OIL *and* GAS POOLS *of* WESTERN MISSOURI

By

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By Frank C. Greene

INTRODUCTION

The presence of oil and gas in the Pennsylvanian formations in the west central part of Missouri has been known for many years. The earliest development of which there is any record was in Kansas City when gas wells were drilled in 1879, or even earlier. Oil was found in Jackson County, north of Belton about 1903, and a year later gas was developed south of Holt in Clay County. In Bates, Cass, Jackson, Clinton, and perhaps other counties, farm wells, drilled primarily for water, found gas which was used on the premises.

Within the last five years, the production of oil and gas has been on a commercial scale. The gas has been piped into cities and towns, and the oil trucked to markets for fuel oil or put through skimming plants to separate the gasoline and fuel oil. The current production of oil and gas in western Missouri has constituted the most important and most recent development of the mineral resources of the state and has established a mineral industry of importance in that part of the state.

ACKNOWLEDGMENTS

Logs and other information were obtained through the whole-hearted cooperation of many individual well owners, drillers, contractors and producers. To all of these the writer wishes to acknowledge his indebtedness. The following devoted considerable time to supplying logs and well locations: Mr. George V. Hassinger and Mr. R. A. Foster, Harrisonville; Mr. Clark Knorpp, Pleasant Hill; Mr. Louis Knoche, Belton; Mr. Lee Shawhan, Lone Jack; Mr. M. J. White, Lees Summit; Dr. Glenn G. Bartle, Mr. J. D. Judd, Mr. Matthew S. Murray, Mr. R. M. Hammond, Mr. Jay Bradford, Mr. Charles Surgi and Mr. M. J. Boreing of Kansas City; Mr. P F [illegible] Walter Brown, and Mr. J. W. McCormack of [illegible]

E. A. Cullum and Mr. R. A. Barton of North Kansas City; and Mr. John Skinner of Avondale. The officials of the Panhandle Eastern Pipe Line Company in the scouting department generously made available ownership maps and scout tickets. To all of these, the writer is especially grateful.

Mr. Martin W. Baden, Trees Oil Company, Winfield, Kansas, and Mr. C. W. Studt, Union Gas Corporation, Independence, Kansas, cooperated with this Bureau in furnishing well logs and elevations.

Well elevations were obtained by Mr. B. R. Thompson by means of an altimeter.

PREVIOUS INVESTIGATIONS OF THE BUREAU

In 1915, this Bureau published a report on the stratigraphy of the Pennsylvanian series[1] and the main features of the stratigraphy were described in detail. A synopsis of the results of earlier workers was included. Two generalized structure contour maps, one on a widespread Pennsylvanian bed and one of the base of the Pennsylvanian were published. These indicated some large structural features on which the recent development has been localized.

In 1917, Jackson County, the scene of the first and most important development of oil and gas, was described.[2] A structure map of Kansas City was issued and logs of many oil and gas wells were published in full.

In the same year, a cooperative agreement with the U. S. Geological Survey, resulted in the publication of the Leavenworth-Smithville folio (No. 206). The structure map in this report led directly to the opening of the Paradise gas pool.

The following year the Belton area[3] was surveyed by plane table and a detailed report issued. A few years later, the demand for information resulted in the publication of a comprehensive report covering the entire state.[4] This included several structure maps, based on plane table surveys and the records of many shallow and deep wells.

Vernon County, near the southern end of the territory was

[1]The Stratigraphy of the Pennsylvanian Series in Missouri, by Henry Hinds and F. C. Greene. Vol. XIII, 2nd Series, 1915.

[2]The Geology of Jackson County, by W. E. McCourt, assisted by M. Albertson and J. W. Bennett. Vol. XIV, 2nd Series, 1917.

[3]The Oil and Gas Possibilities of the Belton Area, by Malcolm E. Wilson, 1918.

[4]The Occurrence of Oil and Gas in Missouri, by Malcolm E. Wilson. Vol. XVI, 2nd Series, 1922.

described in 1926.[5] A detailed geologic map of the county, large scale structure maps of the northwestern part of the county and many well logs were included.

AREA

The producing area extends from southwestern Vernon County (T. 34 N., R. 33 W.) northward through Vernon, Bates, Cass, Jackson, Clay and Clinton counties, with some production in Johnson, Ray and Platte counties. (See Pl. I.) Geologically this area is underlain by Pennsylvanian rocks and the development to date seems to indicate that it is necessary to stay some distance west of the eastern outcrop of the Pennsylvanian in order to be successful. This appears to be due to the tendency of the gas and more volatile parts of the oil to escape to the surface, up dip near the outcrop of the reservoir bed, or through minute openings along joint planes where the overlying cover is not sufficiently thick to form a seal over the reservoir.

While this limits the area south of Missouri River, the same reasoning places all of northwestern Missouri in the potential zone. However, in much of northern Missouri there is a thick covering of glacial drift which completely buries the Pennsylvanian formations. It is possible, or even probable, that structurally favorable areas exist, of which there is not the slightest indication in the surface overlying them. It is significant that the successful drilling has been in areas where there are outcrops which enabled the geologist to determine the surface structure.

In the area of active development the principal pools are as follows:

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[5]The Geology of Vernon County, by F. C. Greene and W. F. Pond. Vol. XIX, 2nd Series, 1926.

TABLE SHOWING OIL AND GAS POOLS IN MISSOURI.

County.	Name of pool.	Nearest town.	T. R.	Production.	Main horizon.	Ave. depth.	Date of opening.
Vernon...	Swarts-Garland.....	Swarts.....	T. 34 N., R. 33 W....	Gas.....	Bartlesville sand.....	200	1928
Vernon...	Richards.....	Richards.....	T. 36 N., R. 33 W....	Oil.....	Bartlesville sand.....	225	1920
Vernon...	Stotesbury....	Stotesbury....	T. 37 N., R. 33 W....	Oil.....	Bartlesville sand.....	250	1901
Bates....	Ackerman....	Hume.....	T. 38 N., R. 33 W....	Gas.....	Bartlesville sand.....	375	1931
Bates....	Lang.....	Amsterdam...	T. 41 N., R. 33 W....	Gas.....	Bartlesville sand.....	350	1931
Cass.....	Harrisonville..	Harrisonville..	T. 44 N., R. 31 W....	Gas.....	Shale gas Lexington coal—Ft. Scott Ls.....	175	1931
Cass.....	West Line....	West Line....	T. 44 N., R. 33 W....	Gas.....	Squirrel sand.....	450	1928
Cass.....	Freeman, Stark and Lash...	Freeman.....	T. 44 N., R. 33 W....	Gas.....	Shale gas Lexington coal—Ft. Scott Ls.....	275	1930
Cass.....	Richardson...	Freeman-Peculiar....	T. 44 N., R. 32 W....	Gas.....	Lexington coal shale and sand below.....	300	1930
Cass.....	Beeghley and Knight.....	Freeman-Peculiar....	T. 45 N., R. 32 W....	Gas.....	Squirrel sand.....	500	1931
Cass.....	Belton.....	Belton.....	T. 46 N., R. 32 W....	Gas and oil.....	Squirrel sand.....	500	1903
Cass.....	Knoche.....	Belton.....	T. 46 N., R. 33 W....	Gas and oil.....	Lexington coal shale and Squirrel sand.....	500	1928
Cass-Jackson....	Knorpp.....	Pleasant Hill..	T. 46-47 N., R. 30 W.	Gas and some oil..	Squirrel sand.....	425	1929
Jackson...	Lone Jack and Shawhan...	Lone Jack....	T. 47 N., R. 29-30 W.	Gas.....	Squirrel sand.....	425	1929
Jackson..	Lees Summit..	Lees Summit..	T. 47-48 N., R. 31 W.	Gas and some oil..	Warrensburg sand.....	300	1929
Jackson...	Grandview....	Grandview....	T. 47 N., R. 32-33 W.	Gas.....	Squirrel sand.....	600	1928*
Jackson...	Martin City...	Martin City...	T. 47 N., R. 33 W....	Oil and gas.....	Squirrel sand.....	550	1906
Jackson...	Blue Springs..	Blue Springs..	T. 48 N., R. 31 W....	Gas.....	Squirrel sand.....	350	1929

Jackson...	Bannister Ridge.....	Raytown.....	T. 48 N., R. 32 W....	Gas.....	Squirrel sand.....	400	1929*
Jackson...	Unity Farm...	Unity Farm...	T. 48 N., R. 32 W....	Oil and gas.....	Squirrel sand.....	400	1924?
Jackson...	Independence .	Independence .	T. 49-50 N., R. 32 W.	Gas.....	Squirrel sand and horizons above.....	400	1922
Jackson...	East Kansas City.....	Kansas City..	T. 49 N., R. 32-33 W.	Gas.....	Squirrel and Bartlesville sands	500	1900*
Jackson...	Kansas City...	Kansas City..	T. 49 N., R. 33 W....	Gas.....	Lexington coal shale gas and Bartlesville.....	...	1879*
Clay.....	Avondale.....	Avondale.....	T. 50 N., R. 32 W....	Gas.....	Squirrel sand.....	475	1930*
Clay.....	Liberty.....	Liberty.....	T. 52 N., R. 32 W....	Gas.....	Lexington coal shale.....	500	1931
Clay.....	Paradise.....	Smithville and Paradise....	T. 53 N., R. 32 W....	Gas.....	Squirrel sand.....	600	1930
Clay.....	Holt.....	Holt.....	T. 54 N., R. 31 W....	Gas.....	Probably Knobtown.....	140	1904
Platte....	Parkville.....	Parkville.....	T. 51 N., R. 34 W....	Gas.....	Upper Labette sand.....	600	1912
Clinton...	Lathrop.....	Lathrop.....	T. 55 N., R. 30 W....	Gas.....	Knobtown.....	300	1921*
Clinton...	Plattsburg....	Plattsburg....	T. 55 N., R. 32 W....	Gas.....	Upper Labette sand and Lexington coal shale.....	550	1930

*Date mentioned or earlier.

In addition to the developed pools, there are many other areas with one or more producing wells, or showings of sufficient importance to warrant indicating them on the state map (Plate I).

SMALL POOLS AND IMPORTANT SHOWINGS.

Sec.	T.-N.	R.-W.	Horizon.	Depth.
31	43	33	Gas—Lexington coal shale	372½
			Gas—Shale in Ft. Scott	430
15	44	29	Oil—Squirrel sand	97
36	44	33	Gas—Upper Labette sand	267½
			Gas—Lexington coal shale	288
13	45	29	Oil—Bartlesville	290
16	45	32	Gas—Lexington coal shale	349½
20	45	33	Gas—Bartlesville	530
17	46	30	Gas reported	.....
7	52	29	Gas—Squirrel sand	353
11	53	32	Gas—Squirrel sand	457
12	54	37	Gas—Squirrel sand	656
8-17	55	30	Gas—Probably Knobtown sand	300
10-16	55	31	Gas—Probably Knobtown sand	360
16	56	29	Gas—Knobtown sand	232

EXTENT OF POOLS AND SIZE OF WELLS

The extent of any particular gas pool in total productive acres can be stated only as to the present development, unless it is completely surrounded by dry holes, or the structure is sufficiently clear as to give some idea of its delineation. There are pools which cover only one-quarter section and others which extend over several square miles, with, however, some interspersed dry holes. Again, it would be difficult to draw a sharp division line between certain pools. The largest groups of pools are comprised in the Blue Springs-Lees Summit-Bannister Ridge District and the Kansas City-Independence District. Each of these groups includes, however, dry intervening areas, covering many square miles. A number of the pools are open on one or more sides and may be further developed by additional drilling.

The oil pools are less numerous than the gas pools. A possible explanation of this is the fact that while gas accumulates in both shales and sands, oil has so far been found in Missouri only in sand[1]. The largest active pool is the Martin City, ex-

[1]Oil has been produced in many fields in adjoining states from porous limestones and dolomites, and asphalt occurs at West Line, Mo., in a porous oolitic phase of the Bethany Falls limestone.

tending in a narrow interrupted belt from the center of section 9, T. 46 N., R. 33 W., to section 6, T. 47 N., R. 33 W., and northwest into Kansas.

The Richards and Stotesbury pools were developed many years ago but are shut down at present and have been inactive for several years. Small fields have been developed near Pleasant Hill, Lees Summit and at Unity Farm.

The Richards and Stotesbury oil came from the Bartlesville sand, and that in the Knorpp pool near Pleasant Hill from the Warrensburg sand, but the Squirrel sand is the chief producer in the active area near Martin City.

The size of the gas wells ranges from an initial open flow of a few thousand cubic feet per day, in the case of wells saved for private house use, to about 2½ million cubic feet. That is, a well far too small to ever pay out as a commercial producer may be saved and be a source of fuel for private house use. From a consideration of all available data, it is believed that 3,000,000 cubic feet initial open flow is the maximum to be expected from any one well in the area now known to be productive. If deeper gas is found farther north, possibly larger wells may be expected because of the greater pressure and more efficient sealing of the reservoir.

The rock pressure is in all cases about normal, ranging from 20 pounds in shallow wells to 190 pounds in the deeper wells. The life of the wells depends entirely on the spacing, the rate at which they are produced and the care taken in their operation. Experience in the Blue Springs District indicates that one well to each 40 acres is the best practice. Individual house wells have produced gas for 20 to 25 years.

The initial flow of oil wells has been reported as much as 50 to 70 barrels per day[1], but 5 to 10 barrels is much more general. After being shot and placed on the pump, they settle to about two barrels per day and maintain this output over a long period. This is probably to be explained by the fact that the oil is of low gravity, mostly 20 to 25 degrees Baumé, and consequently seeps rather slowly from the sand into the wells. Some salt water is produced with the oil, but this trouble can be eliminated to a certain extent if, in the original completion of the well, the hole is stopped above the water level in the sand. The danger line can be fairly well established by watching closely the first well drilled and running accurate elevations on the succeeding wells.

[1]Mo. Bur. Geol. and Mines. Vol. 16, p. 147.

STRATIGRAPHY

The productive horizons of western Missouri, as now known, are contained in approximately 800 feet of Pennsylvanian sediments, ranging from the lower part of the Cherokee shale to the top of the Winterset limestone. Up to the present, no authentic showings of any importance have been found in wells in or below the top of the "Mississippi lime", but with one or two exceptions, all the tests which have been made below the Cherokee, that is, into the deeper formations, have been made in areas of unfavorable structural conditions.

That it is not unreasonable to expect oil or gas, or both, in the top of the Mississippian, is indicated by the presence of dark heavy tar-like oil in that horizon in the Joplin District, and in the exposed and eroded domes west of Schell City, Vernon County, and south of Dresden, Pettis County.

The great number of wells drilled has furnished a vast amount of detailed information on the Pennsylvanian formations. This necessitates some minor changes in the grouping of units, together with the introduction of a few new names, a new correlation of some of the previously named units and the application of some unit names from the adjoining states.

The Pennsylvanian series has been subjected to much study in the last few years and this will probably result in the adoption of a new classification in the near future. A proposed classification of the Pennsylvanian in Kansas, with considerable hearing on Missouri, was recently published by Moore[1]. In this some group terms were redefined and some new groups established, new names were introduced for some units and others were changed because of new correlations.

In view of the fact that the name of a geologic unit is merely a handle, as far as the well driller or operator is concerned, the classification now accepted by this bureau, and in widely established usage among drillers, will be continued.

