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SUBSURFACE GEOLOGY AND OIL AND GAS RESOURCES OF OSAGE COUNTY, OKLAHOMA

PART 7. Townships 20 and 21 North Ranges 11 and 12 East

BY

W. R. DILLARD, N. W. BASS, AND C. T. KIRK

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FOREWORD

This report on the subsurface geology of Osage County, Okla., describes the structural features, the character of the oil- and gas-producing beds, and the localities where additional oil and gas may be found. It embodies a part of the results of a subsurface geologic investigation of the Osage Indian Reservation, which coincides in area with Osage County. The investigation was conducted by a field party of the Geological Survey of the United States Department of the Interior in 1934 to 1937 and involved the study of the records of about 17,000 wells that have been drilled in Osage County. Funds for the investigation were allotted to the Geological Survey by the Public Works Administration. The primary purpose of the examination was to obtain geologic data for use in the administration of the Indian lands. The results of the inquiry have shown that many localities in Osage County outside the present producing oil fields are worthy of prospecting for oil and gas and that additional oil and gas can be found also by exploring deeply buried beds in old producing fields.

All townships in Osage County that contain many wells are described; the information furnished by such townships is ample for drawing detailed subsurface structure-contour maps. The descriptions of several contiguous townships are combined in separate reports, which are issued as parts of a single bulletin. No edition of the consolidated volume will be published, but the several parts can be bound together if desired.

The subsurface investigation of Osage County was carried on mainly by L. E. Kennedy, W. R. Dillard, H. B. Goodrich, Charles T. Kirk, J. D. McClure, Otto Leatherock, Constance Leatherock, W. E. Shamblin, J. N. Conley, H. D. Jenkins, J. H. Hengst, G. D. Gibson, and N. W. Bass, geologists. The work of each geologist contributed more or less to the results of the investigation in each township. However, the investigations of the individual townships in Osage County were made mainly by various individuals of the group, and their names appear in the township descriptions. In addition to those whose names appear above, valuable assistance in the compilation of information was given by Lucile Linton, S. B. Thomas, R. C. Beckstrom, B. A. Lilienborg, J. G. Dwen, K. H. Johnson, J. G. Beaulieu, C. R. Viers, E. L. Hitt, Grace Clark, R. A. Payne, and J. C. Rollins.

Oil companies and individuals who contributed information are too numerous to acknowledge all by name. Special mention is made, however, of Laughlin-Simmons & Co. and the Indian Territory Illuminating Oil Co. for supplying most of the well elevations used in Osage County; of the Continental Oil Co., Tidal Oil Co., Sinclair Prairie Oil Co., Indian Territory Illuminating Oil Co., Phillips Petroleum Co., W. C. McBride, Inc., The Carter Oil Co., and others for supplying well logs, maps, cuttings, and cores of the producing sands in Osage County.

H. D. Miser, geologist in charge of the section of geology of fuels, supervised the work upon which this report is based. Appreciative acknowledgment is here made of many suggestions made by him during the progress of the investigation and during the preparation of the manuscript. Grateful acknowledgment is due the officers of the Osage Indian Agency at Pawhuska and the late John M. Alden and others in the Tulsa office of the Geological Survey for cooperation and assistance; also Hale B. Soyster and H. I. Smith, of the Geological Survey, for sponsorship and interest in the investigation.

N. W. BASS.

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By W. R. Dillard, N. W. Bass, and C. T. Kirk

ABSTRACT

This report describes the subsurface geology and the oil and gas resources of an area adjacent to Tulsa in the southeast corner of Osage County, Okla. The area embraces Tps. 20 and 21 N., Rs. 11 and 12 E.

The production of oil and gas in the four townships began in 1904 and has continued up to the present, and altogether about 1,800 oil and gas wells and dry holes have been drilled. The most prolific fields are the Flat Rock, Country Club, Hominy Falls, and Bird Creek fields. Ten zones, which range in depth from 500 to 2,450 feet, yield oil or gas; they include, in ascending order, the Siliceous lime or Simpson formation, the Mississippi lime, the Burgess sand-Mississippi lime zone, the Taneha, Bartlesville, Red-Fork (Burbank), Skinner and Squirrel (Prue) sands, the Oswego lime, and the Jones sand. The Bartlesville sand produces oil in more wells than all the other producing zones combined, but the Ordovician rocks (Simpson formation or Siliceous lime) produce the largest initial daily yields of both oil and gas. The oil and gas in the Simpson formation and the Siliceous lime, except in one locality, are confined to the higher parts of the domes and anticlines, but the oil and gas in the Bartlesville sand do not appear to be controlled by the attitude of the rocks.

The rocks in this region, as indicated by the altitude of the top of the Oswego lime, dip westward at an average rate of 38 feet to the mile. This regional dip is interrupted, however, by many domes, anticlines, and synclines. The structural closure on most of the domes and anticlines does not exceed 80 feet as measured on the top of the Oswego lime. The subsurface crests of most of the upfolds do not lie directly under the crests as mapped on the surface rocks, and the buried rocks dip more steeply than the surface rocks. The exposed rocks are displaced along faults in three localities in the western part of the area covered by the four townships, but the information available is not sufficient to show to what depth the buried rocks are displaced along the faults.

The investigation has shown that there are a few localities in this part of Osage County not yet completely tested for oil and gas; that yields of oil or gas from certain limy reservoir beds may be increased by acid treatment, and that additional oil may be produced by air or gas repressuring and water flooding of some of the reservoir sands, particularly the Bartlesville sand.

INTRODUCTION

The subsurface geologic features, the oil- and gas-producing beds, and the areas that are favorable for the discovery of additional oil and gas in Tps. 20 and 21 N., Rs. 11 and 12 E., Osage County, Okla., are described in this report, which is the seventh in a series of reports covering parts of Osage County. The stucture of the buried rocks, the oil and gas wells, the abandoned wells and dry holes, and the ownership of leases are shown on the accompanying map (pl. 7). The oil- and gas-bearing beds in each well, producing or abandoned, and the deepest beds penetrated in dry holes are shown on the map by color tints printed over the black well symbols. Wells that produced oil or gas from shallow depths and were drilled deeper to test older beds are indicated by special symbols.

All the beds that have produced oil and gas in the four townships are described briefly, but the other beds that have been penetrated are not described. All the rocks penetrated by the drill are shown graphically, however, in a generalized columnar section on plate 7. The beds that have produced oil or gas are indicated on the columnar section by colored solid circles. The colors on the columnar section correspond to the color overprint on the well symbols on the structure-contour map. The thicknesses of the formations shown on the columnar section are most representative of the central part of the area and are not equally applicable to the remainder because they are not constant. The oil- and gas-producing beds in each of the four townships are listed in the following table:

Oil- or gas-producing beds in Tps. 20 and 21 N., Rs. 11 and 12 E., Osage County, Okla.

T. 20 N., R. 11 E.	T. 21 N., R. 11 E.	T. 20 N., R. 12 E.	T. 21 N., R. 12 E.
	Jones sand.		Oswego lime.
Squirrel (Prue) sand.	Skinner sand.	Skinner sand.	
Red Fork (Burbank) sand.		Red Fork (Burbank) sand.	Red Fork (Burbank) sand.
Bartlesville sand.	Bartlesville sand.	Bartlesville sand.	Bartlesville sand.
Taneha sand.	Taneha sand.	Taneha sand.	Taneha sand.
Burgess sand—Mississippi lime zone.	Burgess sand—Mississippi lime zone.	Burgess sand—Mississippi lime zone.	Burgess sand—Mississippi lime zone.
			Mississippi lime.
Simpson formation or Siliceous lime.	Simpson formation or Siliceous lime.	Simpson formation or Siliceous lime.	Simpson formation or Siliceous lime.

The exposed rocks in the parts of Tps. 20 and 21 N., Rs. 11 and 12 E., in Osage County are, beginning with the oldest, the Coffeyville formation, the Hogshooter limestone, the Nellie Bly formation, the Dewey limestone, and the Ochelata formation, including its prominent member, the Avant limestone. The distribution of the exposed rocks is shown on the State geologic map of Oklahoma by

Miser;[1] the character and structural attitude of the rocks are described by Lloyd and Mather[2] for T. 20 N., R. 11 E., and by Ross[3] for T. 21 N., R. 11 E., and Tps. 20 and 21 N., R. 12 E. The surface structure-contour maps by Lloyd, Mather, and Ross were used extensively in drawing the subsurface contours on plate 7, in the areas, mostly in Tps. 20 and 21 N., R. 11 E., for which few data on the attitude of the Oswego lime are available.

OIL- AND GAS-PRODUCING BEDS

In the area here described oil or gas has been produced from 10 zones, ranging from the uppermost part of the Siliceous lime to the Jones sand in the Coffeyville formation (pl. 7). Depths to the oil- or gas-bearing beds range from 500 to 2,450 feet. Wells producing from the the Simpson formation or from the Siliceous lime have had the largest initial daily yields, but wells producing from the Bartlesville sand, although yielding at a relatively small daily rate, have had the longest lives. Many more wells produce from the Bartlesville sand than from all the other zones combined. In the following pages the oil- and gas-producing rocks, from the oldest to the youngest, are described briefly.

SILICEOUS LIME AND SIMPSON FORMATION

Oil and gas have been found in the Simpson formation or in the Siliceous lime at a dozen localities in Tps. 20 and 21 N., Rs. 11 and 12 E. The most productive localities are on the Country Club and Bald Hill domes, in T. 20 N., R. 12 E., in the northern part of the Flat Rock field, in T. 21 N., R. 12 E., on the Edgewood dome, in T. 21 N., R. 11 E., and on the Wimberley dome, in T. 20 N., R. 11 E.

The Simpson formation, as defined by Luther White,[4] and the upper part of the Siliceous lime are of Ordovician age, and the lower part of the Siliceous lime is of Cambrian age. The Siliceous lime is separated from the Simpson formation by an unconformity, but in most wells it is impossible to differentiate the two without a micoscopic examination of samples. Because such an examination was not made by the authors, precise separation of the two formations was not made. Although oil occurs in both formations, as indicated by drillers' logs, most of it is in the Siliceous lime. The oil and gas in the Siliceous lime and Simpson formation are com-

[1] Miser, H. D., Geologic map of Oklahoma, U. S. Geol. Survey, 1926.

