TPS. 21–23 N., RS. 6–7 E., AND TPS. 23–25 N., RS. 3–5 E.

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INTRODUCTION.

The Osage Reservation has, by general agreement, been divided into an eastern and a western portion. The eastern portion, commonly referred to as the "east side," includes that part of the reservation lying east of R. 7 E., and the "west side" includes that part lying west of R. 8 E. This report describes the southeastern part of the "west side," lying south of T. 24 N. and east of R. 5 E., and the western part, lying west of R. 6 E. and south of T. 26 N. (See fig. 1 and Pls. XLIII and XLIV.) It also includes small portions of T. 25 N., R. 5 E., and T. 24 N., Rs. 6 and 7 E., and shows slight revisions of the map of these townships as published in Bulletin 686–L. The field work was begun in October, 1918, and completed in February, 1919.

The key maps of Plates XLIII and XLIV show the areas mapped by the different geologists, who assume responsibility and are likewise to be accorded credit for the accuracy of the results in the respective areas as shown on the geologic maps. So far as practicable, too, the descriptions of the structure in the several townships were prepared by the geologists who did the field work.

Messrs. Charles Price, W. G. Argabrite, C. E. Dobbin, J. L. Mergner, and Walter Wilson served as instrument men during a part or all of the field season.

STRATIGRAPHY.

EXPOSED ROCKS.

GENERAL FEATURES.

The rocks exposed from east to west across the southern part of the "west side" are illustrated graphically in the columnar section on Plates XLIII and XLIV. They have an aggregate thickness of about 1,500 feet and are of upper Pennsylvanian and lower Permian age. They consist of numerous beds of limestone, ranging in thickness from a few inches to 15 feet or more, interstratified with beds

of sandstone and shale. The principal limestones are continuous from north to south across the entire "west side," but most of them show considerable change in physical character. As a rule the limestones become thinner and more sandy, and the sandstones between them become more prominent toward the south. Above the Neva limestone all the rocks except the limestones are prevailingly red; below the Neva more somber colors predominate, though some of the shales have reddish hues. The limestones are of the greatest aid in working out the structure of the region, hence the most prominent and characteristic of them will be described, but no detailed description of the stratigraphy as a whole will be given.

KEY BEDS.

Lecompton (?) limestone.—The limestone here designated the Lecompton (?) averages about 15 feet in thickness but attains limits considerably above and below that figure. It is known to the commercial geologists as the "Hominy lime." In the southern part of the area it comprises three more or less distinct limestone beds. The upper bed is a thin, platy, gray limestone 1 foot or less in thickness, containing an abundance of fossil *Fusulina*. It is separated from the middle limestone by about 5 feet of shale. The middle bed, which is 1 or 2 feet thick, lies immediately below the shale parting and is a dull-gray, slightly ferruginous limestone, which in some places weathers slightly brown. It is somewhat sandy in composition and as a result weathers to smooth surfaces. It is less resistant to erosion than the lower bed, and therefore as a rule weathers back under the grassy slopes which commonly mark the upper surface of the bed. The lower bed is a gray thin-bedded ledge-making limestone which weathers white. It is the most conspicuous part of the member and generally produces a marked ledge or rim. In vertical faces the thin regular layers of limestone cut by vertical joints present the appearance of an artificial rock wall. Heald[1] has correlated the "Hominy lime" with the Lecompton limestone, but the sequence of beds between the Elgin sandstone and the Bird Creek limestone, the intervals between them, and the lithologic character of the limestones themselves strongly suggest that the "Hominy lime" represents the Deer Creek limestone, and that the thin yellow limestone about 30 feet lower in the section is the equivalent of the Lecompton.

Turkey Run limestone.—The Turkey Run limestone lies about 85 feet above the Lecompton (?) limestone, and is 1 to 3 feet thick. It thins toward the south. The rock is a steel-blue dense, fine-grained

[1] Heald, K. C., and Mather, K. F., report on Tps. 24 and 25 N., R. 8 E.: U. S. Geol. Survey Bull., 686–M, p. 151, 1919.

brittle limestone that rings when struck with the hammer and breaks with a clean-cut fracture. It weathers into rectangular or wedge-shaped blocks, which do not erode easily and are therefore rather conspicuous even on grassy slopes. The most characteristic fossil is a species of small, slender *Fusulina* that is especially abundant in the lower part of the bed. These fossils are, however, most noticeable in the southern part of the area and were not observed in T. 23 N. Because of its thinness, persistence, and easily recognizable character this bed is a most valuable key rock in the areas where it is exposed.

Bird Creek limestone.—The Bird Creek limestone lies 52 feet above the Turkey Run limestone. It is 1 to 4 feet in thickness and thins toward the south. It is very similar to the Turkey Run limestone in physical character but differs slightly in color, mode of weathering, and fossil content. The Bird Creek limestone is dull black, breaks along bedding planes, and weathers into thin plates that scale off the surface parallel to the bedding. The *Fusulina* noted in the Turkey Run limestone were not observed in the Bird Creek limestone. However, considerable care has to be exercised to avoid confusing these two beds.

Cryptozoon-bearing limestone.—The *Cryptozoon*-bearing limestone is 105 feet above the Bird Creek limestone and has a thickness of at least 5 feet at the small outlier in the NW. ¼ sec. 35, T. 22 N., R. 7 E. In T. 23 N. it seems to be only about 2½ feet thick. It is a dense noncrystalline black or gray fossiliferous rock resembling in physical appearance the Bird Creek and Turkey Run limestones. It is distinguished from those beds by its fossils, which comprise *Fusulina*, Cryptozoa, and Bryozoa, besides other less distinctive forms. The *Fusulina* are of medium size and rather abundant and are present in the limestone over the entire area. The Cryptozoa, which are the most diagnostic fossils in this limestone farther north, are very rare in this area and were not observed south of T. 23 N. They occur most commonly in the somewhat limonitic upper portion of the bed. The Bryozoa occur in large circular, rosette-like colonies, as much as 3 or 4 inches in diameter. They are less soluble than the matrix in which they occur and hence are found loose on the surface of the bed or in the débris below it.

Stonebreaker limestone.—The Stonebreaker limestone includes three distinct beds of limestone ranging through an interval of about 55 feet and separated by beds of shale and sandstone. The lowest limestone is approximately 60 feet above the *Cryptozoon*-bearing limestone and is about 12 feet thick but gives the impression at most of the exposures of consisting of two or more beds, because certain layers that are somewhat more resistant to erosion than the remainder of the bed form shoulders separated by areas in which the rock is

concealed. The upper part of the bed weathers white and in places is thickly dotted with spots of white calcite replacing gastropods. About 2 or 3 feet below the top is a layer containing some large, plump *Fusulina*. At the base is a thin yellow layer which is highly fossiliferous.

About 20 to 25 feet above the bed just described is a sandy gray limestone about 2 feet thick, which weathers into rounded masses or boulder-like forms. In places the weathered surface is strongly limonitized and brown, but the prevailing color is light gray. The bed is sparingly fossiliferous, and its chief distinguishable form is a species of small *Fusulina*. The limestone lies immediately above a persistent bed of sandstone and in some places is also overlain by a bed of sandstone. About 20 feet above the gray sandy limestone is a thin drab crystalline fossiliferous limestone lying immediately below a thick, heavy sandstone. This limestone is thin bedded and weathers down quickly, so that it is generally concealed by débris from the beds above. It is commonly exposed on projecting points and weathered fragments of it may be found at other places where the sandstone débris is not too heavy. A species of large *Myalina* is sparingly distributed in this bed. Aside from this the fossils are not distinctive and consist of fragmentary remains. A thin limestone very similar to this one occurs about 35 feet below the Grayhorse limestone and is the only other limestone likely to be confused with the upper bed of the Stonebreaker.