The accompanying generalized cross-section (Plate II) sums up the general character and thickness of the producing horizons and the enclosing beds, and they are also shown in the following table:

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[1]Moore, R. C., Kansas Geol. Soc. Guide Book, 6th Ann. Field Conference, pp. 79-97, 1932.

PENNSYLVANIAN FORMATIONS IN WEST-CENTRAL MISSOURI.

	Thickness, Feet.	Average total Feet.
Douglas formation:		
Iatan limestone	10	10
Weston shale	60-80	80
(Both members locally replaced by sandstone.)		
Lansing formation:		
Stanton limestone:		
Limestone	3	83
Shale	1-16	88
Limestone	17	105
Shale, black and slaty in middle	5	110
Limestone	4	114
Vilas shale	4-20	126
Plattsburg limestone	19	145
Lane shale:		
Shale, locally red or sandy	25-40	175
Limestone (Farley) one to three beds	10	185
Shale, locally sandy	30	215
Kansas City formation:		
Iola limestone	10-80	260
Chanute shale:		
Shale blue	5-35	285
Limestone (Raytown)	5	290
Shale, black and slaty at top, with a thin limestone below slaty part, red and green in lower part, lower part sandy locally	10-20	305
Limestone (Cement City)	5-10	313
Shale, blue, locally black or red	5-15	325
Drum limestone	3-20	330
Cherryvale shale:		
Shale, blue, with one or two thin limestones near base	20-30	355
Winterset limestone*	25-35	385
Galesburg shale:		
Shale, gray, with black, slaty shale* near middle	5	390
Bethany Falls limestone	20	410
Ladore shale:		
Shale, gray, with black slaty shale* near base	5	415
Limestone	1-2	416
Shale (contains sandstone where thick)	1-25	430
Hertha limestone	5-15	440
Pleasanton formation:		
Shale and sandy shale, locally sandstone (Knobtown sand*) near top	90-110	540
Sandstone (Wayside sand* of drillers) disappears to south	0-15	550
Shale, gray, merges with higher and lower shales to south	?-40	560
Shale, black, slaty* (in Cass county)	0-5	562
Unconformity zone:		
Gray shale, red and green, cavy shale, sandy shale and sandstone (Warrensburg*—		

PENNSYLVANIAN FORMATIONS IN WEST-CENTRAL MISSOURI—Cont.

	Thickness, Feet.	Average total. Feet.
marginal phase 0-20 feet, channel phase, 70 feet or more)	20-50	592
Lenapah limestone:		
Present in southeastern Kansas, disappears near western boundary of Cass county	0-10	595
Nowata shale:		
Merges with higher and lower shales where Lenapah and Altamont limestones disappear	?-20	605
Altamont limestone:		
Disappears in Cass county	0-20	610
Bandera shale:		
Includes local sandstone* (Peru), two thin limestones (Worland), and Mulberry coal.	40-60	640
Henrietta formation:		
Pawnee limestone:		
Thins to north	5-25	650
Labette shale:		
Shale, with local sandstone* and limestone lenses, thickens to north	5-20	665
Limestone, Lexington coal cap-rock ("Center Fort Scott" and "Brown lime" of drillers)	5	670
Shale, with black, slaty shale* at top, Lexington or Butler coal below, followed by local sandstone*, thins to north	5-40	680
Fort Scott limestone:		
Limestone (upper Fort Scott), 20-25 feet of limestone in Vernon county, splits northward into an upper ("Chaetetes") and a lower ("Rhomboidal") member, with shale between them	20-25	705
Shale, black, slaty*, with thin coal seam (upper Fort Scott or Summit)	5-10	712
Limestone (lower Fort Scott) present as a series of lenses	0-15	720
Cherokee formation:		
Shale, ranges from gray to black, slaty shale*, with local limestone lenses and coal (lower Fort Scott or Mulky) to sandy shale or sandstone (part of next lower unit)	0-10	725
Sandstone* and shale (Squirrel sand zone) may be all shale or nearly all sandstone, in places extending up to lower Fort Scott limestone	60-100	800
Black shale*, locally containing coal (Bevier or Williams) and under clay	5	805
Limestone, one to three beds (Ardmore or Rich Hill, or Verdigris of Oklahoma)	3-10	810
Shale and sandstone, including many black shales and coal beds. In Vernon and Bates counties, upper half shale with black shales, coal beds and thin sandstones, lower half mostly sandstone (Clear Creek or Bartlesville*). From Cass county north, there is little regularity		

PENNSYLVANIAN FORMATIONS IN WEST-CENTRAL MISSOURI—Cont.

	Thickness, Feet.	Average total. Feet.
except that there is commonly a sandstone 20 to 100 feet thick near the base (Burgess sand). Black shale* about 75 feet below the Ardmore limestone yields gas, and an irregular sandstone 5-50 feet lower also yields gas (Bartlesville sand* of Cass, Jackson, and Clay counties). Thickness ranges from 225 to 275 feet south of Missouri River, increasing from there northward to about 600 feet.....	.....	1035-1410

*Oil and gas horizons.

CHEROKEE FORMATION.

The Cherokee shale is the lowest formation of the Pennsylvanian series of Missouri. It ranges in thickness from 375 feet in Vernon County to 525 feet in northwestern Platte County and 350 feet in western Ray County, and to the north in Nodaway County it reaches a thickness of some 700 feet, but in any locality it appears to be rather more uniform than has been generally supposed. Where the overlying lower Fort Scott limestone is absent, as it is in many places, the top cannot be clearly defined.

In Vernon and Bates counties sandstones in the lower third of the Cherokee, including the Clear Creek (Bartlesville) and the asphalt-bearing sandstone of Deerfield and Ellis, Vernon county above (possibly the equivalent of the Red Fork sand of Oklahoma) contain oil and gas where they are under sufficient cover and up-folded. Northward, the Clear Creek sandstone is possibly the sand termed the Burgess in Jackson, Clay and neighboring counties and usually yields only shows of oil and gas and abundant salt water. However, it is reasonable to suppose that it should contain gas and possibly oil on a well defined uplift.

At about 250 to 350 feet above the base of the Cherokee and 25 to 100 feet below the Rich Hill or Ardmore limestone, is another zone of sands, termed by some drillers, the Bartlesville sand in Cass, Jackson, and Clay counties where it produces gas under the proper structural conditions.

The Rich Hill or Ardmore limestone, consisting of one to three beds aggregating about 10 feet in thickness, is a persistent

marker. It underlies the Bevier coal horizon and the black slaty shale below it yields shale gas.

The upper 100 feet of the Cherokee, the Lagonda shale and sandstone, contains the Squirrel sand, which drillers claim is named because of the manner in which it "jumps around," (that is, varies in the distance below the limestone markers above) may locally be thin or entirely absent or may occupy most of the interval from the Fort Scott to the Rich Hill limestone. It is by far the most important gas and oil sand in the region.

HENRIETTA FORMATION

The term Henrietta has been in use in Missouri since it was first suggested by Marbut in 1896[1]. It was later defined to include three members, in ascending order the Fort Scott limestone, Labatte shale and Pawnee limestone. While this usage will be continued for the present, stratigraphic relations as developed by the present study and paleontologic evidence[2] indicate that the term should be redefined. This is more fully discussed in the description of the Pleasanton Formation.

Fort Scott limestone member. This unit is well defined in Vernon and Bates counties but in Ts. 43 and 44 N., undergoes some rapid changes. The lower member is persistent but discontinuous and where present may be represented by one or two limestones. It is underlain by black slaty shale (Mulky coal horizon of northern Missouri) which produces shale gas. The upper limestone appears to split, the upper split becoming the "bottom rock" of the Lexington coal and the lower split the "Rhomboidal limestone" of northern Missouri. Over the greater part of northern Missouri, the interval between them on the outcrop is about 20 feet and this is maintained to the west of the outcrop as shown by well logs and is marked by red shale in many places. The "Bottom rock" of the Lexington coal is rather discontinuous. Below the "Rhomboidal limestone" is a persistent bed of black slaty shale (Summit coal horizon) which produces shale gas.

Labette shale member. The Labette shale, in Vernon and Bates counties, is marked by the presence of a sandstone and limestone with an intervening black slaty shale, all three beds in the upper half of the member, which is about 50 feet thick.

[1]Marbut, C. F., Physical Features of Missouri, Mo. Geol. Surv. Vol. 10, pp. 14-100, 1896.

[2]See discussion of paleontology by Dr. Bartle, Appendix III.

The Labette thins to the north, but the three beds mentioned are among the most persistent in the section. The limestone is the "Brown lime" of drillers, the black shale is the main shale gas horizon, and the sand below, the lower Labette sand of this report is one of the four sands called the "Peru" by drillers, and an important gas producer. As now correlated, the black shale marks the horizon of the Lexington coal bed. The persistent "Brown lime" or "center Fort Scott" of the drillers or Lexington cap-rock is very uniformly 5 to 7 feet thick. It is used in contouring many of the pools described in this report.

In Ts. 47 and 48 N., R. 33 W., the lower Labette sand appears to occupy a channel which was cut through the underlying limestones and shales into the Squirrel sand zone, and some wells in these townships show a more or less continuous section of sand and sandy shale from the top of the lower Labette sand to the bottom of the Squirrel.

The upper part of the Labette shale between the "Brown lime" and the Pawnee thickens slightly to the north and contains a local sandstone, the upper Labette sand, also termed the "Peru" by drillers, which yields gas and in places shows some oil. In an area centering around the junction of Clay, Ray, Lafayette and Jackson counties this shale contains much lime, and with the Pawnee above and the "Brown lime" below, exhibits a more or less continuous succession of lime about 20 feet thick.

The use of the term "Peru sand" in Missouri drilling has been rather loose and indefinite. As the Peru sand in all probability belongs in the Pleasanton as now used, it is suggested that the term "Peru" as applied to sandstones in the Labette member be dropped, and upper and lower Labette sand be used in mentioning them.

Pawnee limestone member. The Pawnee is the upper of the three members of the Henrietta formation. It is also very uniform in thickness but thins very gradually to the north from 20 feet to 5 feet. As already mentioned it is the upper part of the 20 feet of limestone over the Lexington coal in the Lexington mining district.

PLEASANTON FORMATION

In Vernon and southern Bates counties, the base of the Pleasanton is well defined at the top of the Pawnee limestone, with the Mulberry coal a few feet above the base and the Alta-

mont limestone 50 to 60 feet above the base. The intervening shale is termed the Bandera by Kansas geologists. The Mulberry coal persists to northern Bates county and occasionally has been logged much farther north. In central western Bates County, at Worland a zone of limestones and calcareous shales appear and persists to the north, usually as two limestones, here termed the upper and lower Worland limestone, and an intervening shale. The upper of these frequently has been mistaken for, and termed the Pawnee both in outcrop and in logs. The lower Worland limestone maintains a fairly uniform distance above the Pawnee, but the interval thickens slightly to the north and contains lenses of sandy shale or sandstone, which show gas in places. Unfortunately the sand at this horizon has also been called the "Peru".

The Altamont limestone can be found in logs as far north as T. 43 N., Cass county, beyond which it has not been recognized. In the interval below it (Bandera shale) are lenses of sandstone up to 20 feet in thickness, with showings of gas. This sand is also called the Peru by drillers and it may possibly be that sand named from wells near Peru, Kansas.

North of the disappearance of the Altamont limestone, the top of the Bandera shale can not be defined with certainty. In eastern Kansas just west of Bates and Cass counties, the Nowata shale, a foot to 25 feet thick and the Lenapah limestone 2 to 10 feet thick can be recognized in some logs, but like the Altamont, the Lenapah disappears to the north and the Nowata shale can not be separated from the shales above the Lenapah and below the Altamont.

According to R. C. Moore[1] the Lenapah limestone almost rests on the Altamont, and it is possible, in the area where the Altamont is shown with a querry on its cross section (Plate II), the Lenapah is also represented.

Above the Altamont horizon from northern Bates to Clinton, and in the intervening counties is a zone of gray sandy shale, red and green shale, and sandstone, many wells showing two red beds with sandstone between them. In T. 44-45 N., R. 33 W., a thin bed of black slaty shale marks the top of the zone. It is believed that a period of erosion was associated with these red shales and that during the period deep channels were carved into the underlying limestone and shales of the Henrietta and refilled with sand soon afterward. The channel sandstone ex-

[1]Kansas Geol. Soc. Guide Book, 6th Ann. Field Conference, p. 27, 1932.

posed near Warrensburg and several buried channels in Jackson and the surrounding counties are believed to have been formed at this time in the manner described. Since the outcropping channel deposit is so well exposed at Warrensburg, the name is extended to include the buried channel deposits of this age. In well drilling the associated red and green shales cave as soon as water touches them and cause much trouble.

The sandstone between the two layers of red shale (marginal phase of Warrensburg channel sandstone) is usually barren of oil, gas or water, but the channel sandstone is an important gas producer and contains some oil. It, too, has been termed the "Peru sand" by drillers, and possibly in places it rests on the Peru sand. The so-called "Shoestring sand" in the Big Lake oil field northeast of Paola, Kansas, is believed to be a channel of the same age.

If this period of erosion and unconformity proves to be wide-spread, it may well be the correct dividing line between the Des Moines and Missouri groups (see also appendix III by Glenn G. Bartle).

At a short distance above the uppermost of these red shales, in most of Cass, Jackson, Platte, Clay and Clinton counties, and about 100 feet below the base of the Hertha (top of the Pleasanton and base of the Kansas City) is the widespread and uniform Wayside sand, usually 10 feet thick but decreasing to 5 feet northward. It is sometimes logged as limey sandstone or with a limestone cap rock and is an important gas sand in places. Frequent shows of oil are reported. The name "Wayside" is in general use in western Missouri, but the writer is not prepared to say that it is the same as the sand named from Wayside, Kansas.

Just below the top of the Pleasanton is a zone of somewhat irregular sands, grouped as the Knobtown sand zone. It is named from its outcrop north of Knobtown, Jackson County on U. S. Highway 50, in section 22, T. 48 N., R. 32 W. It produces gas at several places south of Missouri River and becomes an important horizon in northern Clay and southern Clinton counties.

KANSAS CITY FORMATION

The Kansas City formation is at the surface in much of the developed territory from northern Bates County to Clay County, and present beneath the higher formation west of its outcrop. Two widespread black slaty shales are present in the lower part

of the formation. They are important water carriers and in a few places have shown gas. The highest known productive horizon is the top of the Winterset limestone. A well in the Plattsburg pool, section 35, T. 55 N., R. 32 W., is reported to have had a good showing of gas in the top of the Winterset.

The members of the formation have been described in detail in the reports of this Bureau and the names given then have been adopted by drillers and operators. Recent field work by the Kansas Geological Survey[1] indicates that some of the members were not correctly traced from the type locality in Kansas, to the Kansas-Missouri line. Among the changes suggested by Moore are that Sniabar be substituted for Hertha, Westerville[2] for Drum, and Argentine for Iola.

LANSING AND DOUGLAS FORMATIONS.

These formations are present in the northern part of the productive area in Platte, Clay, and Clinton counties. No production or showing has been recorded from any of the members.

