TPS. 21 AND 22 N., R. 11 E.

By CLARENCE S. ROSS.

INTRODUCTION.

The area included in Tps. 21 and 22 N., R. 11 E., lies in the southeastern part of the Osage Reservation and in the eastern part of the Hominy quadrangle. (See fig. 1.) It may be reached from Skiatook and Sperry, on the Midland Valley Railroad, about 4 miles to the east. Two major roads run west from these towns, following the valleys of Hominy and Delaware creeks, but the minor roads are very poor, and much of the area is difficult of access. The entire area is hilly and has a maximum relief of 400 feet. Most of the ridges are timbered, and farming is confined to the alluvial bottoms of the larger creeks.

The areal geology of the Hominy quadrangle has been mapped on a scale of 2 miles to the inch in cooperation with the Oklahoma Geological Survey. The detailed structural examination of Tps. 21 and 22 N., R. 11 E., was made in March, April, May, and June, 1918, by the writer, Sidney Powers, W. S. W. Kew, and P. V. Roundy. All the mapping was done with plane table and telescope alidade.

STRATIGRAPHY.

EXPOSED ROCKS.

The rocks exposed at the surface in this area belong to the middle Pennsylvanian, and consist of sandstone, shale, and limestone, aggregating about 700 feet in thickness. Shale predominates, but sandstone and limestone form the prominent rock exposures.

A few of the strata that may be used as key beds will be described for the benefit of those who may wish to do geologic work in the region. These rocks will be discussed in order of age, the youngest first. The Clem Creek is the highest persistent sandstone in the area, and below it is a group of limestones that weather red, interstratified with sandstones; a group of massive sandstones; and a thick shale. Below the shale lies the Avant limestone, which has been used as the

datum in field work; shale; the Dewey limestone; a very thick shale; a sandstone series; a massive sandstone; and the Hogshooter limestone, the lowest key bed of the region. (See Pls. XXIX and XXX and fig. 30.)

Clem Creek sandstone.—The Clem Creek sandstone, first described by Emery,[1] is the most widespread sandstone in the region. It is exposed on both sides of the plateau north of Hominy Creek in T. 22 N., R. 11 E., and along the plateau between Tall Chief and Turkey creeks in T. 21 N., R. 11 E. The sandstone is massive, generally forming a ledge 6 to 8 feet thick, but a second bench is commonly present 12 to 14 feet below the top. Weathering gives it a peculiar hummock-like surface upon which vegetation is commonly sparse. The interval from the Clem Creek sandstone to the Avant limestone, which is the best key rock of the region, is about 202 feet in the northeast corner of T. 21 N., R. 11 E., and increases to a maximum of 271 feet in sec. 32 of the same township. South of this section the interval decreases rapidly, and in sec. 20, T. 20 N., R. 11 E., it is only 180 feet. The variation of interval between the Clem Creek sandstone and the Avant limestone occurs in the shales that lie immediately above the Avant, and this large convergence is an important obstacle to geologic work in this region. The line of outcrop of the Clem Creek sandstone is indicated on the maps (Pls. XXIX and XXX).

Beds between the Avant limestone and Clem Creek sandstone.—In the northeastern part of T. 22 N., R. 11 E., two siliceous limestones that weather dark red are widely distributed, and locally a third bed of similar character is present below these. The highest of these limestones lies about 44 feet below the Clem Creek sandstone and 154 feet above the Avant limestone, the middle one about 132 feet above the Avant, and the lowest 116 feet above the Avant. Their outcrops are not continuous and they grade laterally into sandstones. In the southwestern part of this township the same limestones, here also locally grading into sandstones, crop out, and the interval from the Avant to the highest is 227 feet in sec. 32, an increase of 73 feet. The intervals between the limestones and the Clem Creek sandstone, though variable, are about the same as in the northeastern area just mentioned. The three limestones are not all found in any one section; two are only locally present, and in some areas all three are replaced by sandstones. This irregularity of occurrence and the absence of distinctive characteristics render their recognition difficult, and in part of this area the heavy sandstones interstratified with the limestones must be used in geologic work.

[1] Emery, W. B., report on T. 23 N., R. 11 E.; Tps. 22 and 23 N., R. 12 E.: U. S. Geol. Survey Bull. 686–B, 1918.

