

## TPS. 20 AND 21 N., R. 12 E.

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### INTRODUCTION.

The fractional Tps. 20 and 21 N., R. 12 E., constitute an area 12 miles long and about 4 miles wide lying in the southeast corner of Osage County. (See fig. 1.) The city of Tulsa is situated just outside the southeast corner of the area, and Sperry lies a mile east of the northern township.

Hominy and Rock creeks cross the northern part of T. 21 N., R. 12 E., and extensive alluvial bottoms occur along their courses. South of the alluvial areas the country is gently rolling, and much of the township is under cultivation. In the southern part of this township and the northern part of T. 20 N., R. 12 E., there is a rugged timbered area, and along the western border of the southern township rise a number of high bald hills, giving a maximum relief to the region of 440 feet. South and east of the areas just mentioned the township is rolling and only partly timbered. Roads are numerous and fairly good in both townships.

### STRATIGRAPHY.

#### EXPOSED ROCKS.

The rocks that crop out in Tps. 20 and 21 N., R. 12 E. (see Pl. XXVII), comprise about 350 feet of middle Pennsylvanian sediments. Sandstone and limestone form only a small part of the geologic section, shale being greatly predominant, as is shown graphically in figure 28. A few of those beds that are suitable as key rocks are described below for the convenience of those who may wish to do geologic work in the region. These rocks are discussed in order of age, the youngest first, and consist of a shale and thin sandstone series, near the base of which lies a massive sandstone; the Hogshooter limestone, used as the datum in the present investigation; and a group of sandstones, the lowest rocks studied in the region.

*Sandstones and shales above the Hogshooter limestone.*—Shales predominate in the series above the Hogshooter limestone in this area, but thin sandstones are interstratified with them, and locally a

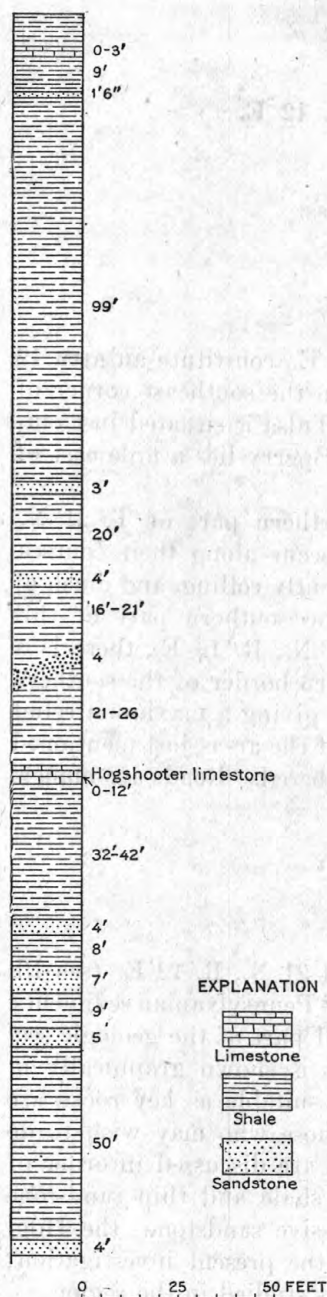


FIGURE 28.—Columnar section of rocks exposed in Tps. 20 and 21 N., R. 12 E.

limestone lies near the top of the group. These shales and interstratified lenticular sandstones appear to be the foreset beds of a delta deposited by a northward-flowing stream in Pennsylvanian time. Their thickness is about 190 feet near the southwest corner of T. 21 N., R. 11 E., but there is evidence of a marked increase in thickness from north to south. This series of beds forms a considerable part of the exposed rocks in the Bald Hill region of T. 20 N., R. 12 E., where they have a steep northward dip that does not correspond to that of the Hogshooter limestone below. These beds were studied and contoured in as much detail as the nature of the exposures permitted and were found to be absolutely valueless for the determination of underground structure. No structure contours, therefore, are shown for the areas where these beds crop out.

A massive sandstone lying at a variable interval above the Hogshooter limestone is exposed over large areas along Rock and Delaware creeks and in the region lying north of Flat Rock Creek. The interval is 25 to 30 feet in T. 21 N., R. 12 E., and the northwest corner of T. 20 N., R. 12 E.; but farther south it increases so greatly that the bed is of little use in contouring the geologic structure.