Grayhorse limestone.—The Grayhorse limestone lies about 90 feet above the top of the Stonebreaker limestone. It is 1½ to 2 feet thick and is the most easily recognized bed in the township. It is a drab crystalline conglomerate limestone which weathers to a dirty pale yellow and contains fossils of a large *Myalina*. The conglomerate pebbles are small, rarely more than a quarter of an inch in diameter, and consist chiefly of shale which weathers dirty bluish gray, giving to the surface of the rock a mottled aspect. The limestone as a rule weathers out in large thin slabs, but it does not produce any marked topographic effect on the landscape.

Foraker limestone.—The Foraker limestone, the base of which lies 100 feet above the Grayhorse limestone, includes a succession of sandstones, shales, and limestones about 110 feet thick. The limestones, which constitute about one-fourth of the unit, are characterized throughout by an abundance of *Fusulina*. For convenience of description the Foraker may be divided into three divisions. The lower division, about 45 feet thick, consists of two thin limestones at the base separated by about 10 feet of shale and overlain by about 35 feet of sediments—principally red shale, some of which is sandy, and one well-defined bed of sandstone. These basal limestones make excellent key beds. They are each about 1 foot thick. The upper

one is lead-gray, and the lower one somewhat lighter in color. They produce small shoulders or terraces at the base of the steep slope formed by the upper limestones and weather out into large slabs, which, as a rule, represent the entire thickness of the individual beds.

The middle division of the Foraker consists of a single limestone overlain by a heavy sandstone in places at least 20 feet thick. The basal part of the limestone is dense, fine grained, and black, weathers in slabs, and is overlain by less resistant limestone which weathers slightly yellow and contains crinoid stems, brachiopods, etc.

The upper division comprises three well-defined limestones, with probably some thinner beds, separated by beds of gray shale. These limestones are all gray, weathering whitish. The lower one is blotched with yellow on the weathered surface and is characterized by an abundance of large round, plump *Fusulina* which weather brown. The next limestone above this contains long, slender *Fusulina* like rice grains and is overlain by a thin bed of orange-colored *Fusulina*-bearing limestone. At the top of the division is a gray limestone which weathers with smooth surfaces, shows few or no *Fusulina*, and contains a considerable amount of secondary calcite. This is the highest bed of the Foraker limestone.

Red Eagle limestone.—The Red Eagle is a gray limestone that weathers nearly white. Its exact thickness was not determined but in T. 24 N., R. 5 E., is at least 6 feet. On the fresh surface the prevailing color is gray tinged with yellow. In some places the yellow predominates, and in others it gives place to spots or streaks of red. The limestone contains a large amount of secondary calcite, which shows as numerous small, grainlike protuberances on the weathered surface. Fossils are not abundant, but brachiopods and fragments of other fossils occur. A thin bed about 15 feet below the Red Eagle contains abundant fossils, predominantly brachiopods. It crops out at the base of the steep slope formed by the Neva limestone and is of little importance as a key bed in this area because its line of outcrop is so close to that of the Neva. The base of the Red Eagle is about 30 feet above the top of the Foraker limestone.

Neva limestone.—The base of the Neva limestone lies about 115 feet above the top of the Foraker. The Neva consists of three distinct members. At the base is a gray crystalline nonfossiliferous thin-bedded limestone about 4 or 5 feet thick, which weathers to a clean white color and breaks out in large thin slabs. It commonly forms the main scarp of the Neva outcrop. This white member is directly overlain by 6 or 8 feet of dirty-yellow cherty limestone containing an abundance of fossil *Fusulina*. This cherty member breaks into small irregular platy pieces and is easily distinguished by its color and the presence of chert and *Fusulina*. Above the cherty member and probably separated from it by a few feet of shale is another white lime-

stone quite similar in color to the white bed at the base but differing in that it commonly contains a few *Fusulina* and is slightly cherty, the weathered surface showing small protuberances of siliceous material. The total thickness of the Neva is about 12 feet.

This limestone is regarded by some geologists as forming the base of the Permian.

Cottonwood limestone.—The Cottonwood limestone lies about 105 feet above the lower member of the Neva and is a light-drab crystalline argillaceous and oolitic limestone that has a slight greenish or in places reddish tint on the fresh surface. It consists of two benches separated by 5 to 15 feet of shale. The lower bench is 2 feet thick at the north side of T. 24 N., R. 4 E., the only place where a clean-cut section of it was observed. The upper bench is probably 3 or 4 feet thick. The matrix of the limestone is distinctly argillaceous, and it is the color of this clayey material that imparts a slightly greenish tinge to the rock. Locally, these green spots resemble "copper stain." In places the clayey material is stained red and imparts a reddish tint to the limestone. Inclosed in the matrix are numerous small elliptical or oval bodies ranging in size from that of flaxseed to that of small rice grains. Many of these bodies exhibit a concentric structure under an ordinary hand magnifier and are clearly oolites; others may be pebbles. Examination of a polished surface would probably be necessary to determine whether all these bodies are oolites or, if not, to determine the ratio of oolites to pebbles. Most of the oolites have a dark central portion, which in cross section is scarcely noticeable but in longitudinal section appears as a dark narrow band. The weathered surface of the rock is pitted and uneven, having a somewhat gnarled appearance, and the small oolites stand out in slight relief, giving the surface a pimpled aspect. In some places the weathered grains have an outer shell of limonite and an inner body of calcite.

The limestone is only slightly fossiliferous. The most common forms are a small gastropod and fragments of crinoid stems. Here and there a brachiopod is observed, and other forms may be present locally.

The Cottonwood does not form a conspicuous ledge but is commonly found outcropping in smooth grassy slopes. It is therefore difficult to trace and in places can not be found through horizontal distances of a mile or more.

The distinguishing characters of the Cottonwood are its oolitic structure, its slightly greenish color, its rough weathered surface with a pimply aspect, and the general absence of the small oval limonitic bodies that characterize the Crouse and Wreford limestones. These criteria do not serve, however, to separate the two benches of the Cottonwood from each other or to distinguish them from the thin bed

occurring locally 22 feet above it. This upper limestone, where observed, contains a few fossil *Myalina* and is distinctly conglomeratic, especially in a thin layer at the top of the bed. The base of the Cottonwood limestone is provisionally taken by the Geological Survey as the base of the Permian.

Crouse limestone.—The Crouse limestone lies about 140 feet above the Cottonwood and ranges in thickness from 6 or 8 feet in the northern part of the area to about 2 feet in the southern part. It is well bedded and forms very conspicuous outcrops, which generally weather in large massive slabs, especially where the limestone is yellow. A notable feature of the Crouse is an abrupt change in color laterally from a gray to a yellow phase in which for about 100 feet all the layers of the bed are consolidated into a massive bed of yellow limestone that has the appearance of a separate lenslike mass. The layers of the gray phase can be traced through the yellow phase, but there they do not form planes along which the limestone weathers as they do in the gray limestone. These features decrease in prominence toward the south, where the upper part of the main bed has a pale orange color and contains an abundance of small yellow limonitized oval bodies. Overlying the orange-colored bed in the southern part of the area is a reddish, in places conglomeratic limestone which weathers back readily and is commonly not well exposed. The limestone contains a fossiliferous layer at the base.