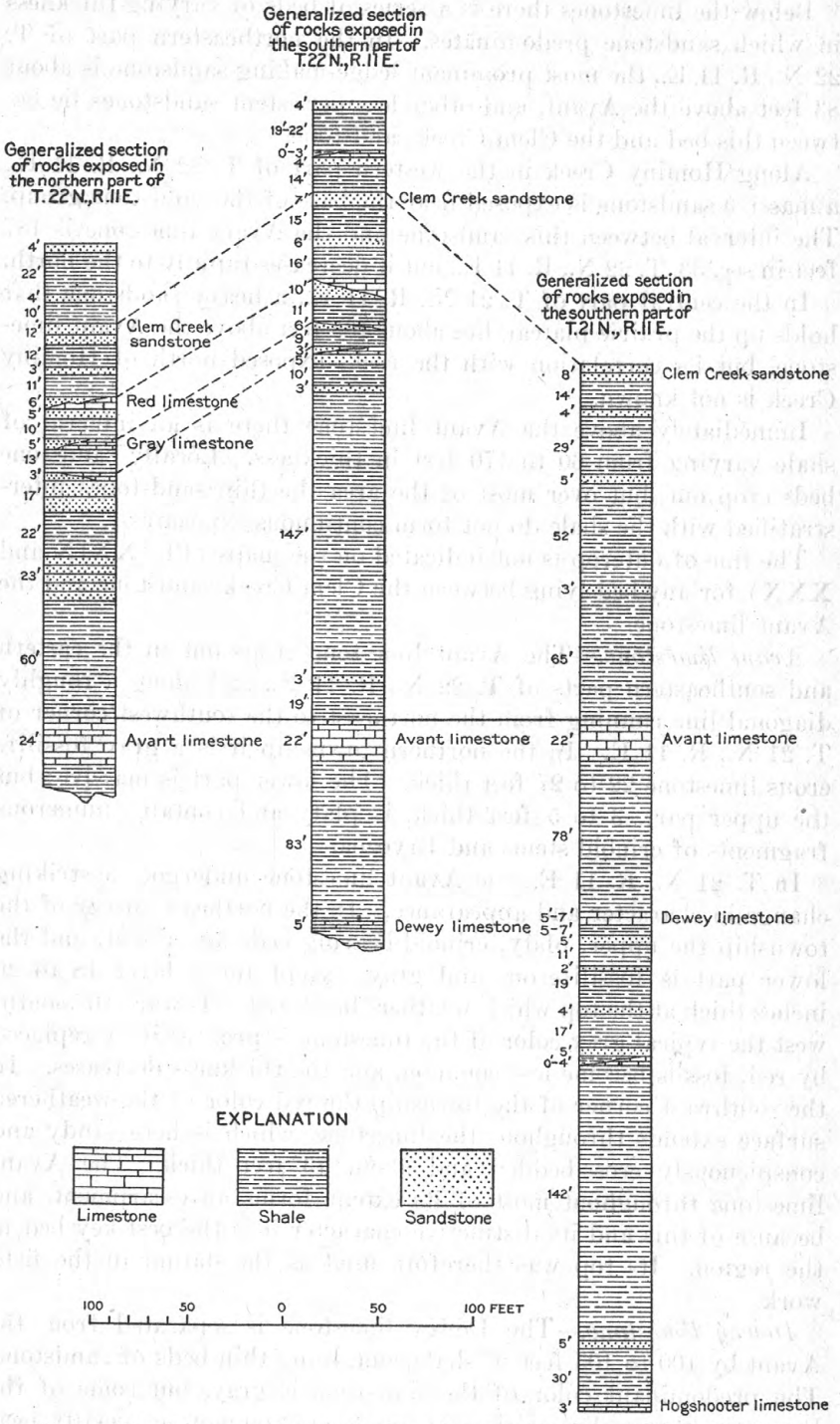


FIGURE 30.—Columnar sections of rocks exposed in Tps. 21 and 22 N., R. 11 E.

Below the limestones there is a series of beds of varying thickness in which sandstone predominates. In the northeastern part of T. 22 N., R. 11 E., the most prominent ledge-making sandstone is about 83 feet above the Avant, and other less persistent sandstones lie between this bed and the Clem Creek sandstone.

Along Hominy Creek in the western part of T. 22 N., R. 11 E., a massive sandstone is exposed near the base of the sandstone group. The interval between this sandstone and the Avant limestone is 187 feet in sec. 33, T. 22 N., R. 11 E., but it decreases rapidly to the north.

