surface rocks affected by this dome, but they are too small, unless they are accentuated below the surface to influence seriously the migration and accumulation of oil. The long monocline extending westward from the dome gives an excellent gathering ground. It seems very probable that the inclosed area of this fold will yield gas, and therefore the test oil wells should be on the west flank. Locations recommended for these wells in the NE. ¼ sec. 22 are shown on Plate XIII. The location nearest the center of the section is preferable, being at the top of a zone of steeply dipping beds and on a southwestward-plunging nose of the anticline. The "Mississippi lime" at this point may be expected at a depth of about 2,125 to 2,150 feet. Should this test prove success-

ful, development should be extended toward the west, south, and east; should it yield neither oil nor gas, the next test should be made on the crown of the dome.

The dome at the southeast end of the axis of the Buffalo anticline is considered fair oil and gas territory. It is separated from the highest dome of the Buffalo anticline on the north by a structural saddle, and from the Lookout anticline on the southeast, in T. 26 N., R. 10 E., by a shallow syncline. Faults convert the east flank into a syncline and are so situated that they may retard migration and aid in the accumulation of petroleum at the crest. The gathering ground for this dome is relatively small because the faults in secs. 26 and 36 may cut off migration, but oil may find its way around the faults or even across them if the oil-bearing stratum is not entirely offset. The location for a test well shown on the map is on the crest near the north end, where the "Mississippi lime" should be reached at a depth of about 2,100 feet, but a thorough test requires drilling to at least 2,400 feet. A study of the productive areas in some of the best-developed and largest fields in Osage County leads to the conclusion that oil may be expected to extend from the Wahhusahhe dome into the Buffalo anticline in secs. 22 and 23, possibly the southwest corner of sec. 24, the E. ½ W. ½ sec. 25, and sec. 26 except the SE. ¼.

WAHHUSAHHE DOME.

The Wahhusahhe (wah-hu-sah'he) dome is a small uplift whose crown is in the NW. ¼ sec. 27 and the NE. ¼ sec. 28. It has a closure of about 10 feet, and its one closed contour incloses less than 40 acres. It has ample gathering ground to the west and north but is narrowly limited on the south and east by a shallow syncline. A well was drilled near the crown to a depth of 2,073 feet, and the log reported "Mississippi lime" at 2,060 feet. It is significant that no oil or gas is reported from the shallow sands which are producing gas in the Myers dome, in sec. 12, T. 26 N., R. 8 E., and in the Buffalo anticline, in sec. 23, T. 26 N., R. 9 E. This well does not, however, condemn the Wahhusahhe dome, because from the best information available from well records the dry hole failed to reach the "Mississippi lime" by about 100 feet. The lime reported at 2,060 feet may be either the Pink lime or another associated with it. The test well at the site indicated on the map (Pl. XIII) should be drilled to a depth of 2,400 to 2,500 feet before condemning the dome. If the test well proves successful, oil will probably be obtained both west and northwest of it, but the productive area will be small, because the rocks are affected by the folding over only a small area.

PETERS DOME.

The name "Peters dome" is applied to a small part of a considerable terrace in sec. 35, which is indicated on Plate XIII by one closed contour. A broad syncline borders the terrace on the east and the southwest. Four wells on the crown are producing oil from the "Mississippi lime," and two dry holes are reported on the east flank, or near the bordering syncline, which appears to limit the productive area in that direction. According to the structure, future development should extend northward and probably southward to the section line.

ANTICLINES IN T. 26 N., R. 10 E.

MIZER ANTICLINE.

The Mizer anticline is a low uplift, with a closure of less than 20 feet and a circular inclosed area of about 160 acres, in the SW. ¼ sec. 7 and the NW. ¼ sec. 18, T. 26 N., R. 10 E. A long, flat anticlinal nose extends westward to the west line of sec. 13, T. 26 N., R. 9 E., where it pitches westward into a monocline. A deep eastward-trending syncline separates this anticline from the Buffalo and Strikeaxe anticlines, to the south, and a shallow, narrow syncline separates the Anontooppe dome and Mizer anticline. Two locations are suggested for test holes on this anticline. (See Pls. XIII and XIV.) The "Mississippi lime" should be reached in the NW. ¼ sec. 13, T. 26 N., R. 9 E., at a depth of about 2,050 to 2,100 feet, and in the NW. ¼ sec. 18, T. 26 N., R. 10 E., at about 2,000 feet, but if necessary these tests should be drilled to 2,300 or 2,400 feet.

LOOKOUT ANTICLINE.