Wreford limestone.—The Wreford limestone occurs 112 to 119 feet above the Crouse. It is 8 to 10 feet thick in the northwestern part of the area and is made up of several layers which generally are not so massive as the Crouse. It decreases considerably in thickness to the south and west, being only 3 to 4 feet thick in T. 25 N., R. 3 E., and not more than a foot thick in places in the extreme southwestern part of the area, where the lower part of it has changed to a calcareous sandstone and locally the entire bed becomes sandy. Its color is commonly gray, but there is at the top a pale yellow or buff layer very similar in appearance to the yellow part of the Crouse. In fact, it would be exceedingly difficult to distinguish hand specimens from the two limestones. The gray portion of the bed is in places spotted with velvet-brown spots which produce brown blotches on the weathered surface. In the northern part of the area the limestone forms prominent escarpments, but in the southwestern part the sandstone above the limestone is the principal rim maker. About 5 feet above the main bed there is a thin upper bed of limestone which is commonly weathered back from the prominent ledge and covered with soil. In Kansas and in other parts of Oklahoma the Wreford is said to contain a large amount of chert, but it has no chert in this area.

Winfield limestone.—About 168 feet above the main bench of the Wreford occurs the main bed of the Winfield limestone, a dull-red argillaceous limestone that forms a ledge about 3 to 4 feet thick. A nonpersistent ledge occurs 5 to 7 feet above the main one, and a good ledge about 18 inches thick occurs about 14 feet below it. The beds between the Wreford and Winfield limestones are principally shales, which have weathered into long, gentle slopes without rock outcrops.

Herington limestone.—The main ledge of the Herington limestone lies about 54 feet above the Winfield. This is a light buff-colored limestone that forms massive ledges 5 to 6 feet thick. A ledge 18 inches thick lying 7 feet above the main one does not form a continuous outcrop, and 8 feet higher there is a very local ledge 4 feet thick.

The interval between the Winfield and Herington limestones is occupied by thin-bedded red sandstones and siliceous shales. Locally a massive sandstone occurs just below the Herington.

UNEXPOSED ROCKS.

GENERAL RELATIONS.

The rocks not exposed at the surface which have been penetrated by the drill to depths of nearly 4,000 feet in or adjacent to the "west side" are shown in Plate XLV.[1] Of the five well records shown, two (columns 3 and 4) represent wells drilled in the Osage Reservation west of R. 8 E.; the other three represent wells adjacent to the "west side" on the east, south, and west. Column 4 is representative of the numerous wells drilled in the Cleveland and Boston pools and many scattering wells in Tps. 21 and 22 N., R. 7 E. From these logs it is possible to gain a fair idea of the strata that probably underlie the "west side." The logs seem to indicate that the lower sands are not so well defined west of the area described (see column 1) as they are east of it.

OIL AND GAS BEARING BEDS.

In the Cleveland pool, in T. 21 N., R. 8 E., oil is found in the Layton, Cleveland, Bartlesville, and Tucker sands. In the Boston pool, which lies mainly east of R. 7 E. but extends into sec. 1, T. 21 N., R. 7 E., and sec. 36, T. 22 N., R. 7 E., these same sands are productive, although the main yield comes from the Bartlesville. In the Section Eight pool, in secs. 8, 9, 10, 15, and 16, T. 23 N., R. 8 E., the chief oil-bearing bed is said to be the Bartlesville sand, but gas in large quantities is obtained from several shallow sands lying above the

[1] Slightly revised, on the basis of additional information obtained, from pl. 21, Bull. 686–L.

1
Log of Margaret Primeux well No. 7
Sec. 4, T. 25 N., R. 2 E.

2
Log of well 1 mile northwest of Ralston
NE.¼ SE.¼ sec. 34, T. 24 N., R. 5 E.

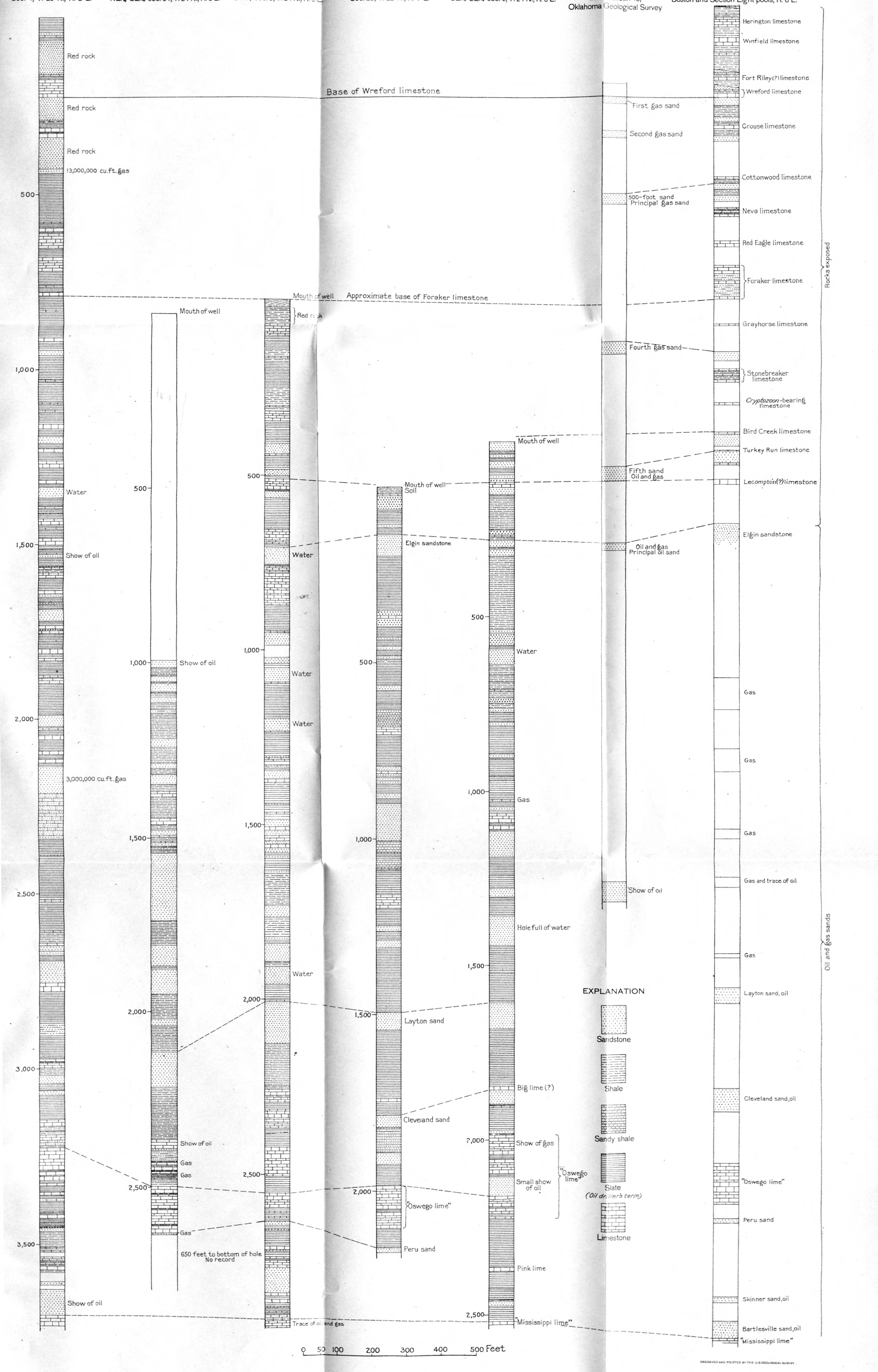
3
Log of well about 1 mile northeast of Fairfax
SW.¼ sec. 5, T. 24 N., R. 6 E.