[2] Lloyd, E. R., and Mather, K. F., in White, David, and others, Structure and oil and gas resources of the Osage Reservation, Okla.: U. S. Geol. Survey Bull. 686, pl. 18, 1922.

[3] Ross, C. S., in White, David, and others, Structure and oil and gas resources of the Osage Reservation, Okla.: U. S. Geol. Survey Bull. 686, pls. 27 and 29, 1922.

[4] White, L. H., Subsurface distribution and correlation of the pre-Chattanooga ("Wilcox" sand) series of northeastern Oklahoma: Oklahoma Geol. Survey Bull. 40, vol. 1, pp. 23–24, 29–32, 1928.

monly confined to the higher parts of prominent domes and anticlines, as, for example, the Country Club, Bald Hill, and Edgewood domes, but the oil pool in these beds in secs. 19 and 30, T. 21 N., R. 12 E., and sec. 25, T. 21 N., R. 11 E., is on a structural terrace or a broad slightly arched fold that lies low on the northwest flank of the Delaware anticline.

The oil-producing beds in the Siliceous lime are confined to its uppermost 50 feet, and in most localities they lie in the uppermost 20 feet. They commonly consist of finely crystalline brown dolomite that contains some chert. The oil-bearing beds in different fields, although occurring at or near the top of the formation in all, probably lie at different stratigraphic horizons owing to the fact that the Siliceous lime was folded and eroded prior to the deposition of the overlying Simpson formation. Deep wells in Osage County indicate that the Siliceous lime is thin or absent on the crests of sharply folded domes and anticlines, where peaks of pre-Cambrian granite or other crystalline rock commonly lie at shallow depth, but that it thickens abruptly to 1,000 feet or more on their flanks. The Bald Hill dome, in T. 20 N., R. 12 E., is an example of such a dome. Three wells on or near its crest entered granite at depths ranging from 2,140 to 2,425 feet. Above the granite the Siliceous lime ranged from only 150 to 320 feet in thickness, and of the three wells this lime was thickest in the well that was farthest from the crest of the dome. A fourth well, located slightly farther from the crest of the dome than any of the other three, penetrated 417 feet of the Siliceous lime without encountering crystalline rock.

The Simpson formation consists of a lower sandstone member, called the Burgen or Hominy sand,[5] and an upper member, the Tyner, which is made up of interbedded green shale and sandstone and a few beds of dolomite. The thickness of the Simpson is about 100 feet in the southern part of the area here described but thins northward.

MISSISSIPPI LIME

Two wells in the NE¼ sec. 16, T. 21 N., R. 12 E., produced oil from a bed of sandy limestone about 200 feet below the top of the Mississippi lime, and the logs of a few other wells recorded shows of oil in this bed.

BURGESS SAND-MISSISSIPPI LIME ZONE

Beds at or near the contact of the Mississippi lime and the Cherokee shale, called herein the Burgess sand-Mississippi lime zone, yield oil or gas at several widely separated places. The main

[5] White, L. H., op. cit., pp. 23–24, 29–32.

localities producing from this zone are on the Page and Turkey Creek domes, in T. 20 N., R. 11 E., on the Red Bluff and Scarp anticlines, on the South Edgewood dome, and in secs. 1 and 12, in T. 21 N., R. 11 E.; in sec. 30, in T. 21 N., R. 12 E.; and on the Bald Hill and Country Club domes, in T. 20 N., R. 12 E. Depths to the oil- or gas-bearing beds range from 1,450 to 2,000 feet. The initial daily yield of the wells ranged from 10 to 700 barrels each, but that of most wells as less than 100 barrels.

In this part of Osage County the Burgess sand consists of fine to coarse, angular to rounded quartz grains. It is commonly from 10 to 30 feet thick and is separated from the Mississippi lime by a thin bed of green and gray shale in some localities and lies directly on the lime in other localities.

The oil and gas occur in the Burgess sand in most wells, but in some wells they are found in the uppermost beds of the Mississippi lime. These beds commonly contain chert, which in drilling is crushed into fine angular particles that resemble sand grains. The chert-bearing beds therefore, are recorded in many logs as sand.

TANEHA SAND

The Taneha sand is a thin, lenticular bed, commonly not more than 30 feet thick, in the lower part of the Cherokee shale. It yields oil in a relatively large area in secs. 3, 6, and 10, T. 21 N., R. 12 E., and secs. 1, 11, and 12 T. 21 N., R. 11 E. The initial daily yield of most wells producing from it was less than 75 barrels each, though that of a few wells was more than 100 barrels each.

BARTLESVILLE SAND

The Bartlesville sand, which lies at a depth of 1,200 to 1,700 feet, yields oil or gas in more wells in these four townships than all the other zones combined. It occurs as elongated lenses 10 to 200 feet thick 100 to 160 feet below the Pink lime in the lower part of the Cherokee shale. The sand is absent at places. A bed of shale 175 to 200 feet thick separates the sand from the underlying Mississippi lime.

The Bartlesville sand, as shown by the investigation of the subsurface geology of Osage County, was laid down as a series of beach deposits on the western shore of the Cherokee sea;[6] and the deposits are alined in parallel or nearly parallel belts, each of which is of slightly different age, although they lie within a stratigraphic zone only about 250 feet thick. A comparison of the drillers' logs of wells

[6] Bass, N. W., Leatherock, Constance, Dillard, W. R., and Kennedy, L. E., Origin and distribution of the Bartlesville and Burbank shoestring oil sands in parts of Oklahoma and Kansas: Am. Assoc. Petroleum Geologists Bull., vol. 21, No. 1, pp. 55–56, 1937.

producing from the Bartlesville in Tps. 20 and 21 N., Rs. 11 and 12 E., reveals that all except the uppermost part of this sand is here somewhat lower stratigraphically than it is in a broad belt a few miles to the northwest that contains many oil pools. It would be permissible, therefore, to designate the sand in Tps. 20 and 21 N., Rs. 11 and 12 E., as the lower Bartlesville. It is believed, however, to be less confusing to refer to it merely as the Bartlesville sand because this term has become established by the usage of all oil-field workers in this region.

Microscopic examination by Constance Leatherock of samples of the sand from a few wells in Tps. 20 and 21 N., Rs. 11 and 12 E., shows it to be similar to the Bartlesville sand in the broad belt a few miles to the northwest and also to the Burbank (Red Fork) sand of western and southern Osage County. The sands in these different areas are, in turn, similar also to the Bluejacket sandstone member of the Cherokee, which crops out in northeastern Oklahoma and southeastern Kansas and is probably approximately equivalent to a part of the Bartlesville sand.

The Bartlesville sand characteristically gives up its oil at a slow rate, but it has yielded for a relatively long period. Many wells in this sand have produced oil for 20 to 30 years, and a few wells drilled on the north flank of the Bald Hill dome in 1904 are still producing. Recently the Bartlesville sand pools have received added attention from the oil industry because of the successful operation of gas-repressuring and water-flooding projects in a few fields in Osage County and in northeastern Oklahoma.

RED FORK (BURBANK) SAND

The Red Fork sand is near the middle of the Cherokee shale and a short distance below the Pink lime. It occupies about the same position as the Burbank sand of western Osage County and is tentatively indicated herein as being equivalent to it. It is present in only parts of the four townships here described and produces oil in about a dozen wells in the southern and western parts of T. 20 N., R. 12 E., in two wells in T. 20 N., R. 11 E., and in two wells in T. 21 N., R. 12 E. The sand is composed largely of fine subangular quartz grains and minor amounts of mica and other minerals. It is similar in composition and physical character to the Bartlesville sand.

SKINNER SAND

The Skinner sand has yielded a small amount of gas from a depth of about 975 feet in one well on the Country Club dome, in T. 20 N., R. 12 E., and it has yielded some gas from a depth of about 1,625

feet in a well on the flank of the Red Bluff anticline, in T. 21 N., R. 11 E. The Skinner sand is really a zone of sand lenses that lies between the Pink lime and the Verdigris lime. Sand in this zone is present in only about a third of the wells in the townships here described.

SQUIRREL (PRUE) SAND

One well has produced oil from the Squirrel sand, which was found at a depth of about 1,300 feet. The sand is a lenticular bed with a maximum thickness of about 75 feet in the upper part of the Cherokee shale, between the Verdigris lime and the Oswego lime.

OSWEGO LIME (FORT SCOTT LIMESTONE)

The uppermost 10 to 25 feet of the Oswego lime yields a small amount of gas in two localities. The lime is a persistent stratum ranging from 700 to 1,300 feet in depth and from 40 to 60 feet in total thickness. It is easily recognized in the well logs, and the top of it is used by most geologists as a datum in mapping the subsurface structure of the rocks in this region. The oil-bearing beds in many places in Osage County are limy and when given acid treatment respond with increased yields.

JONES SAND

The Jones sand lies in the lower part of the Coffeyville formation below the Checkerboard limestone member and a short distance above the Cleveland sand. It is unimportant as an oil and gas producer in this part of Osage County; in the townships here described it has yielded oil in only two wells, one of which is in sec. 7 and the other in sec. 17, T. 21 N., R. 11 E. The depth to the sand in these wells is about 900 feet.

T. 20 N., R. 11 E.

T. 20 N., R. 11 E., is on the south margin of Osage County. The southeast corner of the township is 4 miles west of Tulsa, and its south boundary is about a mile north of Sand Springs. Oil or gas has been produced from six zones in five small fields in the township. The largest initial daily yields have been obtained from wells in the Burgess sand-Mississippi lime zone on the Page dome. Relatively large initial daily yields have been obtained also from the Simpson formation or Siliceous lime on the Wimberly and Turkey Creek domes and from the Bartlesville sand on the Pioneer and Euchee Creek domes. The largest initial daily yields of gas have been derived from the Bartlesville sand on the Pioneer dome. The oil- and gas-producing areas in this township cover in all about 2,400 acres, or 3¾ square miles. A few of the

producing areas might be extended somewhat by the drilling of additional wells.