In the central part of T. 21 N., R. 11 E., a heavy sandstone that holds up the prairie plateau lies about 185 feet above the Avant limestone, but its correlation with the rocks exposed north of Hominy Creek is not known.

Immediately above the Avant limestone there is an interval of shale varying from 60 to 170 feet in thickness. Locally sandstone beds crop out, but over most of the area the thin sandstones interstratified with the shale do not form continuous exposures.

The line of outcrop is not indicated on the maps (Pls. XXIX and XXX) for any bed lying between the Clem Creek sandstone and the Avant limestone.

Avant limestone.—The Avant limestone crops out in the eastern and southeastern parts of T. 22 N., R. 11 E., and along a roughly diagonal line running from the northeast to the southwest corner of T. 21 N., R. 11 E. In the northern township it is a gray fossiliferous limestone 22 to 27 feet thick. The lower part is massive; but the upper part, 3 to 5 feet thick, is platy and contains numerous fragments of crinoid stems and Bryozoa.

In T. 21 N., R. 11 E., the Avant limestone undergoes a striking change in character and appearance. In the northeast corner of the township the upper, platy, crinoid-bearing beds are absent, and the lower part is fossiliferous and gray, except for a layer 18 to 20 inches thick at the top which weathers brick-red. Toward the southwest the typical gray color of the limestone is progressively replaced by red, fossils become less common, and the thickness decreases. In the southwest corner of the township the red color of the weathered surface extends throughout the limestone, which is here sandy and conspicuously cross-bedded and about 15 feet thick. The Avant limestone throughout most of its extent forms an escarpment, and because of this and its distinctive character it is the best key bed in the region. Its top was therefore used as the datum in the field work.

Dewey limestone.—The Dewey limestone is separated from the Avant by 100 to 105 feet of shale containing thin beds of sandstone. The predominant color of the limestone is gray, but some of the layers weather to brownish-red; fossils are common, especially near

the top. Its thickness is not over 3 feet in the southeastern part of T. 22 N., R. 11 E., but is 7 feet in the southern part of T. 21 N., R. 11 E. The outcrop is commonly covered by talus from the Avant escarpment above. The Dewey limestone was used as a key bed in the field, but its outcrop lies close to that of the Avant and has not been marked on the maps.

Sandstones and shales below the Dewey limestone.—Immediately below the Dewey limestone is a group of sandstone beds about 75 feet thick which were used as key beds but which are not indicated on the maps (Pls. XXIX and XXX). The topmost bed of this group lies 12 to 15 feet below the Dewey and is the heavy sandstone that caps the isolated hill near the southwestern part of sec. 24, T. 21 N., R. 11 E., and occurs in a larger area in the southern parts of secs. 26 and 27. South of Delaware Creek in secs. 33 and 34 it is the highest sandstone of the series. The second and third sandstone benches of this group lie 49 and 70 feet below the Dewey limestone and are well exposed in secs. 33 and 34.

Below the sandstones just described is a series of shales and thin sandstones that appear to be forest beds of a delta deposited by a northward-flowing stream in Pennsylvanian time. In this part of the geologic section the beds have a steep north dip that does not correspond to the dips in the beds above and below, and no work in structural geology can be based upon them in the southeastern part of T. 21 N., R. 11 E., where they form a considerable part of the exposed section.

From 25 to 40 feet above the Hogshooter limestone and about 325 feet below the Avant is a massive sandstone 2 to 3 feet thick. It forms the dip slope west of the schoolhouse in the eastern part of sec. 25, T. 21 N., R. 11 E., and crops out along Delaware Creek in secs. 35 and 36. The variation in the interval between the sandstone and the Hogshooter limestone becomes greater in the area to the south.

Hogshooter limestone.—The Hogshooter limestone is exposed in a few places in the southeast corner of T. 21 N., R. 11 E. Its outcrop is not continuous, as this limestone thins to the north and vanishes in this region. The Hogshooter is a coarse-grained gray limestone, containing fragments of crinoid stems. Its maximum thickness is 3 feet, and the interval between it and the Avant is about 356 feet.

ROCKS NOT EXPOSED.

A study of the logs of wells drilled in this area shows that between the surface beds and the productive oil and gas zone lie sandstone, shale, and limestone, with shale largely predominant. This is seen in Plate XXXI, which shows graphically the rocks as reported by the driller in the logs of four selected wells in this area.