4
Log of Monitor Oil Co. well No. 1
Sec. 25, T. 22 N., R. 7 E.

5
Log of Pawhuska Oil & Gas Co. well No. 26
SE.¼ SE.¼ sec. 6, T. 24 N., R. 8 E.

6
Skeleton section showing oil and gas sands at Ponca City from Bulletin 16, Oklahoma Geological Survey

7
Skeleton section of rocks exposed in western Osage County and oil and gas sands in Boston and Section Eight pools, R. 8 E.



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SECTIONS SHOWING DRILLERS' INTERPRETATIONS OF UNEXPOSED ROCKS IN OR ADJACENT TO THE WESTERN PART OF OSAGE COUNTY, THEIR RELATIONS TO THE EXPOSED ROCKS, AND THE PROBABLE CORRELATION OF THE SANDS

Layton sand. In the Pawhuska quadrangle, in the eastern part of Osage County, oil and gas are obtained at two or more horizons in the "Mississippi lime," also in the Bartlesville (here including the Tucker) sand, the "Oswego lime," sands between the "Oswego" and Big limes, the Big lime, and a sand about 100 feet above the Big lime. It is reasonably certain that some of these sands underlie the "west side," and the inference is warranted that oil and gas will be found in them where structural and other conditions favor accumulation. The Ponca City field obtains its oil and gas chiefly from shallow sands, most of which come to the surface in the "west side."

Attention is also called to the large initial production of oil recently obtained from several wells at depths of 300 feet or more in the "Mississippi lime." These include two wells in secs. 13 and 14, T. 22 N., R. 8 E., the "gusher" well in sec. 17, T. 27 N., R. 8 E., and the Mollie Miller well No. 9, in sec. 9, T. 25 N., R. 2 E., near Ponca City. Each of these wells is reported to have had a large initial daily production, amounting in some to 1,000 barrels or more. These large yields from a horizon heretofore essentially untouched in the Osage country are of great promise for the "west side," even though the Bartlesville or other productive sands of the "east side" may not underlie the entire area. The writers, therefore, reiterate the suggestion contained in the chapters of this bulletin previously published, that no test is complete until the drill has penetrated the "Mississippi lime" to a depth of at least 300 feet and that a well now obtaining its supply of oil and gas from higher horizons should not be abandoned until the "Mississippi lime" has been thoroughly tested, especially if the well is on a well-developed anticline or dome.

The probable relation of the oil and gas sands to the key beds described is shown in columns 6 and 7, Plate XLV. Lack of parallelism between strata makes it difficult to correlate beds encountered in drilling in widely separated areas. The correlations shown on Plate XLV are therefore suggestive and tentative rather than conclusive, but they are based on a careful study of the columnar sections of rocks exposed in both the western and eastern part of the Osage country and on a comparison of these sections with the logs of wells whose approximate surface horizons are known.

The correlation of the sands of the Ponca City field with the stratigraphic section of the western part of the Osage Reservation, as shown in Plate XLV, is slightly different from that suggested by Ohern and Garrett.[1] The correlation here given indicates that the

[1] Ohern, D. W., and Garrett, R. E., The Ponca City oil and gas field: Oklahoma Geol. Survey Bull. 16, p. 27, 1912.

500-foot sand of the Ponca City field is probably equivalent to one of the sands associated with the Cottonwood limestone; that the "fourth sand" is probably equivalent to the sandstone above the Stonebreaker limestone which crops out about 4 to 6 miles west of Fairfax; and that the lowest productive sand is at approximately the same position as the Elgin sandstone.

The estimated depths at which the most important oil and gas sands and also the "Oswego lime" and "Mississippi lime" will be encountered in drilling are given in the following table:

Estimated intervals, in feet, from exposed key beds to important oil and gas sands and "Oswego lime" and "Mississippi lime."

Key bed.	Layton sand.	Cleveland sand.	"Oswego lime."	Bartlesville sand.	"Mississippi lime."
Herington limestone	2,841	3,141	3,341	3,780	3,840
Winfield limestone	2,786	3,086	3,286	3,726	3,786
Base of Wreford limestone	2,621	2,921	3,121	3,561	3,621
Crouse limestone	2,509	2,809	3,009	3,440	3,509
Cottonwood limestone	2,369	2,669	2,869	3,309	3,369
Base of Neva limestone	2,259	2,559	2,759	3,199	3,259
Red Eagle limestone	2,189	2,489	2,689	3,129	3,189
Base of Foraker limestone	2,033	2,333	2,533	2,973	3,033
Grayhorse limestone	1,931	2,231	2,431	2,871	2,931
Top of Stonebreaker limestone	1,842	2,142	2,342	2,782	2,842
Cryptozoon-bearing limestone	1,717	2,017	2,217	2,657	2,717
Bird Creek limestone	1,627	1,927	2,127	2,567	2,627
Turkey Run limestone	1,575	1,875	2,075	2,515	2,575
Lecompton (?) limestone	1,490	1,790	1,990	2,430	2,490

This table gives an idea of the depth at which the productive sands of the Cleveland pool, to the southeast, and deeper sands in other productive fields in Oklahoma should be reached in any particular part of the area discussed. The figures are of course only approximations. They are based on a study of the well logs of the Cleveland, Boston, and Section Eight pools, where the relations of the productive sands to the surface key beds can be determined, and on the observed thicknesses of the rocks exposed in the "west side." The table is also based on the assumption that the interval between the key beds and the "Mississippi lime" remains constant across the "west side." If, however, as assumed by Berger,[1] the interval between the "Mississippi lime" and the "Oswego lime" (Fort Scott limestone) decreases rapidly from about the central part of the Osage Reservation westward, of course these intervals, especially those below the "Oswego lime," would not hold in the western part of the area. It is noteworthy, however, that logs of wells in the Ponca City field, lying west of the Osage Reservation, when properly adjusted to the key beds of the section of exposed rocks, coincide within reasonable limits with logs of wells east of R. 7 E., in the reservation.

[1] Berger, W. R., The relation of the Fort Scott limestone to the Boone chert in southeast Kansas and northeast Oklahoma: Jour. Geology, vol. 26, pp. 618–621, 1919.

STRUCTURE AND OIL AND GAS POSSIBILITIES.

GENERAL FEATURES.

The rocks in the area described show an average westward dip of about 40 feet to the mile, or a little less than half a degree. The westward dip is more constant here than in the eastern part of the Osage Reservation, and there are fewer deviations from the general regional structure and consequently fewer anticlines and domes.

