THE LAWTON OIL AND GAS FIELD, OKLAHOMA.

By CARROLL H. WEGEMANN and RALPH HOWELL.[1]

INTRODUCTION.

The Lawton oil and gas field, in Comanche County, Okla., is situated near the eastern end of the Wichita Mountains, about 5 miles east of the city of Lawton. (See Pl. XI and fig. 3.) In the early days of Lawton, in 1901, interest among the settlers is said to have been aroused by the finding of oil in a well dug for water on C Street near what is now the Midland Hotel. This well was 60 or 70 feet deep and its water was so tainted by petroleum that the well was finally abandoned and filled in. In 1904 a well about 90 feet deep is reported to have been put down in the southern part of the city which produced 3 or 4 barrels of oil a day. The oil was sold in Lawton for a period of two or three years.

Drilling for oil in the field 5 miles east of Lawton was begun in 1904 and has been continued intermittently up to the present time, but the field has not produced either oil or gas in commercial quantities. About 50 wells have been drilled, more than 20 of which are less than 500 feet in depth.

The writers desire to express their indebtedness to the oil companies operating in the Lawton field, which have furnished logs of their respective wells; also to many citizens of Lawton who extended courtesies during the prosecution of the field work.

TOPOGRAPHY.

The Lawton field lies in the open plains region of Oklahoma. After the reduction of the surface to a plain by erosion uplift occurred, and the present streams have cut moderately deep valleys below the upland surface. The field is drained by Cache Creek, which rises in the area north of the Arbuckle Mountains and flows southward to Red River. The general altitude of the country is about 1,100 feet.

[1] The following report has been prepared by the United States Geological Survey under a cooperative agreement with the Oklahoma Geological Survey according to which each furnished a part of the funds necessary for the work.

STRATIGRAPHY.

The Lawton field is only 8 miles from the Wichita Mountains, and a discussion of its stratigraphy involves a brief description of the geology of the mountain area. The Wichita Mountains consist of a core of igneous rock which is surrounded by steeply dipping strata of early Paleozoic age. At the east end of the uplift the only representative of these strata which reaches the surface is a limestone formation of Cambrian and Ordovician age, approximately 5,000 feet thick, known as the Arbuckle limestone. The granite and limestone of the mountains rise abruptly from the surrounding plain like islands in a sea. Against them and evidently covering part of their mass lie the almost horizontal strata of the Permian "Red Beds," which form the surface rocks in the Lawton field, as well as in all the area surrounding the mountains.

The "Red Beds" consist of alternating layers of shale and sandstone and, associated with the sandstone, thin layers of shale conglomerate whose pebbles consist of the same material as the shale forming the principal part of the series. Near the base of the Permian, as exposed along the Wichita Mountains, there are several thin beds of limestone only a few inches in thickness. The shale of the Permian is predominantly red, but bluish-gray shale is present, especially near the base of the series. The sandstone is white and in some places red or pink. The Permian strata bear very few fossils, and none were collected in the Lawton area, although the remains of primitive amphibians and sharks as well as fossil plants have been found farther south.[1]

The most prominent bed or group of beds in the Lawton field structurally and stratigraphically is the sandstone that forms the low rounded hills east and north of the gas wells. Its outcrop may be traced for 12 to 15 miles northwest of the Lawton pool and probably much farther along the north flank of the Wichita Mountains. The individual beds of sandstone are lenticular, being interbedded with shale, but the group as a whole appears to be continuous over a large area in this part of the State. It occupies about the same stratigraphic position as the sandstone that forms the high ridge 6 miles north of Loco, in which grahamite was at one time mined in sec. 6, T. 2 S., R. 4 W., and also the prominent wooded ridge extending across T. 1 S., R. 5 W., in the direction of the Duncan gas field. In the Lawton field the sandstone is barren of timber. This sandstone is about 200 feet thick. Some 400 or 500 feet above it lies the sandstone that forms the escarpment about the Duncan gas field, as well

[1] Wegemann, C. H., Anticlinal structure in parts of Cotton and Jefferson counties, Okla.: U. S. Geol. Survey Bull. 602, pp. 25–27, 1915.

as the line of hills 6 miles northeast of the Lawton field.[1] The rocks between these two sandstones are predominantly shale.

The character of the strata which underlie the surface in the Lawton field is indicated by the logs of the gas wells. Alternating beds of sandstone and shale, the shale for the most part red in color, extend to a depth of about 1,150 feet. At 1,165 feet in Marple well No. 4 of the Lawton Natural Gas Co. is recorded a bed of solid limestone, which was penetrated to a depth of 65 feet. As no limestone beds of such thickness are known in the Permian in this region, this bed presumably belongs to a formation older than the Permian and is doubtless separated from the red shale which lies above it by an unconformity as great as that which is to be observed along the mountains a few miles to the northwest, where the Permian with a well-developed basal conglomerate unconformably overlies all older beds. That this unconformity at the base of the Permian is merely local in extent and is confined to the vicinity of the Arbuckle-Wichita Mountain uplift is indicated by the fact that in Clay County, Tex., where the base of the Permian is also exposed, the Cisco formation, the highest division of the Pennsylvanian, appears to be conformable with it.[2] The unconformity at the base of the Permian in the region of the Lawton field is economically important, as it may have had much influence on the accumulation of the oil. (See pp. 76–78.)