The axis of the Lookout anticline trends north in sec. 31 along the township line between Rs. 9 and 10 E. It has a closure in this area of about 20 feet and an inclosed area of about 200 acres. A prominent anticlinal nose trends southwestward across the center of sec. 1 and into sec. 2, T. 25 N., R. 9 E., where a small dome is developed at the end of the nose. This part of the anticline in T. 25 N., R. 9 E., is described by Heald.[1] The Lookout uplift is bordered on the east and west by well-developed synclines, and on the north and northeast it is separated from the Buffalo and Strikeaxe anticlines by shallow synclines or structural saddles. There is fair gathering ground to the west and southwest and no surface evidence to prevent or retard the migration of petroleum into the crest of this fold. A small northwestward-trending fault with a maximum throw of less than 10 feet cuts the surface rocks on the crest of this anticline in sec. 1, T. 25 N.,

[1] Heald, K. C., report on T. 25 N., R. 9 E.: U. S. Geol. Survey Bull. 686–E, 1918.

R. 9 E., but it can have little or no effect on the accumulation of petroleum. This anticline is now being tested. There are two producing wells, one yielding gas and one oil, and two other wells being drilled (August 15, 1918). (See Pls. XIII and XIV.) The detailed logs are not yet available, so the source of the output is not known. The producing wells are nearly on the crest of the anticline, and therefore development should extend between them and westward. The oil well is at the north end, near the point where the axis plunges into the syncline. Structurally the E. ½ sec. 36, T. 26 N., R. 10 E., is favorable for oil production.

STRIKEAXE ANTICLINE.

The Strikeaxe anticline has a crescent-shaped northwestward-trending axis in secs. 29 and 30, T. 26 N., R. 10 E. It has a closure of about 25 feet and an inclosed area of about three-quarters of a square mile. It is limited on the north, east, and south by well-developed synclines. The one on the south is a broad, flat, shallow depression; those on the north and east are deeper and narrower. The Strikeaxe and Lookout anticlines are separated by a narrow structural saddle, and it is not unlikely that the productive area may extend across the saddle from one anticline to the other. The presence of oil and gas in the Lookout anticline places the Strikeaxe anticline almost adjacent to an area that is now producing. This anticline has a considerable gathering area, especially to the northwest, which renders the north and west flanks much more favorable for oil production than the east and south flanks. The broad, flat syncline on the south is not particularly favorable for the migration of petroleum, and the south flank of the Strikeaxe anticline is too short to afford a large accumulation. The results of a dry hole on the south flank in the NW. ¼ sec. 32 enhance the value of the fold rather than condemn it, for although this well is structurally unfavorably located showings of gas were reported at depths of 870, 950, and 1,090 feet, all above the Big lime, and at 2,100 feet, in the top of the "Mississippi lime." This suggests that the east end of the crest of the fold may yield gas or oil, and structurally the north end is much more favorable. Locations for test holes are shown on Plate XIII. The one on the crown may yield gas, but that on the north end of the anticline should yield oil. The "Mississippi lime" should be reached in the test on the crown at about 2,125 to 2,150 feet and in the one at the north end at about 2,050 to 2,100 feet.

Two locations for test holes in sec. 16, T. 26 N., R. 10 E., are indicated on Plate XIV. The structure here is less favorable for the accumulation of oil than it is on pronounced closed uplifts, but,

nevertheless, tests for oil and gas are warranted. These locations are on rather prominent anticlinal noses, which plunge westward into a steeply dipping monocline that terminates in a pronounced depression in secs. 18 and 19, T. 26 N., R. 10 E. The monocline affords good gathering ground, and the zone of steeply dipping rocks followed by the flat anticlinal noses affords favorable conditions for the accumulation of oil. The "Mississippi lime" in these test holes should be reached at about 2,000 feet. Should either or both tests prove successful, further development should first extend westward.

DRY HOLLOW DOME.

The Dry Hollow dome is a prominent uplift in Tps. 26 and 27 N., R. 10 E. The rocks affected by the folding lie in secs. 2 and 3, T. 26 N., and secs. 34 and 35, T. 27 N. The long axis of the dome trends east just south of the township line. It has a closure of about 25 feet and an elliptical inclosed area of nearly half a square mile. The fold is limited on the southeast by a southward-pitching syncline which on the north merges into a broad, flat depression. On the southwest, west, and northwest a long westward-dipping monocline extends for several miles from the crown of the dome and affords ample gathering area for a considerable accumulation of oil and gas. The crown of the dome yields oil from the Bartlesville sand and gas from the "Mississippi lime." Many of the oil wells make some gas, but the Bartlesville sand is not a heavy gas producer here. The "Mississippi lime" has been penetrated only near the crown of the dome, where it is gas bearing, and it will very probably yield oil on the west flank. Future development should be extended south and west from present producing wells in this area. The dry holes near the syncline limit the probable productive area on the southeast, but the dry holes adjacent to producing wells on the southwest flank may not indicate the limit of production in that direction, because an oil well in the SW. ¼ sec. 2 is not as favorably situated on the dome as the dry holes north of it. The dry holes are probably due to "tight sands" or other local conditions. The largest producing wells (50 to 60 barrels) on the dome in T. 26 N. are in the NE. ¼ sec. 3, and producing wells extend down the west flank as low as the 750-foot contour. The future possibilities of this dome appear bright, and before it is abandoned the "Mississippi lime" should be thoroughly tested—first by a number of holes drilled well down on the west flank (probably in the NE. ¼ sec. 3) to determine the oil possibilities of the beds which are producing gas on the crown; and, second, by one or more tests favorably located on the dome and penetrating the "Mississippi lime" to a depth of 300 or 400 feet.