Because of this regional westward dip, the rocks that form the surface are successively younger and higher stratigraphically toward the west. For this reason the rocks that appear at the surface in the "west side" have been eroded from most of the area farther east, and conversely, the rocks exposed in those areas lie below the surface of the "west side" and are not open to inspection. The convergences which are known to occur between these lower rocks in the "east side" have not been taken into account in drawing the structure contours for the "west side." The higher the position of the surface beds in the geologic column the more widely may they depart from parallelism with the rocks below, especially those which, like the "Oswego lime" and "Mississippi lime," and the Bartlesville sand, lie at depths of 2,000 feet or more. This lack of parallelism precludes the possibility of matching structure contours that are drawn on widely separated reference horizons, and consequently some discrepancy may appear between the contours along the common margin between the area herein described and the "east side." The structure contours shown on Plates XLIII and XLIV are drawn on the top of the Bird Creek limestone. The detailed description of structure which follows is presented mainly by township units.

TPS. 21 AND 22 N., R. 7 E.

About one-third of that part of Tps. 21 and 22 N., R. 7 E., which lies within the Osage Reservation is covered by alluvium, sand, and surficial material, which conceal the hard rocks and prevent the determination of structure by surface methods. Over the remainder of the area the regional westward dip is interrupted at several places by north and south dips which give rise to more or less prominent anticlinal noses. Slight easterly dips occur at only a few places.

Boston pool.—The Boston pool lies mainly in T. 21 N., R. 8 E., but extends into the E. ½ sec. 1, T. 21 N., and the southeast corner of sec. 36, T. 22 N., R. 7 E. So far as can be determined from surface evidence, that part of the pool lying in this area occupies the western limb of the fold, whose crest is farther east. The productive area, which is leased mainly by the Gypsy Oil Co., seems to be pretty well defined by several dry holes drilled on the north, west, and south-

west and appears to be confined to the E. ½ sec. 1, T. 21 N., and the SE. ¼ sec. 36, T. 22 N. So far as can be determined from the well records none of the dry holes drilled have entered the "Mississippi lime," and there is therefor still a possibility that oil may be obtained from this formation farther down the slope than the present productive area extends. Most of the oil obtained comes from the Bartlesville sand. The initial daily production of the wells is reported to range from 20 to 5,000 barrels and to average about 350 barrels.

Gas anticline.—The principal axis of the Gas anticline extends southwestward from the northeast corner to the west quarter corner of sec. 25, T. 22 N.; a minor axis crosses the NE. ¼ sec. 26. The axis pitches southwestward about 40 feet across sec. 25 and flattens somewhat across sec. 26. The north and south limbs of the fold have well-defined dips through distances of half a mile or more. There is a very slight east or northeast dip near the west side of the NW. ¼ sec. 25, but it is not sufficient to close a contour. The outline of the fold is based on elevations on the Turkey Run and Lecompton (?) limestones, both of which are well exposed and furnish good key beds. Several gas wells have been brought in along the crest of this anticline in sec. 25, and at least three dry holes have been drilled on its north and west slopes in sec. 26. The gas in the producing wells is obtained from a sand about 50 feet below the base of the "Oswego lime," called in this area the Peru sand, but at a different horizon from the Peru sand in other areas. A log of one of these wells is shown in column 4, Plate XLV. In this well, which begins at about the base of the Lecompton (?) limestone, the Layton sand was reached at 1,500 feet, the Cleveland at 1,790 feet, the "Oswego lime" at 1,990 feet, and the gas sand ("Peru") at 2,165 feet. A log of one of the group of three wells in the W. ½ sec. 25 shows a similar record. Apparently none of these gas wells were drilled to the Bartlesville sand, and the fact that only gas was obtained does not preclude the probability of finding oil at greater depths, either in the Bartlesville sand or in the "Mississippi lime." In fact, the chances are good that oil will be found on this fold in these lower beds. The dry holes on the north and west slopes of the anticline may or may not be adequate tests; no record of them is available by which to judge their merits. Their dry condition may be due to failure to drill deep enough—by which is meant 300 feet more into the "Mississippi lime"—or to their being located too low on the slopes of the fold, although two of them, that at the northeast corner of sec. 26 and that about 1,000 feet south of the north quarter corner, are fairly well located with reference to the structure. Further development of the deeper sands should be undertaken on this anticline.

Minor folds.—A low nose extends southwestward from the SW. ¼ sec. 34, T. 22 N., to the center of sec. 4, T. 21 N., or perhaps farther.

This fold pitches gently to the southwest and has gentle north and south dips. It terminates on the northeast in a broad structural flat or terrace, which in turn is terminated farther northeast by a closed depression. The highest point on the terrace is nearly 10 feet above the center of the depression, so that there is a slight northeast dip, though not enough to be indicated by the closing of a contour. The fold is, therefore, to be regarded as possible oil and gas territory and is sufficiently well defined to warrant the drilling of at least one good test well, which should be located somewhere along a line drawn from a point about 1,000 feet west of the east quarter corner of sec. 34 to the southwest corner of the section. In that area the crest of the fold is capped by sandstones and shales lying above the Bird Creek limestone, which is estimated to lie about 2,567 feet above the Bartlesville sand. A dry hole has been drilled on this fold near the east quarter corner of sec. 34, a little east of the highest point on the terrace. No record of this well has been obtained, but it probably did not penetrate the "Mississippi lime," as all drilling in this area has stopped short of that limestone. A better location for the well would have been at least 1,000 feet farther west.

Another minor fold enters R. 7 E. from the east of the northeast corner of sec. 13, T. 22 N., and occupies the NE. ¼ sec. 13 and a small part of sec. 12. Unless the fold has larger dimensions in the area to the east, a report on which is now in preparation by Robert H. Wood, it may be too small to be of economic importance.

A third fold of minor importance extends westward from the NE. ¼ sec. 2, T. 22 N., to the center of sec. 3. The fold is terminated on the east by a shallow depression which produces an eastward dip of a few feet. The north and south dips are gentle, and the axis of the fold pitches west at the rate of about 40 feet in the first mile. This fold is not regarded as of first importance, but if the more pronounced folds in the township to the north should prove to be productive this fold would at least fall in the category of possible oil and gas territory and would probably justify the drilling of at least one test well, which should be located on the crest of the fold, probably along the south line of the NW. ¼ sec. 2.

T. 23 N., R. 7 E.

The regional westward dip across T. 23 N., R. 7 E., amounts to about 50 feet to the mile, which is considerably higher than the average regional dip in the Osage Reservation. This unusually high dip is the result of rather pronounced folding in the eastern part of the township, with consequent steepening of the beds adjacent to the folded area on the west. In the southwest quarter of the township there is about 6 square miles in which there are no exposures of

hard rock and in which, therefore, the structure can not be worked out from surface observations.

The folded area in the eastern part of the township, forming a crescent stretching from the northeast to the southeast corners, probably represents one major line of folding on which are superimposed three local domes. However, for the sake of clearness and facility in description, it will be described as three independent units—the Upper and Middle Bug Creek domes, and the Lower Bug Creek anticline.

Upper Bug Creek dome.—The Upper Bug Creek dome occupies all of sec. 12 and an adjoining portion of sec. 13, with a long spur projecting northward across the E. ½ sec. 1. The dome as thus outlined is merely part of a larger fold which covers several square miles in the township to the east and on which lies the productive Section Eight pool. To the north the dome is connected by a narrow saddle with the Rainbow anticline, and to the southwest it may be continuous with the Middle Bug Creek dome. On the west and northwest there is a broad unbroken area of westward-dipping beds from which an abundant supply of oil and gas could have been drained if they were present in the rocks. The crest of the dome lies about at the center of the S. ½ sec. 12, and from this point the rocks dip in all directions—gently to the north, east, and south, and steeply to the west, northwest, and southwest. The westward dip amounts to 120 feet in the first mile; the eastward dip probably amounts to about 15 feet but is not accurately determinable because of lack of exposures of dependable key beds. The outline of the dome was determined chiefly by elevations on the Turkey Run and Bird Creek limestones. On account of the productive area near by on the east this dome affords excellent prospective territory in which to drill for oil and gas. The best place for a test well is about the center of the S. ½ sec. 12.