Of about 190 wells in the township 150 have yielded oil or gas in paying quantities. According to the dates on the logs, the earliest test for oil or gas was made in 1900, when a dry hole in the southeast corner of the NE¼ sec. 11 reached the horizon of the Taneha sand; during 1903 two dry holes were drilled, one in sec. 30 and one in sec. 33; a group of wells that produced oil was drilled from 1916 to 1919 on the Page dome; most of the wells on the Turkey Creek dome were drilled from 1918 to 1928; about 25 wells on the Wimberley dome were drilled from 1919 to 1927; several wells in secs. 29 and 30 were drilled from 1925 to 1928; many wells were drilled on the Pioneer dome from 1920 to 1930; and most of the wells in secs. 31 and 32 were drilled from 1923 to 1926.

The subsurface investigation of the township was conducted mainly in 1935 and 1936 by W. R. Dillard and Otto Leatherock. The data on production were compiled in 1939 by M. D. Meribel, of the Osage Indian Agency, from records on file at the agency.

STRUCTURE AND DEVELOPMENT

The regional dip of the rocks in T. 20 N., R. 11 E., is westward at an average rate of 38 feet to the mile as measured on the top of the Oswego lime. It is not uniform, however, but is interrupted by several domes, synclines, and structural basins, among which are the Pioneer, Turkey Creek, and Wimberley domes and the structural basin whose lowest point is in the SE¼ sec. 26. The structure of the buried rocks in general is similar to that of the exposed rocks,[7] but the buried rocks are more steeply folded than the exposed rocks and the crests of their folds do not lie directly beneath the crests of the corresponding folds in the exposed rocks. For example, the Pioneer dome in secs. 5 and 8 appears as only a prominent anticlinal nose in the exposed rocks,[8] and the crests of the Turkey Creek and Wimberley domes in the surface rocks are each about a quarter of a mile removed from their positions on the top of the Oswego lime. The exposed rocks in secs. 18 and 19 and in sec. 5 are cut by faults, each of which trends northwestward.[9] The maximum vertical displacement of the surface rocks is 40 feet along the faults in secs. 18 and 19, and 35 feet along the fault in sec. 5. The data are insufficient to determine whether the deeply buried rocks are displaced by these faults.

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[7] Lloyd, E. R., and Mather, K. F., in White, David, and others, Structure and oil and gas resources of the Osage Reservation, Okla.: U. S. Geol. Survey Bull. 686, pl. 18, 1922.

[8] Idem, pl. 18.

[9] Lloyd, E. R., and Mather, K. F., op. cit., pl. 18.

PIONEER DOME

The Pioneer dome, in secs. 5 and 8, is the most prominent upfold in T. 20 N., R. 11 E. Its structural closure is about 60 feet on the top of the Oswego lime. The rocks dip steeply into the synclines that lie east, southeast, and south of the dome. In all, 47 wells have been drilled on the dome, of which 29 produced oil and 4 produced gas from the Bartlesville sand at a depth of 1,700 to 1,800 feet; 6 wells produced oil from Ordovician rocks at a depth of from 2,237 to 2,372 feet, but it was not determined whether the oil occurs in the Simpson formation or the Siliceous lime; 3 wells on the south flank of the dome produced oil from the Taneha sand at a depth of 1,900 to 2,000 feet. The Burgess sand-Mississippi lime zone, which yields oil elsewhere in this township, was reached in 10 wells but failed to produce either oil or gas.

The initial daily yields of wells producing from the Bartlesville sand ranged from 12 to 70 barrels each. The wells producing from the Taneha sand yielded initially from 30 to 50 barrels a day each, and those producing from Ordovician rocks, from 16 to 95 barrels a day each. The initial daily yields of gas wells producing from the Bartlesville sand ranged from 2,800,000 to 10,000,000 cubic feet each.

The Pioneer dome appears to be completely developed in most oil zones. Deep wells on the east and south flanks of the dome define the margins of the pool in the Bartlesville sand, but as the west and northwest margins are not yet defined, the pool in this sand might be extended northwestward in the NW¼ sec. 5 by the drilling of additional wells, provided the producing wells are not making excessive amounts of water.

The total amount of oil produced from the Pioneer dome to the end of 1938 is shown in the following table:

Oil produced from the Pioneer dome

Tract	Date of first production	Production to end of 1938 (barrels)	Remarks
NE¼ sec. 5	1922	176,042	
NW¼ sec. 5	1920	263,890	
SW¼ sec. 5	1920	204,104	
SE¼ sec. 5	1922	149,571	
NE¼ sec. 8	1921	26,890	Last production in 1936.
NW¼ sec. 8	1921	34,687	Abandoned in 1927.
		855,184	

TURKEY CREEK DOME

The Turkey Creek dome occupies an area of about a square mile in secs. 10, 11, 14, and 15. It has a structural closure of about 40 feet on the top of the Oswego lime, and the crest of the dome on the

top of this lime is 1,800 feet northeast of its crest in the surface beds. In all 20 wells have been drilled on the dome. A few wells on or near the crest have produced oil from Ordovician rocks at a depth of 2,275 to 2,600 feet. The drillers' logs indicate that the oil occurs in the Simpson formation but the producing beds were not positively identified. The initial daily yields of these wells ranged from 30 to 200 barrels each. A few wells have produced gas and others oil from the Burgess sand-Mississippi lime zone, but all except one of these wells have been abandoned. The initial daily yields of the oil wells that produced from this zone ranged from 10 to 45 barrels each, and the initial daily yields of the gas wells ranged from 3,000,000 to 6,000,000 cubic feet.

It is noteworthy that the Bartlesville sand, which is a prolific producer of oil on the Pioneer dome, in sec. 5, is present and has a thickness of 100 to 200 feet on the Turkey Creek dome and yet has failed to yield either oil or gas in commercial amounts. The distribution of the wells on the Turkey Creek dome suggests the desirability of drilling one or more additional wells in the SE¼ sec. 10, on the crest of the dome to test Ordovician rocks, provided the producing wells are not yielding excessive amounts of water. Wells near the crest that are now producing from the Simpson formation should be deepened to test the Siliceous lime.

The total amount of oil produced from the Turkey Creek dome to the end of 1938 is shown in the following table:

Oil produced from the Turkey Creek dome

Tract	Date of first production	Production to end of 1938 (barrels)	Remarks
NE¼ sec. 10	1919	358	Abandoned in 1919.
SE¼ sec. 10	1923	66,463	
SW¼ sec. 11	1924	41,925	
NE¼ sec. 15	1923	51,530	Last production in 1937.
		160,276	

WIMBERLEY DOME

The Wimberley dome, in secs. 21, 22, 27, and 28 has a structural closure of about 70 feet on the top of the Oswego lime and about 20 feet in the exposed rocks. The crest of the dome on the Oswego lime lies about 1,800 feet southwest of its crest in the exposed rocks. Of 27 wells drilled on the dome 11 yielded oil, 10 yielded gas, and 6 were dry. The oil is found in the uppermost beds of Ordovician age, and, although the producing beds have not been positively identified, the drillers' logs indicate that some of the oil occurs in the Simpson formation but that most of it occurs in the top few feet of the

Siliceous lime. Several wells, all of which have been abandoned, produced gas from the Burgess sand-Mississippi lime; four wells, one of which has been abandoned, produced gas from the Bartlesville sand; and two wells, both of which have been abandoned, produced gas from the Red Fork sand.

The depth to the top of the Siliceous lime is about 2,400 feet; to the Burgess sand-Mississippi lime zone, 2,000 feet; to the Bartlesville sand, about 1,700 feet; and to the Red Fork sand, about 1,575 feet. The initial daily yields of the oil wells ranged from 11 to 370 barrels each; the gas wells producing from the Burgess sand-Mississippi lime zone yielded initially 1,000,000 to 6,500,000 cubic feet a day each; those producing from the Bartlesville sand yielded initially 750,000 to 14,000,000 cubic feet a day each; and those producing from the Red Fork sand yielded initially 2,000,000 to 3,500,000 cubic feet a day.

The total amount of gas produced from the dome was not learned, but the total amounts of oil produced from the SE¼ sec. 21, to the end of 1938, were 83,340 barrels, 298,497 barrels from the NE¼ sec. 28, and 12,131 barrels from the SE¼ sec. 28.

The distribution of the oil wells on the Wimberley dome suggests that well 2–62 in the SE¼ sec. 21 should be deepened to the Siliceous lime before it is abandoned. The oil-bearing beds in several of the wells producing from the Simpson formation or the Siliceous lime were treated with acid a few years ago, and the wells responded with greatly increased yields. Moreover, the improved yields have been maintained since treatment, although at a slowly declining rate. These results suggest that other producing wells and any new wells that may be drilled into these beds should be given acid treatment.

SHELL CREEK DOME AND DOME IN E½ SEC. 29

The Shell Creek dome in sec. 29 and 30 and the small dome in the E½ sec. 29 lie along the crest of a relatively large anticline that extends westward from the southwest flank of the Wimberley dome. However, the position of the structure contours on the dome in the E½ sec. 29 as mapped is largely hypothetical but is indicated by the presence of a low dome in the exposed rocks.[10]

Of 16 wells that were drilled on these two domes, 4 produced gas, 1 produced oil, and 1 produced both gas and oil. The last-mentioned well—No. 3 in the NW¼ sec. 29—produced gas from the Simpson formation at an initial daily rate of 3,000,000 cubic feet, and after producing for several years was deepened to the Siliceous lime, from which it produced oil at an initial daily rate of 85 barrels. Well 4 in the NW¼ sec. 29 tested the Siliceous lime and found it

[10] Lloyd, E. R., and Mather, K. F., op. cit., pl. 18.

barren but produced gas from the Simpson formation. Well 1 in the SE¼NE¼ sec. 30 produced oil at an initial daily rate of 30 barrels from the Simpson formation. Two wells in sec. 29 produced initially 1,500,000 and 4,000,000 cubic feet of gas a day, respectively, from the Taneha sand, encountered at a depth of 1,935 feet. One well in sec. 29 produced initially 1,750,000 cubic feet of gas a day from the Bartlesville sand.

The fact that the crests of the two small domes in secs. 29 and 30 are from 60 to 100 feet structurally lower than the crest of the Wimberley dome indicates that these domes are not particularly favorable sites for the occurrence of large amounts of oil. The success experienced in finding oil in the Siliceous lime in well 3, in the NW¼ sec. 29, however, suggests that a few more wells near the crest of the Shell Creek dome and a test well in the southeast corner of the SW¼NE¼ sec. 29 might find oil in the Siliceous lime.