STRUCTURE.

The Wichita and Arbuckle uplifts are of the nature of great arches or anticlines, the free Permian sedimentary rocks which now are exposed along their margins having at one time extended completely over their crests. The mountains appear to have been produced by at least two uplifts—the first at the close of Mississippian time and the second at or near the end of Pennsylvanian time. Each uplift was followed by erosion and degradation of the mountain mass, and the Permian strata were formed of the materials removed from the mountains after the second uplift. Since the deposition of the Permian beds, perhaps in very recent geologic time, the Arbuckle-Wichita axis has been subjected to very slight uplift, which has bent the Permian strata covering the region between the two ranges into what appears to be a low anticlinal arch. Only the north limb of this arch can be recognized, because only north of the axis are the rock strata sufficiently well exposed to make geologic observations possible.

[1] Wegemann, C. H., The Duncan gas field, Stephens County, Okla.: U. S. Geol. Survey Bull. 621, pp. 43–50 (Bull. 621–D).

[2] Munn, M. J., Reconnaissance of the Grandfield district, Okla.: U. S. Geol. Survey Bull. 574 p. 8, 1914.

The Lawton oil and gas pool lies about 8 miles southeast of the southeast end of the Wichita Mountains, on the axis of the low arch just described. As will be apparent from an examination of the map (Pl. XI), the folds on which oil and gas occur are by no means simple ones. The type of irregular folding is the same as that which has been found to exist in the Healdton and Loco oil and gas fields, as well as in areas examined in Tillman, Cotton, and Jefferson counties, Okla.[1]

The principal anticlinal axis in the Lawton field extends southeastward from the Wichita Mountains and is interrupted by a narrow syncline which crosses it almost at right angles, and which probably contains a small subsidiary dome in sec. 31, T. 2 N., R. 10 W. East of this dome lies the continuation of the principal axis of the fold. Southeast of the Lawton field, because of the absence of rock exposures, the exact position of the anticlinal axis connecting the two mountain uplifts can not be determined.

The marked escarpment formed by the group of sandstone beds in the vicinity of the Duncan gas field, 10 miles east of the town of Duncan, westward to a hill 1 mile north of the town, thence northwestward across the northeastern part of T. 1 N., R. 8 W., and the southwestern part of T. 2 N., R. 8 W., and thence in a due northwest direction past the northeast corner of the Fort Sill Indian Reservation to the region northeast of the Wichita Mountains. From these mountains it is about 6 miles distant. Along the escarpment the beds dip at angles of 1° or less toward the northeast, and the slope is in most places covered with post oak.

The lower group of sandstone beds which form the hills just east of the wells in the Lawton field are not in this area timber covered, so that the region between the escarpment of the upper group of sandstone beds and the oil wells is almost treeless. Ten miles southeast of the wells, however, in sec. 24, T. 1 N., R. 9 W., a sandstone bed which appears to be of considerable thickness is exposed and the surface is covered with oak timber similar to that which covers the surface formed by the upper group of sandstone beds. It seems very probable that the sandstone exposed in sec. 24 represents this upper group and lies either on the crest of the arch between the Arbuckle and Wichita uplifts or south of it. From sec. 24 the edge of the timbered area may be traced southeastward, and in sec. 32, T. 1 N., R. 8 W., there appears to be a slight dip to the south or southwest. The axis of the Wichita-Arbuckle fold probably lies a mile or two northeast of this locality, and as its trend is southeasterly it probably passes about a mile southwest of the town of Duncan.

[1] Wegemann, C. H., and Heald, K. C., The Healdton oil field, Carter County, Okla.: U. S. Geol. Survey Bull. 621, pp. 13–30, 1915 (Bull. 621–B). Wegemann, C. H., The Loco gas field, Stephens and Jefferson counties, Okla.: Idem, pp. 31–42 (Bull. 621–C). Munn, M. J., Reconnaissance of the Grandfield district, Okla.: U. S. Geol. Survey Bull. 547, 1914. Wegemann, C. H., Anticlinal structure in parts of Cotton and Jefferson counties, Okla.: U. S. Geol. Survey Bull. 602, 1915.

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R. 11 W. R. 10 W. R. 9 W.

T. 4 N. T. 3 N. T. 2 N. T. 1 N.

LEGEND

- Arbuckle limestone (Reagan sandstone not exposed in area)
- Red and pink granite
- Red and pink granite porphyry

CAMBRIAN AND ORDOVICIAN; PRE-CAMBRIAN

Outcrops at the southeast extremity of the Wichita Mountains. Mapped by J. A. Taff in U.S. Geological Survey Professional Paper 31

- Dip and strike
- Occurrence of oil seeps or asphalt-bearing sandstones
- Outcrop of sandstone beds
- Structure contours drawn on "400-foot sand" Contour interval 20 feet Datum is sea level
- Drilling well
- Oil well
- Gas well
- Dry hole
- Oil and gas well
- Show of oil
- Show of gas
- Show of oil and gas

FORT SILL MILITARY RESERVATION

LAWTON

COMANCHE CO
STEPHENS CO

Base line

98th Meridian, west longitude

R. 12 W. R. 11 W. R. 10 W. R. 9 W. R. 8 W.

A. HOEN & CO. BALTIMORE

MAP OF THE LAWTON OIL AND GAS FIELD AND ADJACENT TERRITORY, OKLAHOMA

BY CARROLL H. WEGEMANN AND RALPH W. HOWELL

1 0 1 2 3 4 5 6 Miles

1915

INTERPRETATION OF STRUCTURE CONTOURS.