Middle Bug Creek dome.—The Middle Bug Creek dome occupies practically all of sec. 23 and parts of secs. 13, 14, and 24. On the northeast it is separated from the Upper Bug Creek dome by a narrow belt of steep dips which serves as a step from the higher to the lower level. On the south it is separated by a low, narrow saddle from the Lower Bug Creek anticline. To the west and southwest the westward dip, amounting to 100 feet in the first mile, is unbroken, and up this slope oil and gas would probably migrate to the crest of the dome, where they would be entrapped by the reversal of dip. This reversal is gentle, and from the crest of the dome, about 700 feet south and 300 feet west of the center of sec. 23, amounts to about 20 feet on the northeast and 30 feet on the southeast. The exposure of the Turkey Run limestone around the upper slopes of this fold and the Bird Creek limestone lower down furnish good

key beds from which to obtain data for the deciphering of the structure. The fold is regarded as good prospective oil and gas territory. A test hole should be located near the center of sec. 23.

Lower Bug Creek anticline.—That part of the Lower Bug Creek anticline lying in this township is a triangular area whose axis trends northwestward from the margin of the township to the north-central part of sec. 26; it thus occupies parts of secs. 25, 26, and 36 in this township and extends eastward an undetermined distance. The relation of this fold to the Middle Bug Creek dome has already been pointed out. On the south the beds dip steeply to a flat and shallow syncline near the township boundary. The westward dips are unbroken so far as they are determinable, and like the folds above described, this one has a good catchment area in that direction. The crest of the fold is sharp and well defined in sec. 26 but broadens out and partakes more of the nature of a broad flat, on which there are minor local protuberances, in secs. 25 and 36. Within this township the fold exhibits no well-defined or appreciable eastward dip. Its shape and extent, like those of the folds described above, were determined from elevations on the Turkey Run and Bird Creek limestones, supplemented by elevations on the sandstones between them. The fold is regarded as favorable prospective oil and gas territory. A good location for a test well would be near the northwest corner of sec. 36, or in the W. ½ SE. ¼ sec. 26.

Upper Sycamore dome.—The Upper Sycamore dome lies principally in secs. 9 and 16 but extends westward for a short distance into secs. 8 and 17. The dome is cut off on the east by a normal fault dipping 60°–75° E. and trending northwest and north. The trace of the fault at the surface is about 2 miles long and markedly curved. This curving is probably due, at least in large part, to the combined effects of dip of the fault plane and the topography of the ground, though there may be some actual curving in the fault plane. The maximum vertical displacement caused by the fault is about 70 feet. On its east or downthrow side the beds dip steeply toward it, producing a closed depression about 70 feet deep. North of this depression the beds dip away from the fault and give rise to a small dome about 20 feet high closing against the fault. On the west of the fault the dome has about 70 feet of dip, nearly 50 feet of which closes against the fault. On the assumption that the oil sands are sealed along the fault plane so as to prevent the escape of oil and gas, its effect on their migration and accumulation would be the same as that of an eastward dip of the strata—that is, the fault would form an obstruction to the further eastward migration of the oil and gas and cause them to accumulate in the crest of the dome. If this assumption is true the dome would furnish an excellent reservoir for the accumulation of oil and gas, and there is a large

drainage area to the west from which these substances might have been gathered. The extent of the fault underground is of course unknown. It may largely die out in the Cherokee shale before reaching the Bartlesville sand; on the other hand, it may possibly increase in magnitude with depth, and the amount and direction of its dip and strike may also change. The best locations for test wells would be along a line drawn from a point 1,500 feet south of the northwest corner of sec. 16 through the north quarter corner of the same section to the fault plane. The first well should be located near the fault. If gas and no oil is obtained along the crest of the fold, tests for oil should be made farther down the slope. As the fault dips eastward, wells drilled at a considerable distance east of the fault trace as it appears at the surface would pass through the fault plane before reaching the oil sands, penetrating them on the west side of the fault, where they would yield oil and gas if these substances are present. On the other hand, wells entering the pay sands east of the fault plane would have very little chance of obtaining oil or gas. The contours are drawn to the trace of the fault as it appears at the surface rather than to its theoretical position at the datum plane, as the data at hand are not sufficient to determine the position of the fault below the surface.

Gas and oil sands.—No wells have been drilled in T. 23 N., R. 7 E., but two dry holes have been put down in the northern part of the township to the south. However, the Section Eight pool, in secs. 8, 9, 10, 15, 16, and 17, T. 23 N., R. 8 E., and the Boston pool, partly in sec. 1, T. 21 N., R. 7 E., and sec. 36, T. 22 N., R. 7 E., furnish many well logs, which with the logs of a few other scattered wells afford a means of forecasting the probable oil and gas sands to be encountered in the area under discussion. There are about a dozen sands that have yielded oil or gas in these wells.

The Bartlesville sand is the main producing sand of the adjacent territory, but two wells in secs. 13 and 14, T. 22 N., R. 8 E., lately obtained large initial yields from a recently discovered oil sand about 300 feet below the top of the "Mississippi lime."

Below is an estimate of the depth below the Turkey Run limestone at which the several sands should be encountered. The Turkey Run limestone is a prominent though thin lime, well exposed in much of the township under discussion.

It will be noted that the drillers in the Boston pool have called a sand below the "Oswego lime" the "Peru sand." Northeast of this township, however, the name Peru sand is used to indicate a sand above the "Oswego lime" and below the Big lime. This inconsistency is probably due to the fact that the Big lime is not as well developed to the south as to the northeast.

Estimated depth of oil and gas sands below the Turkey Run limestone in T. 23 N., R. 7 E.

Depth below Turkey Run limestone.	Remarks as to conditions in wells to east and south.
Feet.	
650	Sand, which shows a small amount of gas in many wells.
740	Sand giving as much as 1,000,000 feet of gas in some wells.
850	Sand giving as much as 1,000,000 feet of gas in one well, small amount in several wells.
900	Sand giving as much as 3,000,000 feet of gas in some wells.
955	Sand giving as much as 25,000,000 feet of gas in one well and much gas in many wells.
1,120	Sand giving 2,000,000 feet of gas in one well.
1,260	Sand giving 8,000,000 feet of gas in one well and smaller quantities in several wells.
1,310	Sand giving 2,500,000 feet of gas in one well.
1,475	Do.
1,575	Layton sand; some gas, little oil.
1,875	Cleveland sand; gas, oil.
2,075	"Oswego lime."
2,275	"Peru sand" of Boston pool; little gas, oil.
2,460	Skinner sand; oil.
2,515	Bartlesville sand; main pay oil, some gas.
2,775	Tucker sand; little oil.

The Bartlesville sand and the bed about 300 feet below the top of the "Mississippi lime" will probably be the main oil sands, although some of the higher sands may produce oil in commercial quantities. Gas will probably be found in the higher sands.