The total amount of gas produced from the domes in secs. 29 and 30 was not learned, but the total amount of oil produced to the end of 1938 was compiled from records of the Osage Indian Agency. A total of 25,243 barrels was produced from the NW¼ sec. 29 from 1923 to the end of 1938, and a total of 648 barrels from one well in the NE¼ sec. 30 during a part of 1925, after which the well was abandoned.

EUCHEE CREEK DOME

The Euchee Creek dome, whose crest is near the boundary between secs. 31 and 32, is partly in Osage County and partly in Tulsa County. Several wells on or near the crest of the dome produced oil from the Siliceous lime, which was reached at a depth of 2,450 to 2,575 feet, and several wells in sec. 31, low on the northwest flank of the dome, produced oil from the Bartlesville sand at a depth of 1,650 to 1,750 feet. The initial daily yields of the wells producing from the Siliceous lime ranged from 6 to 40 barrels, and the initial daily yields of wells producing from the Bartlesville sand ranged from 8 to 75 barrels.

The total amount of oil produced from the Euchee Creek dome in Osage County to the end of 1938 is shown in the following table:

Oil produced from the Euchee Creek dome in Osage County

Tract	Date of first production	Production to end of 1938 (barrels)
NE¼ sec. 31	1924	5,095
NW¼ sec. 31	1923	34,469
SW¼ sec. 31	1921	130,712
SE¼ sec. 31	1920	55,877
SW¼ sec. 32	1920	21,292
		247,445

PAGE DOME

The Page dome, in secs. 23, 24, and 26, has a structural closure on the top of the Oswego lime of less than 20 feet. It is represented in the exposed beds by a broad anticlinal nose only. Of about 30 wells on the dome, many have produced oil from the Burgess sand-Mississippi lime zone at a depth of about 2,000 to 2,075 feet. The drillers' logs indicate that no Burgess sand is present and that the oil-bearing bed is in the uppermost part of the Mississippi lime. The initial daily yields of the wells ranged from 10 to 700 barrels each. The total production of oil to the end of 1938 is shown in the following table:

Oil produced from the Page dome

Tract	Date of first production	Production to end of 1938 (barrels)	Remarks
NE¼ sec. 23	1919	2,664	Abandoned in 1921.
SE¼ sec. 23	1918	424,257	
SW¼ sec. 24	1918	38,157	Abandoned in 1923.
NE¼ sec. 26	1919	93,691	Abandoned in 1922.
		558,769	

Up to the present no well on or near the crest of the dome has tested the Siliceous lime, and it might pay to drill a test well near the center of the E½NW¼SE¼ sec. 23, where the lime would be reached at a depth of about 2,450 feet. The well should be given acid treatment if the lime is found to be oil-bearing.

ANTICLINAL NOSE IN SEC. 35

The broad anticlinal nose in sec. 35 shown on plate 7 is hypothetical, and the attitude of the surface beds should, therefore, be carefully determined before the drilling of a test well is contemplated.

SEC. 3

One well in the NW¼ sec. 3 produced a few barrels of oil from the Squirrel sand at a depth of 1,352 feet, but three other wells nearby failed to find oil.

T. 21 N., R. 11 E.

T. 21 N., R. 11 E., is in southeastern Osage County, and its southeast corner is about 7 miles northwest of Tulsa. Six localities produce oil and gas, which occur in six zones ranging in depth from about 500 to 2,450 feet. The Ordovician rocks, the Burgess sand-Mississippi lime zone, and the Taneha sand are greater producers than the other three zones. The Bartlesville sand has produced oil or gas in only a few wells, although it is a prolific producer in many fields in the southeastern part of Osage County.

About 225 wells have been drilled, of which about 145 have yielded oil or gas. Most wells in the Hominy Falls field in secs. 1, 2, 11, and 12 were drilled in 1920 and 1921, although a few were drilled as early as 1918. Most of the development on the Edgewood dome in secs. 5 and 6 took place from 1923 to 1925, and the wells in secs. 25 and 36 were drilled from 1921 to 1924. Several wells in sec. 29 on the Red Bluff anticline were drilled in 1931. Some intermittent drilling was done from 1920 to 1927 on the structural terrace and low anticline in secs. 17 and 20.

The subsurface investigation of T. 21 N., R. 11 E., was conducted mainly in 1935 and 1936 by W. R. Dillard and Otto Leatherock. The data on production were compiled in 1939 by M. D. Meribel of the Osage Indian Agency from records on file at the agency.

STRUCTURE AND DEVELOPMENT

The regional dip of the rocks is westward at the rate of 40 feet to the mile as measured on the top of the Oswego lime, and it is interrupted by a few folds, among which are the Scarp and Red Bluff anticlines and the Edgewood dome.

Several normal faults that cut the surface rocks in secs. 3, 4, 9, 10, 15, 30, and 31 are roughly parallel, and with one exception they trend northwestward and lie en échelon in a northeastwardly trending belt. Most of the faults are less than a mile and a half in length and their vertical displacement, as revealed by the exposed rocks, is 60 feet or less. The data on the subsurface rocks were insufficient to determine whether or not the faults cut the Oswego lime and other deeply buried rocks.

SCARP ANTICLINE

The Scarp anticline is part of a complex group of folds. It trends southwestward from the W½ sec. 6, T. 21 N., R. 12 E., through secs. 1, 12, and 11 into sec. 14, T. 21 N., R. 11 E. Two subsidiary domes that have structural closures of 30 to 40 feet on the Oswego lime occupy the crest of the anticline, and a third dome in the W½ sec. 1 lies on the northwest flank. The Scarp anticline was mapped on the exposed rocks in 1918 by Ross[11] and recommended by him as a favorable area for prospecting. Since the examination by Ross, a total of 1,655,553 barrels of oil and an unknown amount of gas have been produced on the anticline from three zones—the Taneha sand, the Burgess sand-Mississippi lime zone, and the Simpson formation or Siliceous lime.

The oil pool in the Taneha sand was first developed by wells whose initial daily yields ranged from 10 to 500 barrels. Later,

[11] Ross, C. S., in White, David, and others, Structure and oil and gas resources of the Osage Reservation, Okla.: U. S. Geol. Survey Bull. 686, p. 188 and pl. 29, 1922.

many of the wells were deepened to the Burgess sand-Mississippi lime zone, which yielded oil in many wells and gas in a few. The initial daily yield of most oil wells from this zone was less than 50 barrels each, and the initial daily yield of the gas wells was 2,000,000 to 20,000,000 cubic feet each. Still later, many wells were further deepened into the Ordovician rocks, which yielded oil, and new wells, also, were drilled into these rocks. Although the oil-bearing beds in the deepened wells were not definitely identified, the drillers' logs indicate that they are in the Simpson formation.

The identity of the producing zone in many wells in the field is not really known, because accurate records of the wells are not available. Therefore, although the symbols on plate 7 showing the producing zones represent the best information available to the authors, little confidence can be placed in the designations there given.

Many wells in the field produce oil from both the Taneha sand and the Burgess sand-Mississippi lime zone; others produce from both the Burgess sand-Mississippi lime zone and the Simpson formation or Siliceous lime. The Taneha sand ranges from 10 to 40 feet in thickness and is found at a depth of 1,700 to 1,825 feet, or about 50 feet above the Mississippi lime. This sand is being repressured with gas in an effort to increase the yields of the wells. The Burgess sand-Mississippi lime zone lies at a depth of 1,750 to 1,900 feet. The drillers' logs indicate that the oil and gas occur in the Burgess sand, which lies on the Mississippi line, but the available data were insufficient to positively identify the producing bed. The oil-bearing zone in the Ordovician system (Simpson formation or Siliceous lime) lies at a depth of 2,050 to 2,250 feet, and the initial daily yields of the wells producing from this zone ranged from 5 to 200 barrels each.

The total amount of oil produced to the end of 1938 on the Scarp anticline is shown in the following table:

Oil produced on the Scarp anticline

Tract	Date of first production	Production to end of 1938 (barrels)	Remarks
NE¼ sec. 1	1919	7,196	
NW¼ sec. 1	1920	145,775	
SW¼ sec. 1	1920	87,620	Abandoned in 1934.
SE¼ sec. 1	1919	236,104	
NE¼ sec. 2	1921	7,212	Abandoned in 1926.
SE¼ sec. 2	1921	1,735	Abandoned in 1922.
SW¼ sec. 2	1922	29,921	Abandoned in 1931.
NE¼ sec. 11	1920	111,634	
SE¼ sec. 11	1920	38,940	Abandoned in 1925.
NE¼ sec. 12	1924	13,556	
NW¼ sec. 12	1920	848,022	
SW¼ sec. 12	1929	127,838	
		1,655,553	

EDGEWOOD DOME

The Edgewood dome, whose crest is at about the center of the SW¼NW¼ sec. 5, is a small sharply folded dome that has a narrow subsidiary nose extending northwestward across the NE¼ sec. 6 into sec. 31, T. 22 N., R. 11 E. The structural closure of the dome is about 50 feet on the top of the Oswego lime, which is about twice its closure on the surface rocks.[12] The crest of the dome on the Oswego lime lies about 800 feet northeast of its crest in the exposed rocks.

The Edgewood dome was mapped on the surface rocks by the Geological Survey in 1918 and, as a result of that mapping the dome was recommended as a prospective site for the production of oil and gas.[13] Subsequently, many wells were drilled on the dome, and these produced oil. The oil is obtained from Ordovician beds, either the lower part of the Simpson formation or the uppermost part of the Siliceous lime, at a depth of about 2,300 feet. The drillers' logs indicate that most of the producing beds are probably in the uppermost part of the Siliceous lime but that some are in the Simpson formation. The initial daily yields of the wells ranged from 3,000 to 3,500 barrels. It is noteworthy that the well that had the maximum initial yield and the well that had the minimum initial yield are offset wells—less than 600 feet apart. This fact, and the fact that the wells are not on the crest of the dome indicate that, although the dome is the dominant factor in the accumulation of oil here, the porosity and the permeability of the oil-bearing beds probably control the location of the oil pool. The distribution on the dome of the wells producing oil from the Siliceous lime suggests the advisability of drilling additional wells to the Siliceous lime in the NW¼ sec. 5 and the N½SW¼ sec. 5, provided the existing wells are not producing excessive amounts of water.