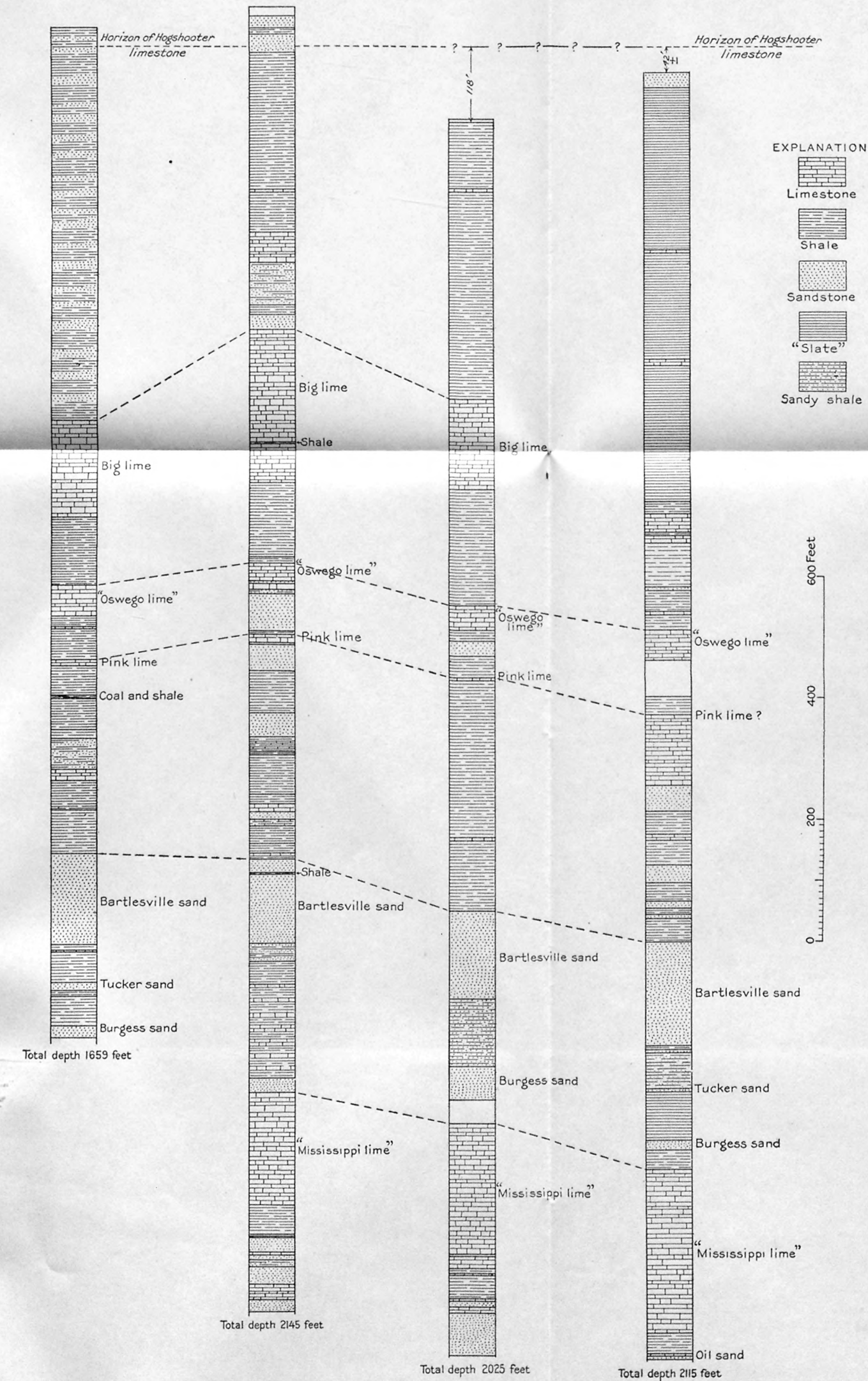
*Hogshooter limestone.*—The Hogshooter limestone crops out over a large part of this area, being exposed along both sides of Delaware Creek in T. 21 N., R. 12 E., in the rugged area lying just north and south of the township line, and along a roughly diagonal line running from the northeast to the southwest corner of T. 20 N., R. 12 E. In the southwestern part of T. 20 N., R. 12

Well No. 224  
Osage Oklahoma Company  
NE 1/4 sec. 20, T. 21 N., R. 12 E.

Well No. 4  
Producers Oil Company  
Sec. 33, T. 21 N., R. 12 E.

Well No. 8  
Devonian Elliot Oil Company  
Sec. 10, T. 20 N., R. 12 E.