SAND CREEK ANTICLINE.

The crest of the Sand Creek anticline is in sec. 31, T. 27 N., R. 11 E., but a long anticlinal nose trends southwestward through secs. 1 and 12 and into sec. 11, T. 26 N., R. 10 E., where it pitches westward into a long monocline. The closure of the crest is about 25 feet, and the inclosed area covers about 1 square mile. The rocks affected by this folding cover about 6 square miles and are situated in the adjoining corners of four townships, Tps. 26 and 27 N., Rs. 10 and 11 E. The uplift is limited on the south and east by a major well-developed northeastward-trending syncline, which is broad and shallow through sec. 6, T. 26 N., R. 11 E., and it is separated from the Dry Hollow dome, on the west, by a southward-pitching syncline. A number of wells have been drilled on various parts of this anticline. On the west flank of the main crest in sec. 31, T. 27 N., R. 11 E., and sec. 36, T. 27 N., R. 10 E., several oil wells and at least one gas well have shown good yields from the Bartlesville sand. That part of the anticline lying in the area covered by this report, however, has not been properly tested. In this township a well in the NW. ¼ sec. 1 is now abandoned though still making some gas, and a dry hole is reported near the east quarter corner of the same section, but this report was not verified in the field. The latter hole is not especially well located structurally, but no record is available, and therefore it may not constitute a thorough test even of this part of the fold. This anticlinal nose should yield considerable oil along its west flank, especially in the NE. ¼ sec. 11, where a small dome is developed at the end of the nose. The long monocline on the west affords a good gathering area for a considerable accumulation of petroleum. At the location for a test hole indicated on Plate II, the "Mississippi lime" will probably be reached at about 1,900 feet. If this test proves successful, all sec. 11 but the S. ½ S. ½ may be expected to produce oil.

REVARD ANTICLINE.

The Revard anticline is a long anticlinal nose with northwestward-trending axis and in a broad way is a part of the Lost Creek anticline in the southwest corner of T. 26 N., R. 11 E. It has a small dome at the north end, indicated on Plate XIV by one closed contour, which incloses about 40 acres. It is limited on the north and east by a major syncline with pronounced depressions in sec. 12, T. 26 N., R. 10 E., and sec. 19, T. 26 N., R. 11 E. A long, nearly uniform monocline extends west and southwest for several miles from the crest of this nose and affords excellent gathering area for a considerable accumulation of petroleum. It is very probable that the crest of the anticline will yield gas, but the west flank should yield

considerable oil. A well on the west flank near the 840-foot contour (see Pl. XIV), in the NW. ¼ sec. 24, is yielding gas from the "Mississippi lime," and this indicates that a well in the SW. ¼ sec. 13, T. 26 N., R. 10 E., will probably yield gas. The location for a test hole shown on Plate XIV is a little higher on the fold than the gas well in sec. 24, and from structural considerations, therefore, a well here may yield gas, but it is also a favorable location to test the westward-plunging nose of the anticline. If it yields only gas, a second well should be drilled 1,000 feet due west. The "Mississippi lime" at the test site indicated on the map is believed to lie at a depth of about 1,850 feet and 1,000 feet to the west at about 1,775 to 1,800 feet. According to the structure, the most favorable part of this anticline for the accumulation of oil lies is the E. ½ sec. 14, the NE. ¼ sec. 23, and the NW. ¼ sec. 24.

ANTICLINES IN T. 26 N., R. 11 E.

LOST CREEK ANTICLINE.

The Lost Creek anticline has a northward-trending axis extending from secs. 5 and 6, T. 25 N., R. 11 E., into sec. 31, T. 26 N., R. 11 E. A long anticlinal nose extends northwestward through secs. 30 and 19, T. 26 N., R. 11 E., and joins the Revard anticline in secs. 13 and 24, T. 26 N., R. 10 E. Two domes rise on the crest of this uplift; the south one, in sec. 32, T. 26 N., R. 11 E., has a closure of nearly 10 feet and its one closed contour incloses about 80 acres; the north one, in sec. 31, has a closure of nearly 20 feet and an inclosed area of about 60 acres. The uplift is limited on the north and east by deep synclines. A long uniform monocline extends westward for about 5 miles from the crest of the anticline and affords a large gathering area with no structural features to prevent migration of oil and gas up the dip to the east. This anticline includes a large area which is structurally very favorable for oil production. No adequate test has been made of it, for the only well yet drilled, though it reached the "Mississippi lime" and obtained a showing of oil, was not very favorably located structurally. This well is near the east quarter corner of sec. 36, T. 26 N., R. 10 E., on the west flank of the Lost Creek anticline, at the upper end of a small terrace. Wells in similar structural situations have proved productive in some parts of Osage County, but this is not an established rule, for in other places the lower part of the terrace in the zone of the steeply dipping beds is the productive area. This well, therefore, does not condemn the oil possibilities of this fold, and in any event one dry hole should never be considered as completely condemning an area of favorable structure. Several locations for test holes are suggested on Plate XV. The one in the SE. ¼ sec. 31, T. 26 N., R. 11 E., is