On or near the crest of the dome the Bartlesville sand, 125 feet thick, has yielded gas in four wells, at a depth of about 1,650 feet. The initial daily yields of the gas wells from this sand ranged from 9,000,000 to 16,000,000 cubic feet, but all except one of the wells have been abandoned. Only the uppermost part of the sand is gas-bearing. Many logs record water in the lower part of the Bartlesville sand.

On December 31, 1938, a total of 242,537 barrels of oil had been produced from the NW¼ sec. 5, and 470,418 barrels had been produced from the NE¼ sec. 6.

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[12] Ross, C. S., op. cit., pl. 29.
[13] Ross, C. S., op. cit., p. 188.

SOUTH EDGEWOOD DOME

The South Edgewood dome in secs. 7 and 8 has a structural closure of about 35 feet on the top of the Oswego lime. The dome is represented on the map of the surface beds[14] by an anticlinal nose that trends northwestward through the SW¼ sec. 8 and the SE¼ and and N½ sec. 7. The crest of the surface anticlinal nose in the SE¼ sec. 7 lies about 1,700 feet southwest of the crest of the subsurface dome in the NE¼ sec. 7 and the NW¼ sec. 8. The crest of the dome in the Oswego lime is about 60 feet lower structurally than the crest of the Edgewood dome in sec. 5.

Several wells on the southwestern flank of the dome yield oil from the Burgess sand-Mississippi lime zone at a depth of about 2,000 feet. The drillers' logs indicate that the oil occurs in the uppermost part of the Mississippi lime and that no Burgess sand is present here. The initial daily yields of the oil wells ranged from 100 to 446 barrrels. Well 1 in the southeast corner of the NE¼ sec. 7 yields oil from the Jones sand at a depth of 825 feet. This well was plugged back after testing the Siliceous lime, which was found barren of oil and gas. Inasmuch as many domes in this part of Osage County yield oil in large amounts from the Siliceous lime, it is suggested that this lime be tested by a well in the center of the E½NE¼ sec. 7, where it should be reached at a depth of 2,300 to 2,350 feet.

The total amount of oil produced in the NE¼ sec. 7 from 1925 to the end of 1938 was 84,782 barrels, and the total amount produced in the SE¼ sec. 7 from 1925 to 1932, when the wells in this quarter section were abandoned, was 96,843 barrels.

ANTICLINE IN SECS. 17 AND 20

A broad, low anticline on the Oswego lime extends northeastward across parts of secs. 20 and 17. In the NW¼ sec. 20 and the SW¼ sec. 17 the anticline assumes, in the surface beds,[15] the position of a low structural nose, and in the E½ sec. 17 it assumes the position of a syncline. In the SW¼ sec. 17 two wells have produced gas from the Bartlesville sand, and one has produced oil from the Siliceous lime. One well in the NE¼SE¼ sec. 17 has produced oil from the Jones sand. The initial daily yield of one of the gas wells was 11,000,000 cubic feet. The initial daily yield of the well producing oil from the Siliceous lime was 30 barrels, and that of the well producing from the Jones sand was 25 barrels.

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[14] Ross, C. S., op. cit., pl. 29.
[15] Ross, C. S., op. cit., pl. 29.

From 1924 to the end of 1938, 11,185 barrels of oil was produced from the SE¼ sec. 17, and 18,931 barrels was produced from the SW¼ sec. 17.

RED BLUFF ANTICLINE

The Red Bluff anticline, whose crest is in the SE¼ sec. 29, has a structural closure of about 40 feet on the top of the Oswego lime. The crest of the anticline on the top of the Oswego lime lies about 1,800 feet southeast of its crest in the exposed rocks,[16] thus this anticline differs from most of the other domes and anticlines in Osage County, whose crests in the buried rocks are offset to the west from the crests in the exposed rocks. The Red Bluff anticline was mapped in 1918 by Ross who recommended it as a site for an oil and gas field.[17]

Many wells on the crest and northwest flank of the anticline yield oil from the Burgess sand-Mississippi lime zone at a depth of about 1,950 feet. The initial daily yield of the wells ranged from 15 to 500 barrels each, but that of most of them was less than 50 barrels each. In the W½SE¼ sec. 30, low on the west flank of the anticline, one well yielded gas for a time from the Skinner sand, another yielded gas for a time from the Bartlesville sand, and a third yielded gas from the Burgess sand-Mississippi lime zone. One well in the southwest corner of the NW¼ sec. 21, on the northeastern extension of the anticline, produces oil from the Siliceous lime. Its initial daily yield was about 25 barrels.

The distribution of the wells in sec. 29 suggests that the producing area in the Burgess sand-Mississippi lime zone might be extended in the S½ and NE¼ sec. 29 by the drilling of additional wells. Inasmuch as many domes and anticlines in this part of Osage County produce oil in large amounts from the Siliceous lime and in lesser amounts from the Simpson formation, the deepening of well 3 in the SE¼ sec. 29, near the crest of the anticline, to test the Siliceous lime and the Simpson formation appears advisable. The Siliceous lime would be encountered at a depth of about 2,400 feet. The northeastern extension of the anticline into the W½ sec. 21 and the northwestwardly trending nose in the S½ sec. 20 should be tested for oil in the Siliceous lime.

The total amount of oil produced from the Red Bluff anticline to the end of 1938, as compiled from records on file at the Osage Indian Agency, is shown in the following table:

[16] Ross, C. S., op. cit., pl. 29.
[17] Ross, C. S., op. cit., p. 189, 1922.

Oil produced from the Red Bluff anticline

Tract	Date of first production	Production to end of 1938 (barrels)
NW¼ sec. 21	1921	16,682
NE¼ sec. 29	1929	32,118
SW¼ sec. 29	1929	17,981
SE¼ sec. 29	1934	72,661
		139,442

SECS. 25 AND 36

A small oil-producing area occupies the eastern parts of secs. 25 and 36, on the western margin of the Flat Rock field. About 20 wells have produced oil, a few of which each produced from three zones, namely, the Simpson formation or Siliceous lime, at a depth of about 2,000 feet, the Burgess sand-Mississippi lime zone, at a depth of 1,625 feet, and the Bartlesville sand, at a depth of about 1,350 feet. The average initial daily yield of the wells producing from the Simpson formation or the Siliceous lime was about 35 barrels each; that of the wells producing from the Burgess sand-Mississippi lime zone was about 65 barrels each. Three wells yielded initially 1 to 40 barrels of oil a day each from the Bartlesville sand, and one well yielded gas.

The total amount of oil produced in secs. 25 and 36 to the end of 1938, as compiled from records on file at the Osage Indian Agency, is shown in the following table:

Oil produced in secs. 25 and 36

Tract	Date of first production	Production to end of 1938 (barrels)	Remarks
NE¼ sec. 25	1921	60,338	Abandoned in 1931.
SE¼ sec. 25	1920	76,467	
NE¼ sec. 36	1920	1,503	Abandoned in 1930.
SE¼ sec. 36	1920	472	Abandoned in 1920.
		138,780	

LAKE VIEW DOME

The southeastern part of the Lake View dome, which lies mainly in T. 22 N., R. 11 E.,[18] occupies parts of secs. 3 and 4, T. 21 N., R. 11 E. The dome has a closure of about 40 feet on the top of the Oswego lime. No wells have been drilled in T. 21 N., R. 11 E., on this part of the dome, but several wells on it in T. 22 N., R. 11 E., yield oil or gas. There the Oswego lime, Bartlesville sand, Burgess

[18] Bass, N. W., Kennedy, L. E., Dillard, W. R., Leatherock Otto, and Hengst, J. H., Subsurface geology and oil and gas resources of Osage County, Okla., pt. 1, Tps. 22 and 23 N., Rs. 10 and 11 E.; U. S. Geol. Survey Bull. 900–A, pl. 1, 1938.

sand-Mississippi lime zone, and Simpson formation or Siliceous lime have produced either oil or gas. It might prove profitable to drill a test well in the northwest corner of sec. 3, T. 21 N., R. 11 E., on the Lake View dome, where the Siliceous lime would be reached at a depth of about 2,400 feet.

SEC. 28

In 1929 well 1 in the southeast corner of the NW¼ sec. 28 produced initially 45 barrels of oil a day from the Burgess sand-Mississippi lime zone at a depth of about 1,900 feet. Later in the year, after producing 698 barrels of oil, this well was abandoned.

T. 20 N., R. 12 E.

The western two-thirds of T. 20 N., R. 12 E., lies in the southeast corner of Osage County, and the southeast corner of the township adjoins Tulsa. The township is in a region containing many oil fields, and oil or gas has been produced from nearly every section in the part of it that is in Osage County. All of the Country Club field lies in the township as do also large parts of such well-known fields as the Flat Rock and the Turley.

Oil or gas has been found in six zones, which are, in descending order, the Skinner, Red Fork (Burbank), Bartlesville and Taneha sands, the Burgess sand-Mississippi lime zone, and the Simpson formation or Siliceous lime. These zones lie at depths ranging from 875 to 2,225 feet. Four of the oil- and gas-producing zones—the Skinner, Red Fork, Bartlesville, and Taneha sands—are lenticular beds in the Cherokee shale, and the oil pools in them appear to be controlled mainly by the pinching out of the sand bodies rather than by the attitude of the rocks. On the other hand, oil pools in the Ordovician rocks, with one notable exception, are restricted to the high parts of the domes and anticlines, and the accumulation of oil that forms them appears, therefore, to be controlled by the structural features.

About 630 oil and gas wells have been drilled in the part of this township that is in Osage County. About 430 of these tested the Bartlesville sand; about 120 tested Ordovician rocks; and about half of the others tested the Burgess sand-Mississippi lime zone. Oil and gas have been produced from the Bartlesville sand in the northern part of the township since 1904, and it is noteworthy that several of the early wells are still producing. Development in the township proceeded intermittently from 1907 to 1910, mostly in the NW¼ sec. 16 and the NE¼ sec. 17; from 1913 to 1916, in the area in and near sec. 22; and from 1917 to 1920 on the Bald Hill dome. The deeper drilling to the Ordovician rocks was begun in 1923 and continued through 1927

on the Bald Hill and Country Club domes. A few wells are still being drilled in the township.

