T. 20 N., R. 11 E.

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INTRODUCTION.

T. 20 N., R. 11 E., lies in the southeastern part of the Osage Reservation, in the Hominy quadrangle. (See fig. 1.) There is no town or railroad in the area, but Sand Springs, on the Missouri, Kansas & Texas Railway, is only a mile from the south border, and the southeast corner of the township is 4 miles from Tulsa. The township is mostly rugged and has a maximum relief of about 400 feet. Roads are poor, and only a small part of the township is cultivated.

The field work in this township was done in July and August, 1918, by the writers, assisted by C. R. Bickel and M. G. Gulley, instrument men. The area mapped by each geologist is shown by the diagram inserted on Plate XVIII. The whole area was mapped with plane table and telescope alidade.

STRATIGRAPHY.

ROCKS EXPOSED.

GENERAL CHARACTER.

The rocks exposed in T. 20 N., R. 11 E., are of middle Pennsylvanian age and comprise from 650 to 750 feet of sandstone, shale, and limestone. The character and succession of the beds of the upper 350 feet of the series are shown graphically in figure 23. Shale constitutes by far the larger part of the exposed rocks, although the sandstone beds are most prominent. The three beds of limestone form only a minor part of the section.

KEY BEDS.

For the convenience of those wishing to do geologic work in the township, a few of the most important or key beds will be described in detail.

Avant limestone.—The Avant limestone is the more conspicuous and the higher of the two limestones present in the western part of

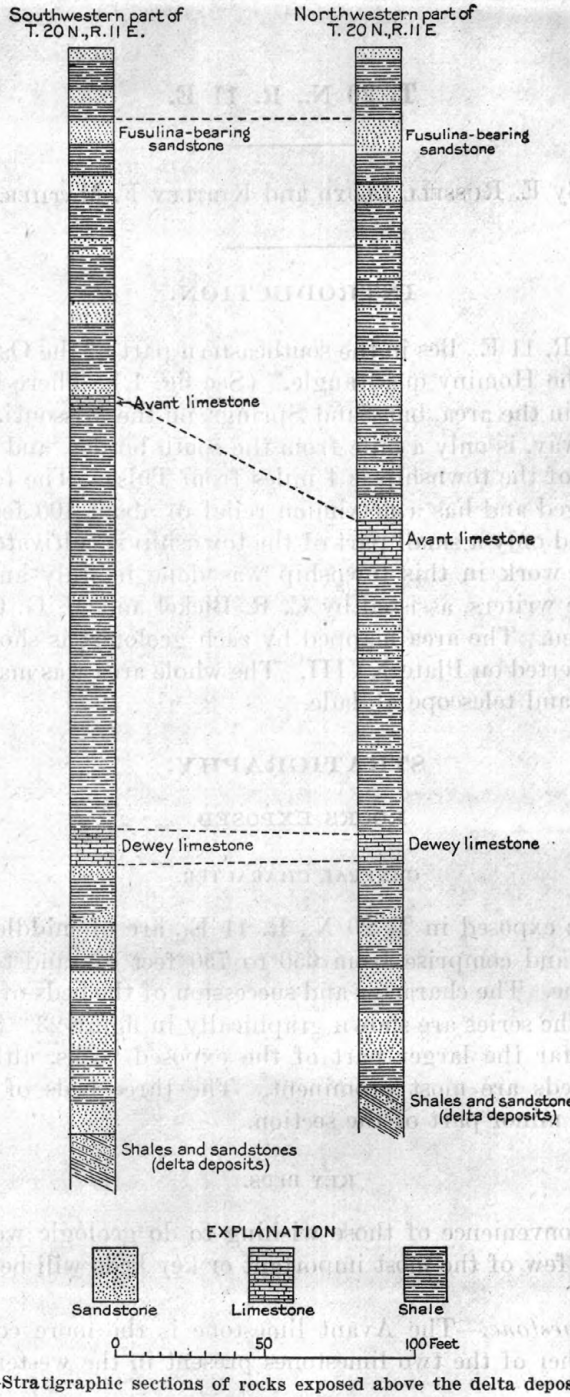


FIGURE 23.—Stratigraphic sections of rocks exposed above the delta deposits in T. 20 N., R. 11. E.

T. 20 N., R. 11 E. It is extremely variable in thickness and in composition, but generally appears as a hard ledge forming a low cliff and bench along the hillsides in the northwestern part of the township. On wooded slopes, however, it may be entirely hidden beneath talus, soil, and vegetation for considerable distances along its outcrop. Its weathered surface is nearly everywhere a shade of brownish red, although certain beds within it are gray in some localities. The color on fresh fracture is ordinarily purplish gray, although this characteristic is also rather variable.