The Big lime of the drillers, being the first heavy limestone below the Avant, is easily recognizable. The reported thickness of this limestone ranges from 25 to about 100 feet. In sec. 9, T. 22 N., R. 11 E., it lies 917 feet below the Avant limestone, and in sec. 27, T. 21 N., R. 11 E., it lies 1,168 feet below the Avant limestone. The top of the Big lime is gas bearing in parts of this area.

Below the Big lime is 110 to 160 feet of shale, under which lies the "Oswego lime," 50 to 65 feet in thickness. This limestone is about 1,105 feet below the Avant limestone in sec. 9, T. 22 N., R. 11 E., 1,146 feet below in sec. 12, T. 21 N., R. 11 E., 1,288 feet below in sec. 27 of the same township, and 970 feet below in sec. 12, T. 22 N., R. 10 E.

The "Oswego lime" is underlain by 350 to 440 feet of shales and thin limestones, of which the only good marker is the Pink lime of the drillers, 1,350 to 1,520 feet below the Avant limestone.

A series of sands lying 130 to 160 feet below the Pink lime contains the productive oil and gas zones of the district. The top of this productive series lies 1,480 feet below the Avant limestone in sec. 9, T. 22 N., R. 11 E. In sec. 12, T. 21 N., R. 11 E., the interval is 1,576 feet, in sec. 27 it is 1,720 feet, and in sec. 12, T. 22 N., R. 10 E., it is 1,410 feet.

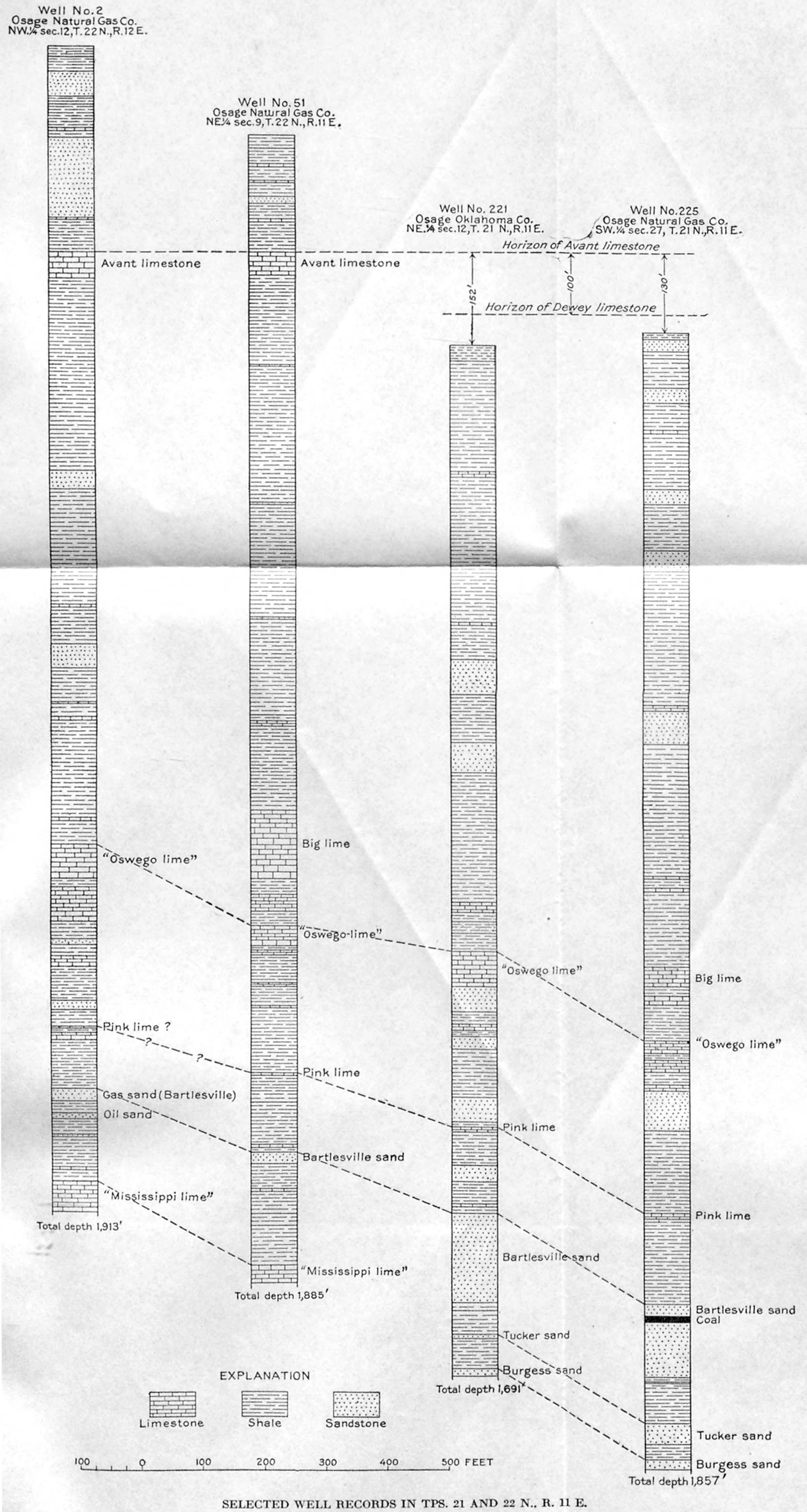
In the Bartlesville area the productive sand lies about 1,350 feet below the top of the Avant limestone, and in sec. 26, T. 23 N., R. 11 E., according to Emery,[1] the interval is 1,440 feet. Thus the well records show a distinct thickening toward the south of the strata lying above the "Mississippi lime."