intended to test the oil and gas possibilities of the south dome of the anticline. The crest of this dome will probably contain gas, but the west flank is very favorable oil territory. The "Mississippi lime" should be reached in this test hole at about 1,825 to 1,850 feet. If this well should produce gas, the next well should be drilled 1,000 feet to the west. The test hole in the NW. ¼ sec. 31, T. 26 N., R. 11 E., should reach the "Mississippi lime" at about 1,800 to 1,825 feet, and, to judge from the structure, should yield a good supply of oil. The crown of the dome in the NE. ¼ sec. 31 is almost sure to yield gas if open sands are continuous, but it should be tested. The test hole in the NE. ¼ sec. 30 should reach the "Mississippi lime" at about 1,700 to 1,750 feet. Should these test holes prove successful oil wells, further development should be extended in every direction to determine the limits of the pool, especially to the west, where the most favorable territory lies. If these holes produce gas, other tests for oil should be made down the dip to the west.

SYCAMORE DOME.

The Sycamore dome is a small uplift on a structural terrace. It has a closure of nearly 30 feet and an inclosed area of one-third of a square mile in the SW. ¼ sec. 7, T. 26 N., R. 11 E. It is limited on the northwest and south by a well-developed syncline and is separated from the large Buck Creek anticline on the east by a narrow, shallow depression. Although the closure of this dome is sufficient to afford a good catchment area the gathering ground is limited to the synclinal area on the west, and the production, if any, will probably be less than in domes with large gathering areas. This dome is untested, and two locations for test holes are suggested on Plates XIV and XV. At these places the "Mississippi lime" should be reached at about 1,900 to 1,925 feet. The crown may yield gas, and if so oil will probably be encountered down the west flank.

The axis of the Sand Creek anticline, which is described on page 107, under the discussion of anticlines in T. 26 N., R. 10 E., traverses the northwest corner of sec. 6, T. 26 N., R. 11 E. A location for a test hole in this section is indicated on Plate XV. If this test proves successful further development should extend westward, but the productive area will probably be small, because the southeast flank of this anticline in this township is structurally unfavorable for oil accumulation.

BUCK CREEK ANTICLINE.

The Buck Creek anticline is a large upfold with an eastward-trending axis extending through secs. 8, 9, and 10, T. 26 N., R. 11 E. It consists of three minor anticlines separated by low structural sad-

dles. The rocks affected by the major uplift cover about 7 or 8 square miles. The anticline is practically surrounded by well-developed synclines.

The normal attitude of the rocks in sec. 17 is affected by two north-northwestward-trending faults. The east block of the west fault has been dropped a maximum of less than 10 feet, and the west block of the east fault has been dropped a maximum of about 30 feet. The center of the line on the map (Pl. XV) representing the trace of each fault indicates approximately the point of the maximum throw. The throw diminishes in each direction and dies out within half a mile of the point of maximum displacement.

The west anticline of the Buck Creek uplift, in secs. 5, 8, and 17, has a northeastward-trending axis about 2 or 3 miles long which runs transverse to the axis of the main fold. It has a closure of nearly 20 feet and an inclosed area of about 40 acres. It is separated from the middle anticline by synclinal reentrants which terminate in a low structural saddle between secs. 8 and 9. The steeply dipping southwest, west, and northwest flanks afford good gathering area for the accumulation of considerable petroleum. The anticline has been tested by gas-producing wells on the crest and oil wells on the northward and southward pitching anticlinal noses as well as near the upper portion of the synclinal reentrant on the southeast flank of the anticline. The oil wells are all small producers, and several dry holes are reported alongside of oil wells, a relation which indicates variable sand conditions. Structurally the west flank of this anticline is very promising oil territory, for the long monocline extending westward furnishes a good gathering area and the crest of the fold and its steeply dipping west flank afford favorable conditions for oil accumulation. Locations for further testing the oil possibilities of the anticline are shown on the map (Pl. XV). The oil on the south and east flanks of this anticline probably comes from the Bartlesville sand, and that on the northward-pitching nose comes from about the position of the Peru sand between the Big lime and the "Oswego lime." Some of the dry holes in secs. 4 and 9 were drilled to the "Mississippi lime," but the locations are not structurally favorable and therefore do not condemn the favorable portions of the anticline. The logs of the gas wells on the crest of the anticline are not available, and the source of the gas is not known. In the test holes suggested the "Mississippi lime" should be reached at 1,775 to 1,825 feet. If these tests prove successful they would indicate that much good oil territory may be found north, west, and south of them.