The structure contours given on Plate XI are drawn on the surface of the "400-foot gas sand" (see Pl. XII), which appears to be the equivalent of the principal gas sand in the Duncan field. As the contours in the Duncan field are drawn on the same horizon the maps of the two fields may be easily compared.[1] The contours represent the shape of the folded surface of the bed on which they are drawn. Every point along any one contour is at the same elevation above or below sea level, the lines being drawn at intervals of 20 feet. To one unfamiliar with the interpretation of contours the following somewhat fanciful conception may be of assistance.

Were it possible to remove all the overlying strata and to walk about on the surface of the oil sand, the course followed by one who endeavored to walk always at an elevation of 800 feet above the sea, never stepping up or down, would be that indicated by the 800-foot contour on the map. When the pedestrian came to a knoll or jutting point he would be compelled, if he did not wish to ascend, to walk around its side. When he crossed the valley which lay between this knoll and the next he would be compelled, if he did not wish to descend, to walk up the valley to a point where its floor was level with that of the hillside which he had just left. In other words, his course, were it indicated by a line, would represent the form of the hills and valleys or their contour. A series of lines drawn at regular intervals above sea level shows very clearly, to one accustomed to the reading of contours, the form of the surface which they represent.

OIL AND GAS.

POSITION OF OIL SANDS.

Oil and gas are found in the wells of the Lawton field in three different sands, which are known in the field as the "200-foot," "400-foot," and "800-foot" sands. The "200-foot sand" is from 10 to 30 feet thick, and lies at depths of 150 to 250 feet, according to the location of the well with reference to the Lawton anticline. This sand has been found in the greater number of the wells and generally carries at least a show of oil. In some wells a production of several barrels of heavy oil is reported from this sand, and in at least three of the wells gas is reported from it, though only in small quantity. In sec. 25, T. 2 N., R. 11 W., and sec. 30, T. 2 N., R. 10 W., there is a second sand from 60 to 75 feet below the first one which also has yielded a show of oil. This sand, however, is recorded in only three of the well logs.

[1] Wegemann, C. H., The Duncan gas field, Stephens County, Okla.: U. S. Geol. Survey Bull. 621, pp. 43–50, 1915 (Bull. 621-D).

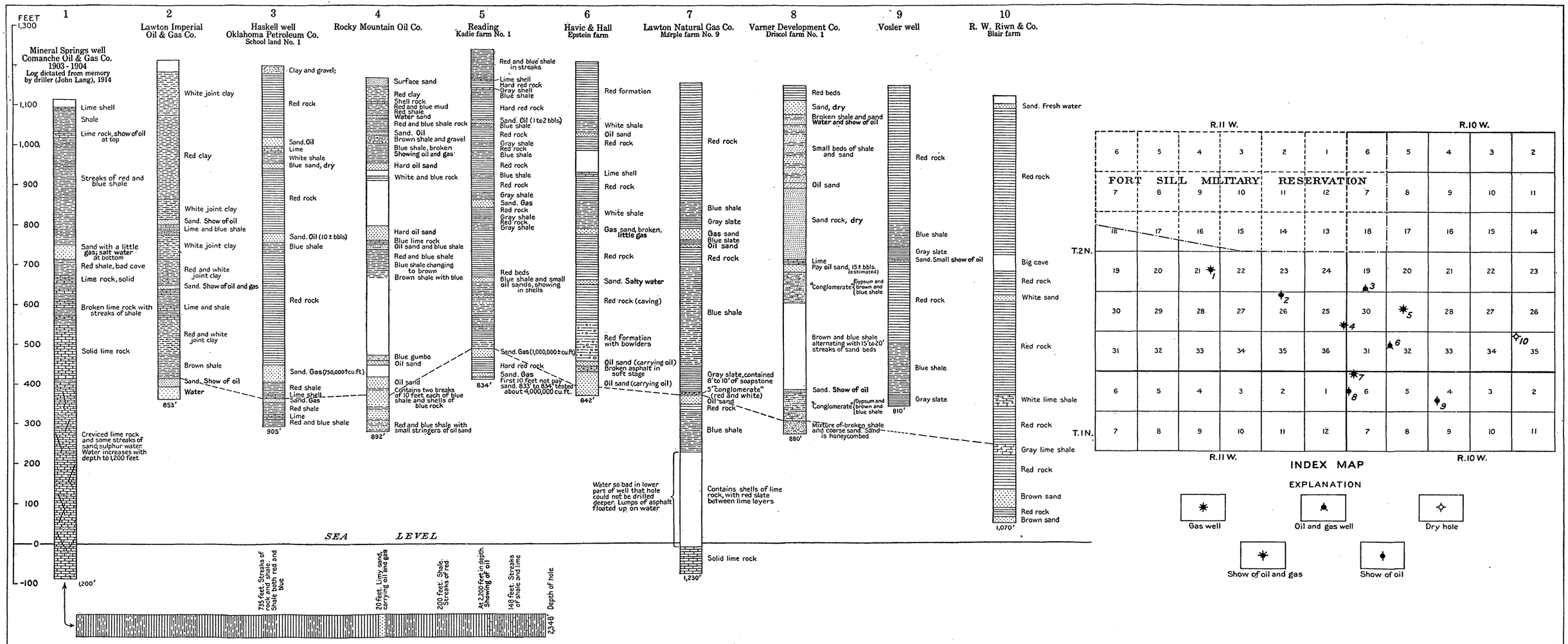
The "400-foot sand," which appears to be recognized in all the wells that are deep enough to reach it, is found at 350 to 450 feet below the surface. Where it occurs as a single stratum it ranges in thickness from 6 to 30 feet. In certain wells two sands are found at about this horizon and are separated by shale from 5 to 60 feet thick. This sand is reported to yield from 10 to 15 barrels of oil in certain wells, and in Marple No. 2 of the Lawton Natural Gas Co. a flow was obtained from it, though lasting only a short time. The oil appears to be somewhat lighter in gravity than the oil found in the shallower sand. In some of the wells gas is reported in the "400-foot sand." Marple No. 1 of the Lawton Natural Gas Co. had an initial flow of 660,000 cubic feet. In other wells the production has been estimated as high as 1,000,000 cubic feet, but no accurate measurements appear to have been made to support these estimates. From a comparison of well logs it is believed that the "400-foot sand" in the Lawton field is the approximate equivalent of the main gas sand in the Duncan field.[1]