DETAILED DESCRIPTION OF POOLS

The pools described and mapped in the following pages are selected not because they are considered the most important, but because they are typical and represent all parts of the productive area as developed at present. As a matter of fact some of the pools described are extremely small but they emphasize the fact that small structures do produce and that other similar structures in their general vicinity may also be found to be productive. One of the principal districts, the Blue Springs, is described in a separate report (Appendix III).

The accompanying structure contour maps were made by computing the altitude of some easily recognized member and drawing lines through points of equal elevation at 10-foot intervals. In several pools the maps indicate that the productive area may be extended.

SWARTS-GARLAND POOL.

Location and area. This pool is on the Kansas-Missouri State line in sections 25 and 36, T. 26 S., R. 25 E., Bourbon

[1]Moore, R. C., Kansas Geol. Soc. Guide Book, 6th Ann. Field Conference, pp. 79-97, 1932.
[2]Based on field work in October, 1932, by R. C. Moore, G. E. Condra and F. C. Greene.

County, Kansas, and Section 6,[1] T. 34 N., R. 33 W., Vernon County, Missouri. It is about 2 miles long and 1½ miles wide. It was opened in 1928.

Outcropping formations. The surface rocks are the Rich Hill or Ardmore limestone and the shales and coal beds just above and below it.

Producing horizons. Gas is found in the Clear Creek or Bartlesville sand, which is about 70 feet thick. It occurs in two beds separated by shale. Both beds carry gas. The base of the lower sand is about 200 feet deep. Two wells found a lower sand just above the Mississippian. In one it was 15 feet thick, and showed oil and gas, in the other it was 6 feet thick. The top of the Mississippian limestone is found at a depth of approximately 250 feet.

The following is the log of a well which was carried to the Mississippian:

LOG OF F. C. BURNS ET AL. CALDWELL NO. 1.
Sec. 6, T. 34 N., R. 33 W.
Elevation, 830 feet.

	Thickness, Feet.	Depth, Feet.	
Soil	4	4	
Shale	1	5	
Coal	1	6	
Gray shale	12	18	
Lime	3	21	
Coal	2	23	
Gray shale	6	28	
Sand	14	42	Water.
Black slate	6	48	
Lime	1	49	
Black slate	3	52	
Gray shale	12	64	
Blue shale	6	70	
Gray shale	10	80	
Brown shale	27	104	
Sand	14	118	Gas and water.
Lime	2	120	
Gray shale	8	128	
Sand	15	143	Gas (top of Bartlesville).
Gray shale	27	170	
Sand	25	195	Water (bottom of Bartlesville).
Blue shale	30	225	
Sand	15	240	Oil and gas.
Black slate	3	243	
Coal	3	246	
Mississippi lime	9	255	T. D.

[1]Section 6 is approximately 3 miles long and 1½ miles wide.

Structure. Information on this pool is not complete, but it can be stated that there is a north and south dip of about 30 feet and an east dip of 20 feet from the top of the dome which is near the center of section 25.

Production. Recorded initial open flow capacity is 65,000 to 260,000 cubic feet, with a pressure of 34 pounds.

RICHARDS AND STOTESBURY POOLS.

Location and area. The Richards pool includes areas in secs. 8, 9, 15, 16, 21, 28, 29, 30, 31, 32 and 33 T. 36 N., R. 33 W., and the Stotesbury pool, wells in secs. 14, 22, 23, 26, 27, 28, 33, 34, 35 and 36, T. 37 N., R. 33 W. Other wells are also reported in adjoining or nearby sections. About 200 wells have been drilled. The first drilling was done about 1901, but most of it took place in 1920 and 1921.

Outcropping formations. The Rich Hill or Ardmore limestone and the shale and coal beds above and below are at the surface in most of the area. Between the two pools there is a ridge capped by the Fort Scott limestone.

Producing horizons. The producing sands are in the Clear Creek or Bartlesville, which is 80 to 100 feet thick but broken by several shale beds. The depth to the base ranges from 200 to 300 feet, depending on the topography. Several wells have been drilled into the Mississippian rocks or deeper without shows of any consequence.

LOG OF MINNEAPOLIS O. & R. CO.
Jim Holloran No. 4.
Sec. 35, T. 37 N., R. 33 W.

	Thickness, Feet.	Depth, Feet.	
Black soil	2	2	
Yellow clay	5	7	
Black lime	10	17	Water at 14 feet.
Black shale	20	37	
Gray shale	33	70	
White shale	15	85	
Black shale	25	110	
Gray shale	20	130	
Blue shale	5	135	
Sand	20	155	Gas and oil (top of Bartlesville).

[1]See, Greene, F. C. and Pond, W. F., The geology of Vernon County, Mo. Bur. Geol. & Mines, Vol. XIX, 2nd ser. 1926, for detailed account of this district.

LOG OF MINNEAPOLIS O. & R. CO.—Continued.

	Thickness, Feet.	Depth, Feet.	
White shale	5	100	
Sand	15	175	Water.
Gray shale	5	180	
Sand	40	220	Oil T. D.

Structure. Information on drilling in this district is rather meagre and no attempt has been made to prepare a structure contour map.

Production. At the present time all activity in the district has stopped. Greene and Pond[2]—state that "None of the oil wells of the district have been given a systematic test, so that it is impossible to say what the production will be. One well was pumped separately for ten days during which it averaged about five barrels per day and the operator believes the well will settle down to a production of about two barrels per day."

ACKERMANN POOL.

Location and area. The Ackermann Pool, as developed at present covers less than 160 acres in the NE. ¼ sec. 9, T. 38 N., R. 33 W. Five gas wells have been drilled. The pool was opened in 1931.

Outcropping formations. The surface formation is the lower part of the Pleasanton. The Altamont limestone, about 60 feet above the base outcrops at the Ackermann house in the southeast corner of the quarter section and the Mulberry coal has been stripped a short distance west of the pool.

Producing horizons. The main gas occurs in the Bartlesville sand. Shows of gas have been found in the sand in the Labette shale, the Squirrel sand, the black shale under the Rich Hill limestone and the black shale about 30 feet above the Bartlesville sand.

Showings of oil are reported in the Squirrel sand and the Bartlesville sand in structurally low wells.

Two wells are reported to have been carried into or below the top of the Mississippi lime, and although no logs are available, evidently no production was found.

[2]Op. cit., p. 107.

LOG OF BOURBON PIPE LINE COMPANY

Mrs. J. G. Ackermann, Serial No. 4.

NE. ¼ Section 9, T. 38 N., R. 33 W.
Elevation, 935 feet.

	Thickness, Feet.	Depth, Feet.	
Soil	2	2	
Yellow clay	20	22	
Shale, blue	24	46	
Lime	22	68	(Pawnee.)
Shale, sandy	7	75	
Shale, dark	10	85	
Sand	10	95	
Shale, blue	10	105	
Shale, light	14	119	
Lime	22	141	(Upper Ft. Scott.)
Shale, blue	7	148	Water.
Lime	4	152	(Lower Ft. Scott.)
Shale, black	5	157	
Sand	15	172	Little gas.
Shale	66	238	
Lime	14	252	(Rich Hill.)
Shale, black	5	257	
Shale, light	20	277	
Shale, dark	13	290	
Lime shells	2	292	
Shale, light	10	302	
Lime	2	304	
Shale, blue	20	324	
Shale, dark	6	330	
Shale, black	10	340	Gas.
Shale, blue	10	380	
Shale, light	20	370	
Sand	10	380	Oil showing (top of Bartlesville).
Sand	20	400	
Sandy shale	10	410	
Shale, white	6	416	
Sand	8	424	Gas. T. D.

Structure. Fig. 1 shows the structure of the Ackermann pool on the base of the lower Fort Scott limestone from well elevations obtained by an altimeter. There is a northeast dip of 14 feet. No information is available as to the southeast dip or the amount of closure.

Production. The initial open flow capacity ranged from 100,000 to 180,000 cubic feet according to the best information obtainable. The rock pressure is 108 pounds. The wells are connected to the line of the Bourbon Pipe Line Company.

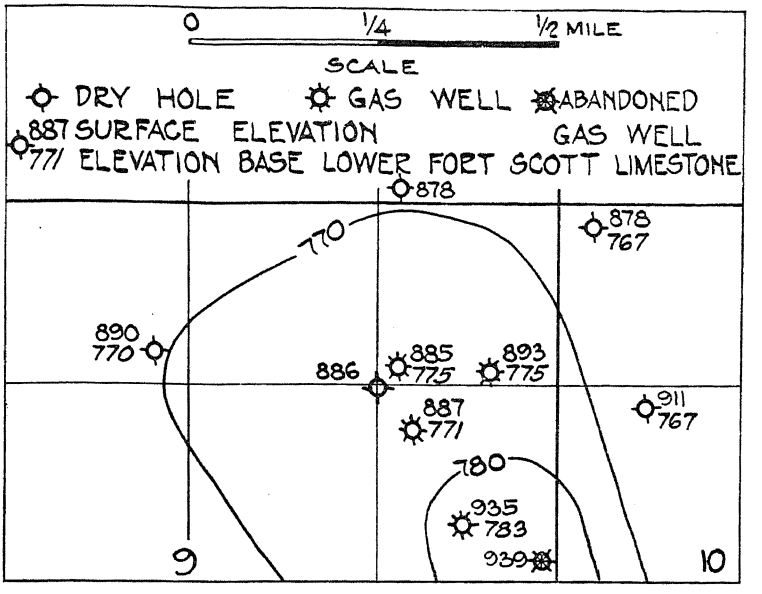


FIG. 1. Ackermann Gas Pool. T. 38 N., R. 33 W., Bates County, Mo. Contour interval 10 feet.

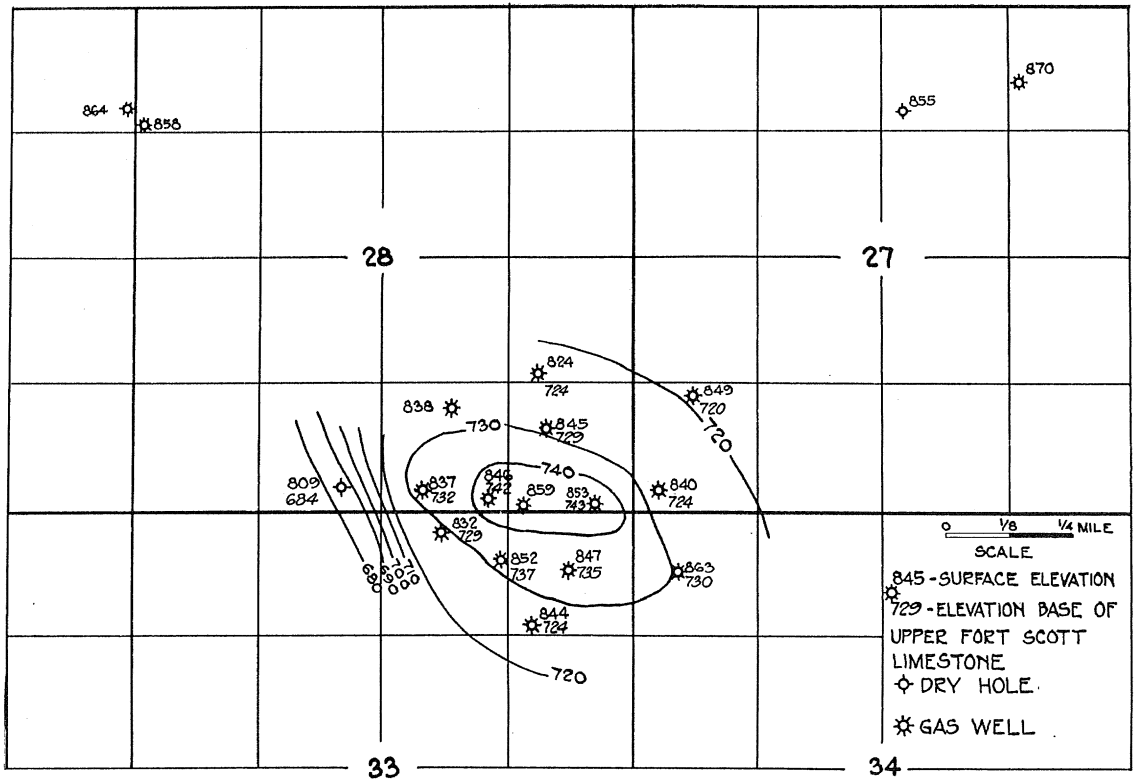
LONG POOL.

(Plate III.)

Location and area. The long pool is northeast of Amsterdam in Bates County. It is in the SW. ¼ sec. 27, SE. ¼ sec. 28, NE. ¼ sec. 33 and NW. ¼ sec. 34, T. 31 N., R. 33 W. There are 14 producing wells, which were drilled in 1931.

Outcropping formations. The surface formations are in the very basal part of the Pleasanton with the Pawnee limestone a few feet below the surface.

Producing horizons. Gas ranging from a show to a measurable amount has been found in the black shale below the Lexington cap rock, the black shale below the upper Fort Scott limestone, the Squirrel sand, the black shale below the Rich Hill limestone and the Bartlesville sand, the latter by far the most important. The lower part of the Squirrel sand has shown some oil.



Long Gas Pool. T. 41 N., R. 33 W., Bates County, Mo. Contour interval 10 feet.

LOG OF KAW OIL AND GAS COMPANY.

C. L. Long No. 1.

SE. ¼ SE. ¼ Sec. 28, T. 41 N., R. 33 W.
Elevation, 845 feet.

	Thickness, Feet.	Depth, Feet.	
Clay	6	6	
Sand	13	19	
Shale, gray	6	25	
Lime, hard	12	37	(Pawnee.)
Shale, gray	15	52	
Lime, hard	5	57	
Slate, black	7	64	Gas.
Sand	9	73	
Shale, gray	14	87	
Lime	16	103	(Upper Ft. Scott.)
Slate	2	105	
Shale	5	110	
Lime	3	113	(Lower Ft. Scott.)
Shale	1	114	
Sand	3	117	(Top of Squirrel.)
Shale	3	120	
Sand	42	162	Gas.
Shale, gray	2	164	
Sand	36	200	
Shale, gray	17	217	
Lime	2	219	(Rich Hill.)
Shale	3	222	
Lime	1	223	
Slate, black	1	224	Gas.
Shale, gray	8	232	
Sand, gray	3	235	
Shale, gray	9	244	
Sand	2	246	
Shale, gray	7	253	
Slate, black	1	254	
Shale, gray	2	256	
Sand	2	258	
Shale, gray	15	273	
Sand	2	275	
Shale, brown	5	280	
Shale, black	14	294	
Slate, black	4	298	Gas.
Shale, gray	4	302	
Shale, white, sandy	32	334	(Top of Bartlesville.)
Sand	10	344	Gas.
Shale	1	345	
Shale, sandy	3	348	
Sand	4	353	
Shale, gray	4	357	T. D.

Structure. The Long pool is on an elongated dome with about 20 feet of closure. The southwest side is marked by an

unusually steep dip. Well elevations were determined by an altimeter.

Production. The black shales had an initial open flow of 47,000 to 165,000 cubic feet with a rock pressure of 85 to 102 pounds. The sand gas ranged from 78,000 to 397,000 with rock pressure from 115 to 128 pounds. On Nov. 30, 1931, the total open flow capacity was more than 3,000,000 cubic feet.