Any productive sand in this zone is commonly referred to as the Bartlesville sand, and although it may not be the same as the productive sand at Bartlesville, the sands seem in a broad way to occupy similar stratigraphic positions. Gas is commonly encountered in the upper part of the series, and in some places the gas sand is separated from the underlying oil sands by a varying thickness of shale, but in other places there is no shale between the gas and oil bearing parts of the series. The productive sand aggregates 50 to 160 feet in thickness in this region.

About 190 feet below the top of the Bartlesville sand there is usually found a thinner sand called the Tucker, and 55 to 65 feet lower is the Burgess sand. In this region these sands, including the Bartlesville, form the basal portion of the Cherokee shale—that is, of the Pennsylvanian.

A few wells in this region have penetrated to a limestone generally known as the "Mississippi lime," which lies about 1,660 feet below the Avant limestone in the northern part of the region and

[1] Emery, W. B., op. cit.



SELECTED WELL RECORDS IN TPS. 21 AND 22 N., R. 11 E.

about 1,850 feet below in the southern part. West of this area, in sec. 12, T. 22 N., R. 10 E., the interval from the Avant limestone to the "Mississippi lime" is 1,523 feet. The thickness of this limestone as reported from three wells in Tps. 20 and 21 N., R. 12 E., ranges from 190 to 210 feet. It may represent the Boone limestone of northeastern Oklahoma and southeastern Kansas, but without more detailed information than is now at hand such a correlation can not be definitely made.

Beds below the top of the "Mississippi lime" have yielded oil or gas in commercial amounts at several localities in eastern Osage County, and no well should be regarded as constituting a complete test of a district in this region unless it penetrates the "Mississippi lime" to a depth of 300 feet.

STRUCTURAL FEATURES.

AREAS OF FAVORABLE STRUCTURE.

GENERAL FEATURES.

This area is 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 that may yield oil in commercial quantities. A study of the records of production in the eastern part of the Osage region shows that oil is most likely to occur on the west flank of such an uplift and gas on the crown, and that the east flank is more likely to be dry.

In general there is a westerly dip in T. 22 N., R. 11 E. A zone of close folding extends diagonally across the northwestern part of the township and northward into T. 23 N., R. 11 E. On the southeast a large pitching syncline extends across the township. Faulting has occurred in the eastern part of the township, and faults in the southern part extend across the township line into T. 21 N., R. 11 E. The southeastern part of the township is an area of open structure.

The greater part of T. 21 N., R. 11 E., is a steeply northwestward-dipping monocline relieved by a few minor irregularities. An area of marked faulting occurs in the northern part of the township in secs. 3 and 4, T. 21 N., R. 11 E. A fault in sec. 31 crosses into sec. 5, T. 20 N., R. 11 E.

The structure is shown on the maps (Pls. XXIX and XXX) by 10-foot contour lines which are based solely on surface data and are drawn on a theoretical bed 500 feet below the top of the Avant limestone.

The area on the southeast comprising Tps. 20 and 21 N., R. 12 E., has been contoured on a theoretical bed 300 feet below the top of the Hogshooter limestone. The interval between the Avant limestone

and the Hogshooter limestone is approximately known for the region near the southeast corner of T. 21 N., R. 11 E., but the interval farther south is not known, although there is evidence of great thickening to the south. For this reason the same bed can not be used for contouring in the two regions.