The "800-foot sand," which has been penetrated in only 13 wells, appears to be the most promising source of oil and gas in the field. It ranges in depth from 750 to 850 feet and is variously reported as one bed of sandstone about 90 feet thick or as several beds separated by shale. In the Havic & Hall well, on the Epstein farm, in the SW. ¼ NW. ¼ sec. 32, T. 2 N., R. 10 W., this sand was encountered at a depth of 756 feet. In the top 12 feet the sand carried oil; next came a soft shaly sandstone 14 feet thick, which was impregnated with asphalt; and the lowest 60 feet carried oil, but in small quantity. In the Reading well, in the SE. ¼ NW. ¼ sec. 29, T. 2 N., R. 10 W., on the Kadie farm, the sand was struck at a depth of 763 feet, is 22 feet thick, and carried gas with an estimated initial flow of 1,000,000 cubic feet. Below the sand is 38 feet of hard red rock, which is underlain by 10 feet of sand that did not yield gas. Below this sand is a gas sand, which was penetrated only 1 foot and which is said to have had a rock pressure of 400 to 500 pounds to the square inch, and an initial flow of gas of 4,000,000 cubic feet. In the well of the Lawton Imperial Oil & Gas Co., in the NE. ¼ NW. ¼ sec. 26, T. 2 N., R. 11 W., the sand was struck at a depth of 800 feet. The first 20 feet yielded a show of oil, but the next 33 feet carried water.

ORIGIN OF THE OIL AND GAS.

If, as is now generally believed, oil and gas are derived from organic remains, it is evident that rocks that were deposited in waters in which life abounded are to be considered a more probable source of oil than those that give little evidence of the existence of plant and

[1] Wegemann, C. H., The Duncan gas field, Stephens County, Okla.: U. S. Geol. Survey Bull. 621, pp. 43–50, 1915 (Bull. 621–D).



LOGS OF TEN WELLS IN THE LAWTON FIELD, OKLA., DRILLED TO A DEPTH OF 800 FEET OR MORE.

The rock descriptions were given by the driller and are subject to correction. Many of the depths and descriptions were dictated from memory

animal life at the time of their formation. The Permian "Red Beds" carry very few fossil remains compared with the rocks of the preceding series, the Pennsylvanian. For this reason, if for no other, the Pennsylvanian rather than the Permian might be considered as the source of the oil and gas which are found in the Permian. Moreover, the Pennsylvanian is known to include in northern Oklahoma a great oil-bearing formation, and when this fact is taken into consideration, it seems more than probable that from the Pennsylvanian rocks were derived the oil and gas that are now found in the Permian strata in southern Oklahoma.

If the oil and gas of the Lawton field were derived from Pennsylvanian rocks, they probably rose along the steeply rising beds of the Pennsylvanian to the unconformity which exists between the Pennsylvanian and the overlying Permian. This unconformity marks an old erosion surface on which flat-lying sediments with probably a basal conglomerate were deposited, and these sediments doubtless are porous strata along which oil or gas might easily migrate. As the old erosion surface was somewhat irregular, sandstone beds in the lower part of the Permian probably terminate against its irregularities, making it easy for oil flowing along the unconformity to find its way into the sandstone beds of the overlying formation without being compelled to pass through strata of comparatively impervious shale. Were the sandstone beds of the Permian gently folded so that the influence of anticlinal structure would accelerate accumulation, the oil (or gas which later condensed into oil) might traverse these beds for several miles before at last finding lodgment near the crest of the anticline. Under such conditions the strata in which the oil was originally formed would not necessarily immediately underlie the place of accumulation.