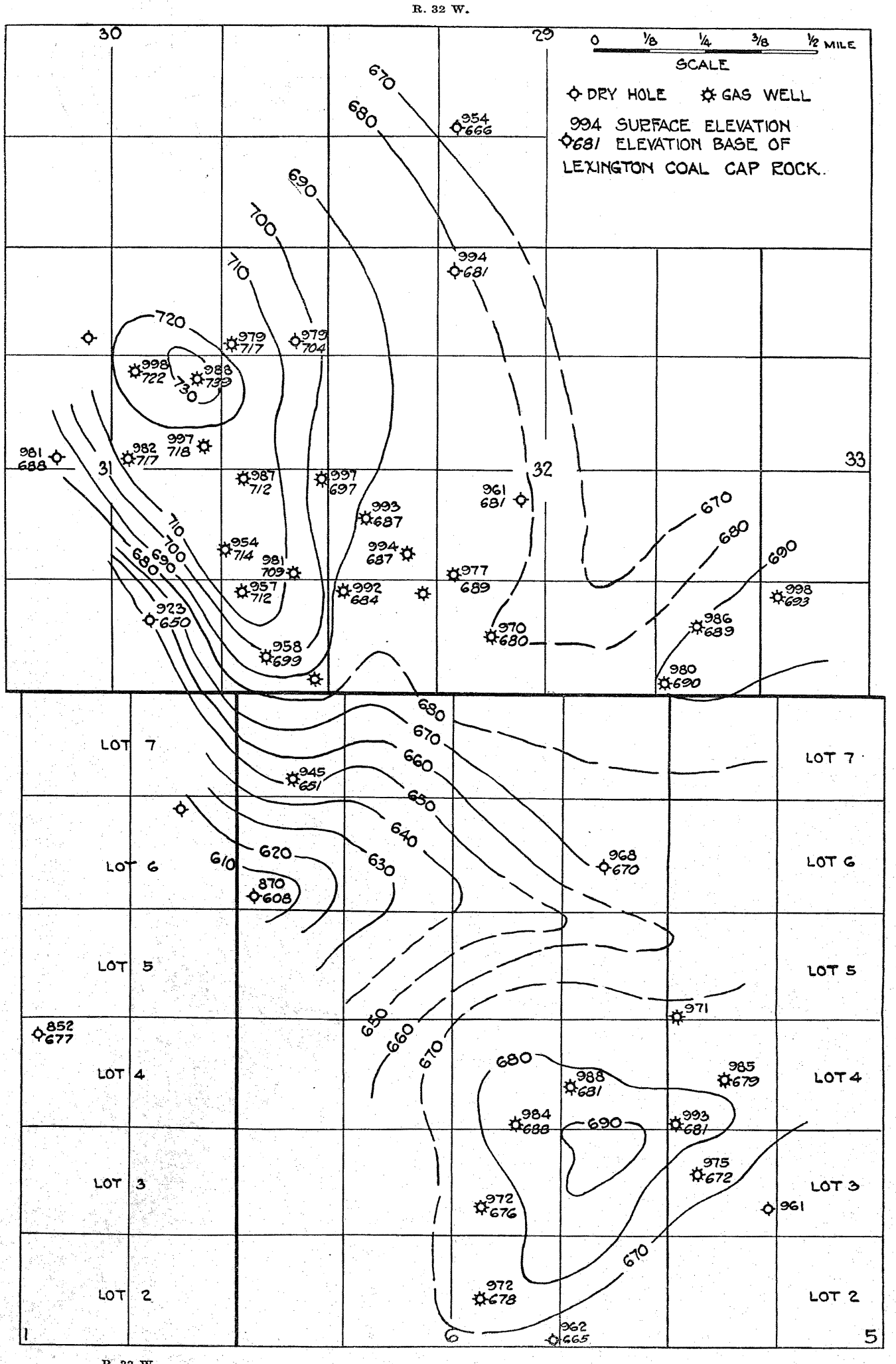
FREEMAN—PECULIAR DISTRICT.

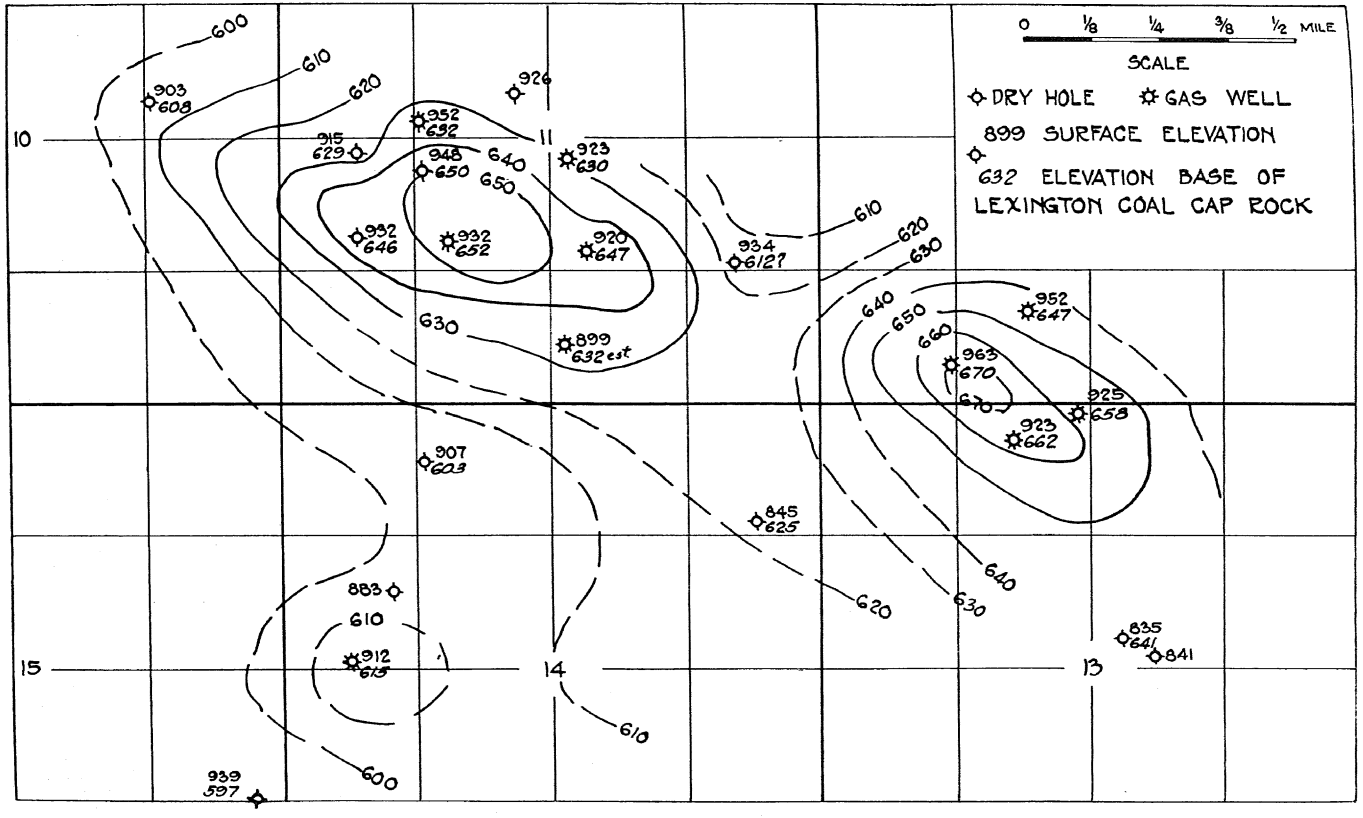
(Plates IV and V.)

Location and area. The district includes a number of pools ranging in size from one well to 20 wells. Those shown on Plates IV and V are the Beeghley, secs. 31 and 32, T. 45 N., R. 32 W., Knight, secs. 32 and 33, T. 45 N., R. 32 W., Richardson, secs. 5 and 6, T. 44 N., R. 32 W., Stark and Lash, sec. 11, T. 44 N., R. 33 W.; and Freeman, secs. 12 and 13, T. 44 N., R. 33 W. There are a number of others of the same type in which well elevations were not secured. Development began in 1930.

Outcropping formations. The uplands are capped with the basal limestones of the Kansas City formation, the Hertha, Bethany Falls, and Winterset, and the surface elevation ranges from 900 to 1,000 feet. Wells in the valleys of Grand River and its tributaries start in the Pleasanton formation.

Producing horizons. The first gas horizon reached is a black shale at 150 to 175 feet below the Hertha (top of unconformity zone) which shows gas, but almost invariably has water with it. The Lexington coal horizon, 50 to 70 feet lower yields shale gas. The black shale below the lower Fort Scott limestone and the upper part of the Squirrel sand just below produce gas in a few wells. The Squirrel sand zone is largely shale in this area but the lower part contains another gas sand. The black shale below the Ardmore (Rich Hill) limestone yields gas and the sandstone below (sometimes termed Bartlesville or upper Bartlesville sand) is an important producer. A typical log is given below:


R. 32 W.
30
29
0 1/8 1/4 3/8 1/2 MILE
SCALE
DRY HOLE
GAS WELL
994 SURFACE ELEVATION
681 ELEVATION BASE OF
LEXINGTON COAL CAP ROCK.
T. 45 N.
31
32
33
LOT 7
LOT 6
LOT 5
LOT 4
LOT 3
LOT 2
T. 44 N.
1
6
5
R. 33 W.
R. 32 W.



Gas pools near Freeman, Cass County, Missouri. Contour interval 10 feet.

LOG OF INTERSTATE PIPE LINE COMPANY.
McGill, 5-C.
SE. ¼ Sec. 31, T. 45 N., R. 33 W.
Elevation, 957 feet.

	Thickness, Feet.	Depth, Feet.	
Clay	4	4	
Shale and gravel	4	8	
Lime	12	20	(Hertha.)
Blue shale	4	24	
Very white shale	12	36	
Gray shale	57	90	
Sand	6	96	
Gray shale	19	115	
Dark gray shale	10	125	
Lime	1	126	
Gray sand	10	136	(Wayside.)
Gray shale	47	180	
Dark shale	10	190	Gas.
Light shale	12	202	
Lime	2	204	
Green shale	4	208	
Lime	14	222	
Dark shale	4	226	
Lime	8	234	(Pawnee.)
Blue shale	7	241	
Brown lime	4	245	(Lexington cap rock.)
Black slate	2	247	
Sand	5	252	Gas.
Gray shale	3	255	
Lime	4	259	(Top of Ft. Scott.)
White shale	3	262	
Lime	6	268	
White shale	3	271	
Lime	3	274	
White shale	2	276	
Lime	2	278	
Gray slate	2	280	
Lime, hard	1	281	
Broken gray slate	8	289	
Lime	4	293	(Bottom of Ft. Scott.)
Gray shale	4	297	
Black slate	2	299	
Gray shale	5	304	
Sand	2	306	(Top of Squirrel.)
Gray shale	20	326	
Dark shale	10	336	
Gray shale	27	363	
Sand	22	385	Gas.
Gray slate	7	392	
Lime	2	394	(Rich Hill.)
Gray sand shale	15	409	
Red bed	4	413	
Gray shale	32	445	
Sand	20	465	Gas (Bartlesville).
Shale	7	472	T. D.

Four wells have been drilled into the Mississippi lime, topped at 640 to 690 feet below the Hertha and one was drilled to 1,560 feet. One in section 11, T. 44 N., R. 33 W., well located structurally found a show of oil and gas in the upper part of the Clear Creek sandstone. The others found only water in the porous horizons.

Structure. The maps reproduced on Plates IV and V are based on approximated locations and altimeter elevations and are contoured on the base of the Lexington cap rock ("Brown lime" or "Center Fort Scott" of drillers) in the Labette shale, that is, the top of the main shale gas horizon. The production closely follows structure and the closure ranges from a few to about 50 feet.

The general dip appears to be to the south but reconnaissance work south of Grand River indicates that it changes to the north there.

Production. Wells of large size have not been drilled in this area. The best producers range from 100,000 to 250,000 cubic feet initial open flow capacity, though wells with only 20,000 or 30,000 cubic feet have been saved if close to a gathering line. The rock pressure ranges from 50 to 120 pounds.

The district is connected to the line of the Interstate Pipe Line Company.

KNORPP POOL.

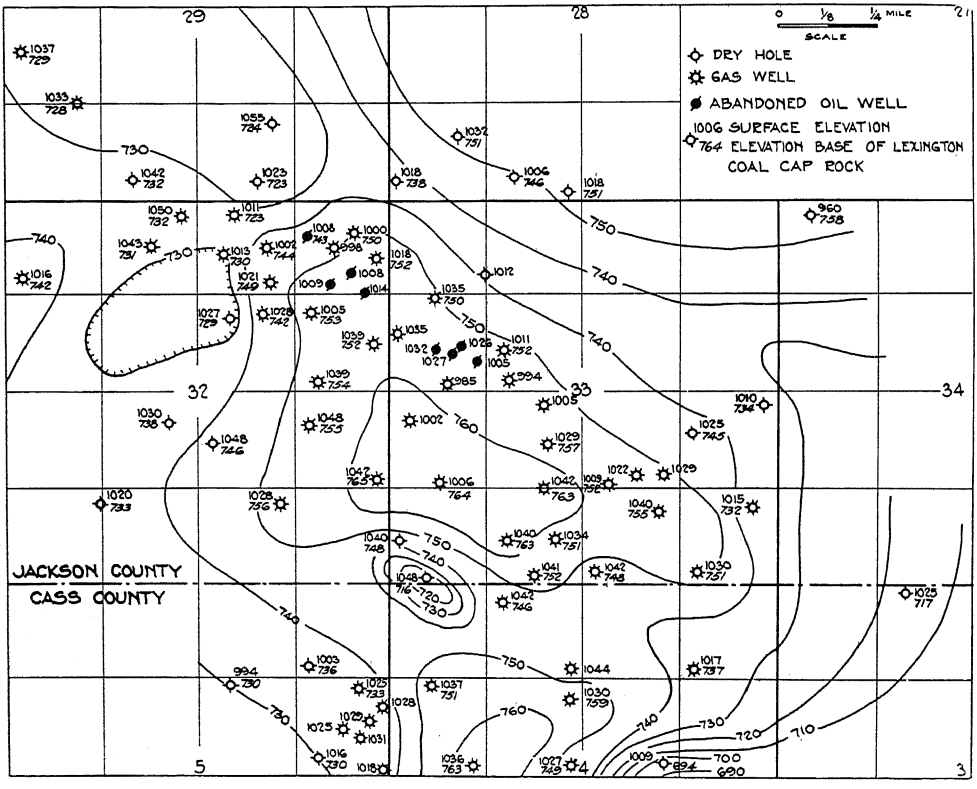
(Plate VI.)

Location and area. The Knorpp pool is on the line between Cass and Jackson counties in secs. 4 and 5, T. 46 N., R. 30 W., and secs. 32 and 33, T. 47 N., R. 30 W. It covers approximately 800 acres. The total number of producers is somewhat doubtful, but is around 60, of which 8 were completed as small oil wells that were soon abandoned. The pool was opened in 1929.

Outcropping formations. Practically all of the area is underlain by the Winterset or Bethany Falls limestone, but in a few areas small patches of the overlying Cherryvale shale are present.