ANTICLINES IN T. 22 N., R. 11 E.

SOUTH BROWN ANTICLINE.

The most promising upfold in T. 22 N., R. 11 E., lies in secs. 4, 8, and 9 and is called the South Brown anticline. A similar anticline in sec. 33, T. 23 N., R. 11 E., forming a part of the same broad uplift as the South Brown anticline, has been described by Emery[1] as the Brown anticline. The South Brown anticline is outlined by the 210-foot contour and has a closure of 40 feet, but it is in reality a part of a much larger fold that extends toward the north and west and is outlined by the 190-foot contour. On the north a saddle-like syncline separates it from the Brown anticline. On the northeast lies a deep closed syncline, south of which a long nose extends from the southeastern flank of the South Brown anticline northeastward across secs. 10 and 3 and is separated from a small dome in sec. 2 by a low saddle. From the southern flank a smaller nose extends into secs. 21 and 20.

The South Brown anticline offers great promise as productive oil territory. A group of gas wells on the crown tap a gas sand in the Big lime but do not reach the Bartlesville sand. A well drilled to the "Mississippi lime" in the NE. ¼ sec. 9, far down the east flank, showed a trace of oil in spite of its poor location, and a well far down the south flank, on the west side of the nose in the northeast corner of sec. 20, has recently been brought in with a reported production of 25 barrels from the Bartlesville. On the southeast flank of the Fox dome, 2 miles to the northwest, in secs. 5 and 6 of this township, wells are producing from territory that is structurally less favorable. The eastern parts of secs. 5 and 8 and the northeastern part of sec. 17 are favorable areas for the production of oil, and locations recommended for test wells are indicated on the map (Pl. XXX). Oil is likely to be present also in the southern part of sec. 9 and a large part of sec. 16. The higher parts of the fold in secs. 4 and 9 yield gas from the Big lime, and it is probable that the lower sands will yield gas, but oil may be found in them.

The nose extending across secs. 10 and 2 lies on the east flank of this anticline and a deep closed syncline lies to the northwest. This greatly limits the gathering area and makes even the small dome in sec. 2 rather unpromising as a source of oil.

[1] Emery, W. B., op. cit.

FOX DOME.

The crown of the Fox dome, which lies in sec. 31, T. 23 N., R. 11 E., has been described by Emery;[1] but the south flank extends into sec. 6, T. 22 N., R. 11 E. The western part of sec. 5 and the eastern part of sec. 6 have been drilled, and the presence of oil there has been demonstrated. The southern limit of the productive area has been delineated by a series of dry holes in the southern part of sec. 6, but productive territory may be expected in the northern half of the section west of the tested area.

CEDAR BLUFF DOME.

An elongated dome of much promise lying in secs. 18 and 19 near the mouth of Turkey Creek has been called the Cedar Bluff dome. Oil is being produced far down the west flank, in secs. 13 and 24, T. 22 N., R. 10 E., but favorable locations on the south and west flanks in T. 22 N., R. 11 E., have not been tested. Locations recommended for test wells are indicated on the map (Pl. XXX). The crown of the dome is most likely to yield gas but may yield oil.

LAKE VIEW DOME.

South of the Lake View School, in T. 22 N., R. 11 E., lies a sharp upfold which has been called the Lake View dome. It covers all of sec. 33, and extends a short distance into secs. 3 and 4, T. 21 N., R. 11 E. It is bounded on the east by a fault that has a maximum throw of 50 feet. The effect of such a fault is not definitely known, but it does not seem probable that it would affect the accumulation of oil unfavorably. A dry hole just east of the fault in sec. 34 is in so unfavorable a location that it does not in the least discredit the area west of the fault. The most favorable location for a test well is indicated on the map (Pl. XXX), but much of sec. 33 may prove to be productive territory.

In sec. 32 a small terrace forming the west flank of the Lake View dome and the north flank of the Edgewood dome may be productive. A good location for a test well would be near the center of the NW. $\frac{1}{4}$ sec. 32.

STRUCTURE IN SEC. 12 AND ADJACENT SECTIONS.