The Lawton oil and gas pool lies 5 miles southeast of an outcrop of Arbuckle limestone, of Cambrian and Ordovician age, the beds of which dip 4° SE. and strike N. 35° E. As the thickness of the beds between the top of the Arbuckle limestone and the base of the Pennsylvanian is approximately 5,000 feet, it is evident that if the dip of 4° holds for any considerable distance east of the outcrop of Arbuckle limestone mentioned above, the beds of the Pennsylvanian would lie at a distance of much more than 5 miles east of the Lawton field. Even were the dip of the rocks considerably steeper than 4°, the Pennsylvanian would hardly underlie the region of the oil and gas wells. It is, of course, possible that this area may contain faults, which may throw the Pennsylvanian very much nearer to the mountain uplift than it would be under conditions of regular folding. The occurrence, however, of asphalt in a zone encircling the Wichita Mountains and at about the same distance from them as the Lawton

pool would suggest that the same general conditions prevail on all sides of the mountains and that the presence of faults is improbable.

There is a possibility that the oil and gas in the vicinity of the Wichita Mountains, as well as the asphalt, which is the residuum left by the evaporation and oxidation of petroleum, were derived from rocks older than the Pennsylvanian, perhaps from the Arbuckle limestone. In the deep well known as the Mineral Springs well, in the SE. ¼ NE. ¼ sec. 21, T. 2 N., R. 11 W., thick limestone beds, presumably those of the Arbuckle limestone, were encountered at 440 feet. (See Pl. XII.) "Showings" of oil are reported at 1,935 and 2,200 feet, and there seems little question that the beds in which it was found also belong to the Arbuckle limestone. On the south side of the SE. ¼ sec. 17, T. 2 N., R. 12 W., a bed of sandstone in what is presumably the Arbuckle limestone is impregnated with oil, but the oil in this locality may have come from overlying Permian beds that have since been removed by erosion.

The fact that the Arbuckle limestone is oil bearing of course does not preclude the Pennsylvanian from being also a source of oil and gas—probably the principal source in the region.

QUALITY OF THE OIL AND GAS.

No samples of the oil in the Lawton field were obtained. Oil from the "800-foot sand" is reported to test as high as 44° Baumé, but this test has not been verified. Oil in the shallower sands is of higher specific gravity (lower Baumé). A sample of gas from the "800-foot sand" was obtained and has been analyzed by the Bureau of Mines as indicated below.

Analysis of gas from the Redding No. 1 Kadie well, SW. ¼ NW. ¼ sec. 29, T. 2 N., R. 10 W., Lawton field, Okla.

[Collected Oct. 19, 1914. Laboratory No. 5863.]

CO_2	0.2
CH_4	90.5
C_2H_6	7.1
N_2	2.2
	100.0

Specific gravity (air=1) 0.60.

Heating value at 0 °C. and 760 millimeters pressure, 1,096 British thermal units.

PROSPECTING IN THE LAWTON FIELD.

The early history of the Lawton field from its discovery to the autumn of 1910 is given in the following extract:[1]

The first well was located on the N. ½ NW. ¼ sec. 6, T. 1 N., R. 10 W., just 5 miles east of Lawton. It was completed in August of 1904 at a depth of 400 feet and had an initial rock pressure of 125 pounds and a production of about half a million cubic feet of gas per day.

[1] Hutchison, L. L., Preliminary report on the rock asphalt, asphaltite, petroleum, and natural gas in Oklahoma: Oklahoma Geol. Survey Bull. 2, pp. 241-242, 1911.

During the same year the company completed a well southeast of their No. 1. Gas was not found, as had been anticipated, but a light production of black oil was obtained. Nothing more was done in the pool until 1906, when a dry gas well was drilled in the E. ½ NE. ¼ sec. 1, T. 1 N., R. 11 W., being less than a half mile from the first one. It had an initial rock pressure of 100 pounds and produced a little less than a half million cubic feet of gas per day.

The third well drilled by the Lawton Co. was on the N. ½ NW. ¼ sec. 6, a location southeast of the first gas well. Oil was found at a depth of 320 feet. Packers were so set as to save the oil, and the well was drilled on to the 400-foot sand, where gas was found. The initial rock pressure was about 100 pounds, and the well is estimated to have produced 300,000 cubic feet per day, while the oil produced from the 320-foot sand originally amounted to about 15 barrels daily. A pump has been installed and the well is still producing a little oil.

The same company's well, No. 5, was drilled during 1906 in the N. ½ NE. ¼ sec. 1, a few hundred feet northwest of No. 3. Oil was found at a depth of 400 feet. The capacity has never been tested, though oil is reported to be standing within 30 feet of the top.

The next well drilled was 200 feet to the southwest of No. 5 and was brought in during 1906 as a dry gasser at a depth of 400 feet. In 1907 the well tested nearly 450,000 cubic feet per day.