The middle anticline of the Buck Creek uplift in secs. 9 and 16 has a southeastward-trending axis 1½ miles long which runs transverse to the axis of the main uplift. It has a closure of nearly 20

feet and an inclosed area of about one-third of a square mile. It is separated from the east and west anticlines of the Buck Creek uplift by synclinal reentrants which terminate in low structural saddles. An anticlinal nose trends southeastward toward the Whisky Hollow anticline and is separated from it by a low structural saddle. The effective gathering area for this anticline is limited to the long, broad synclinal reentrant on the southwest and to the smaller synclinal reentrant on the north. Structurally the southwestern portion of the anticline is more favorable for oil accumulation than the remainder of it, because this portion has a larger gathering area to supply the oil and better conditions for its accumulation. The faults above described may, however, retard the migration of oil and cause some accumulation on their west sides. An abandoned well on the crown of the fold west of the south quarter corner of sec. 9 is now making some gas. Several wells in the NW. ¼ sec. 16 are producing oil from the Bartlesville sand, and future development should extend toward the southeast from these wells. The north flank of this anticline is not unfavorable for the accumulation of oil and may show a good yield. A well is now being drilled near the west quarter corner of sec. 9, and if it proves successful oil may be expected in any direction except due east toward the bottom of the shallow syncline. If the well is a failure after penetrating the "Mississippi lime" 300 to 400 feet, another test hole should be drilled about the center of the SW. ¼ sec. 9, where the "Mississippi lime" may be expected at about 1,825 to 1,850 feet.

The east anticline in secs. 9 and 10 forms the east end of the main Buck Creek uplift, and their axes coincide. It has a closure of nearly 10 feet and its one closed contour incloses an area of about a quarter of a square mile. It is limited on the north and south by well-developed synclines and is separated from the rest of the Buck Creek uplift on the west and from the Buck Point anticline on the east by low structural saddles. Dry holes have been drilled on the south and north of this anticline, but they are in synclines or other unfavorable localities and therefore are not an index to the oil or gas possibilities of this anticline. An abandoned well on the crown of the upfold near the west quarter corner of sec. 10 is making some gas, but the source of the gas is not known. This well, however, indicates that the crest will yield gas and that the flanks may yield oil. A favorable locality for the accumulation of oil is the anticlinal nose extending northeastward into sec. 3, although a dry hole is reported at the northwest corner of sec. 10, a locality which structurally is not unfavorable. The log of this well is not available, but it does not necessarily condemn this part of the anticline. At the location for a test hole indicated on the map (Pl. XV) the "Mississippi lime" should be reached at about 1,700 to 1,725 feet.

If this well proves a success, oil may be expected to the north, west, and southwest.

Structurally the Buck Creek uplift as a whole has great oil and gas possibilities, but some of the wells already drilled are not particularly encouraging and indicate variable sand conditions as well as small production. The producing wells further indicate that there are at least three horizons at which oil or gas, or both, may be obtained—the Peru sand, the Bartlesville sand, and the top of the "Mississippi lime." This "lime," however, has not been thoroughly tested, and there may be porous beds below horizons penetrated by the drill that will yield considerable oil.

DOE CREEK DOME.

The Doe Creek dome is a sharp, roughly circular uplift with a small crown in the N. ½ sec. 3, T. 26 N., R. 11 E. An anticlinal nose trends northwestward from the crown into secs. 33 and 34, T. 27 N., R. 11 E. The dome has a closure of nearly 60 feet and an inclosed area of three-quarters of a square mile. The rocks affected by the uplift cover about 3 square miles. It is limited on the north and south by major well-developed synclines, which merge into a sharp structural saddle on the east side of the dome. That part of the dome situated in T. 26 N., R. 11 E., has not been tested, but the anticlinal nose extending into secs. 33 and 34, T. 27 N., R. 11 E., is showing a good oil production and is reported to have two gas wells, one of which is said to be abandoned. The logs of the gas wells are not available and the source of the gas is not known. Some of these oil wells are reported to have had an initial daily production of as much as 75 barrels, probably from the Bartlesville sand. The crown of the dome is likely to be gas bearing, but from structural considerations the west, north, and south flanks should yield good quantities of oil. The map (Pl. XV) shows a location for a test of this dome in sec. 3, T. 26 N., R. 11 E., where the "Mississippi lime" is believed to lie at a depth of about 1,750 to 1,800 feet and to be favorable for the production of oil and gas. If this test hole yields oil, further development should extend in all directions, but the most favorable territory lies to the south and west.

BUCK POINT ANTICLINE.