The subsurface investigation of T. 20 N., R. 12 E., was made mainly in 1936 by W. R. Dillard. The statistics of oil production were compiled in 1939 by M. D. Meribel, from records on file at the Osage Indian Agency.

STRUCTURE AND DEVELOPMENT

The regional dip of the rocks in T. 20 N., R. 12 E., is westward at an average rate of 38 feet to the mile as measured on the top of the Oswego lime, but it is interrupted by several folds, the most prominent of which are the Bald Hill and Country Club domes. The structural features in the buried rocks are in general similar to those in the surface beds,[19] except that the buried rocks are more steeply folded than the surface rocks, and the crests of upfolds in the buried rocks do not lie directly beneath the crests of these folds in the surface beds.

BALD HILL DOME

The Bald Hill dome, whose crest is in the NE¼ sec. 8, is the most prominent upfold in T. 20 N., R. 12 E. Its structural closure is about 100 feet on the top of the Oswego lime. The dome is prominent also in the exposed rocks,[20] but its crest in these rocks lies a few hundred feet east of its crest on the top of the Oswego lime. The Mississippi lime dips somewhat more steeply than the Oswego lime, and the Siliceous lime in turn dips much more steeply than the Mississippi lime. Deep wells on the dome, four of which reached the basement rocks, show that the Siliceous lime, the Simpson formation, and the Mississippi lime are much thinner on the crest of the dome than on the flanks. In well 21 in the northeast corner of sec. 8, near the crest of the dome, the basement rocks, commonly called granite, were encountered at a depth of 2,140 feet, beneath 151 feet of Siliceous lime, but in well 27, on the south flank of the dome, in the center of the west line of the SE¼NE¼ sec. 8, these rocks had not been reached at a depth 2,567 feet, after 417 feet of the Siliceous lime had been penetrated.

The oil and gas are produced mainly from the Bartlesville sand and from Ordovician rocks—the Simpson formation or the Siliceous lime. The area producing from the Bartlesville sand extends far beyond the limits of the dome, but the areas producing from the Ordovician rocks are confined to the structurally higher parts of the main dome and to the subsidiary domes and anticlinal noses. The Burgess sand-

[19] Ross, C. S., in White, David, and others, Structure and oil and gas resources of the Osage Reservation, Okla.: U. S. Geol. Survey Bull. 686, pl. 27, 1922.

[20] Ross, C. S., op. cit., pl. 27.

Mississippi lime zone has yielded gas in several wells and oil in a few, and the Taneha sand yields gas in one well in the NE¼SW¼ sec. 9.

The Bartlesville sand of the Bald Hill dome is a lenticular bed ranging in thickness from a feather edge to a little more than 200 feet, and it lies at a depth of 1,200 to 1,400 feet. Most of the oil produced on the dome has come from this sand. The location of the oil-bearing area in the sand bears little relation to the attitude of the rocks, for the area extends from near the crest of the dome down the flanks to points where the rocks are 160 feet structurally lower than on the crest. The large area of oil-bearing Bartlesville sand in secs. 16 and 17 lies low on the south flank of the dome and appears to be separated from the main pool in this sand by a gas-bearing area in the SW¼ sec. 9. The initial daily yields of the wells producing from the Bartlesville sand ranged from 5 to 130 barrels each and many of the wells have been producing for more than 20 years and some for 35 years.

The oil- and gas-bearing beds of Ordovician age lie at a depth of about 2,000 feet, and although the drillers' logs do not provide data by which the producing beds may be definitely identified, they suggest that oil and gas occurs in both the Simpson formation and the uppermost 50 feet of the Siliceous lime. Oil and gas have been produced from these beds by several wells on or near the crest of the dome, and a few, like those in sec. 18, that are low on the flank. The initial daily yields of the oil wells producing from the Ordovician beds ranged from 35 to 1,500 barrels each; those of the gas wells ranged from 2,000,000 to 12,000,000 cubic feet each.

Several wells that are widely separated on the dome produced gas from the Burgess sand-Mississippi lime zone at a depth of about 1,700 feet. The initial daily yield of one well was 1,000,000 cubic feet, that of another was 5,000,000 cubic feet, and that of a third, 17,000,000 cubic feet, but the initial yields of the other wells producing from this zone are not known. The drillers' logs indicate that the gas in this zone occurs in the Burgess sand and not in the Mississippi lime. The sand is about 25 feet thick and appears in some localities to be separated from the lime by a thin bed of shale and in others to lie directly on the lime.

One well in the NE¼SW¼ sec. 9 and another near the northwest corner of sec. 9 have produced gas from the Taneha sand.

A subsidiary dome on the northeast flank of the Bald Hill dome occupies part of the N½ sec. 4 and extends into sec. 33, T. 21 N., R. 12 E. On it are many wells producing from the Bartlesville sand. One well in the SE¼SE¼ sec. 32, T. 21 N., R. 12 E., on the northwest flank of the dome, has produced some oil from Ordovician

beds, but no well near the crest of the dome has reached these rocks. It would therefore appear advisable to deepen at least one well near the crest of the dome into Ordovician rocks.

DELAWARE ANTICLINE

The south end of the Delaware anticline is in secs. 5 and 6. The anticline has gently dipping flanks, and its crest is about 140 feet lower than the crest of the Bald Hill dome. Oil has been produced from the Bartlesville sand in many wells on the east flank of the anticline; gas was produced for a time from the Burgess sand-Mississippi lime zone in one well on the south nose of the anticline; and oil is produced from the Ordovician beds—Siliceous lime or Simpson formation—in three wells on or near the crest of the anticline. The initial daily yield of the oil wells was less than 50 barrels each, and that of the gas well was 5,000,000 cubic feet. It appears probable that the area producing from the Bartlesville sand could be extended southward and westward by drilling more wells, but small daily yields should be expected.

COUNTRY CLUB DOME

The Country Club dome, whose crest is in the NE¼ sec. 28, has a structural closure of about 60 feet on the top of the Oswego lime. Oil or gas has been produced on the dome from six zones.

Of about 65 wells that have been drilled on the dome, 50 tested the Ordovician rocks and found oil in them over a larger area than in most fields in Osage County. The oil, as shown by the drillers' logs, occurs in both the Simpson formation and the Siliceous lime, but the available data are inadequate to determine which of the two formations contains the main oil-bearing beds. The depth to this zone is about 2,000 feet. The initial daily yields of the wells ranged from 25 to 1,200 barrels each, and 7 or more wells yielded initially more than 500 barrels a day each. Most of these wells have been producing for about 15 years.

Several wells on the Country Club dome produced initially from 1,000,000 to 25,000,000 cubic feet of gas a day from the Burgess sand-Mississippi lime zone. The drillers' logs indicate that the gas occurs in the Burgess sand, which in most localities is separated from the Mississippi lime by a thin bed of shale.

A few wells produced gas from the Taneha sand. The initial daily yield of each of the two gas wells in the E½ sec. 28 was 4,000,000 cubic feet. Several wells produced gas and a few produced oil from the Bartlesville sand. The initial daily yield of the gas wells ranged from 2,000,000 to 5,000,000 cubic feet each, and that of the oil wells was 50 barrels or less each. The Bartlesville sand is thin in many places

and absent on much of the central and south parts of the dome.

A few wells produced gas and a few others produced oil from the Red Fork sand. One well, whose initial daily yield was 2,000,000 cubic feet, produced gas from the Skinner sand.

DOME IN NW¼ SEC. 20

A broad dome lies low on the northwest flank of the Country Club dome, and its crest, which is in the NW¼ sec. 20, is a little more than 100 feet lower than the crest of the Country Club dome. Several wells on this dome have produced oil and one has produced gas from the Bartlesville sand, both at a depth of about 1,400 feet. Most of the oil and gas was obtained from the uppermost 20 feet of the sand; water occupied the lower part. The initial daily yield of the oil wells ranged from 10 to 40 barrels each, as recorded in the drillers' logs. Although well 5 in the NE¼ sec. 19 is on the flank of the dome, it yielded an initial daily flow of 15,000,000 cubic feet of gas, and well 1–386 in the NW¼ sec. 20 yielded 10,000,000 cubic feet. In the NW¼ sec. 20 the Ordovician rocks have been tested in several wells and found barren of oil and gas except in well 9, which produced initially 15 barrels of oil a day.

TURLEY FIELD

The western part of the Turley field is in secs. 15, 22, and 27 and the southeast corner of sec. 10. This part of the field lies on an anticline and a structural terrace, which are separated by a deep syncline from the Bald Hill dome and by a shallow syncline from the Country Club dome. The attitude of the rocks in the Turley field appears to have little or no connection with the location of the oil pool in the main producing bed—the Bartlesville sand—but probably it is the factor that has controlled the localization of the oil in the Ordovician rocks.

Of about 100 wells in this part of the Turley field in Osage County, 90 produced oil or gas from the Bartlesville sand, one produced oil from the Ordovician rocks, and two produced oil or gas from the Burgess sand-Mississippi lime zone.

The average initial daily yield of the wells producing oil from the Bartlesville sand was about 25 barrels each, and many of the wells that were drilled from 1913 to 1916 are still producing. The Bartlesville sand lies at a depth of about 1,400 feet and ranges from 50 to 200 feet in thickness. In most wells the uppermost 50 feet of the sand yields oil or gas, and the lower part yields water. It is probable that the producing area in the sand could be extended in the E½ sec. 15 and the SE¼ sec. 10 by drilling more wells. Small daily yields should be expected, however. Before the field is aban-

doned it should be investigated for repressuring the sand with gas or water.

Four wells in the S½ sec. 22 have tested the uppermost part of the Ordovician rocks, and, according to the drillers' logs, two of the wells produced a small amount of oil from the upper part of the Simpson formation. The initial daily yield of one of the producing wells was 10 barrels, and that of the other was 16 barrels. Well 8 in the NE¼SE¼SW¼ sec. 22 reached the Siliceous lime; the drillers' logs indicate that the other three wells stopped in the Simpson formation.

Well 202 in the NW¼NE¼ sec. 27 produced initially 6,000,000 cubic feet of gas a day from the Burgess sand-Mississippi lime zone.

YIELDS

The total amount of oil produced in T. 20 N., R. 12 E., from July 1916 to the end of 1938, as compiled in 1939 by M. D. Meribel, of the Osage Indian Agency, from records on file at the agency, is shown in the following table. Records of production prior to July 1916 are not available.