Well No. 7 was drilled during December, 1906, a few hundred feet southwest of the one last mentioned. Oil of an estimated capacity of 2 or 3 barrels a day was found at a depth of 250 feet. Drilling continued to a depth of 390 feet, where the gas was found and the well completed as a gasser.

The last well reported by this company was completed during January of the present year [1910]. Showings of oil were encountered at 225 and 250 feet, but the sand was dry at 380 feet. Owing to the general topography of the region the sand at 380 feet appears to be the regular 400-foot sand, so it is probable that this will ultimately prove to be a dry hole.

Besides the wells already enumerated, the Lawton Natural Gas Co. drilled one in the E. ½ NW. ¼ sec. 6. It was completed during 1907 and produced oil in the 400-foot sand, but has since been abandoned.

A partial list of the wells which have been drilled in the field and the companies which own them is given below.

	Wells.
Lawton Natural Gas Co.	11
Boone & Warner	4
Epstein Oil Co.	4
Deming Investment Co.	3
Night and Day Oil Co.	3
Havic & Hall	2
Owen, Wilson & Chaffee	2
Companies having only 1 well each in the field	14

Notwithstanding the number of wells that have been drilled in this field, the pool has not yet been thoroughly prospected. The "800-foot sand," which appears to be the bed from which the greatest production is to be expected, has been reached in only 13 of the wells. Of these almost half have been drilled in localities that are geologically unfavorable. The highest part of the anticline in the field lies in the SW. ¼ sec. 28, the SE. ¼ sec. 29, the NE. ¼ sec. 32, and the NW. ¼ sec. 33, T. 2 N., R. 10 W. This anticline has been tested by three wells in sec. 29, T. 2 N., R. 10 W., all of which are among the

best in the field, and there is no reason why the quarter sections named above should not produce equally good wells. A dry hole has been drilled in the NW. ¼ sec. 35, T. 2 N., R. 10 W., so that it is probable that the oil and gas pool does not extend far to the southeast. The area mentioned as most promising should be tested first, and if it is found productive the pool should be traced by carefully spaced wells in a direction a little south of east from the SE. ¼ corner of sec. 29, T. 2 N., R. 10 W.

The crest of the small dome lying in sec. 31 (see Pl. XI, p. 74) has not been tested by wells that reached the lowest sand, although wells that obtain showings of oil in this sand have been drilled east and northwest of it. Before the dome can be regarded as fully tested, one well deep enough to reach the "800-foot sand" should be drilled on the crest of this dome, as indicated on Plate XI. A test might also be made in the NW. ¼ sec. 24, T. 2 N., R. 11 W., northwest of the asphalt seep that occurs near the center of the section, although this territory is probably not so promising as that 2 miles southeast of it.

It is reasonable to believe that by careful testing of the areas outlined on Plate XI a profitable though small field may be developed in the Lawton anticline which will supply sufficient gas for the use of Lawton and give a moderate production of oil. Whether or not oil exists on the low arch of the Permian strata between the Wichita and Arbuckle uplifts it is impossible to say. The crest of this arch can not be very accurately defined but probably extends from the Lawton field east and south to the southeast corner of T. 2 N., R. 10 W., thence to about the middle of the east line of T. 1 N., R. 9 W., and from this point southeastward, passing south of the town of Duncan. Prospecting along this axis, while it may be productive of valuable results, will probably be very hazardous financially and should be undertaken only by companies that can well afford to risk considerable sums in such work.

ASPHALT SEEPS AND OCCURRENCES OF OIL AND GAS IN THE VICINITY OF THE WICHITA MOUNTAINS.

No report on the Lawton field would be complete without mention of the numerous asphalt seeps and showings of oil and gas which occur in the region of the Wichita Mountains within and near the field.

Asphalt is formed by the evaporation and oxidation of petroleum, and its occurrence is in itself an indication of the presence of petroleum, now or in times past, in the vicinity, although not necessarily immediately below the seep. It is not to be regarded as proof of the presence of petroleum in commercial quantity. An asphalt seep may be derived from only a small accumulation of petroleum, or the reservoir which furnished the asphaltic material may have been drained of

the greater part of its contents by the asphalt seep itself. The possibility of the migration of the oil for considerable distances along the sandstone beds of the Permian has been suggested on page 77, and it is evident that the oil from which the asphalt seeps were formed may have traveled for a considerable distance from its original source. The same is true of the "showings" of oil or gas which are observed in many wells sunk for water. Although such indications are found in most large oil fields, yet they may also be observed in many places in which oil and gas do not occur in commercial quantity.

A list of the occurrences of oil, gas, and asphalt in the vicinity of the Wichita Mountains, with a brief description of the localities, is given below.

T. 2 N., R. 11 W.

SW. ¼ NE. ¼ sec. 21 (elevation of asphalt, 1,089 feet), in the east bank of the creek a little north of the junction of the main stream with a small draw entering from the east. Here fine shaly sandstone is impregnated with and smells of petroleum for approximately 150 feet along its outcrop. The layers of shaly sandstone carrying the petroleum are not over 6 inches thick and are interbedded with shale that does not show oil. At one place asphalt oozes from the containing rock. There are small faults in the beds here, but no pronounced break. The oil probably migrates to the surface along joints or small fault planes. About 10 feet above the asphalt is dark-red shale. Underlying this and including the sandy layers bearing the asphalt is greenish-gray shale which weathers to gumbo.