The rocks in secs. 12 and 13 are broken by two parallel faults, and the resultant structure is complex. Between the faults the rocks have been folded down into a syncline, and east of the eastern fault the structure is also in part synclinal. West and north of the faults, however, the structure is anticlinal, and in the western part of sec. 12 there is a closure of more than 10 feet against a fault. These

[1] Emery, W. B., op. cit.

structural features are shown graphically on Plate XXX to which attention is called in this connection. It seems possible that oil may have accumulated in the western part of sec. 12 and the eastern part of sec. 11, in what is in effect an anticline, and it also seems possible that the anticlinal nose which is strongly developed in the SW. ¼ sec. 1 may have influenced the accumulation of oil in that area. The only test that has been made of this fold is that of the Barnsdall Oil Co. in the NE. ¼ sec. 14, which proved a dry hole. This well was drilled to the "Mississippi lime" without obtaining oil or gas. A single dry hole does not necessarily condemn a fold, however, and it is thought that a test of the structurally higher area in the W. ½ sec. 12 west of the faults should be made before the area is definitely classed as without value for oil. It is also possible that a well drilled in the southeast corner of sec. 1 may yield oil.

ANTICLINES IN T. 21 N., R. 11 E.

SCARP ANTICLINE.

In secs. 1, 12, and 13, T. 21 N., R. 11 E., is a low uplift which has been called the Scarp anticline. It is outlined by the 350-foot contour, and two low crowns are formed on it by closures of the 360-foot contour. The south flank is a broad terrace lying in the northwestern part of sec. 13, and the north flank is a terrace lying in sec. 1 and the southern part of sec. 36, T. 22 N., R. 11 E. On the east the anticline is limited by a shallow syncline, and on the west there is a steep westerly dip. A well with showings of oil and gas is reported in the NE. ¼ sec. 12 on the east flank of the anticline, which indicates that gas would probably be found on the higher parts of the fold and that oil is to be expected in wells on the west flank. The most favorable areas lie in the western part of sec. 1, the eastern parts of secs. 2 and 11, the northwestern part of sec. 12, and the northeast corner of sec. 14 and adjacent parts of sec. 13. Locations recommended for test wells are indicated on Plate XXIX.

EDGEWOOD DOME.

A low uplift whose crest is in the western part of sec. 5 has been called the Edgewood dome. It is outlined by the 170-foot contour and the 180-foot contour is the only other one to close. On the east lies a shallow syncline, on the southwest is a narrow pitching syncline, and on the west and northwest the rocks dip northwest. The area in which it may be possible to obtain oil includes the western part of sec. 5, the eastern part of sec. 6, and a small tract in the southern part of sec. 32, T. 22 N., R. 11 E. The most promising location for a test well is thought to lie in the eastern part of sec. 6.

RED BLUFF ANTICLINE.

The Red Bluff anticline, in the southwestern portion of the township, is a large fold, separated from the Edgewood dome by a syncline. The main anticline runs from the southern part of sec. 20 southwestward across sec. 29 and into sec. 31, where a fault cuts it near the end. The highest crown is marked by the 300 and 310 foot contours, which close against a fault. The 290-foot contour forms a low crown near the center of sec. 29 and another crown in the southwestern part of sec. 20. Close to the west flank the 280-foot contour forms another low crest not far from the center of sec. 30. The northwestern brow of the anticline is a broad terrace that runs from the southern part of sec. 20 across the northwestern part of sec. 29 and ends in the southeastern part of sec. 30. On the west the beds dip to the northwest, and on the southeast there is a long, shallow syncline, beyond which the beds dip to the northwest. On the north a large pitching anticlinal nose extends from sec. 20 across sec. 17 into sec. 8, and a pitching syncline lies northeast of the anticline.

The northwest flank of the Red Bluff anticline offers excellent possibilities for oil development. The area in which oil may be obtained probably includes the eastern part of sec. 19, the western part of sec. 20, a small area in the northwest corner of sec. 29, most of sec. 30, and the part of sec. 31 west of the fault. This fault has a small throw in sec. 31 and probably would not have an unfavorable influence on the accumulation of oil. Along the crest gas is more likely to be found than oil.

The entire area outlined is not equally favorable for yielding oil, and the most promising locations for test wells lie on the northwest flank of the main anticline in secs. 19 and 20, on the west flank in sec. 30, and on the southwest flank in sec. 31. The northeast flank could be best tested in the southeastern part of sec. 20. These locations are indicated on the map (Pl. XXIX).

ANTICLINAL NOSE NORTH OF RED BLUFF ANTICLINE.