Producing horizons. The Wayside sand is the first horizon encountered to show gas, but it is unimportant. The main production is from the Squirrel sand or from the channel sandstone which trends northwest-southeast across sections 32 and 33. The Squirrel sand is well developed and is reported 80 feet thick

MISSOURI BUREAU OF GEOLOGY AND MINES. R-30 W. BIENNIAL REPORT, 1931-1932. APP. II, PL. VI.



Knorrp Gas Pool. T. 46-47 N., R. 30 W., Cass and Jackson Counties, Mo. Contour interval, 10 feet.

in one well. The channel sand has a maximum known thickness of 70 feet. It usually rests on the limestone below the Lexington coal horizon, but where the maximum thickness is developed, it even replaces this limestone.

One well has been drilled to the Mississippi Lime, about 600 feet below the Hertha. It found 95 feet of sand and sandy shale at the Bartlesville horizon and 35 feet of Burgess sand, but neither was productive. The log of the well published in the discussion of the Lone Jack district is typical of the normal section in this pool.

Structure. As determined by well elevations obtained by altimeter readings, the Knorpp pool is on an irregular dome, elongated in a northwest-southeast direction. It is bordered on the northeast by a very shallow syncline and on the south by a small sharp closed depression and another small dome. The total closure is about 30 feet.

Production. Very little information was obtained concerning the size of the wells in the Knorpp pool, but it is believed that in general the wells were not as large as in other pools in Cass and Jackson counties.

Eight wells in a line in about the center of the channel sandstone were completed as oil wells but were soon abandoned. The oil is reported to have been of low gravity and viscous.

The gas wells are connected to the lines of the Interstate Pipe Line Company.

LONE JACK DISTRICT.

Location and area. There are two pools in this district, the Lone Jack townsite pool along the range line in secs. 19 and 30, T. 47 N., R. 29 W., and 24 and 25, T. 47 N., R. 30 W., and the Shawhan pool in secs. 13, 14, 23 and 24, T. 47 N., R. 30 W., Jackson County.

In the Lone Jack pool 18 wells were drilled and in the Shawhan pool 24 wells were drilled. Information is not complete as to the exact number of producers, but it is known that these figures include some that were dry or too small to be saved. The pools were opened in 1929.

Outcropping formations. The three basal limestone members of the Kansas City formation outcrop over most of the area, but a few of the deeper valleys have been cut down into the Pleasanton.

Producing horizons. Gas is found in the black shales at the Lexington, Summit and Mulky coal horizons, but practically all the wells were drilled to the Squirrel sand where the main supply of gas was found. Two holes have been drilled into the top of the Mississippian and one of them was carried to 1265 feet. The Bartlesville sand appears to be absent and the Burgess sand contained water. The followng is a typical log.

LONE JACK OIL AND GAS COMPANY.

D. Lee Shawhan No. 6.

NW. cor. SE. ¼ SE. ¼ sec. 14, T. 47 N., R. 30 W.
Elevation, 1,032 feet.

	Thickness, Feet.	Depth, Feet.	
Soil and clay	11	11	
Lime	3	14	
Blue shale	4	18	
Dark shale	2	20	
Lime	22	42	(Winterset.)
Shale	7½	49½	
Lime	17½	67	(Bethany Falls.)
Dark shale	9	76	
Light shale	19	95	
Lime	3	98	(Hertha.)
Dark shale	11	109	
Red rock	5	114	
Shale	136	250	
Lime	3	253	
Shale	15	268	
Brown lime and sand	4	272	
Sand	6	278	
Dark shale	6	284	
Lime	2	286	(Pawnee.)
Shale	14	300	
Lime	8	308	(Lexington cap rock.)
Slate	4	312	Gas.
Lime	4	316	(Top of Ft. Scott.)
Shale	21	337	
Lime	2	339	
Black slate	2	341	
Shale	14	355	
Lime	2	357	(Bottom of Ft. Scott.)
Shale	13	370	
Sand	3	373	Gas (top of Squirrel.)
Sandy shale	5	378	
Gas sand	36	414	
Shale	41	455	
Lime	2	457	(Rich Hill.)
Black shale	2	459	
Light shale	25	484	
Lime	1	485	
Shale	30	515	

LONE JACK OIL AND GAS COMPANY—Continued.

	Thickness, Feet.	Depth, Feet.	
Black shale	10	525	
Gray shale	25	550	
Lime	2	552	
Gray shale	92	644	
Sand	8	650	
Gray shale	40	690	
Water sand	10	700	
Shale, dark	3	703	
Lime	190	895	(Miss. lime.)
Shale break	2	895	
Lime	100	995	
Shale break	2	997	
Lime	107	1105	
White sand	29	1134	
Dark green shale	6	1140	
Dolomite	125	1265	T. D.

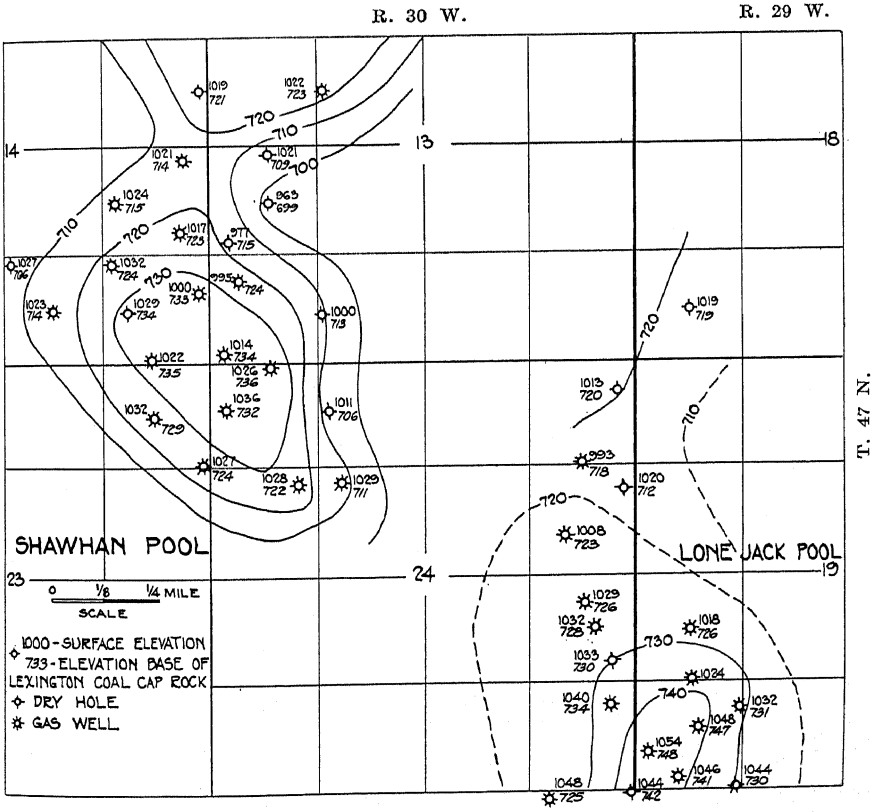


FIG. 2. Shawhan and Lone Jack Gas Pools. T. 47 N., R. 29-30 W., Jackson County, Mo. Contour interval, 10 feet.

Structure. The surface structure in that area was first observed by Mr. D. Lee Shawhan and the drilling was done under his supervision.

Well elevations were obtained by an altimeter and the structure is shown in Fig. 2 on the base of the Lexington Coal cap rock. Both pools are on domes elongated in a north-south direction with a suggestion of northwest-southeast trends. The Lone Jack pool has a known east dip of 17 feet and the Shawhan 29 feet. Mr. Shawhan's observations indicates a marked syncline between the two pools.

Production. Two wells in the Lone Jack district are reported to have had an initial flow capacity of 1,100,000 and 1,300,000 cubic feet and several others ranged between 200,000 and 250,000 cubic feet. The line of the Interstate Pipe Line Company takes the gas.

BELTON-MARTIN CITY DISTRICT.

Location and area. This is one of the oldest producing areas in the State, the first well having been drilled in 1903. There was a revival of operations in 1928 which was still in progress in the fall of 1932. The district includes the Belton oil and gas pool extending from sec. 14, T. 46 N., R. 33 W., Cass County to sec. 36, T. 47 N., R. 33 W., Jackson County; the Knoche oil and gas pool in secs. 3, 4, 5 and 9, T. 46 N., R. 33 W., Cass County, the Martin City oil and gas pool extending from sec. 6, through 4, 5, 7, 8, 9, 16, 21, and into sec. 28, T. 47 N., R. 33 W., Jackson County and the Grandview gas pool in secs. 17, 18, 19, and 20, T. 47 N., R. 32 W., and secs. 13, 24, and 25, T. 47 N., R. 33 W., Jackson County.

Outcropping formations. The upland surface is capped by the Iola limestone and the valley of Blue River exposes the top of the Pleasanton, so that the entire thickness of the Kansas City formation outcrops. The surface relief is over 250 feet.

Producing horizons. Gas is found in the Wayside sand, the upper and lower Labette sands and in the intervening Lexington coal shale, in the Squirrel sand and in the Bartlesville sand. The oil is found in both the upper and lower part of the Squirrel sand zone. Wells on the upland which start in the Iola limestone reach the Lexington coal horizon at around 500 feet, the top of the Squirrel sand zone at about 525 feet and the top of the Bartlesville sand at 650 feet.

The following is the log of a well which was drilled into the Mississippian.

LOG OF BELTON GAS COMPANY.

Scott and Marsh No. 3.

SE. ¼ sec. 2, T. 46 N., R. 33 W.
Elevation, ... feet.

	Thickness, Feet.	Depth, Feet.	
Soil	5	5	
Joint clay	7	12	
White lime	10	22	(Iola.)
Blue shale	5	27	
Red shale	10	37	
Blue lime	20	57	
White slate	10	67	
White lime	3	70	
Blue slate	5	75	
White sand	15	90	
White slate	20	110	
White lime	40	150	(Winterset.)
Black slate	5	155	
White lime	15	170	(Bethany Falls.)
Black slate	5	175	Water at 175.
Blue lime	15	190	(Hertha.)
White slate	92	282	
Gas sand	12	294	(Wayside.)
White shale	17	311	
Black slate	4	315	
White slate	30	345	
White sand	10	355	
White slate	10	365	
White lime	8	373	(Worland.)
White shale	7	380	
Blue lime	15	395	(Pawnee.)
White shale	5	400	
Black slate	6	406	
Blue lime	7	413	
Black slate	5	418	Water and gas (Lexington coal horizon).
Gas sand	7	425	
White slate	5	430	
Sand and lime	10	440	(Upper Ft. Scott.)
Dark slate	3	443	
White slate	7	450	
Lime	5	455	(Lower Ft. Scott.)
White slate	20	475	
Oil sand	15	490	(Top of Squirrel.)
Shale, white	15	505	
Black shale	25	530	
Gas sand	15	545	
Black slate	10	555	
Flint lime	5	560	(Rich Hill.)
White slate	40	600	

LOG OF BELTON GAS COMPANY—Continued.

	Thickness, Feet.	Depth, Feet.	
Black slate	40	605	
White slate	35	640	Set 6 ¼ casing.
White slate	10	650	
Dark slate	50	700	
Gray oil sand	35	735	Small showing.
White slate	20	755	
Oil sand	10	765	
White shale	15	780	Salt water 780.
Oil sand	25	805	
Black slate	10	815	
Sandy lime	5	820	T. D. (Mississippian).

Structure. While the logs and elevations of many wells drilled in the Belton area have been obtained by the Bureau, these data are far from complete and no attempt is made to present a subsurface map. Preliminary studies of some of the pools in the district indicate that the production is on structural features with a north-south trend.

Production. Oil was formerly produced in the Belton pool, but at the present production is from the Knoche and Martin City pools, and is obtained from the Squirrel sand zone. The initial production, after shooting, has been reported to be as much as 50 to 70 barrels, but 5 or 10 barrels is more common. However, the wells settle to about two barrels per day and maintain this output rather steadily. The oil is of low gravity and is mostly sold in Kansas City as fuel oil, but during the summer of 1932, a small skimming plant was operated on the Duck lease in sec. 16, T. 47 N., R. 33 W.

Initial open flow capacity of the gas well ranges from four thousand cubic feet per day to 1,580,000 cubic feet. Gas from a sand at 522 feet had a rock pressure of 187¼ pounds.

INDEPENDENCE POOL.

(Plate VII.)

Location and area. This pool covers about 640 acres in section 26 and 35, T. 50 N., R. 32 W., Jackson County. It probably is not clearly defined from the Independence townsite area which is directly south of it and in which several private wells have been drilled. The total number of producing wells drilled in the area is probably around 25 or 30. The area was

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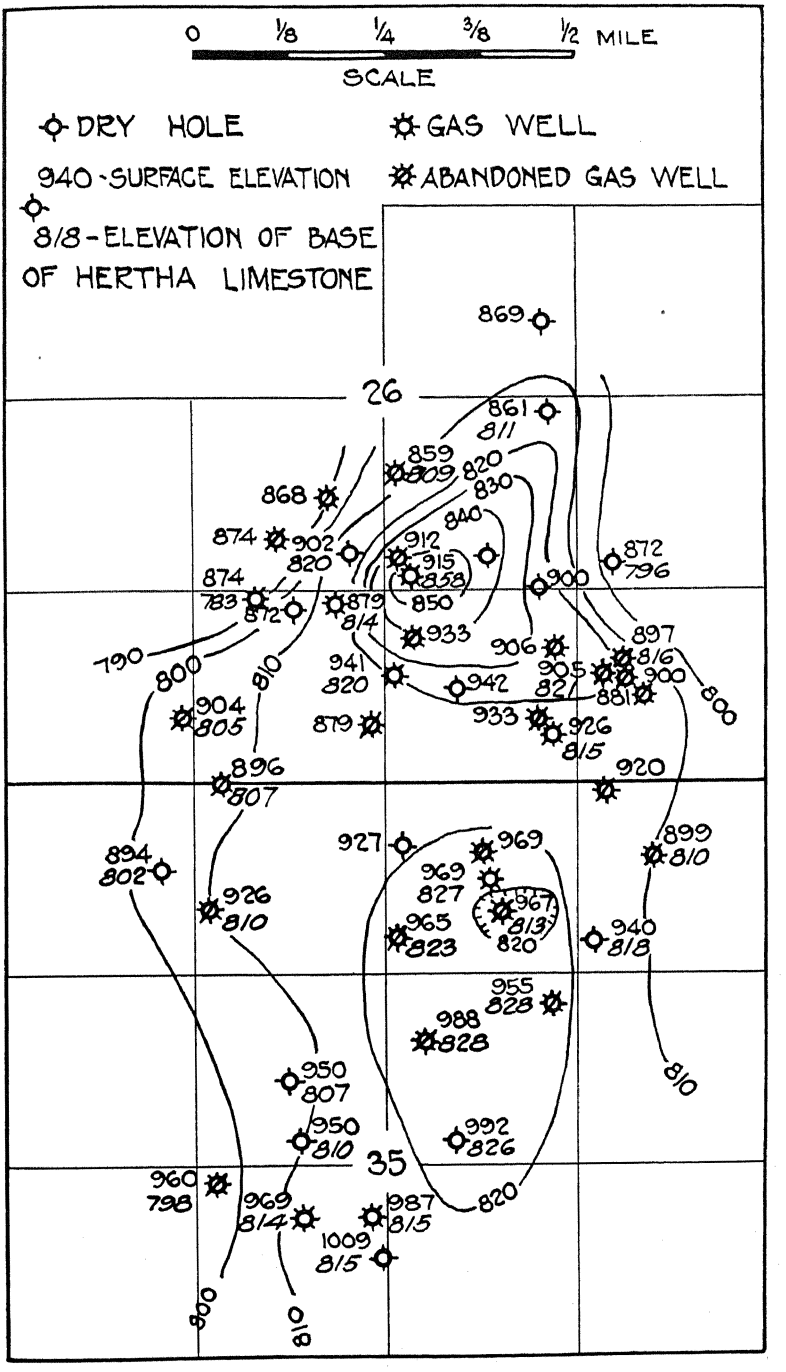

Independence gas pool, Jackson County, Missouri. Contour interval 10 feet.

first drilled in 1924 by the Independence Natural Gas Company and the wells put on the pump to increase the flow. After about two years the field was abandoned, to be redrilled in 1931 and 1932 by Mr. James E. Brusha. Information on the wells of the Independence Natural Gas Company is not complete.