Well No. 229  
Osage Oklahoma Company  
Sec. 22, T. 20 N., R. 12 E.



SELECTED WELL RECORDS IN TPS. 20 AND 21 N., R. 12 E.

E., the maximum thickness is 12 feet, but the limestone thins toward the north and has not been observed in T. 21 N., R. 11 E., or far north of Delaware Creek in T. 21 N., R. 12 E. This limestone is gray on fresh fracture and usually weathers gray, though locally the exposed surface is red. It is immediately overlain and underlain by shale, and the upper layers are usually coarse grained and fossiliferous, containing horn corals and crinoid fragments. The lower layers are finer grained and less fossiliferous than the upper layers. The Hogshooter limestone forms a low ledge in the southern part of the area, but in the northern part it is so thin that it is in many places entirely covered by talus from the sandstone bed above.

*Sandstone beds below the Hogshooter limestone.*—A group of sandstones and sandy shales lying below the Hogshooter limestone are exposed in the same general area as the limestone. Persistent beds of sandstone lie 42, 54, and 68 feet below the Hogshooter, and a sandstone exposed in sec. 15, T. 20 N., R. 12 E., lies about 125 feet below it. The highest sandstone of the group is about 18 inches thick. It is hard and weathers into angular blocks. The two middle sandstones are massive, light colored, very micaceous, and soft, weathering away rapidly. The lowest sandstone is thin bedded, but the topmost layer forms a persistent outcrop.

#### ROCKS NOT EXPOSED.

A study of the well logs of the Osage region shows that between the surface beds and the productive oil and gas zone lie sandstone, shale, and limestone, with shale largely predominant. A few of the large number of well logs available are plotted on Plate XXVIII and show graphically the beds encountered in drilling.

The Big lime, whose thickness is 25 to 180 feet, is the first heavy limestone encountered and is usually reported by drillers, but according to the drillers' records, the thickness is so variable that it does not form a good key bed in this region. Below the base of the Big lime is 110 to 190 feet of shale, under which lies the "Oswego lime," 50 to 65 feet thick. The interval between the "Oswego lime" and the Hogshooter limestone is about 890 feet in sec. 20, T. 21 N., R. 12 E., but it increases toward the south and in sec. 22, T. 20 N., R. 12 E., is about 957 feet.

The "Oswego lime" is underlain by 360 to 500 feet of shales and thin sandstones, below which is a series of sands containing the productive oil and gas zones of the district. The top of this productive series lies 1,328 feet below the Hogshooter limestone in sec. 20, T. 21 N., R. 12 E., and about 1,470 feet below this limestone in sec. 22, T. 20 N., R. 12 E., a divergence of nearly 150 feet in about 7 miles. A study of the well records in the eastern part of the Osage Reservation shows that in general there is a divergence between the productive



sands and the higher beds from north to south, and this condition prevails in the townships here described.

The productive sand lying at the top of this series is commonly referred to as the Bartlesville sand, and although it may not be the same as the productive sand at Bartlesville, the two 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-bearing sands by a varying thickness of shale, but in other places there is no shale between the gas and oil sands. The productive zone, including the gas sand, which is best regarded as part of the Bartlesville, aggregates 50 to 170 feet in thickness in this area.

The Tucker sand, 10 to 30 feet thick, lies 190 to 240 feet below the top of the Bartlesville, and the Burgess sand, which is slightly thicker, lies 70 to 90 feet below the top of the Tucker. The entire series embraces the basal portion of the Cherokee shale.

A few wells in this region have penetrated to a limestone generally known as the "Mississippi lime." In sec. 33, T. 21 N., R. 12 E., the "Mississippi lime" lies 1,725 feet below the Hogshooter, and in sec. 22, T. 20 N., R. 12 E., it lies about 1,840 feet below. It has been completely penetrated in three wells in this area, and the reported thickness ranges from 187 to 270 feet. This limestone 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 asserted.

At several localities in the eastern part of Osage County beds below the top of the "Mississippi lime" have yielded oil or gas in commercial amounts, 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.