The Buck Point anticline, an irregular-shaped upfold in secs. 11 and 14, T. 26 N., R. 11 E., is a small part of the major uplift that trends southwest and embraces the Whisky Hollow anticline, the Okesa dome, and the Jones anticline. (See Pl. XV.) The Buck Point anticline has a closure of about 25 feet and an inclosed area

of about three-quarters of a square mile. It is limited on the north and west by well-developed synclines. A prominent northward-pitching anticlinal nose extends for 1½ miles from the crown and terminates in a syncline which separates the Buck Point uplift from the Doe Creek dome and a long southwestward-pitching anticlinal nose from sec. 36, T. 27 N., R. 11 E. Low structural saddles separate the Buck Point anticline from the Whisky Hollow anticline and from the monocline on the northwest flank of the Panther Creek anticline. Structurally this anticline has excellent oil and gas possibilities. The north and west flanks of the anticline, between the bottom of the bordering syncline and the crest of the upfold, afford good gathering area, and the closure is sufficient to assure favorable conditions for accumulation. This anticline has been drilled and is yielding both gas and oil. The gas wells are on or near the crest and the oil wells are on the west flank. The gas is reported from the Burgess sand directly overlying the "Mississippi lime," and the oil comes from the Bartlesville sand and from the Burgess sand. Showings of oil are reported from the Peru, but there are no producing wells that obtain oil from this sand. Future development should extend the present productive area. The most favorable localities for oil wells are on the northward-pitching anticlinal nose in the W. ½ sec. 11, the westward-plunging nose in secs. 14 and 15, and the north flank of the anticline. A location for a test hole is suggested (see Pl. XV) in the SE. ¼ NW. ¼ sec. 11, where the "Mississippi lime" may be expected at about 1,750 to 1,775 feet. If this proves to be a successful oil well, further development should extend in all directions, but the most favorable territory is probably to the north and west.

WHISKY HOLLOW ANTICLINE.

The Whisky Hollow anticline is an irregular-shaped uplift which forms a small part of a larger uplift embracing the Buck Point anticline on the north and the Okesa dome and Jones anticline on the south. The axis trends northeast through secs. 21, 22, and 23, T. 26 N., R. 11 E. It has a closure of about 15 feet and an inclosed area of nearly half a square mile. It is limited on the south and east by a shallow syncline and on the northwest by a deep syncline which separates it from the Buck Creek uplift. The west flank is a long monocline which extends about 3 miles from the crest of the anticline and affords an excellent gathering area for the accumulation of oil. The west and northwest flanks are therefore the most favorable portions of the anticline for oil wells. The anticline has been drilled and is producing some oil and gas. Gas wells near the 980-foot contour indicate that the west flank of the anticline may be gas-bearing between that contour and the crest. Down the dip from the gas wells on the same flank several oil wells have been drilled, and a few

of them are still producing. The gas wells and most of the oil wells receive their supply from the top of the "Mississippi lime" or near it, and the rest of the oil wells are producing from the Bartlesville sand. A dry hole was drilled, probably to the "Mississippi lime," on the south flank of the anticline in the SW. ¼ sec. 22. This test is in a structurally unfavorable position, because the south flank of the anticline has little or no gathering ground and oil or gas migrating up the west flank would be trapped in the crest of the Whisky Hollow anticline and the crown of the Okesa dome. Another dry hole in which a show of oil was reported was drilled to the "Mississippi lime" on the northwest flank of the anticline, in the SW. ¼ sec. 15. It is well down on the northwest flank of the anticline and is unfavorably located for the accumulation of oil. A location for a test hole is suggested on the map (Pl. XV). It is near the center of sec. 21, at the end of the anticlinal nose at the top of the steeply dipping monocline, where the "Mississippi lime" may be expected at a depth of about 1,650 to 1,675 feet. This hole may yield gas, but structurally it is favorable for the production of oil. If it proves a successful oil well, further development should extend toward the west and northwest.

OKESA DOME.

The Okesa dome, a small triangular uplift in sec. 28, T. 26 N., R. 11 E., is a part of the larger uplift that embraces the Buck Point, Whisky Hollow, and Jones anticlines. It has a closure of nearly 40 feet and an inclosed area of nearly one-third of a square mile. A prominent anticlinal nose pitches westward from the crown of the dome through sec. 29 and joins an anticlinal nose of the Lost Creek anticline. A broad, flat syncline borders the Okesa dome on the east, and a deep, rather broad syncline separates the dome from the Lost Creek anticline on the southwest. The rocks affected by this upfold cover about 2 square miles. A monocline extends for several miles to the west and northwest from the crown of the dome and forms an excellent gathering ground for oil. The closure, together with the anticlinal nose and the steeply dipping west flank, affords ample reservoir space for a considerable quantity of petroleum. The crown of the dome is nearly certain to yield considerable gas, but the anticlinal nose and the west and northwest flanks are structurally very favorable oil territory. No wells have yet been drilled in the inclosed area, but several oil and gas wells have been drilled on the northwest flank as low as the 930-foot contour. (See Pl. XV.) Some of the oil wells had an initial daily production as high as 20 to 30 barrels, probably from the Bartlesville sand, but no information is available regarding the source of the gas or its yield. The location for a test hole sug-