The limestone is sandy, incloses lenses of shale, and is notably crossbedded where exposed near the middle of the west side of the township but is much more free from impurities farther north, where it is commonly very dense, fine grained, and hard. Crinoid stems are numerous in it everywhere, and a varied fauna is present in some places. Its thickness ranges between 5 and 15 feet, decreasing irregularly from north to south.

At the north margin of the township the vertical distance between the Avant and Dewey limestones is approximately 105 feet. This interval increases toward the south and reaches a maximum of 145 feet in sec. 20. A corresponding southward convergence of the strata above the Avant is also of considerable importance in detailed mapping. In sec. 18 there is a sandstone bed, thickly crowded with fossil *Fusulina*, 86 feet above the Avant. Toward the north this interval increases until, in sec. 5, this *Fusulina*-bearing sandstone is 135 feet above the Avant. These two convergences so nearly compensate each other that the *Fusulina*-bearing sandstone is approximately parallel with the Dewey limestone, although neither is parallel with the intermediate Avant limestone in this township. The outcrop of the Avant is shown on the map (Pl. XVIII).

Dewey limestone.—The Dewey limestone is coarse grained, massive, and highly fossiliferous and consists of alternating bands of gray and brownish-red limestone. It crops out at the foot of the same escarpment as the Avant, but the exposures are not continuous, being in many places concealed by a soil mantle. The Dewey limestone has a maximum thickness of about 12 feet, is immediately overlain by a thick shale, and grades downward into a highly ferruginous nonresistant sandstone. The outcrop of the Dewey is not shown on the map.

Sandstone benches below Dewey limestone.—Immediately below the Dewey limestone and associated ferruginous sandstone is a group of sandstone beds with a total thickness of 75 feet or more. The higher beds of this group are flaggy, the lower part massive. The topmost bench, which is 12 to 15 feet below the top of the Dewey limestone, caps the higher hills in the central part of the township east of Shell Creek. West of Shell Creek this upper sandstone bed is fossiliferous, but throughout the greater part of the area no fossils were found. In

a few places the overlying ferruginous sandstone is preserved, but for the most part the horizon can be recognized only by the fact that this is the highest sandstone east of the Dewey-Avant escarpment and by the interval to the next underlying bench.

The second distinctive bench below the Dewey, 20 feet below the top bench, is formed by a typically massive sandstone and is in most places readily recognizable. Another prominent bench marking the top of a lower sandstone of the group is 50 feet below the top bench. This sandstone also is a typically massive sandstone and in the southern part of the township is separated by shale from the massive sandstone above it. The horizon of the top bench in the northern part of the township and the top of the lower bench in the southern part are shown on the map (Pl. XVIII).