SW. ¼ NE. ¼ sec. 24, asphalt impregnating a bed of sandstone which is also exposed on several rounded knolls a mile or so to the northwest. The outcrop occurs at the head of a small draw draining toward the northwest which has been dammed to form a "tank," or water reservoir. The rock is a medium-grained sandstone, of which 3 or 4 feet is exposed at the surface and a greater thickness is probably concealed. The impregnation with asphalt or oil is so thorough that specimens of the rock are plastic and sticky. This asphaltic rock has been quarried.

NE. ¼ NE. ¼ sec. 24. In the bottom of a small draw opening southward just south of the Fort Sill Military Reservation a small spring issues from sandstone, and the surface of the water is covered with a scum of heavy oil, which is seen also on the bed of the draw for a few feet downstream. Apparently the oil comes from some bed beneath the sandstone exposed at the surface, for this rock shows no impregnation of oil.

T. 3 N., R. 11 W.

SW. ¼ NE. ¼ and SW. ¼ NW. ¼ SE. ¼ sec. 9. In three small southward-opening draws that drain the S. ½ sec. 10 seepages of asphalt or asphaltic oil occur at about the same elevation, as if derived from

one bed. The asphalt flows out of joints in red shale about 3 feet below a conglomerate of shale and sandstone. This conglomerate forms the base of a mass of sandstone which is probably the same as that capping the higher rounded knobs in sec. 14, T. 2 N., R. 11 W., and also that in which the asphalt occurs in sec. 24, T. 2 N., R. 11 W. The most westerly seep arises in an oil-soaked mud cone which holds about a pailful of thick black asphaltic oil. About 150 feet down this draw to the south sulphur water issues from a small spring.

T. 4 N., R. 11 W.

SE. ¼ SW. ¼ sec. 30. A dug well 72 feet in depth is reported to have struck dark heavy oil amounting to 4 or 5 barrels.

SE. ¼ NE. ¼ sec. 32. About 10 feet of asphaltic sandstone, containing conglomerate in certain layers, is exposed in the bed of the creek. Asphalt impregnates several layers of the sandstone. The beds dip about 1° N. or NE. and are about 40 feet below the base of the sandstone which caps the highest rounded knob in sec. 14, T. 2 N., R. 11 W.

NW. ¼ NW. ¼ sec. 34. It is reported that in a well drilled to a depth of 500 or 600 feet enough gas was encountered to burn for three weeks with a flame that could be seen for some distance. The report has not been verified.

NW. ¼ SW. ¼ sec. 26. About 8 feet of sandstone, some of which is impregnated with asphalt, is exposed east of the schoolhouse, on each side of a draw opening to the north. The rock has been quarried and is said to have been used in Lawton for paving. The sandstone probably represents one of the upper beds of the sandstone outcropping in the high knob of sec. 14, T. 2 N., R. 11 W.

T. 2 N., R. 12 W.

NW. ¼ NE. ¼ sec. 34. On the west side of a southward-flowing stream 8 to 12 feet of fine-grained and much cross-bedded sandstone is exposed. Asphalt impregnates the beds irregularly and appears to be more abundant in the thicker layers. Asphalt-bearing sandstone in considerable amount has been quarried at this locality for use in paving the streets of Lawton.

SW. ¼ NW. ¼ sec. 21. On both sides of a small draw which runs north about 10 feet of sandstone is exposed and is underlain by red shale. The sandstone is fine grained, somewhat cross-bedded, and irregularly impregnated with asphalt. It has been prospected by small open pits about 4 feet in depth.

SE. ¼ SE. ¼ sec. 17. Asphalt impregnates sandy layers or lenses in a sandy limestone in the roadbed where the east-west section line crosses the limestone, which is exposed in a ridge to the southwest. The exposure occurs on the north side of the road where the road has been graded.

T. 3 N., R. 12 W.

Oil occurs along the bed of a draw opening east into Cache Creek in the Fort Sill Military Reservation, in what would be the NE. ¼ sec. 29 were the land sectionized. The oil is contained in a cemented breccia or conglomerate of granitic rock that crops out along the creek bed and on its banks and may represent the basal conglomerate of the Permian. The outcrop lies close to the granite area. It is probable that the presence of the oil is due either to upward migration from some source farther to the east (see p. 77) of petroleum along the unconformity at the base of the Permian or to downward migration from "Red Beds" that formerly covered this area but have been removed by erosion. The rock, which is composed of fragments of altered rhyolite, yields on heating in a test tube a light-yellow oil.

T. 5 N., R. 12 W.

NE. ¼ NE. ¼ sec. 7. Oil is reported in a water well at 70 feet.

NE. ¼ NW. ¼ sec. 17. Oil is reported in a drilled well at 250 feet.

T. 2 N., R. 13 W.

SW. ¼ SW. ¼ SE. ¼ sec. 15. On the west bank of a stream flowing southeast a large ledge of massive sandstone is impregnated in some layers with asphalt.