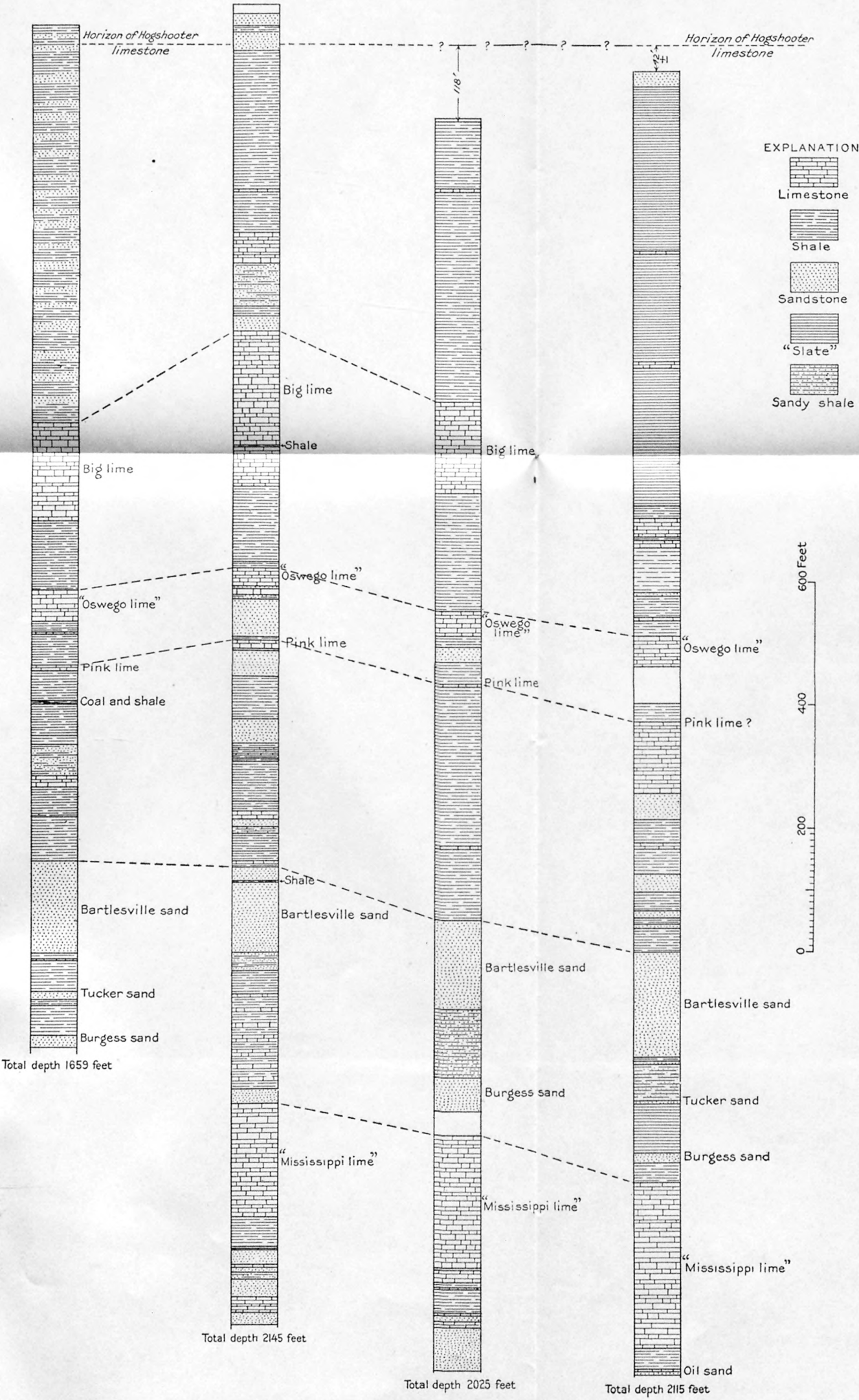
These townships are part of a large region in which the general dip of the rock beds is westerly or northwesterly. The presence of an easterly dip is therefore significant, for it indicates an upfold that may yield oil in commercial quantities. A study of the records of production in the Osage region shows that in general 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 very likely to be dry. The occurrence of dry holes in productive areas seems attributable to locally patchy conditions of the sands. Some of them, however, may rep-

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SELECTED WELL RECORDS IN T. 20 AND 21 N., R. 12 E.

resent failure to reach the productive sands. Not all the well logs are available for satisfactory comparison.

In the northern part of T. 21 N., R. 12 E., lies a steeply north-westward-dipping monocline. An area of marked folding extends southeastward from the northern edge of sec. 30, T. 21 N., R. 12 E., across the southern part of this township and involves most of T. 20 N., R. 12 E. In the southern part of T. 20 N., R. 12 E., the beds dip to the northwest, and west of the area of folding the dip is westerly.