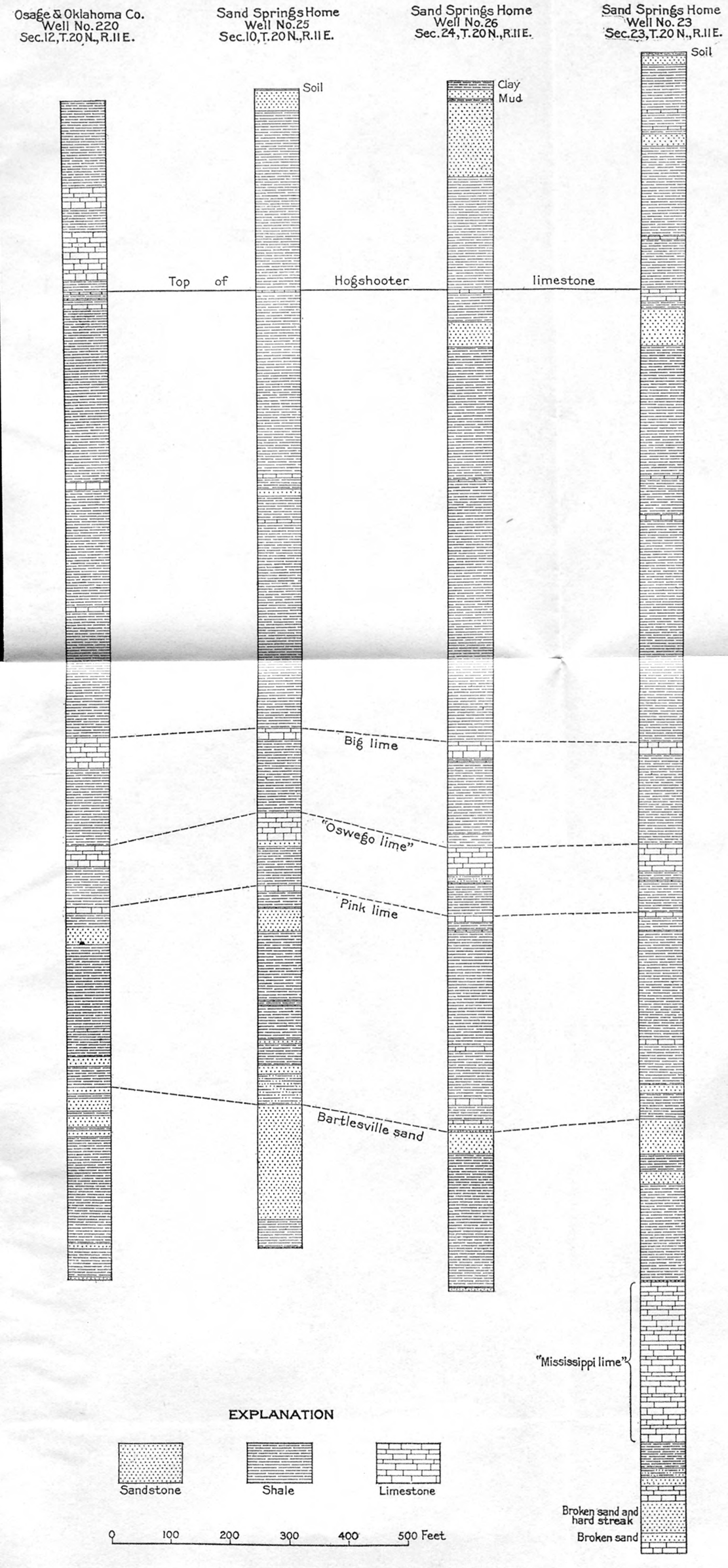
Shales and sandstones (delta deposits) above Hogshooter limestone.—Below the group of sandstones described above is a thick series of shale and sandstone which was deposited in the delta of a northward-flowing stream. The series consists in greater part of shale but includes a number of very prominent massive sandstone beds, which are, however, very lenticular and, at least for the most part, are foreset delta deposits. These deposits are well exposed in the valleys of Turkey and Blackboy creeks and in the hills to the east. The deltaic origin of the rocks is shown by the lenticularity of the sandstone beds and by their generally northward dips, which do not correspond with the structure of overlying and underlying rocks.

There is evidence of a very marked decrease in the thickness of these delta deposits from south to north. The logs of the wells in secs. 23 and 24 show that the interval between the Dewey and Hogshooter is 400 to 410 feet. In sec. 10 the interval is a little less, about 375 feet. In T. 21 N., Rs. 11 and 12 E., however, the corresponding interval is not over 260 feet. The sandstone beds of this series were studied and contoured in as much detail as exposures would permit and proved to be absolutely valueless for determining the underground structures. No structure contours, therefore, are shown in the area where these beds crop out.

Hogshooter limestone.—The Hogshooter limestone crops out in the valley of Blackboy Creek in sec. 36. In this area it is a prominent bed, 12 to 20 feet thick, alternating gray and brick-red in color, thin bedded, and highly fossiliferous. The uppermost foot or two is composed largely of crinoid stems and contains numerous cup corals.

ROCKS NOT EXPOSED.

A study of well logs shows sandstone, shale, and limestone between the surface beds and the productive oil and gas zones, with a great preponderance of shale. The wells of which detailed logs are avail-



SELECTED LOGS OF WELLS IN T. 20 N., R. 11 E.

able lie in the eastern part of the township, and of these logs four have been selected to show the succession of beds below the surface. (See Pl. XIX.)

The Hogshooter limestone in each of the wells of which the logs are shown on Plate XIX lies between 300 and 400 feet below the surface. The first easily recognizable bed below the Hogshooter is a limestone 20 to 50 feet thick, usually called the Big lime by the drillers. It lies from 730 to 760 feet below the Hogshooter, and the intervening rocks consist very largely of shale with thin beds of limestone and some sandstone; the sandstone is more prominent toward the south. Below the Big lime is 130 to 150 feet of shale and then the "Oswego lime" of the drillers, which is 40 to 50 feet thick.

Below the "Oswego" is a series of shale with thin beds of sandstone and limestone 300 to 400 feet thick, below which in turn is the series of sandstone beds that include the productive oil and gas zones of the district.