SW. ¼ SW. ¼ NE. ¼ sec. 22. Farther down the same stream what is probably the same massive sandstone bed outcrops in one small exposure on the northwest bank and bears asphalt.

T. 5 N., R. 13 W.

NE. ¼ NE. ¼ sec. 6. "Wildcat" well. No information is available.

T. 1 N., R. 14 W.

NW. ¼ NW. ¼ sec. 1. A dug well is said to have shown oil at a depth of 10 feet. When examined no trace of oil was seen.

SW. ¼ SW. ¼ SW. ¼ sec. 2. In grading the road across a sandstone outcrop a small spring was opened which when first discovered is said to have smelled of oil. No trace of oil was apparent at the time of examination.

T. 2 N., R. 14 W.

SE. ¼ sec. 36. On both sides of the creek flowing southeastward across the section are exposures of massive sandstone. Asphalt is reported from one place on the southwest bank of the creek, but no asphalt could be found on examination.

NE. ¼ NE. ¼ NW. ¼ sec. 24. North of the town of Cache a well drilled in 1904 is reported to have obtained a show of oil at a depth of 500 feet or more.

SE. ¼ SE. ¼ sec. 25. A well is reported to have shown oil. No indications were observed on examination.

T. 5 N., R. 14 W.

SE. ¼ SE. ¼ sec. 18. Oil occurs in a water well.

T. 6 N., R. 14 W.

SW. ¼ SW. ¼ sec. 32 (J. H. Madden farm). Oil is reported in a water well.

T. 6 N., R. 15 W.

SE. ¼ SE. ¼ SW. ¼ sec. 23 (Fox farm). Oil is reported to have been struck in a well at a depth of 75 feet, in 7-foot sand. Oil is said to have been bailed from this well.

NW. ¼ NW. ¼ sec. 23. "Showing" of oil is reported in a well 90 feet deep.

SW. ¼ SW. ¼ sec. 23. Oil is reported in a well at a depth of about 100 feet, in sufficient quantity to be used in the vicinity.

NW. ¼ sec. 13. Gas is said to have been encountered in a water well on the Underwood farm.

NW. ¼ sec. 11. Scum of oil occurs on water in a well on the Van Kirk farm. Southeast of this well is another which has a slight flow of water, and three "showings" of oil are reported from the well in 400 feet.

SW. ¼ sec. 12. A water well on the T. A. Cook farm is said to have showed traces of oil and gas. Oil was struck at a depth of 280 feet.

NW. ¼ sec. 2. Oil is reported in a well on the Givens farm.

SE. ¼ SE. ¼ sec. 19. A showing of oil was seen at the time of examination in a well 42 feet deep on the Reynolds farm. After the well is pumped nearly dry, globules of oil may be observed on the water.

SE. ¼ sec. 29. Water in a well about 80 feet in depth is reported to show a "rainbow" of oil.

SW. ¼ SW. ¼ sec. 31. "Showing" of oil is reported in a water well. Sugar Creek flows across E. ½ secs. 32 and 29, and oil is reported to seep from its banks in warm weather. The report was not verified.

T. 7 N., R. 15 W.

NW. ¼ sec. 13. A 40-foot well in this section is said to have struck a "pocket of oil" in drilling for water. The report was not verified.

NW. ¼ sec. 24. A well 1,000 feet deep on the Franklin farm is said to have struck oil and gas at about 900 feet. The well is now flowing fresh water.

T. 1 S., R. 10 W.

NE. ¼ sec. 27. In a draw which discharges northeastward across the NE. ¼ sec. 27 several thin ledges of sandstone crop out. At one place a specimen was collected from which a light-yellow distillate of petroleum was obtained, on heating in a test tube.

OIL WELLS IN GOTEBO FIELD.

The oil and gas field of Gotebo lies at the northwest end of the Wichita Mountains in a position somewhat similar to that of the Lawton field. The field was not studied in detail, but for the sake of comparison the tracts in which oil wells have been drilled are given below.

T. 7 N., R. 16 W.:
- NE. ¼ NW. ¼ and NW. ¼ NE. ¼ sec. 19. Oil wells.
- E. ½ sec. 27. Eight oil and five gas wells.
- SW. ¼ SW. ¼ sec. 27. Oil well.
- SE. ¼ SE. ¼ sec. 28. Two oil wells.
- NE. ¼ NE. ¼ sec. 33. Two oil wells.
- NW. ¼ NW. ¼ sec. 34. Three oil wells.
- SW. ¼ NW. ¼ and NW. ¼ SW. ¼ sec. 35. Two oil wells.
- NE. ¼ NW. ¼ NW. ¼ SE. ¼ sec. 31. Two oil wells.

T. 6 N., R. 16 W.:
- SE. ¼ SE. ¼ sec. 10. Two oil wells.
- NW. ¼ SW. ¼ and SE. ¼ sec. 7. Six oil and three gas wells.

T. 6 N., R. 17 W.:
- NE. ¼ SW. ¼ sec. 1. Oil well.
- NE. ¼ sec. 12. Three gas wells and one oil well.