Oil produced in T. 20 N., R. 12 E.

Tract	Date of first production	Production to end of 1938 (barrels)	Remarks
NE¼ sec. 3	1919	6,902	
SW¼ sec. 3	Prior to 1916	314,123	
SE¼ sec. 3	do	30,040	
NE¼ sec. 4	do	461,626	
NW¼ sec. 4	do	417,926	
SW¼ sec. 4	do	297,747	
SE¼ sec. 4	do	435,240	
NE¼ sec. 5	1917	115,933	
NW¼ sec. 5	1918	185,368	Abandoned May 24, 1937.
SW¼ sec. 5	Prior to 1916	177,092	
SE¼ sec. 5	do	368,379	
NE¼ sec. 6	1918	322,830	
SE¼ sec. 6	1922	4,588	
NE¼ sec. 8	Prior to 1916	894,701	
NW¼ sec. 8	do	388,625	
SW¼ sec. 8	do	124,837	
SE¼ sec. 8	do	35,278	Abandoned Mar. 1, 1932.
NE¼ sec. 9	do	836,027	
NW¼ sec. 9	do	874,938	
SW¼ sec. 9	do	345,542	
SE¼ sec. 9	1918	100,465	
NE¼ sec. 10	Prior to 1916	113,974	
NW¼ sec. 10	1917	763,790	
SW¼ sec. 10	1918	79,362	
SE¼ sec. 10	Prior to 1916	31,497	
SW¼ sec. 14	do	26,212	
NE¼ sec. 15	do	62,682	
SW¼ sec. 15	do	25,970	Abandoned Feb. 19, 1932.
SE¼ sec. 15	do	208,372	
NW¼ sec. 16	do	17,477	
SW¼ sec. 16	do	66,765	
SE¼ sec. 16	do	2,661	Abandoned in 1920.
NE¼ sec. 17	do	410,367	
NW¼ sec. 17	1921	61,265	
SW¼ sec. 17	1924	22,815	Abandoned Nov. 15, 1932.
SE¼ sec. 17	1918	192,292	
NE¼ sec. 19	1920	11,601	Abandoned June 13, 1927.
NW¼ sec. 20	1919	16,598	Abandoned Nov. 1, 1928.
SW¼ sec. 20	1920	2,424	Abandoned in 1923.

Oil produced in T. 20 N., R. 12 E.—Continued

Tract	Date of first production	Production to end of 1938 (barrels)	Remarks
SE¼ sec. 20	1923	5,194	Abandoned in April 1930.
SW¼ sec. 21	1924	5,594	Abandoned Nov. 20, 1934.
SE¼ sec. 21	1924	62,933	Abandoned Nov. 15, 1932.
NE¼ sec. 22	Prior to 1916	248,327	
NW¼ sec. 22	do	102,798	Abandoned Oct. 31, 1936.
SW¼ sec. 22	do	40,996	Abandoned Apr. 27, 1935.
SE¼ sec. 22	do	233,679	
NW¼ sec. 23	do	15,273	
SW¼ sec. 23	Prior to 1916	346	Abandoned in 1918.
SW¼ sec. 27	1922	11,486	Abandoned in 1926.
NE¼ sec. 28	1922	634,108	
NW¼ sec. 28	1923	792,571	
SW¼ sec. 28	1924	27,868	
SE¼ sec. 28	1922	13,128	Abandoned Nov. 20, 1934.
NE¼ sec. 29	1924	301,723	
SW¼ sec. 29	1924	6,760	
SE¼ sec. 29	1926	15,226	Abandoned Nov. 16, 1934.
		11,526,341	

T. 21 N., R. 12 E.

Approximately the western two-thirds of T. 21 N., R. 12 E., is in southeastern Osage County; the eastern third of the township is in Tulsa County and thus outside the area described in this report. The southeast corner of the Osage County part of the township lies 5½ miles north of Tulsa; the northeast corner of this part of the township is 2 miles south of Skiatook.

Oil and gas have been produced in the Osage County part of this township from seven zones, ranging in depth from about 875 to 2,100 feet. These zones include, in descending order, the Oswego lime, the Red Fork (Burbank), Bartlesville, and Taneha sands, the Burgess sand-Mississippi lime zone, the Mississippi lime, and Ordovician rocks —either the Simpson formation or the Siliceous lime. Of these seven zones, the Bartlesville sand is the oil or gas-bearing bed in about two-thirds of the producing wells. In the northeastern part of the township this sand lies at a depth of about 1,200 feet and in the southwestern part at a depth of about 1,350 feet. Beds in the Ordovician system have produced oil in about 50 wells at a depth of about 1,900 feet. The Taneha sand has produced oil or gas in about 30 wells. The other four producing zones have yielded oil or gas in only a few wells.

About 750 wells have been drilled in the Osage County part of the township. The dry hole in the southwest corner of sec. 27 was drilled in 1903. Many wells were drilled in secs. 3 and 10 from 1906 to 1910 and many others from 1917 to 1920. Many of of the wells in sec. 9, N½ sec. 16, and sec. 17 were drilled from 1920 to 1924; all those in the SE¼ sec. 16, SW¼ sec. 15, and sec. 22 were drilled from 1922 to 1927; and most of those in sec. 6 were drilled from 1919 to 1921. In the

large Flat Rock field most of the wells that produce from the Bartlesville sand were drilled from 1914 to 1920, and most of those that produce from Ordovician rocks were drilled from 1923 to 1926. It is noteworthy that only a few wells in this field have been abandoned.

The subsurface investigation of T. 21 N., R. 12 E., was made mainly in 1935 and 1936 by W. R. Dillard. The data on production were compiled in 1939 by M. D. Meribel of the Osage Indian Agency from records on file at the agency.

STRUCTURE AND DEVELOPMENT

The regional dip of the rocks in T. 21 N., R. 12 E., is westward at the rate of about 45 feet to the mile as measured on the top of the Oswego lime, but it is not uniform, being interrupted by several low domes and anticlines and a few shallow structural basins. The attitude of the buried rocks is similar to that of the exposed rocks,[21] except that the dips in the buried rocks are steeper than those in the exposed rocks and the crests of the folds in the subsurface beds do not lie vertically beneath the crests of the folds in the exposed rocks. The attitude of the rocks appears to be less important in controlling the distribution of the oil pools in this township than in many parts of Osage County. Although the oil pools in the Ordovician rocks appear to be confined for the most part to anticlines, the location of the pools in the Bartlesville and Taneha sands apparently bears no relation to the attitude of the beds.

FLAT ROCK FIELD

The northern part of the Flat Rock field occupies a large area in the southwestern part of the township. In this field the rocks have been gently folded into several domes, anticlines, synclines, and structural basins. Among these are the Delaware anticline, in secs. 31, 32, 29, and 30, the dome in the SW¼ sec. 33, the low anticline and structural terrace in the S½ sec. 19 and the N½ sec. 30, the small dome in the SE¼ sec. 20, and the large structural basin in sec. 32.

Oil or gas has been produced from five zones. Most of the oil however, has been produced from the Bartlesville sand and from Ordovician beds.

The Bartlesville sand lies at a depth of 1,200 to 1,350 feet, and its thickness ranges from a few feet to 150 feet. Most wells producing from it were drilled through its uppermost 40 to 75 feet only. The initial daily yields of the wells in this sand were relatively small, ranging from 5 to 100 barrels, but the initial yield of most wells

[21] Ross, C. S., in White, David, and others, Structure and oil and gas resources of the Osage Reservation, Okla.: U. S. Geol. Survey Bull. 686, pl. 27, 1922.

was less than 40 barrels a day each. The wells are long-lived, for many that were drilled from 1913 to 1915 are still producing oil.

The east boundary of the oil pool in the Bartlesville sand is defined by several dry holes that lie along a gently curved line extending in a southerly direction from the NE¼NE¼ sec. 20 to the SW¼SE¼ sec. 33. The west boundary of the pool is more irregular than the east boundary. The nearly straight course of the east boundary is like the boundaries of the shoestring sand pools in western Osage County and in Cowley, Butler, and Greenwood Counties, Kans., where many dry holes near the oil pools have found no sand at the horizon of the sand that produces in the pools. It is noteworthy that the logs of the dry holes just east of the Flat Rock pool record Bartlesville sand to its full thickness, but the wells were drilled many years ago, before it was customary the examine samples of the rocks with a microscope and before drillers distinguished sandy shale and sand as carefully as they do now. The rocks just outside the Flat Rock oil pool at the horizon of the Bartlesville sand may then really consist of sandy shale or very silty sand instead of sand, as recorded in the logs.

Except for a narrow area is sec. 20 and the N½ sec. 29, the oil pool in the Bartlesville sand is practically continuous in the Flat Rock field, and the distribution of the oil is not controlled primarily by the attitude of the beds. For example, oil occurs in this sand on the crest of the Delaware anticline in the NW¼ sec. 32, on the crest of the dome in the SW¼ sec. 33, and in the syncline in the SW¼ sec. 20. The sand is more than 100 feet lower in the last-named locality than on the crest of the anticline in sec. 32, and 125 feet lower than it is on the dome in sec. 33. Moreover, if the initial daily yields of all wells be indicated on a map of the oil pool, it is found that the distribution of the wells according to small and large initial yields bears no relationship to the position of the wells on the domes, anticlines, and structural basins.

Several undrilled tracts in the Flat Rock field are nearly or completely surrounded by producing wells. Some of these tracts are in the SE¼ sec. 31, S½ and NE¼ sec. 32, and NW¼ sec. 33. Doubtless if wells were drilled to the Bartlesville sand in these tracts they would produce oil, but their rate of production would be small. The yield of many wells in the field would be increased by drilling them deeper into the Bartlesville sand, provided they are not producing excessive amounts of water. It is probable that much oil could be obtained by repressuring the sand with gas or by systematically flooding it with water. The application of either of these processes should be preceded by a thorough investigation, including the collection and examination of many cores of the sand.