The top of the productive sandy series lies 1,300 to 1,400 feet below the Hogshooter limestone. The interval to the Avant limestone is more variable because of the variation in thickness of the delta deposits described above and also because of the convergence between the Dewey and Avant limestones.

In the eastern part of the Osage country gas is commonly encountered in the upper part of the group of sands, and in places the gas sand is separated from the underlying oil-bearing sands by a varying interval of shale, but elsewhere the sands are continuous. East of this area, in Tps. 20 and 21 N., R. 12 E., the oil-bearing sands aggregate 50 to 160 feet in thickness.

Any sand productive of oil in this zone is commonly called the Bartlesville sand, but it may not be the same as the productive sand at Bartlesville. There the productive sands lie about 1,350 feet below the top of the Avant. In the Avant district these sands lie from 1,360 to 1,440 feet below the top of the Avant limestone.[1] Thence southward the interval gradually increases, and in the southern part of T. 20 N., R. 11 E., it is about 1,750 feet.

So far no oil has been found in the Bartlesville sand in this township, the production being obtained from a thin sand about 300 feet below the top of the Bartlesville, commonly known as the Burgess sand. This sand, which is only a few feet thick, rests immediately on a massive limestone series which is called the "Mississippi lime." One well (No. 23 in sec. 23; see Pl. XIX) has been drilled 450 feet into the "Mississippi lime," disclosing two beds of sandstone. Elsewhere in the Osage country sandstone beds in the "Mississippi lime" have been productive of oil, and no anticline or dome in this town-

[1] Emery, W. B., U. S. Geol. Survey Bull. 686, p. 4, 1918 (Bull. 686–B).

ship should be considered thoroughly tested until a well has been drilled at least 400 feet into the "Mississippi lime." The well in sec. 23 is not favorably situated with regard to structure and probably for this reason found no oil.

STRUCTURAL FEATURES.

AREAS OF FAVORABLE STRUCTURE.

This township is a part of a large region where the general dip is westerly or northwesterly. The presence of an easterly dip is therefore significant, for it indicates an upfold which may yield commercial quantities of oil. The general westerly dip is accentuated in a zone 1 to 1½ miles wide extending across the central part of the township from northeast to southwest. East of this is a zone of open structure with two and possibly three folds that are very favorable for the accumulation of oil and also two or more which are smaller. The structure of the eastern tier of sections is undetermined. In the northwestern part of the township the general westerly dip is continued with small irregularities, one of which may be of sufficient extent to serve as an oil reservoir. There is a little faulting in the western part, but none in the remainder of the township.

The structure is shown on the map (Pl. XVIII) by 10-foot structure contours, which are based solely on surface data and are drawn on a theoretical bed 400 feet below the top of the Dewey limestone. The steep westerly dip shown in secs. 25 and 36 by dashed contours is based on the Hogshooter limestone, the interval from the Hogshooter to the Dewey being undetermined on account of the presence of the delta deposits. The structure mapping based on the Hogshooter is not correlated with that based on the higher beds.

The two most prominent upfolds in the township and the most promising for oil lie at the east border of the region of steep westerly dip. The northern one is near the head of the westerly branch of Turkey Creek, in secs. 10, 11, 14, and 15, and is called the Turkey Creek dome. The southern one, in secs. 21, 22, 27, and 28, is near Wimberley School and is called the Wimberley dome. Both lie along the same anticlinal axis and have a gathering ground extending to the west for at least 3 or 4 miles.

The crest of the Turkey Creek anticline in the eastern part of secs. 10 and 15 is outlined by the 570-foot contour. The 560-foot contour almost surrounds the fold but does not close on the south. This contour also outlines a small syncline east of the dome in secs. 11 and 14. A much smaller dome, really a part of the larger one, is outlined by the 570-foot contour in the southeastern part of sec. 15. The dip on the west side of the Turkey Creek dome is

comparatively steep, but that on the east side is very gentle. The probably productive area lies northwest, west, and southwest of the crest of the dome, the gently dipping east flank being less promising. A productive well recently drilled in the SE. ¼ NE. ¼ sec. 10, approximately on the 530-foot contour, some distance down on the northwest flank, is particularly promising for future wells drilled farther south on this dome.