gested on Plate XV is in the NW. ¼ sec. 28, where the "Mississippi lime" may be expected at a depth of about 1,675 to 1,700 feet. It is on the west point of the triangular dome and just below the 1,000-foot contour, or about 20 feet vertically below the crown. If this test yields gas the next well should be drilled 1,000 feet to the west. According to the structure oil may be expected on this dome in the N. ½ and the N. ½ S. ½ sec. 29, the SE. ¼ sec. 20, and the SW. ¼ sec. 21, but the NW. ¼ sec. 28, on and near the crown of the dome, is for the most part gas territory.

JONES ANTICLINE.

The Jones anticline is a small upfold which forms a part of a larger uplift that trends northeast and embraces the Okesa dome and the Whisky Hollow and Buck Point anticlines. These different crests or crowns of the major uplift are separated by narrow structural saddles. The Jones anticline has a closure of about 15 feet and an inclosed area of about one-third of a square mile. It is limited on the west by a deep syncline and on the south, east, and north by a broad, shallow syncline. The effective gathering area is limited to the west flank between the crest of the upfold and the bottom of the syncline. This anticline has been drilled and has a number of producing wells. Several wells are producing gas on the crest of the anticline, but the source of the gas is not known. The oil wells on the west flank obtain their oil from the Bartlesville sand. Some of these had an initial daily production of as much as 40 barrels and are now yielding from 3 to 5 barrels. Several dry holes adjacent to the oil wells are reported and indicate variable sand conditions. Structurally most of the W. ½ sec. 33 is favorable oil territory except along the west and south lines of the section. Further development for oil should be extended south and east from the present producing wells. Several dry holes on the east flank of the anticline substantiate the rule that in general little or no production may be expected from the east flanks of anticlines in this area. The crest will probably yield gas from any petroleum-bearing bed, but structurally the west flank is favorable for obtaining oil from the Bartlesville sand and probably from the "Mississippi lime," which on the crest may be expected at a depth of about 1,900 feet.

PHILLIPS ANTICLINE.

The Phillips anticline is an elongated uplift with northward-trending axis mainly in the northeast corner of T. 25 N., R. 11 E., and is described by Hopkins.[1] Two domes occur along the anticlinal axis.

[1] Hopkins, O. B., report on T. 25 N., Rs. 11 and 12 E.: U. S. Geol. Survey Bull. 686–H, 1918.

The north dome extends into T. 26 N., R. 11 E., where anticlinal noses pitch north and west into secs. 35 and 36. The crown of the north dome in sec. 1, T. 25 N., R. 11 E., has a closure of about 20 feet and the lowest closed contour (1,150-foot) incloses about a quarter of a square mile, 15 acres of which is in sec. 36, T. 26 N., R. 11 E. A well-developed syncline borders it on the east, and it is separated from the Panther Creek anticline on the northeast by a narrow, shallow syncline which plunges westward through secs. 36, 35, and 26. A steeply dipping monocline extends westward from the crest of the anticline for about 2 miles, ending in a broad, shallow syncline, and affords an excellent gathering area for the accumulation of oil. Several holes have been drilled on this anticline, and some of them are reported to have been failures. Three dry holes are reported on the north flank. These are favorably located structurally, but the records are not available and therefore they may not constitute real tests. Another hole near the southeast corner of sec. 36, T. 26 N., R. 11 E., was drilled to the Bartlesville sand. Conflicting reports are given for the results of this well; some say it is a gas well with a show of oil and some an oil well with a show of gas. It is on the northeast flank of the anticline and near the bordering syncline and is therefore not so favorably located as the dry holes above mentioned. Several wells are producing gas from the crown of the north dome of the Phillips anticline, in the N. ½ sec. 1, T. 25 N., R. 11 E., but the logs are not available and therefore the source of the gas is not known. A location for a test hole for oil is suggested on the west flank (see Pl. XV), between the 1,120 and 1,130 foot contours, where the "Mississippi lime" may be expected at a depth of about 1,775 feet or more. If this well yields oil, further development should extend west and north as well as east.

PANTHER CREEK ANTICLINE.