The structure is shown on the map (Pl. XXVII) by 10-foot contours, which are based solely on surface data and are drawn on a theoretical bed 300 feet below the top of the Hogshooter limestone.

The area on the northeast comprising Tps. 21 and 22 N., R. 11 E., has been contoured on a theoretical bed 500 feet below the top of the Avant limestone. The interval between the Avant limestone and the Hogshooter limestone in the region near the southeast corner of T. 21 N., R. 11 E., is approximately known, but the interval south of this region is not known, although there is evidence of great thickening to the south. For this reason the two regions can not be contoured on the same beds.

The region here described has been rather thoroughly developed and forms a productive oil field. Geologic work here may possibly be of more value in showing the close relation between upfolds and the accumulation of oil than in indicating possible extensions of the producing territory, and in that way it will prove rather clearly the service that such work can render in the undeveloped parts of the Osage Reservation.

#### ANTICLINES IN T. 21 N., R. 12 E.

##### SPERRY FIELD.

In secs. 3 and 10, T. 21 N., R. 12 E., northeast of Sperry, oil is being produced in large amounts, but the structure of the productive rocks can not be determined from surface observations, for all of sec. 3 is covered by alluvium, and the sandstone that crops out in the eastern part of sec. 10 can not be definitely traced toward the southwest. The correlation of this sandstone with the beds to the southwest indicates, however, that the northwesterly dip in sec. 16 gives place in sec. 10 to a westerly dip, a phenomenon which suggests that these sections lie on the western flank of a fold. In the absence of definite structural information no suggestions can be made about possible extensions of the field.

##### DELAWARE ANTICLINE.

A rather broad, flat fold on Delaware Creek extending from the northern parts of secs. 29 and 30, T. 21 N., R. 12 E., southward to the township line is here called the Delaware anticline. It lies in

the SW.  $\frac{1}{4}$  sec. 29, the eastern part of sec. 31, and the western part of sec. 32, being outlined by the 460-foot contour, and has a low crown in the southeast corner of sec. 31 inclosed by the 470-foot contour. The northern brow extends into the southeast corner of sec. 19, beyond which the beds dip steeply to the northwest for a considerable distance. Near the center of sec. 32 is a shallow closed syncline outlined by the 450-foot contour.

Alluvium prevents accurate mapping of the western part of sec. 30 and the northwestern part of sec. 31, but a small terrace appears to lie on the west flank of the Delaware anticline in this region.

The Delaware anticline, being a part of one of the most productive oil fields of Osage County, has been rather thoroughly developed, and the areas of most favorable geologic structure have been drilled. Possible extensions of the field have been outlined by drilling operations, but geologic work indicates that a few more wells may be expected on the northern brow of the anticline in the southeastern part of sec. 19 and the southwestern part of sec. 20, on the western flank in secs. 30 and 31, and in the southern part of secs. 31 and 32.

#### NORTHEASTERN EXTENSION OF THE BALD HILL DOME.

A terrace extends from the northeastern flank of the Bald Hill dome in sec. 4, T. 20 N., R. 12 E., northeastward across the southeastern part of sec. 33 and the western part of sec. 34, T. 21 N., R. 12 E. A small crown in the eastern part of sec. 33 is marked by the closure of the 520-foot contour.

The western part of sec. 33 has been developed, and a few dry holes near the center of the section are reported, but it is possible that productive wells may be drilled in the eastern part of sec. 33 and the western part of sec. 34.

#### ANTICLINES IN T. 20 N., R. 12 E.

##### BALD HILL DOME.

The Bald Hill dome occupies most of secs. 4, 5, 8, and 9, T. 20 N., R. 12 E., and is the largest uplift in the area and one of the most pronounced domes in the Osage Reservation. It has a closure of about 70 feet, is roughly pear-shaped and rather symmetrical in outline; and is marked by a series of terraces on its flanks. The rocks dip westward from the crown of this dome for 2 miles, but farther west the structure is obscured by unconformable delta deposits of Pennsylvanian age and the position of the synclinal axis can not be determined from surface data. On the south, about 2 miles from the crest of the dome, there is a large saddle, and on the southeast, at about an equal distance from the crown, there is a closed syncline. On the northeast a saddle which trends northwest from the southeast corner



of sec. 4 separates the Bald Hill dome from a low anticline in sec. 3. The Delaware anticline, described above, lies northwest of the dome.

The dip of the beds on the flanks of the Bald Hill dome is shown in figure 29, a cross section in which the horizontal scale is equal to the vertical scale. This section serves to emphasize the slightness of the dips that are necessary to allow the accumulation of oil in this region.