The Wimberley dome is in most aspects very similar to the Turkey Creek dome. It is kidney shaped in outline, and the highest part is at the north, nearly at the corner of secs. 21, 22, 27, and 28. The greater part of the favorable structure occurs in sec. 28. The highest contour is the 580-foot, and the lowest one to close is the 570-foot contour. The 560-foot contour outlines the dome but does not close on the northeast. This contour partly incloses a shallow syncline east of the dome, extending in a northeasterly direction approximately along the valley of Euchee Creek. No wells have been drilled on this dome, the nearest one being a dry hole on Euchee Creek in the NE. ¼ sec. 33, at the bottom of the syncline on the east. The area of probably productive territory is considerably larger in the Wimberley dome than in the Turkey Creek dome and extends along the west flank of the dome from a point near the center of sec. 21 southward across sec. 28. Two very favorable localities for a test well are shown on the map (Pl. XVIII)—one on the west flank of the north end of the dome, near the south line of sec. 21, and the other on the west flank of the south end, in the SW. ¼ sec. 28. The crest of the dome is more likely to produce gas, and the east flank is unpromising.

The alinement of the Wimberley and Turkey Creek domes strongly suggests the probability of a similar uplift in the northeastern part of the township, in the valley of Turkey Creek. The structure in this area, however, could not be contoured on account of the irregularities in dip of the delta deposits which crop out there.

A small terrace in the eastern part of sec. 23 and the western part of sec. 24 has been proved by three productive wells. This terrace lies on the ridge extending eastward from the Greer farm in sec. 23, and could be only partly mapped on account of the presence of the delta deposits. It is outlined by the 630-foot contour, but the well drilled in the SE. ¼ sec. 23 shows that oil in commercial amounts may be expected as far west as the 620-foot contour. In the western part of sec. 23 there is a slight easterly dip, but not enough to make a closed contour. East of the center of this section the normal westerly dip is resumed. The extent of the potentially productive area toward the north can only be conjectured, because the surface in that direction is occupied by the delta deposits, on which structure contours can not be drawn.

The steep westerly dip west of the Wimberley and Turkey Creek line of anticlinal structure is interrupted by a small dome in sec. 29, from which a long nose extends westward across sec. 30. On this dome the 500-foot contour is the only one that is closed. The probably productive area lies in the central and western parts of sec. 29 and extends westward through sec. 30. The area has not been tested, and favorable localities for test wells are shown on the map (Pl. XVIII)—one on the northwest flank of the dome, north of the center of sec. 29, and another on the westerly nose, near the center of sec. 30. A terrace which lies mostly outside the Osage Reservation extends northwestward into the SE. ¼ sec. 31 and the SW. ¼ sec. 32. The extent of this terrace toward the south has not been mapped. The most favorable locality for a test well on that part of it which lies within the Osage Reservation is in the southeast corner of sec. 31.

Most of the northwestern part of the township has a general westerly dip, with small irregularities which in general are not suggestive of valuable oil territory. One exception is a terrace that lies mostly in the SE. ¼ sec. 5 and is outlined by the 370-foot contour. The probably productive area lies on the west flank of the terrace, in the SW. ¼ sec. 5 and the NW. ¼ sec. 8. A long nose extends westward from this terrace, the northern part of which has been cut off by a fault. A favorable locality for a test well is on the west flank of the terrace, near the south line of sec. 5.

AREAS OF UNFAVORABLE STRUCTURE.

Eastern Osage districts that have been thoroughly prospected show that accumulations of oil occur generally on the western flanks of the anticlines, domes, and terraces, extending from points near the crest down the flank. The crest of a fold is more commonly gas territory, and the east flank is generally unproductive. The shallow syncline east of the Turkey Creek and Wimberley domes may therefore be considered as probably offering unfavorable structure. Similarly a region of moderate uninterrupted westerly dip is generally unproductive. The area from Euchee Creek eastward to the ridge running north from Sand Springs and much of the northwestern part of the township, with the exception of the terrace previously described, have structure of this type and are therefore unpromising. The two dry holes shown on the map, in secs. 32 and 33, are probably in as unfavorable locations as could be selected in the township.

SAND CONDITIONS.

Very little is known of the sand conditions in T. 20 N., R. 11 E., but this very important factor in the accumulation of oil and gas

must not be overlooked. Farther east the productive sands are known to be irregular both in thickness and texture. Little detailed study of sand conditions in Osage County has been made by the Survey, and only generalized statements can be presented. In a region of general dip in one direction the thinning out of an oil-bearing sand or a marked decrease in porosity in a direction opposite to the dip may have as much influence on the accumulation of oil as the structure. Thus the effect of the structure may be counteracted, making areas of apparently good structure unproductive and causing accumulation where the attitude of the strata is not itself conducive to the accumulation of oil. However, the oil in this region does not occur in a single sand but in a number of sands extending through a series several hundred feet in thickness, and it is improbable that in any anticlinal fold in this township unfavorable conditions affect all the sands.