The Panther Creek anticline is an elongated upfold with northward-trending axis which roughly parallels the township line between Rs. 11 and 12 E. (See fig. 21.) The crest lies east of the township line and has four small domes. Each of the southern two domes has a closure of about 15 feet and an inclosed area of about 40 acres, and each of the northern two has a closure of less than 10 feet and an inclosed area of about 50 acres. These domes are separated from one another by shallow structural saddles across which the productive area will probably be continuous. The major anticline exclusive of the southernmost dome has a closure of about 30 feet and an inclosed area of about 1½ square miles. The Panther Creek anticline is separated from the Phillips anticline on the south by a narrow structural saddle. The axis of an anticlinal nose pitches northeastward from the crest of the uplift into the alluvial valley of Sand Creek,

in sec. 7, T. 26 N., R. 12 E. A monocline extends 1½ to 2 miles west from the crest and affords an excellent gathering ground for the accumulation of oil. This uplift has been tested by drilling and is now yielding good quantities of oil and gas. The crowns of two northern domes of the anticline and their west flanks down as far as the 1,100-foot contour (see map, Pl. XV) are almost completely drilled. The oil produced comes from the Bartlesville sand, and some of the wells had an initial daily production as high as 300 barrels. The southern domes are not so largely drilled, but several wells on them are producing oil and gas. Here the oil comes from the Bartlesville sand and the gas from the top of the "Mississippi lime." The west flank of the main uplift is yielding gas from the "Mississippi lime" in secs. 13, 24, and 25 between the 1,110-foot and 1,050-foot contours. This indicates one of a number of conditions: (1) That the "Mississippi lime" on the crest of this anticline will probably yield high-pressure gas; (2) that the structure of the "Mississippi lime" in this vicinity does not conform to the surface structure, which is not likely because the oil wells indicate that the structure of the Bartlesville sand conforms with the surface structure; (3) that the gas-bearing stratum varies in porosity, being closely cemented high on the anticline and thus trapping the gas well down on the west flank; or (4) that the gas may have been trapped by a terrace in the unexposed rocks which is not shown by the surface rocks. The evidence seems to indicate that the "Mississippi lime" on the crest of the Panther Creek anticline and its west flank between the crest and the present gas wells will yield considerable gas. The "Mississippi lime" should be reached on the crest of the anticline at depths of about 1,725 to 1,775 feet.

AREAS OF UNFAVORABLE STRUCTURE.

Experience in drilling and developing oil lands in Osage County has shown that oil and gas production is confined to the major uplifts and that the major synclines or depressions yield no oil or gas. Several localities are known, however, where oil is obtained in an area of synclinal structure, but such a depression is usually an integral part of a major uplift. The list below is intended to point out the localities in this area which on the basis of the surface structure alone appears to have little or no chance of yielding oil. The greater part of these localities will probably be barren, though exceptions due to variations in sand conditions, lack of parallelism in the strata, or some other cause may be found. The lands in the area covered by this report which are unfavorable for the accumulation of oil because they are situated in or near the bottoms of major,

well-developed synclines are as follows (see Pls. XIII–XV and fig. 22):

T. 26 N., R. 9 E.:
- Sec. 6, N. ½ and SE. ¼.
- Sec. 12, NE. ¼.
- Sec. 24, E. ½.
- Sec. 35, E. ½.

T. 26 N., R. 10 E.:
- Sec. 6, SW. ¼.
- Sec. 12, NE. ¼ and SW. ¼.
- Sec. 18, S. ½ S. ½.
- Sec. 19, NW. ¼.
- Sec. 20, W. ½.
- Sec. 29, N. ½.
- Sec. 31 E. ½.
- Sec. 32, S. ½ and S. ½ N. ½.

T. 26 N., R. 11 E.:
- Sec. 1, SW. ¼.
- Sec. 2, SE. ¼ and NW. ¼.
- Sec. 3, SE. ¼.
- Sec. 4, N. ½.
- Sec. 5, NW. ¼.
- Sec. 6, S. ½.
- Sec. 15, NW. ¼.
- Sec. 16, E. ½ NE. ¼.
- Sec. 19, N. ½.
- Sec. 23, SW. ¼ and NE. ¼.
- Sec. 27, SE. ¼.
- Sec. 32, N. ½ and SE. ¼.
- Sec. 34, W. ½ and NE. ¼.

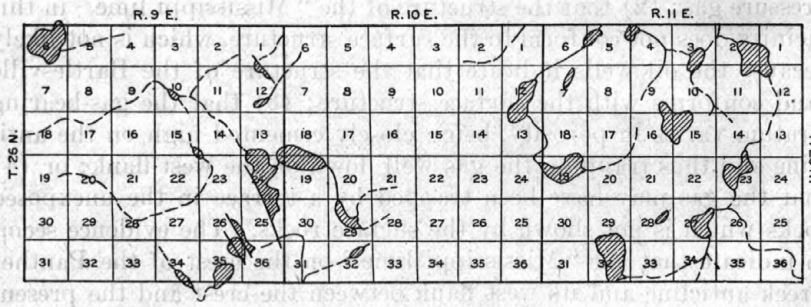


FIGURE 22.—Sketch showing roughly the position of synclinal axes in T. 26 N., Rs. 9, 10 and 11 E., shaded to indicate areas within closed contours.