Wells that produce from Ordovician rocks have been drilled on the Delaware anticline and on a gently dipping anticline and structural terrace in secs. 19 and 30. The drillers' logs indicate that some oil is produced from several beds in the Simpson formation, whose thickness is 100 feet or more, but that most of the oil is derived from the top 50 feet of the Siliceous lime. The initial daily yield of the wells producing from Ordovician rocks in secs. 19 and 30 ranged from 10 to 3,000 barrels each; but only a few yielded initially more than 100 barrels a day each. Well 16 in the NW¼ sec. 32, on the crest of the Delaware anticline, had the largest initial daily yield—5,000 barrels of oil and 20,000,000 cubic feet of gas. In general, wells in the Flat Rock field that have produced both oil and gas from the Siliceous lime had large initial daily yields; their yields declined rapidly however and later the wells produced large amounts of water. The treatment of the reservoir beds in the Siliceous lime with acid has greatly increased the oil yield in many wells. It is suggested that well 8, on the small dome in the NE¼-SE¼ sec. 30, should be deepened to the Siliceous lime before it is abandoned. The small dome in the SW¼NE¼ sec. 31, on the Delaware anticline, might also yield oil from the Siliceous lime.

Several wells in the Flat Rock field have produced oil and gas from the Burgess sand-Mississippi lime zone, at a depth ranging from 1,500 to 1,650 feet. The wells near the crest of the Delaware anticline have produced gas and most wells elsewhere have produced oil. The initial daily yield of the oil wells was commonly about 40 barrels each. The initial daily yield of the gas wells is unknown except that of well 645 in the SW¼ sec. 29, which was 6,000,000 cubic feet. Well 12 in the SE¼ sec. 19 produced initially 75 barrels of oil a day, and well 186 in the NW¼ sec. 32 produced an unrecorded amount of gas from the Red Fork sand. Well 13 in the SW¼ sec. 20 produced oil from the Taneha sand at an initial daily rate of 12 barrels.

SECS. 3, 4, AND 10 AND THE N½ SEC. 15

Secs. 3 and 10 and the N½ sec. 15 form the western part of an area in which the rocks are folded in several places. The main folds in this area in Osage County are a dome in the SE¼ sec. 10 and a structural basin in sec. 3. The Bartlesville sand yields oil in many wells that are widely distributed in secs. 3 and 10, the E½ sec. 4, and the N½ sec. 15; the Taneha sand and the Burgess sand-Mississippi lime zone yield oil in several wells in secs. 3 and 10; and Ordovician rocks yield oil in a few wells in sec. 10 and gas in several wells in the N½ sec. 3. The initial daily yield of wells producing from the Bartlesville sand ranged from 5 to 50 barrels of oil each; of wells

in the Taneha sand, from 17 to 60 barrels each; of wells in the Burgess sand-Mississippi lime zone, from 8 to 119 barrels each; and of wells in the Ordovician rocks, from 2 to 25 barrels of oil each or from 7,000,000 to 12,000,000 cubic feet of gas each. The drillers' logs indicate that the oil and gas in the Ordovician rocks occur in the Simpson formation.

DOME IN SECS. 15, 16, 21, AND 22

A small dome whose crest is in the SE¼ sec. 16 occupies parts of secs. 15, 16, 21, and 22. The structural closure of the dome on the top of the Oswego lime is about 30 feet. The Bartlesville sand yields oil at a depth of about 1,350 feet in several wells on the crest and flanks of the dome, and the initial daily yield of the wells ranged from 10 to 50 barrels each. The Burgess sand-Mississippi lime zone yields oil at a depth of about 1,550 feet in two wells on the north and west flanks of the dome, and the initial daily yields of the wells were 4 and 60 barrels each, respectively. Ordovician rocks yield oil in six wells at a depth of about 1,900 feet, and their initial daily yield ranged from 4 to 40 barrels each. It is impossible to determine from the logs whether the oil occurs in the Simpson formation or the Siliceous lime. None of the wells producing from Ordovician rocks are on the crest of the dome.

DOME IN SEC. 22

A small dome whose structural closure on the top of the Oswego lime is about 30 feet, occupies the west-central part of sec. 22. Five wells on the dome produce oil from the Bartlesville sand at a depth of about 1,275 feet, and their initial daily yield ranged from 2 to 20 barrels each. The total thickness of the Bartlesville sand here is about 150 feet, of which only the upper part yields oil; the lower part yields water. Since beds on the crest of the dome, beneath the upper part of the Mississippi lime have not been tested, it would appear advisable to deepen to the Siliceous lime one of the wells near the crest before it is abandoned.

ANTICLINE IN SEC. 9, NW¼NW¼ SEC. 15, AND SECS. 16 AND 17

Oil is produced from four zones on an anticline whose crest extends southwestward through sec. 16 from its NE¼NE¼ into sec. 17. The Bartlesville sand, which lies at a depth of about 1,350 feet, is the main producing bed. The initial daily yield of the wells producing from the Bartlesville sand ranged from 2 to 70 barrels each, but that of most wells was about 25 barrels each. The Taneha sand yielded oil at the initial rate of 2 barrels a day in one well in the northeast corner of sec. 17. The Burgess sand-Mississippi lime zone yields oil in a few

wells, which had an initial daily yield ranging from 6 to 60 barrels each. A bed of sandy limestone that lies in the Mississippi lime about 200 feet below its top has yielded oil in wells 4 and 5 in the NE¼ sec. 16, and the initial daily yield of these wells was 20 and 12 barrels each, respectively. The wells are shown without a colored overprint on plate 7. Well 5 in the southeast corner of sec. 9 has produced a small amount of oil from the Simpson formation or Siliceous lime at a depth of 2,050 feet. Wells 5 and 9 in the NE¼ and well 9 in the NW¼ sec. 16 tested Ordovician rocks and found them barren of oil and gas.

ANTICLINAL NOSE IN SECS. 4, 5, AND 6

A broad westward-plunging anticlinal nose extends through the southern part of secs. 4 and 5 into sec. 6. The position of the contour lines in this part of plate 7 is largely hypothetical, however, because the altitiude of the Oswego lime is known at only a few places. It is possible that there is a small dome in the S½ sec. 5. Well 1 in the SE¼ sec. 4 yielded oil at the initial rate of 5 barrels a day from the Bartlesville sand, and four wells in the SW¼ sec. 5 and SE¼ sec. 6, near the west end of the nose, have yielded gas in unrecorded amounts from the Bartlesville sand. Well 1744 in the SW¼ sec. 5 yielded gas from the uppermost 9 feet of the Oswego lime at a depth of 873 feet. If later investigation shows the presence of a dome on the anticlinal nose, the drilling of a test well to the Siliceous lime would be advisable.

SEC. 6

The Taneha sand yields oil at a depth of about 1,600 feet in about 30 wells in sec. 6. The initial daily yield of the wells ranged from 10 to 400 barrels, but that of half of the wells was about 75 barrels each. Some wells in this sand produced as much as 7,000,000 cubic feet of gas a day along with the oil. The Bartlesville sand, whose top is about 300 feet above the top of the Taneha sand, yielded initially from 2 to 50 barrels a day each from five wells in sec. 6.

YIELDS

The total amount of oil produced from July 1916 to the end of 1938 in T. 21 N., R. 12 E., as compiled in 1939 by M. D. Meribel of the Osage Indian Agency from records on file at the agency, is shown in the following table. Records of oil produced prior to July 1916 are not available.

Oil produced in T. 21 N., R. 12 E.

Tract	Date of first production	Production to end of 1938 (barrels)	Remarks
NE¼ sec. 3	Prior to July 1916	132,067	
NW¼ sec. 3	1917	311,491	
SW¼ sec. 3	Prior to July 1916	84,471	
SE¼ sec. 3	do	127,919	
NE¼ sec. 4	1918	62,551	
SE¼ sec. 4	1919	9,745	
NE¼ sec. 6	1921	8,443	
NW¼ sec. 6	1919	322,205	
SW¼ sec. 6	1920	71,071	Abandoned Aug. 12, 1926.
SE¼ sec. 6	1921	5,266	Abandoned June 1, 1928.
SW¼ sec. 9	1924	23,768	
SE¼ sec. 9	1922	75,716	
NE¼ sec. 10	Prior to July 1916	107,529	
NW¼ sec. 10	do	90,576	
SW¼ sec. 10	do	70,601	
SE¼ sec. 10	do	94,927	
NE¼ sec. 15	1918	26,966	
NW¼ sec. 15	1918	60,507	
SW¼ sec. 15	1925	271,233	
NE¼ sec. 16	1922	70,439	
NW¼ sec. 16	1923	94,409	
SW¼ sec. 16	1923	37,081	
SE¼ sec. 16	1923	109,061	
NE¼ sec. 17	1920	40,936	
NW¼ sec. 17	1926	52,856	
SW¼ sec. 17	1920	49,370	
SE¼ sec. 17	1923	25,108	
SW¼ sec. 19	1918	86,650	
SE¼ sec. 19	1917	619,152	
NE¼ sec. 20	1919	233,655	
NW¼ sec. 20	1919	33,044	
SW¼ sec. 20	1918	134,207	
SE¼ sec. 20	1919	259,511	
NE¼ sec. 21	1925	6,609	Abandoned Apr. 30, 1934.
NW¼ sec. 21	1920	22,744	
SW¼ sec. 21	1920	107,393	
NW¼ sec. 22	1925	57,272	
SW¼ sec. 22	1926	9,787	Abandoned Feb. 1, 1938.
NW¼ sec. 28	1920	273,041	
SW¼ sec. 28	1918	568,193	
NE¼ sec. 29	Prior to July 1916	223,785	
NW¼ sec. 29	do	389,801	
SW¼ sec. 29	do	655,092	
SE¼ sec. 29	do	250,795	
NE¼ sec. 30	do	482,720	
NW¼ sec. 30	1918	397,507	
SW¼ sec. 30	1917	209,654	
SE¼ sec. 30	Prior to July 1916	393,836	
NE¼ sec. 31	do	1,200,942	
NW¼ sec. 31	1917	499,638	
SW¼ sec. 31	1918	285,334	
SE¼ sec. 31	Prior to July 1916	393,260	
NE¼ sec. 32	do	269,520	
NW¼ sec. 32	do	490,697	
SW¼ sec. 32	do	51,789	
SE¼ sec. 32	1917	121,141	
NW¼ sec. 33	1917	341,091	
SW¼ sec. 33	Prior to July 1916	628,891	
SE¼ sec. 33	1919	3,417	Abandoned Aug. 13, 1922.
		12,136,280	