The Bald Hill dome has been rather thoroughly developed, as all of sec. 4, part of sec. 5, and most of secs. 8 and 9 have been drilled. Dry holes in secs. 3, 7, 18, 17, 16, 21, 15, and 10 almost encircle the dome and make any large extension of the producing area doubtful. Oil production, however, may be considerably increased in sec. 5, and the productive area may be extended into the eastern parts of secs. 6 and 7. An increase in the number of wells in the southern parts of secs. 8 and 9 and the northern parts of secs. 16 and 17 is also probable. On the east some new wells in secs. 3 and 10 may be

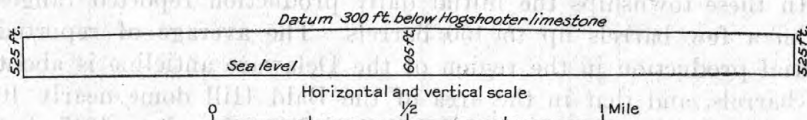


FIGURE 29.—Sketch showing dip of beds on Bald Hill dome.

expected. The reported dry holes in the southeastern part of sec. 9 are in a low saddle and do not preclude the possibility that the higher structure in sec. 10 may yield oil.

FOLD IN SEC. 22.

Secs. 15 and 22 appear to lie on the northwestern flank of a fold which extends into the township to the east but which is obscured by alluvium. The syncline in the northwestern part of sec. 15 probably prevents much extension of the productive area in that direction, and a series of dry holes along the southern border of sec. 22 seems to limit productive territory there. A slight westward extension of the producing area is possible in the eastern part of sec. 21 and the southeastern part of sec. 16.

#### AREAS OF UNFAVORABLE STRUCTURE.

The alluvium of Hominy Creek covers most of the northern tier of sections in T. 21 N., R. 12 E., and consequently the structure in these sections is mostly unmapped, but work in the township to the west indicates that a syncline extends into the southern part and a small anticline into the northern part of sec. 6, T. 21 N., R. 12 E. It is possible and indeed probable that the monocline mapped south of the alluvium-covered area along Hominy and Rock creeks extends northward under this alluvium-covered area. Nothing, however, can

be learned about the oil possibilities of this area from surface observations. The central part of the township is an area of steep monoclinal dip that is not likely to produce notable amounts of oil, as is shown by the dry holes drilled in secs. 9, 16, 17, 18, 20, and 21 and the northern parts of secs. 27 and 28.

The delta beds of Pennsylvanian age prevent accurate structure mapping of the western border of T. 20 N., R. 12 E., and little can be said about the oil possibilities in that region.

The southern part of T. 20 N., R. 12 E., lies on a westward-dipping monocline. It is said that oil wells of minor production and a few small gas wells have been obtained in this area, but dry holes are much more numerous than producing wells, and it seems likely that the area will only yield a local and scanty supply of oil.

### PRODUCTION:

In these townships the initial daily production reported ranges from a few barrels up to 150 barrels. The average of reported initial production in the region of the Delaware anticline is about 45 barrels, and that in the area of the Bald Hill dome nearly 40 barrels. Drilling commenced in 1908 and continued to 1917, but more wells were drilled in 1914 than in any other one year. By the end of 1917 the average production for the whole area had dropped to about 10.5 barrels per well. The present rate of production seems to be rather well maintained.

The areas of most favorable geologic structure have all been developed, and it is probable that the initial production of future wells will be smaller than that of those heretofore brought in.

Almost all the oil wells of this region derive their oil from the Bartlesville sand, but it is reported that two wells in sec. 3, T. 21 N., R. 12 E., had an initial daily production of nearly 100 barrels from the "Mississippi lime." Some wells have been drilled to the "Mississippi lime" on the flanks of the Bald Hill dome, but nearly all these wells had been dry in the Bartlesville sand. There is no record of a thorough test of the "Mississippi lime" in a favorable area on either the Delaware anticline or the Bald Hill dome.

The distribution of gas wells in this region is somewhat anomalous. Both oil and gas are found near the crown of the Bald Hill dome, and gas is reported from the flanks of this dome and the Delaware anticline. Gas is derived from beds at various horizons, but only a very incomplete record is at hand. The largest yield seems to be derived from the Bartlesville sand or from the gas sand which is usually the upper part of the Bartlesville, but incomplete data prevent a study of gas production in this area.