T. 23 N., R. 6 E.

The regional westward dip in T. 23 N., R. 6 E., averages about 33 feet to the mile. Local deviations from this general westward inclination gave rise to north and south dips, but with the exception of a slight eastward dip on the Sycamore anticline, no reversals or eastward dips occur in that part of the township where the exposures afford an opportunity for working out the structure. As will be observed from the map (Pl. XLIII), however, about one-third of the surface of the township is covered by loose sand, soil, and alluvium, which conceal all the hard-rock formations and prevent the determination of structure in these areas from surface observations.

In addition to the Lower Sycamore anticline, the township contains a few noses which are briefly described. They are not of sufficient importance to be recommended for drilling in wildcat territory, but if future development demonstrates the existence of oil and gas in the better-defined anticlines and domes in adjacent areas, some of these noses might be worth testing.

Lower Sycamore anticline.—The Lower Sycamore anticline occupies the SE. ¼ sec. 35 and the S. ½ sec. 36, and also extends south into secs. 1 and 2, T. 22 N. The north and south dips amount to at least 20 feet, and there is a slight east dip but not sufficient to close a contour, the axis being nearly horizontal for more than half a mile. Because of

its isolation with respect to other well-defined folds the anticline is well situated for the accumulation of oil and gas. It is not recommended for drilling, however, until other more favorable anticlines and domes in the western Osage country have been tested. The highest point on the fold is about 1,000 feet east of the southwest corner of sec. 36, and this would therefore be the most favorable location for a test well. The fold is capped by a heavy sandstone that overlies the highest limestone bed of the Stonebreaker limestone. By reference to the table on page 288, the depth to the oil and gas bearing sands may be approximately determined.

Minor folds.—A nose, narrower but somewhat longer than the Lower Sycamore anticline, extends from the SW. ¼ sec. 24 to the NW. ¼ sec. 26. The complete details of this fold can not be worked out because on its southern limb the rocks are concealed by sand. On the southwest the nose is limited by steep dips, and on the northeast it merges into a narrow terrace.

Another nose occupies the N. ½ sec. 1, but the north and south dips on it are gentle and do not exceed 20 feet.

There also appears to be a small nose with a southwest trend in the N. ½ sec. 6, but the details of the fold are indeterminable because of lack of exposures. Its outline is based on elevations on a limestone which crops out along the east side of the river, and on evidence obtained in the township adjoining on the north. This fold seems to be broader and to have a steeper inclination of its axis than any of the other folds here described.

Besides the larger noses described there are several smaller ones which are too small to merit individual description and are probably also too small to be of economic interest.

TPS. 23 AND 24 N., RS. 3 TO 5 E.

In Tps. 23 and 24 N., Rs. 3 to 5 E., there is a greater deviation from the regional westward dip common in the Osage Reservation than in any of the other townships shown on Plate XLIV. This deviation from the regional dip gives rise to several anticlines and domes and a number of minor folds. The best-defined anticlines and domes offer structurally favorable places for the accumulation of oil and gas. Some of these folds are small and are probably not worth testing unless the larger ones prove to contain oil and gas in commercial quantities. As in other parts of the field there is a belt along Arkansas River ranging from less than half a mile to several miles in width in which the hard-rock formations are covered by alluvium, sand, or surficial material. In these areas the structure can not be worked out from surface observations. This belt is especially wide in R. 3 E., where it includes the greater part of that portion of Tps. 23 and 24 N. lying within the Osage Reservation. In

T. 23 N. numerous water wells put down as much as 2 miles back from the present river channel have penetrated unconsolidated river sand to a depth of about 90 feet before reaching bedrock. This suggests that the river channel formerly extended considerably farther north than at present. Part of this area is in a direct line north of the Otoe anticline, which is producing gas and, according to reports, some oil on the south side of the river in T. 23 N., R. 3 E. It may well be, therefore, that in this area of concealed hard-rock formations there are structural features favorable for the accumulation of oil and gas. A detailed study of the outcrops in the bluffs immediately south of the river would throw some light on the conditions north of the river.

Dogy dome.—The Dogy dome occupies part of secs. 7 and 18, T. 24 N., R. 5 E., and secs. 12, 13, and 24, T. 24 N., R. 4 E. It covers an area of more than 2 square miles and has a maximum eastward dip of nearly 20 feet, with a closure of 10 feet over an area approximately half a mile wide and 1½ miles long, trending northeastward. To the northwest, west, and southwest the dip is very steep, ranging from 50 to 70 feet in the first half mile and then gradually decreasing. To the north there is a long space extending from the center of sec. 7, R. 5 E., to about the center of sec. 6, which offers possibilities for oil accumulation. To the south the dip is apparently not so steep, but little information regarding the structure can be had in that direction because of lack of exposures of hard rock in the river valley. The highest point on the fold is approximately at the northeast corner of sec. 13, T. 24 N., R. 4 E., and this would therefore be the most favorable place for a test well. Should gas be obtained here other tests should be made for oil farther down the west slope.

The surface rock over the crest of the fold is the sandstone immediately overlying the Neva limestone. The depth to the "Oswego lime" and "Mississippi lime" is therefore about 2,780 and 3,280 feet, respectively.

East Belford dome.—The East Belford dome lies in the SW. ¼ sec. 28 and the SE. ¼ sec. 29, T. 24 N., R. 4 E. It has an eastward closure of about 10 feet over an area of about half a mile. The details of the fold were determined mainly by elevations on a prominent sandstone ledge lying about 70 feet above the Crouse limestone. The highest point on the fold lies about 1,500 feet north of the southwest corner of sec. 28. From this point the rocks dip gently to the north, south, and east but more steeply to the west. Immediately north of the fold there is a broad, shallow syncline. This dome is so small that it may not have had much effect in inducing oil accumulation. If, however, the Dogy dome, about 4 miles to the northeast, proves to be productive, the prospects for obtaining oil in the East Belford dome would be increased. To test the fold a hole should be

drilled not more than 1,500 feet north of the southwest corner of sec. 28. At this place the depth to the "Mississippi lime" is estimated to be about 3,580 feet.

West Belford dome.—The West Belford dome is a small fold occupying the SE. ¼ sec. 30 and the NE. ¼ sec. 31, T. 24 N., R. 4 E. It has an eastward dip of about 15 feet and a closure of 10 feet over about a quarter of a square mile. The dip to the north and south amounts to 15 or 20 feet, and that to the west to about 30 feet in the first half mile. The outline of the fold was determined by elevations on the Wreford limestone and the prominent sandstone overlying it. The fold is small, but with an eastward dip of 10 to 15 feet and a large gathering ground it is well worth testing. The crest of the fold extends nearly due north through a point about 1,500 feet west of the southeast corner of sec. 30. A test hole should be located along the crest not more than 1,000 feet either north or south of the line between secs. 30 and 31. The sandstone immediately above the Wreford limestone covers the crest of the fold. The depth to the "Oswego lime" is therefore about 3,135 feet and to the "Mississippi lime" about 3,635 feet.