Outcropping formations. The area slopes to the north from an altitude above 1,000 feet to about 850 feet so that wells in the northern end of the pool start in the Winterset while those in the south start in the upper part of the Kansas City formation.

Producing horizons. The first showing of gas is in the Wayside sand, about 100 feet below the Hertha. Below the Wayside is a 5-foot bed of red shale and at 25 to 40 feet lower a gas sand at the horizon of the Warrensburg channel sandstone. The Lexington, Summit and Mulky coal shales all show gas in some amount. The Squirrel sand at 275 feet, and the so-called Bartlesville at 375 feet below the Hertha, both produced in structurally high wells. Lower sands have been drilled and found barren of gas or to contain salt water.

The Wayside, Warrensburg and Squirrel sands had oil showings in many of the wells.

LOG OF HENLEY AND COLLEY WELL.

NE. cor. SE. ¼ SW. ¼ sec. 35, T. 50 N., R. 32 W.
Elevation, 1,009 feet.

	Thickness, Feet.	Depth, Feet.	
Soil	5	5	
Clay	7	12	
Lime shelly	4	16	
Shale	27	43	
Lime	10	53	
Shale	7	60	
Lime	12	72	
Shale	15	87	
Lime	8	95	
Shale	15	110	
Lime	8	118	
Shale	2	120	
Lime	23	143	
Shale	1	144	(Winterset.)
Lime	6	150	
Shale	4	154	
Lime	24	178	(Bethany Falls.)
Slate	3	181	Water enough to drill.
Lime	2	183	

LOG OF HENLEY AND COLLEY WELL—Continued.

	Thickness, Feet.	Depth, Feet.	
Shale	2	185	
Lime	2	187	
Shale	2	189	
Lime	5	194	(Hertha.)
Shale	6	200	
Lime	2	202	
Shale	21	223	Set 6 ¼ csg. at 212.
Lime	6	229	
Shale	1	230	
Lime	4	234	
Shale	51	285	
Sand	10	295	Oil good (Wayside).
Shale black	3	298	
Red rock	2	300	
Shale	5	305	
Sand	4	309	
Shale	1	310	
Sandy lime or shale	18	328	
Shale, gray	4	332	
Shale, blue	7	339	
Red rock	2	341	
Oil sand	8	349	Rich.
Shale black	2	351	
Sand	20	371	Oil.
Shale	4	375	
Lime	10	385	
Shale	5	390	
Lime	10	400	
Shale	3	403	Water 200 feet in hole (Lexington coal horizon).
Lime, hard	7	410	
Shale	15	425	Set 4 7-8 casing at 415.
Lime	8	433	
Shale slate	4	437	
Lime	3	440	
Shale	4	444	
Lime	6	450	
Shale, white	1	451	
Shale, black	4	455	Some gas.
Shale, white	10	465	
Red rock	3	468	
Lime	3	471	
Sand	12	483	Oil (Squirrel)
Sand	2	485	Gas showing.
Sand	5	490	Water.
Shale, white	10	500	
Shale, black	2	502	
Lime	4	506	
Shale, black	4	510	
Lime	2	512	
Shale, black	4	510	
Lime	4	520	
Shale, blue-black	3	523	

LOG OF HENLEY AND COLLEY WELL—Continued.

	Thickness. Feet.	Depth. Feet.	
Lime	2	525	
Shale, dark sandy	15	540	
Lime	2	542	
Shale, dark	2	544	
Lime	2	546	
Shale, dark	4	550	
Lime	4	554	
Shale, dark	1	555	
Lime	2	557	
Shale	2	559	
Lime, hard	5	564	
Shale, light sandy	10	574	Set packer.
Slate and coal	3	577	
Gas sand	6	583	(Bartlesville.)
Blue shale	2	585	

Structure. The structure of the Independence pool (Plate VII) is based on well elevations determined by altimeter. It exhibits many inconsistencies, which are particularly noticeable in the presence of dry holes structurally high and producers which are structurally low. Most, if not all these inconsistencies, are due to lack of information on the earlier holes.

As mapped, there is a north-south trending axis with 62 feet of east dip in section 26, and at least 18 feet in section 35. Control is lacking at the south end of the area, but there are reasons for believing that the axis extends southward into or beyond the townsite of Independence.

Production. No information was obtained on the measured open flow capacity or rock pressure of the wells in the Independence pool, but according to Mr. M. J. White of Lees Summit, Missouri, one of the wells drilled to the Bartlesville sand exhibited rather unusually large pressure.

AVONDALE POOL.

(Plate VIII.)

Location and area. This pool covers the area of Avondale townsite and the surrounding region in secs. 6 and 7, T. 50 N., R. 32 W., Clay County, Mo. It covers nearly one and a half square miles. The total number of producers, as nearly as can be ascertained, is forty-five. The pool was opened in 1930.

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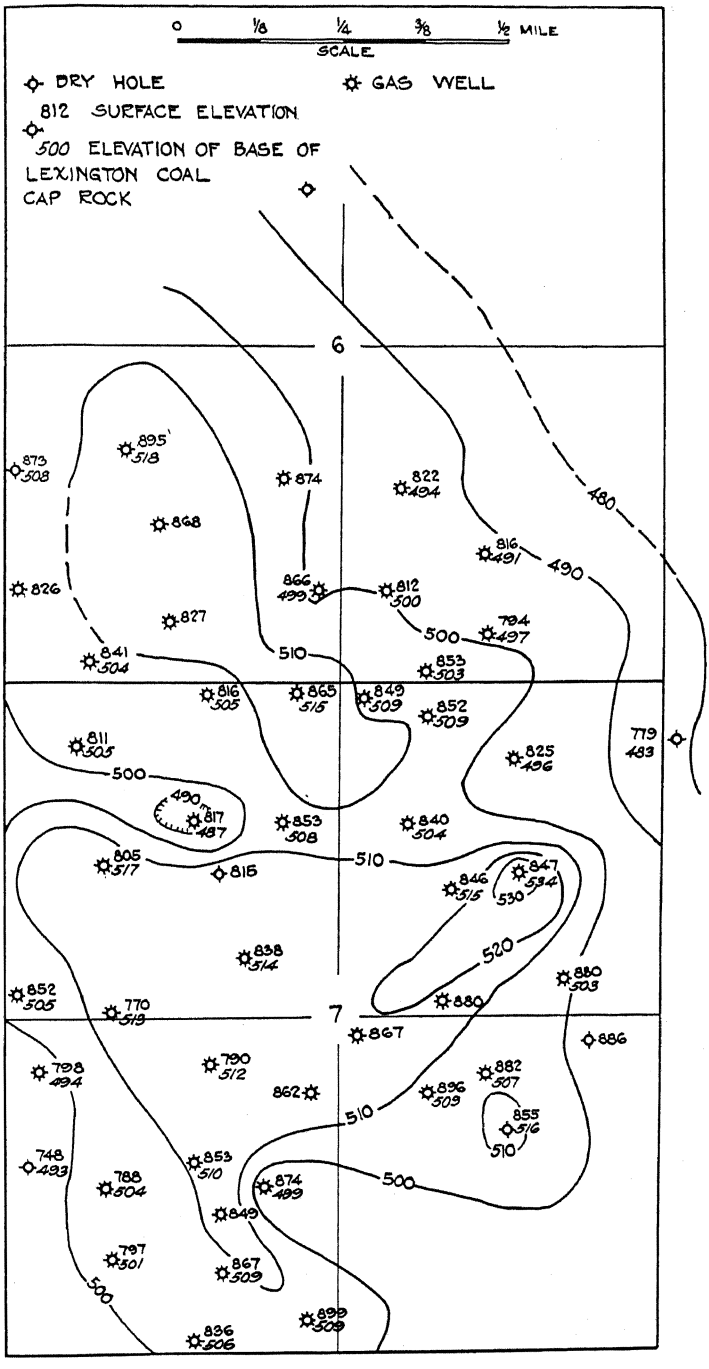
R. 32 W.



Avondale gas pool, Clay County, Missouri. Contour interval 10 feet.

Outcropping formations. In most of the area the top of the Winterset limestone is the first hard rock encountered, but above the Winterset is a blanket of loess and drift, the thickness of which depends on the topographic situation of the well. Wells on the hills in the SE. ¼ sec. 7, where the elevation is around 900 feet above sea level, penetrate 100 feet of clay and sand, and lower wells, topographically, a less thickness.

Producing horizons. All the gas-bearing formations from the Knobtown sand to the Squirrel sand show gas in the Avondale pool, but the upper showings are usually passed up, and the wells are completed in the black shale at the Lexington coal horizon or in the Squirrel sand. The Squirrel sand here occurs in the lower part of the zone at a depth of 400 to 500 feet. The Lexington black shale gas is about 200 feet below the Hertha limestone and the top of the Squirrel sand 300 to 325 feet below the Hertha.

No well in the pool has been carried to any great depth, although one in the northwest corner of sec. 8, T. 50 N., R. 32 W., was drilled to the "Bartlesville." It was a low well structurally and found only water. The Mississippi lime will be found 625 to 650 feet below the Hertha. The following is a typical log:

LOG OF BAKER, STEENSTRY AND SKINNER-SHIPPE NO. 1.

Cen. S. line SW. ¼ SE. ¼ sec. 6, T. 50 N., R. 32 W.
Commenced May 24, 1930.
Elevation, 853 feet.

	Thickness, Feet.	Depth, Feet.	
Soil and clay	35	35	
Sand	20	55	
Lime	3	58	
Black shale	2	60	
Gray shale	5	65	
Lime	2	67	
Gray lime	28	95	(Winterset.)
Gray shale	6	101	
Lime	21	122	(Bethany Falls.)
Dark shale	3	125	
Lime	2	127	
Dark shale	1	128	Gas bubbles.
Lime	15	143	(Hertha.)
Sandy gray shale	7	150	
Sand	6	156	Gas (Knobtown).
Gray shale	78	234	

LOG OF BARKER, STEENSTRY AND SKINNER-SHIPPE NO. 1—Cont'd.

	Thickness, Feet.	Depth, Feet.	
Sand	11	245	Trace of oil and gas bubbles of gas (Wayside).
Gray shale	2	247	
Red bed	5	252	
Gray shale	8	260	
Lime	12	272	
Gray shale	3	275	
Red bed	7	282	
Green shale	6	288	
Gray shale	6	294	
Lime	1	295	
Light shale	12	307	
Sand	7	314	Gas, light showing of oil.
Gray shale	11	325	
Black slate	1	326	
Gray lime	4	330	(Pawnee.)
Gray shale	15	345	
Lime	5	350	
Black slate	3	353	Gas good (Lexington coal horizon).
Dark shale	7	360	
Gray shale	20	380	
Light shale	6	386	
Lime	4	390	
Light shale	5	395	
Sandy shale	5	400	
Gray shale	24	424	
Black lime	3	427	
Slate	3	430	
Gray shale	15	445	
Dark shale	7	452	
Lime sand	3	455	(Top of Squirrel sand.)
Sandy shale	20	475	T. D.

Structure. Well elevations were obtained by altimeter, which may account for some of the eccentricities of the Avondale structure. A high area, of irregular outline extends across the pool in a NW.-SE. direction. From the highest well, which appears to be abnormally high there is a northeast dip of 51 feet and a southwest dip of 41 feet. The dry hole line is roughly at the 500-foot contour, but there are several exceptions to this.

Production. When the pool was first drilled in 1930, the larger wells had an initial open flow capacity of 500,000 cubic feet, but the close spacing, an average of one well to about 15 acres caused the volume to drop off rapidly. At present the average well furnishes sufficient gas for only a few families.

LIBERTY POOL.

Location and area. The Liberty pool is situated in the southeastern part of T. 52 N., R. 32 W., Clay County, in secs. 34, 35 and 36. Thirteen gas producers have been completed. It was opened in 1931 (Fig. 3, p. 48).

Outcropping formations. In general this pool is on a high escarpment capped by the Plattsburg limestone of the Lansing formation. Some of the wells start below the Plattsburg in the Lane shale and in others on the highest points, some glacial drift overlies the Plattsburg. The altitude ranges from 933 to 1,049 feet above sea level.

Producing horizons. The Hertha limestone at the base of the Kansas City formation is found at an average depth of 300 feet, the Wayside sand at 400 feet and the Lexington shale gas horizon at 500 feet. Showings of gas are encountered in the black shale in the Galesburg, in the Knobtown sand and other beds between the Wayside and Lexington, but these two are the main horizons. One well penetrated the black shales at the Summit and Mulky coal horizons and went into the Squirrel sand zone where only sandy shale was found. No showings are reported below the Lexington shale gas horizon. The following log is typical of the pool.

LOG OF HALL ET AL.

Land No. 1.

Cen. NW. ¼ SE. ¼ sec. 35, T. 52 N., R. 32 W.
Drilled May 3 to 15, 1931.
Elevation, 1,005 feet.

	Thickness, Feet.	Depth, Feet.	
Soil	3	3	
Shale and boulders	7	10	Water.
Lime	10	20	(Plattsburg.)
Shale, gray	23	43	
Lime	3	46	
Shale, gray	14	60	
Sandy shale	30	90	Water.
Lime	22	112	(Iola.)
Shale, gray	21	133	
Lime	6	139	
Black slate	2	141	
Lime	1	142	
Shale, gray	12	154	
Lime	5	159	

LOG OF HALL ET AL.—Continued.

	Thickness, Feet.	Depth, Feet.	
Shale, dark	5	164	
Lime	14	178	
Shale, dark	20	198	
Lime	1	199	
Shale, gray	2	201	
Lime	2	203	
Shale, gray	9	212	
Lime	7	219	
Shale	2	221	(Winterset.)
Lime	18	239	
Black slate	3	242	Gas 4,000.
Gray shale	2	244	
Lime	23	267	(Bethany Falls.)
Slate, dark	2	269	Show gas.
Lime	2	271	
Shale, gray	4	275	
Lime	10	285	(Hertha.)
Shale, gray	29	314	
Sandy shale	11	325	
Shale, gray	48	373	
Sand	4	377	Gas 200,000 RP. 85 pds. (Wayside.)
Shale, gray	3	380	
Sandy lime	2	382	
Red rock	5	387	
Shale, light gray	6	393	
Sandy lime	15	408	
Shale, gray	26	434	
Lime	7	441	
Shale, gray	15	456	
Lime	5	461	(Pawnee.)
Shale, gray	7	468	
Shale, dark	7	475	
Lime	5	480	
Shale, black	5	485	Gas 70,000 (Lexington coal horizon).
Lime	4	489	
Shale, gray	12	501	T. D.