An anticlinal nose extends from the northern brow of the Red Bluff anticline in sec. 20, T. 21 N., R. 11 E., northward across secs. 7, 17, 18, 19, and 20, and is separated from the Edgewood dome by a saddle in sec. 8. East of the northward-pitching nose a pitching syncline trends in the same direction. The convergence between the higher beds and the Avant limestone accentuates the north dip on the nose and syncline, and for this area elevations based on higher beds are reduced to an Avant datum.

The most favorable locations for test wells on this nose lie in the western parts of secs. 17 and 20. (See Pl. XXIX.)

AREAS OF UNFAVORABLE STRUCTURE.

In view of the spotted distribution of the producing wells in this general region, it would be hazardous to state that certain structural features in this area are not favorable for oil. It seems unlikely, however, that commercial quantities of oil will be found in the major synclines, such as that in secs. 21 and 22, the northern parts of secs. 23, 28, and 29, and the southern parts of secs. 14, 15, 20, and 30, T. 22 N., R. 11 E.; that in sec. 7; or the deep closed syncline in the western part of sec. 3 and the eastern part of sec. 4. In T. 21 N., R. 11 E., the synclinal area extending from sec. 4 across the eastern parts of secs. 8 and 17 and the western parts of secs. 9, 16, and 21, is not likely to yield a large quantity of oil.

An examination of records of production in eastern Osage County shows that in general oil is not likely to occur in monoclinal areas such as that in the southeast corner of T. 22 N., R. 11 E. Most of the southeast half of T. 21 N., R. 11 E., is a monocline dipping steeply to the northwest and can not be considered the most favorable territory for oil production. West of the uplift in the western part of this township the dip is west, and therefore the western parts of secs. 6, 7, 18, and 19 should be considered slightly unfavorable.

The effect of faulting on the accumulation of oil is difficult to foretell, but the faulted areas in secs. 12 and 13, T. 22 N., R. 11 E., and secs. 3 and 4, T. 21 N., R. 11 E., can hardly be considered favorable territory.

In sec. 36, T. 21 N., R. 11 E., the delta deposits of Pennsylvanian age prevent accurate mapping of the structure, but in general a north dip is indicated, and dry holes in the southeast corner of sec. 36 seem to support the opinion that this area is not likely to produce large amounts of oil.

SAND CONDITIONS.

Little is known about the effect of sand conditions in Osage County, as no detailed work on the sands has been attempted. Undoubtedly changing sand conditions may affect favorably or unfavorably the oil production in any region and may nullify the effects of otherwise favorable structure or cause the accumulation of oil in areas where its presence would not be indicated by the structure. The tightening of the sands down the dip from places of favorable structure might prevent the migration of oil into such places, and on the other hand the tightening of the sands up the dip from a porous sand might cause the accumulation of oil in a monocline or even on the flanks of a syncline.

PRODUCTION.

The only oil-producing territory in the area here discussed is in secs. 5 and 6, T. 22 N., R. 11 E., on the southeastern flank of the Fox dome, and in sec. 20 of the same township, where there is one well. In this part of the Fox dome the initial production is small, and the present average production is about 1 barrel a day. These wells are unfavorably located, and their production does not indicate what may be expected from wells in more favorable structural positions. The one well in sec. 20 is said to be producing 25 barrels a day.

Some idea of the possibilities of obtaining oil in this area may be gained from the conditions in Tps. 20 and 21 N., R. 12 E., to the southeast, where development has been more thorough. Here the initial production ranges from a few barrels to 150 barrels a day and the average is between 40 and 50 barrels. Drilling began in 1908 and reached its climax in 1914. By the end of 1917 the average production per well had dropped to about 10 barrels a day, but this rate seems to be rather well maintained.

The Bartlesville sand is yielding most of the oil produced in the eastern part of Osage County, and it seems probable that this sand will prove to be the most productive here also. In the southeastern part of T. 22 N., R. 10 E., oil is derived from the Cleveland sand, 750 to 800 feet below the Avant limestone, and this bed may yield some oil in Tps. 21 and 22 N., R. 11 E. A few wells in sec. 3, T. 21 N., R. 12 E., are reported to be producing oil from the "Mississippi lime," and that bed should be thoroughly tested in this region at a locality favorable for oil. Drilling has usually been continued to the "Mississippi lime" only where the beds at higher horizons proved to be dry, and so there have been few adequate tests of that formation.