Sand Creek anticline.—The Sand Creek anticline is a northward-trending fold occupying parts of the four sections cornering on the intersection of Tps. 23 and 24 N., Rs. 3 and 4 E. Details of the west limb of the fold can not be determined because of lack of exposures. The structure of the remainder was worked out from elevations on the Wreford limestone, the thin limestone about 20 feet above the Wreford, and the sandstones immediately underlying these two limestones. The east limb of the fold is cut by a northwestward-trending fault, the extent of which can not be accurately determined. The maximum vertical displacement caused by the fault seems to be about at the center of sec. 6, T. 23 N., R. 4 E., where the Wreford limestone has been dropped down (relatively) on the west side about 50 feet. From this point the amount of displacement decreases both to the north and south. It seems to be only 15 or 20 feet in the SW. ¼ sec. 31, T. 24 N., R. 4 E. The Sand Creek anticline pitches south and shows no closure on the north, but near the south end there is a slight structural depression in its crest, south of which there is a small local dome that has a closure of about 8 feet. This fold is well situated, and although it has no northern closure it should afford good opportunity for the accumulation of oil and gas. Good locations for test wells would be anywhere within the area closed by the —20-foot contour on the south end of the fold or along a line 500 to 700 feet west of the line between Rs. 3 and 4 E. to a point not more than 2,000 feet north of the corner between Tps. 23 and 24 N At these places the depths to the "Oswego lime" and "Mississippi lime" should be about 3,150 and 3,650 feet, respectively.

Minor folds.—A long northwestward-trending nose lying about 1½ miles southwest of Fairfax extends diagonally across secs. 13, 14, and 24, T. 24 N., R. 5 E. The exact outline of this fold can not be determined, because a part of it lies in the valley of Arkansas River, where there are no exposures of hard rock. In the bluffs skirting the river on the east the rocks dip northwest at an average rate of 60 feet to the mile. Work on the opposite side of the river failed to disclose any corresponding southward dips. In fact, the rocks rise more or less regularly from the northernmost exposures in the bend of the river to the south side of the township. These exposures, however, are about 1½ miles away from those exhibiting the steep dips on the east side of the river, and there is thus room for a reversal of structure in the river valley. From the evidence available the axis of the fold seems to pitch northwest, being parallel to and probably coincident with the bluffs along the east side of the river. It may well be, however, that the axis of the fold trends more nearly west, and, if so, the northwest dips exhibited along the river bluff represent only a part of the northwest limb of the fold. On this assumption the greater part of the fold lies in the river flat and the north and south dips are 50′ or 60′ greater than those indicated on the assumption of a northwest trend to the fold. In either event there is no east dip, and the fold, therefore, does not rank as one of the first importance. If its axis trends west the fold is of considerable importance, even though it has no eastward dip. A good location for a test well on this fold would be about the center of the SE. ¼ sec. 14, on the flats on the east side of the river.

A long nose trending southwestward extends more or less uninterruptedly from the northeast corner of sec. 11, T. 24 N., R. 4 E., to the valley of Arkansas River at the northwest corner of sec. 21. The trend of this nose is approximately parallel to that of the Dogy dome. It has no pronounced flats, steepenings, or saddles along its crest that would seem to offer favorable conditions for local accumulations of oil or gas, and it is probably not sufficiently pronounced to have induced large accumulations through its entire length. It is therefore not regarded as promising oil or gas territory.

There is also a small nose trending east along the line between Tps. 24 and 25 N., R. 4 E. The amount of north and south dip here is very slight, and it is probably not sufficient to have induced the accumulation of oil and gas.

T. 25 N., R. 4 E.

The rocks exposed in T. 25 N., R. 4 E., show a gradual westward dip. This dip is the normal regional dip of the strata, which in the western Osage country averages about 40 feet to the mile. There is no distinct anticlinal or dome structure in the exposed strata of this

township, but a slight variation from the normal westward dip occurs in the center of the township, in secs. 15, 16, 21, and 22, where there is a minor buckling of the strata. Just south of the center there is a structural flat or terrace. In the Appalachian and Gulf coast oil fields and locally in the Mid-Continent field such a nose or terrace induces the accumulation of a minor pool of oil; but the prospects of obtaining oil in this area on such structural features is not favorable enough to warrant a test at present. It might be justified, however, at some time in the future when the scarcity of oil would necessitate the drilling of the less favorable areas. For such a possibility it would appear that in the whole township the two best places to drill would be in the southeast corner of sec. 16 and in the NE. ¼ sec. 34. To reach the "Mississippi lime" a well would have to be drilled about 3,600 feet in this area.

T. 25 N., R. 3 E.

The structural geology of T. 25 N., R. 3 E., as shown on Plate XLIV, is based solely on the beds exposed at the surface. These beds dip west about 40 feet to the mile, showing the westward dip normal to this portion of Oklahoma.

Alluvium and river sands have prevented geologic mapping in the south tier of sections in T. 25 N., R. 3 E., and the portion of T. 24 N., R. 3 E., lying north of Arkansas River. Rocks are exposed in part of T. 25 N., R. 2 E., east of the river, where only west dips are indicated. Few rock exposures occur south of the river in T. 26 N., R. 3 E., but on the map dotted contours are shown connecting the areas in T. 25 N., R. 3 E., mapped during the present investigation with those north of the river in T. 26 N., R. 3 E., as mapped by Trout.[1] These contours indicate a westward-pitching syncline extending across secs. 34, 35, and 36, T. 26 N., R. 3 E., and secs. 1 and 2, T. 25 N., R. 3 E. A nose is also indicated extending from the northeast into secs. 4, 3, and 2, T. 25 N., R. 3 E., where there is some possibility that oil may be found.

Gentle shale slopes without rock outcrops preclude mapping the structure in some portions of T. 25 N., R. 3 E., but these areas are small and dotted contours have been extended across most of them. The greater part of the township with its westward-dipping beds offers little encouragement to the oil prospector. The most promising locality for the production of oil in the entire township is to be found in the W. ½ sec. 20 and the E. ½ sec. 19, where a very distinct flat-topped nose occurs. The most favorable location for a test well lies in sec. 19 about 1,000 feet west and 1,500 feet north from the southeast corner of the section.

[1] Oklahoma Geol. Survey Bull. 19, pt. 2, p. 269, 1917.

ADJUSTMENTS IN PORTIONS OF T. 25 N., R. 5 E., AND T. 24 N., RS. 6 AND 7 E.

Additional information acquired while mapping the area on which this report is based make slight adjustments necessary along the margin of the area adjoining on the north and east, represented on Plates XXII and XXIII of Bulletin 686–L. The most important of these adjustments occur in the west half of T. 25 N., R. 5 E., the southwestern part of T. 24 N., R. 6 E., and the southeast corner of T. 24 N., R. 7 E. These corrections and others of minor importance are shown on Plates XLIII and XLIV.

In T. 25 N., R. 5 E., the effect of the revision is to accentuate slightly the nose trending westward from the central part of the township.

In T. 24 N., R. 6 E., the data at hand show that in place of the Lower Salt Creek anticline there is merely a very small westward-trending nose of little significance with respect to the accumulation of oil and gas.

In T. 24 N., R. 7 E., the outline of the Rainbow anticline is slightly modified. As the anticline was incorrectly named in the previous report the description is reproduced here under the proper title. The Rainbow anticline occupies parts of secs. 25 and 36, T. 24 N., and extends eastward into the Pawhuska quadrangle. That part of the fold lying in the "west side" was outlined by elevations on the Bird Creek limestone, which shows north, south, and west dips. The anticline has a fairly good gathering ground and is regarded as affording good opportunities for the accumulation of oil and gas. The highest part of the fold and therefore the best place for a test well is probably about the center of the SE. ¼ sec. 25.