Structure. As contoured on altimeter elevations and with meagre control in the western part of the pool, this dome appears to have two axes, one north-south in sec. 36, and one east-west, across the southern part of secs. 34, 35 and 36. There is an east dip and closure of 22 feet.

Production. The initial open flow ranged from 130,000 cubic feet to 450,000 cubic feet, with a pressure of 94 to 105 pounds, but in most wells 98 pounds. The wells are connected to the pipe line of the Missouri Power and Light Company.

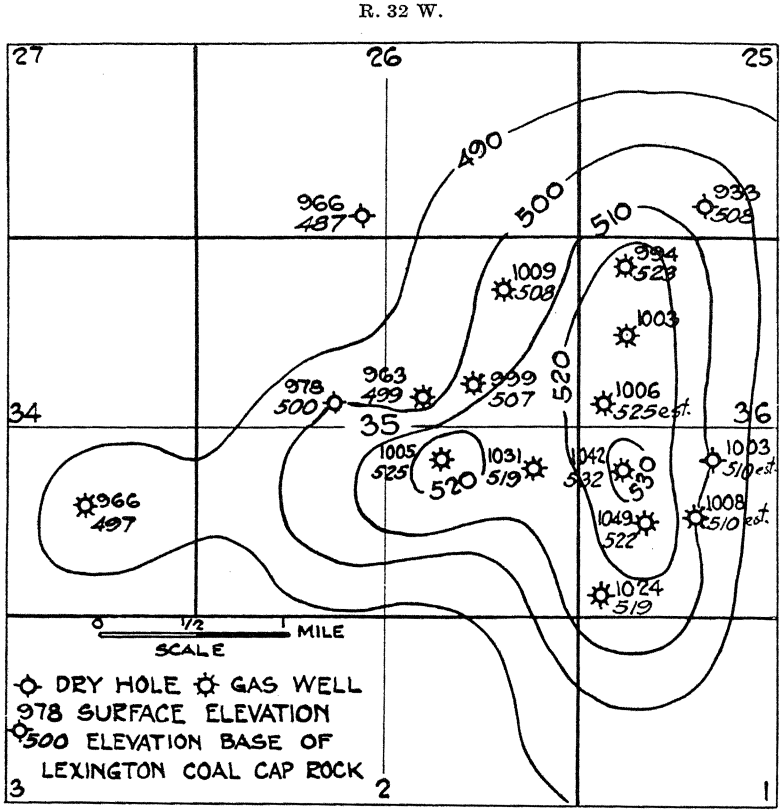


FIG. 3. Liberty gas pool, Clay County, Missouri. Contour interval 10 feet.

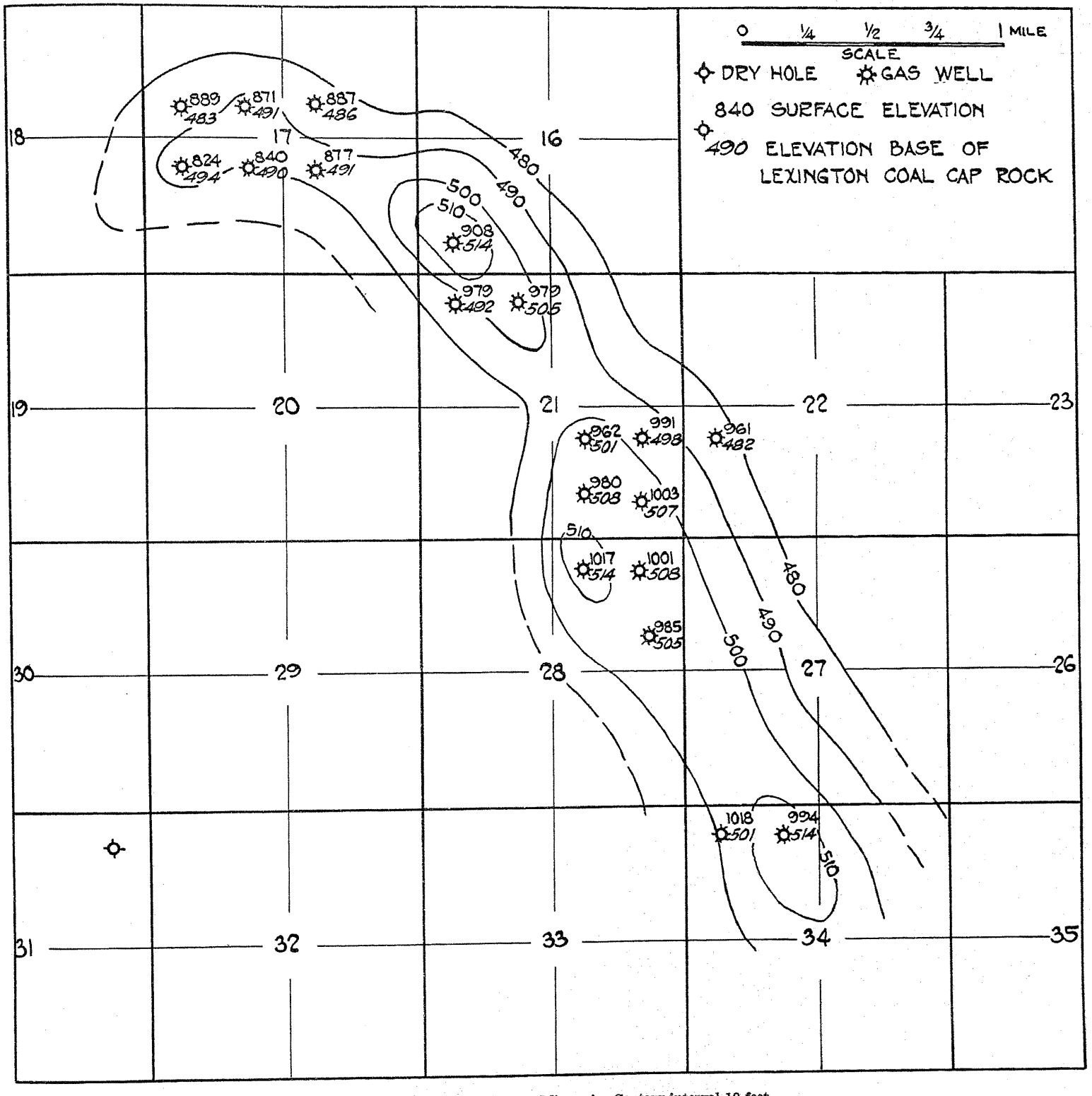
PARADISE POOL.

(Plate IX.)

Location and area. The Paradise (sometimes termed the Smithville) pool is on a long narrow anticline extending from sec. 17, through 16, 21, 22 and 28 to sec. 34, T. 53 N., R. 32 W., Clay County. A total of 19 producers have been completed since the pool was opened in 1930.

Outcropping formations. Wells on the upland start in glacial drift and encounter the Plattsburg limestone of the Lansing formation within a few feet. The wells in sec. 17 start in the lower part of the Lansing or in the upper part of the Kansas City formation. The upland elevation is around 1,000 feet above sea level.

Producing horizons. Practically all the wells are drilled to a sand, which occurs in the lower part of the Squirrel sand zone. Gas, as mere showings to commercial size, is also found



Paradise gas pool, Clay County, Missouri. Contour interval 10 feet.

in the black shale below the Bethany Falls limestone, the Knobtown sand, the Lexington shale and at various places in the Squirrel sand zone above the main sand. A type well log is as follows:

THE TREES OIL COMPANY.

Duncan No. 1.

Cen. NE. ¼ NE. ¼ sec. 28, T. 53 N., R. 32 W.
Drilled Aug. 19 to 25, 1930.
Elevation, 1,001 feet.

	Thickness, Feet.	Depth, Feet.	
Soil	2	2	
Clay	18	20	
Boulders	10	30	
Lime	6	36	
Shale	2	38	(Plattsburg.)
Lime	7	45	
Shale	4	49	
Sandy shale	21	70	
Shale	20	90	
Sandy shale	20	110	
Limey flint	12	122	(Iola.)
Shale	20	142	
Lime	3	145	
Shale	7	152	
Lime	1	153	
Shale	2	155	
Limey shale	8	163	
Lime	10	173	
Shale	9	182	
Lime	7	189	
Shale	21	210	
Lime	7	217	
Shale	9	226	
Lime	6	232	
Shale	2	243	(Winterset.)
Lime	21	255	
Shale	5	260	
Lime	20	280	(Bethany Falls.)
Shale	3	283	Gas bubbles 280-283.
Lime	3	286	
Shale	2	288	
Lime	12	300	(Hertha.)
Shale	10	310	
Sandy shale	20	330	
Shale	25	355	
Sandy shale	20	375	
Shale	15	390	
Sand	6	396	(Wayside.)
Shale	3	399	
Red bed	5	404	
Sand	21	425	

THE TREES OIL COMPANY—Continued.

	Thickness, Feet.	Depth, Feet.	
Shale	6	431	
Lime	3	434	
Limey shale	6	440	
Shale	5	445	
Lime	3	448	
Shale	3	451	
Sandy shale	19	470	
Lime	6	476	(Pawnee.)
Shale	10	486	
Lime	7	493	
Shale	3	496	(Lexington coal horizon.)
Lime	5	501	
Sandy shale	15	516	
Shale	3	519	
Lime	7	526	
Limey shale	9	535	
Sandy shale	29	564	(Top of Squirrel zone.)
Sand	3	567	
Sandy shale	13	580	
Lime	11	591	
Shale	9	600	
Sandy shale	15	615	T. D.

No deep well has been drilled in the producing area, but 30 years ago one was drilled in section 35, only one mile east of production, to a depth of 1,032 feet, entering the Mississippi lime at 1,022 feet. Porous horizons in the lower part of this hole were as follows: Lexington shale gas horizon 513-525; sand, 525-537; sand (main Squirrel), 647-671; sand, 677-695; sand, 826-838; sand, 856-886, oil sand, 886-898; sand with traces of oil, 916-952; sand with salt water, 982-992.

Structure. The Paradise anticline was first made known when the western end was found and mapped in the course of field work on the Smithville quadrangle.[1] Subsequent field work indicated its extension to the southeast and the area was leased and drilled by the Trees Oil Company of Winfield, Kansas.

As shown by subsurface mapping, based on plane table elevations, but lacking control outside of the producing area, the Paradise anticline is about 4 miles long, with several small domes along the axis. The trend is northwest-southeast. The greatest amount of northeast dip known from the present development is 32 feet.

[1]Leavenworth-Smithville folio No. 206, U. S. Geol. Survey, 1917, (Mapped in cooperation with the Missouri Bur. Geol. & Mines).

Production. The initial open flow capacity ranged from 75,000 cubic feet to 1,900,000 cubic feet. The rock pressure in the Squirrel sand ranged from 165 to 185 pounds. The gas is piped into Smithville, Liberty, and other nearby towns.

PLATTSBURG POOL.

Location and area. The Plattsburg pool was discovered in 1930. Four or five producing gas wells have been drilled in the east half of section 35, T. 55 N., R. 32 W., Clinton County.

Outcropping formations. Wells in this area start in the Stanton or Plattsburg limestone, or the upper part of the Lane shale.

Producing horizons. The main gas sand is the upper Labette sand (locally termed Peru). Commercial amounts of gas have also been found in the black shale at the Lexington coal horizon and in the Knobtown sand. Good showings have been found in the top of the Winterset limestone and in the Galesburg and Ladore shale. The main gas sand is at a depth of 410 to 500 feet.

Structure. Development to date has not covered sufficient area to justify any definite conclusions as to the structure. The highest well in the field is on the southeast edge in the NW. cor. NE. ¼ SE. ¼ sec. 35, T. 55 N., R. 32 W. There is a southeast dip of 49 feet to a dry hole in the NW. cor. sec. 6, T. 54 N., R. 31 W., and a south dip of 44 feet to a dry hole in the center of the NE. ¼ SW. ¼ sec. 2, T. 54 N., R. 32 W. These dips indicate the possibility of extending the pool to the south.

Production. Two of the best wells had an initial open flow of 800,000 and 1,175,000 cubic feet, respectively.

LATHROP POOL.

(See Fig. 4)

Location and area. The Lathrop pool is in secs. 21, 22, and 28, T. 55 N., R. 30 W., Clinton County. There are seven producing wells in an area of approximately 400 acres. Gas was first found in this area in 1921, but most of the wells were drilled in 1930 and 1931.

Outcropping formations. In the immediate area of the pool the Pennsylvanian rocks are covered by 60 to 85 feet of glacial drift, below which structurally high wells enter the

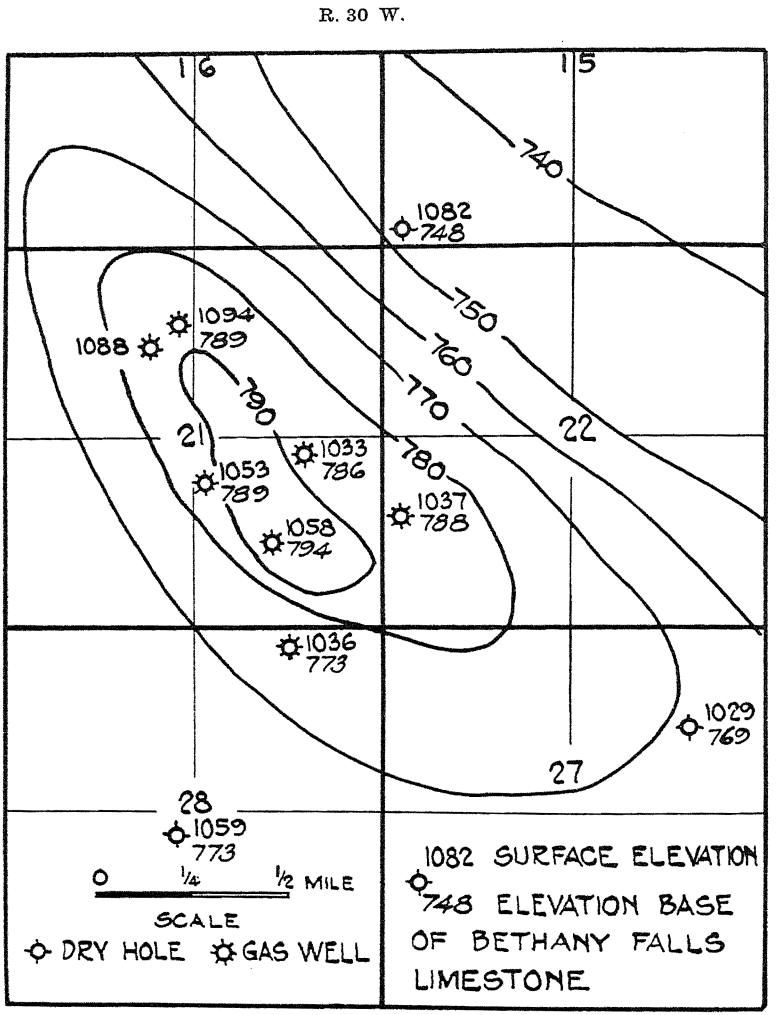


Fig. 4. Lathrop gas pool, Clinton County, Missouri. Contour interval 10 feet.

Lane shale. Wells to the north and south of the dome encountered the basal part of the Plattsburg limestone below the drift.

Producing horizons. The main production is obtained from the Knobtown sand, at a depth ranging from 275 to 325 feet. Showings of gas are reported in the Galesburg and Ladore shales.

Several wells have been drilled below the Knobtown sand. One well located structurally found a showing of gas in the upper Labette sand and a flow of 100,000 cubic feet at what is probably the Lexington coal horizon. An off-structure well was drilled to the "Mississippi lime" which was found at a depth of 1,031

feet (697 feet below Bethany Falls and 680 feet below Hertha). The log of the well is as follows:

MESSLER GAS COMPANY.

Glen Brilhart Well No. 1.

SW. ¼ SW. ¼ sec. 15, T. 55 N., R. 30 W.
Drilled in 1931.
Elevation, 1,082 feet.

	Thickness, Feet.	Depth, Feet.	
Soil	2	2	
Clay, white	41	43	
Yellow clay and quick sand	22	65	Water.
Lime	18	83	(Plattsburg.)
Gray shale	14	97	
Lime	2	99	
Gray shale	4	103	
Gray shale	6	109	
Lime, hard	4	113	
Gray shale	3	116	
Dark shale	17	133	
Lime	2	135	
Gray shale	30	165	
Lime	5	170	(Iola.)
Gray shale	4	174	
Lime	7	181	
Gray shale	8	189	
Black shale	1	190	
Gray shale	10	200	
Lime	7	207	
Red bed	2	209	
Gray shale	16	225	
Lime	6	231	
Gray shale	28	259	
Lime	5	264	
Gray shale	13	277	
Lime	1	278	
Gray shale	4	282	
Lime	26	308	(Winterset.)
Black shale	4	312	
Lime	22	334	
Black shale	3	337	(Bethany Falls.)
Lime	14	351	(Hertha.)
Gray shale	9	360	
Red bed	4	364	
Gray shale	3	367	
Sand	18	385	
Sandy shale	40	425	
Gray shale	25	450	
Green shale	10	460	
Sand	5	465	Gas bubbles 464.
Sand and lime	10	475	
Sand	8	483	
Brown shale	7	490	

MESSLER GAS COMPANY—Continued.

	Thickness, Feet.	Depth, Feet.	
Gray shale	10	500	
Brown lime	8	508	
Sandy shale	17	525	
Lime	5	530	(Pawnee.)
Water sand	8	538	Water.
Lime	3	541	
Black shale	2	543	Water (Lexington coal horizon).
Broken lime	5	548	Set 6 ¼ casing.
Sandy lime	7	555	Light showing of oil.
Green shale	9	564	
Black shale	1	565	
Sandy shale (gray shale)	11	576	
Lime	5	587	
Sandy lime (white)	6	593	
Sandy shale	27	620	
Sandy lime	7	627	
Gray shale	15	642	
Sandy shale	8	650	
Gray shale	26	676	
Lime	2	678	(Rich Hill)
Gray shale	3	681	
Black shale	2	683	
Gray shale	3	686	
Lime	6	692	
Sandy shale	22	714	
Lime	3	717	
Red bed	1	718	
Gray shale	16	734	
Black shale	2	736	
Gray shale	11	747	
Lime	6	753	
Gray shale	27	780	
Dark shale, hard	25	805	Cavy.
Gray shale, shelly	122	927	
Lime	5	932	Light oil showing.
Sand, light	44	976	
Dark shale	4	980	
Sand	5	985	
Dark shale	2	987	
Lime	5	997	
Gray shale	7	1000	
Dark shale	37	1037	
Hard lime	13	1050	(Miss. lime) T. D.

Structure. The Lathrop dome is elongated in a northwest-southeast direction. There is a closure of at least 25 feet and a northeast dip of 62 feet.

Production. The initial open flow ranges from 75,000 to 200,000 cubic feet. The gas is piped into Lathrop.

PARKVILLE POOL.

Location and area. The Parkville pool was discovered in 1911, when the Tiffany Springs Oil and Gas Company drilled a well in the southeastern part of sec. 8, T. 51 N., R. 34 W., Platte County. Subsequently the Parkville Gas Company was organized and drilled several more wells in sec. 17. The gas was piped into Parkville for several years.

Outcropping formations. The Plattsburg and Stanton limestones of the Lansing formation are at the surface in this area, but some of the higher wells penetrate a few feet of sandstone above the Stanton limestone.

Producing horizons. The main gas sand is the upper Labette sand, but showings are found in the Wayside sand and the Lexington coal shale. One hole was drilled to 915 and although it was dry, it is a very complete section of the formations in the pool. It is as follows:

LOG OF E. W. HARRINGTON NO. 1.

SW. cor. SE. ¼ NE. ¼ sec. 17, T. 51 N., R. 33 W.
Commenced Dec. 8, 1929.
Elevation, 926 feet.

	Thickness, Feet.	Depth, Feet.	
Soil, sandy	9	9	
Lime	12	21	(Stanton.)
Black shale	4	25	
Lime	4	29	
Blue shale	16	45	
Lime	18	63	(Plattsburg.)
Gray shale	22	85	
Blue shale	8	93	
Lime	3	96	
Blue shale	5	101	
Lime	3	104	
Gray shale	41	145	
Lime	30	175	(Iola.)
Dark shale	4	179	
Lime shale	7	186	
Lime	9	195	
Light shale	12	207	
Lime	17	224	
Gray shale	14	238	
Lime	4	242	
Gray shale	4	246	
Lime	4	250	
Gray shale	4	254	

LOG OF E. W. HARRINGTON NO. 1—Continued.

	Thickness, Feet.	Depth, Feet.	
Lime	6	260	
Lime shale break	5	265	(Winterset.)
Lime	20	285	
Black shale	5	290	
Lime	20	310	(Bethany Falls.)
Light shale	3	313	
Lime	2	315	
Dark shale	2	317	Water.
Lime	10	327	(Hertha.)
Light shale	8	335	
Lime shale, broken	20	355	
Gray shale	13	368	
Gray sand	10	378	
Gray shale	56	434	
Sandy shale	8	442	
Red rock	5	447	
Green shale	1	448	6 ¼ casing at 449.
Sand	19	467	Show of gas.
Gray shale	7	474	
Gray sand	11	485	Show of gas.
Gray shale	13	498	
Lime	4	502	
Black shale	2	504	
Br. lime	4	508	
Gray shale	9	517	
Br. lime	6	523	(Pawnee.)
Light shale	3	526	
Dark sand	8	534	Show of gas (upper Labette sand).
Blue shale	11	545	
Lime	3	548	
Black shale	3	551	Show of gas (Lexington horizon).
Dark shale	19	570	
Black shale	5	575	
Dark shale	13	588	
Lime	3	591	
Dark shale	4	595	
Sandy white shale	27	622	
Light shale	5	627	
Dark shale	15	642	
Black shale	3	645	
Shale, black	5	650	Gas, none.
Gray shale	34	684	
Lime shale, dark, broken	5	689	
Black slate	6	695	No water; no gas.
Shale	5	700	
Lime	1	701	
Lime and shale	2	703	
Lime and shale	4	707	
Lime shale	8	715	
Sand	4	719	(Bartlesville.)
Shale	1	720	
Light shale	15	735	SLM.

LOG OF E. W. HARRINGTON NO. 1—Continued.

	Thicknes, Feet.	Depth, Feet.	
Lime	3	738	
Dark shale	11	749	L. M. 749.
Black shale	3	752	
Dark shale	43	794	
Sandy shale	11	806	
Black shale	4	810	
Sand	8	818	
Shale, white, sandy	4	822	
Sand	18	840	
Shale, light	13	853	
Sand	5	858	Water.
Shale, dark	7	865	
Lime, dark	6	870	
Coal	1	871	
Sand and lime	3	874	SLM.
Sandy dark shale, shell	6	880	
Dark shale	5	885	
Dark shale	5	890	
Soft sand	25	915	T. D. Water.

Structure. Logs have been obtained of a few wells. These show 22 feet of dip from the well in sec. 8 to the well in the SW. cor. sec. 9, about one-eighth mile east, 7 feet to a dry hole one-half mile south and 70 feet to a dry hole to the southwest in the SE. cor. NW. ¼ sec. 17.

Production. The only well on which production figures are available is the discovery well. This is reported to have flowed 1,000,000 cubic feet per day. The original rock pressure is reported to have been 145 to 147½ pounds.

FUTURE DEVELOPMENT.

In all of the counties in which production has been found there are unexplored areas. If the surface formations show folding indicative of favorable structure, any of the undrilled areas in these counties are worthy of testing.

The counties north and west of the productive area have had less than twenty-five holes sufficiently deep to test even the Knobtown sand zone in the upper part of the Pleasanton formation. However, these holes, several of them made with a diamond drill, prove conclusively that black slaty shales and sandstones are present over the entire northwestern part of the state, and under favorable structural conditions, may reasonably be expected to produce.

The Bureau has been actively engaged in securing well logs, well cuttings and elevations in the northwestern counties, and while this type of information is incomplete, the results are constantly posted and available to drillers and operators for guidance in prospecting.

Logs of several deep wells in the northern counties are appended.

LOG OF NORTH CENTRAL OIL AND GAS COMPANY.

Wm. Berndt No. 1.

SW. ¼ NE. ¼ sec. 1, T. 66 N., R. 24 W., Mercer County.
Drilled Oct. 30 to Nov. 15, 1930.
Elevation, 1,036 feet.

	Thickness, Feet.	Depth, Feet.	
Clay and sand	90	90	
Shale	48	138	
Sandy lime	4	142	
Sandy shale	13	155	
Shale, grey	55	210	
Shale, dark	8	218	
Sandy lime	7	225	
Lime shells and shale	39	264	
Slate	2	266	(Lexington coal horizon.)
Lime	13	279	
Shale	2	281	
Lime	4	285	(Upper Ft. Scott.)
Sandy lime	5	290	
Lime	4	294	
Shale	17	311	
Lime	6	317	(Lower Ft. Scott.)
Shale	4	321	
Sandy shale	49	370	(Squirrel.)
Shale, gray	20	390	
Shale, dark	5	395	
Shale	3	398	Show coal.
Shale, black	5	403	
Limey sand	9	412	(Rich Hill.)
Sandy shale	8	420	
Shale, black	5	425	
Shale	22	447	
Shale, gray	4	451	
Lime, brown	3	454	
Shale, black	10	461	
Shale, gray	19	480	
Shale, black	25	505	
Shale	8	513	
Red rock	2	515	
Shale	20	535	
Shale, black	55	590	
Sand	10	600	
Shale, black	5	605	

LOG OF NORTH CENTRAL OIL AND GAS COMPANY—Continued.

	Thickness, Feet.	Depth, Feet.	
Lime and shale	22	627	
Sand	18	645	Water.
Shale, dark	15	660	
Sand	8	668	
Shale	12	680	
Sandy shale	15	695	
Sandy lime	5	700	
Shale	59	759	
Sand	8	767	
Lime	3	770	
Sand, white	12	782	Water.
Shale	8	790	
Shale, black	23	813	
Sand, some lime	17	830	
Shale	3	833	
Sand, white, fine	34	867	Burgess, water.
Lime	91	958	T. D. Mississippian.

Casing Record.

10-inch.....125 feet
8-inch.....464 feet
6-inch.....756 feet

LOG OF QUITMAN OIL AND GAS COMPANY.

Getta Karr No. 1.

SE. ¼ SE. ¼ sec. 22, T. 64 N., R. 37 W., Nodaway County.
Completed Aug. 28, 1926.
Elevation, 923 feet.

	Thickness, Feet.	Depth, Feet.	
Surface	6	6	
Clay, yellow	10	16	
Gravel	15	31	
Sand	15	46	
Clay, yellow	10	56	
Clay, blue	10	66	
Lime, hard	3	69	
Shale, broken	27	96	
Lime, gray	2	98	
Shale, blue	2	100	
Lime	3	103	
Shale, blue	27	130	
Lime	25	155	
Shale, broken	5	160	
Lime	15	175	
Shale and lime	10	185	
Lime	15	200	

LOG OF QUITMAN OIL AND GAS COMPANY—Continued.

	Thickness, Feet.	Depth, Feet.	
Shale, blue	10	210	
Lime, white	6	216	
Shale, brown	34	250	
Lime, white	10	260	
Shale, black	3	263	
Lime	5	268	
Shale, brown	7	275	
Lime, gray	8	283	
Shale, light	5	288	
Shale, brown	4	292	
Lime, white	6	298	
Shale, dark	1	299	
Lime	11	310	
Shale, sandy	5	315	
Lime, gray	5	320	
Shale, dark	10	330	
Lime, gray	5	335	
Shale, sandy	21	356	
Shale, brown	9	365	
Shale, light	57	422	
Shale, dark	75	497	
Lime	1	498	
Shale, light	3	501	
Lime, hard	6	507	
Shale, dark	11	518	
Lime	4	522	
Shale, dark	8	530	
Lime, gray	5	535	
Shale, light sandy	5	540	
Lime, gray	5	545	
Shale, dark	10	555	
Lime, gray	2	557	
Shale, light sandy	3	560	
Lime	5	565	
Slate, dark	8	573	
Lime	7	580	
Shale, sandy	6	586	
Lime	3	589	
Shale, sandy	12	601	
Lime	2	603	
Shale, sandy	20	623	
Shale, dark	19	642	
Lime	1	643	
Shale, light	5	648	
Lime, gray	4	652	
Shale, dark	15	667	
Lime	2	669	
Shale	6	675	
Lime	15	690	
Shale, sandy	5	695	
Shale, dark	6	701	
Lime, gray	6	707	
Shale, sandy	5	712	

LOG OF QUITMAN OIL AND GAS COMPANY—Continued.

	Thickness, Feet.	Depth, Feet.	
Lime	5	717	
Lime, gray	11	728	
Shale, light	5	733	
Lime	3	736	(Winterset.)
Shale	5	741	
Lime	13	754	Gas.
Shale	5	759	
Lime, blue	26	785	(Bethany Falls.)
Shale, dark	11	796	
Lime, black	17	813	(Hertha.)
Shale, light	5	818	
Shale, dark	5	823	
Shale, light	10	833	
Lime	7	840	
Shale, light	3	843	
Lime	7	850	
Shale	13	863	
Shale, red	4	867	
Lime	5	872	
Shale, broken	5	877	
Lime	3	880	
Shale, light	5	885	
Shale, broken, sandy	35	920	
Lime	3	923	
Shale, sandy	20	943	
Shale, dark	30	973	
Lime, hard	4	977	
Shale, blue	16	993	
Lime	2	995	
Shale, blue	5	1000	
Lime	2	1002	
Shale, dark	25	1027	
Shale, blue	20	1047	
Lime	2	1049	
Shale, dark	25	1074	
Lime	1	1075	
Shale, dark	30	1105	
Lime	5	1110	(Rich Hill.)
Shale, black	10	1120	
Shale, light	12	1132	
Lime, hard	3	1135	
Shale, light	23	1158	
Lime	1	1159	
Shale, light	16	1175	
Shale, dark	20	1195	
Lime	2	1197	
Shale	3	1200	
Shale, black	5	1205	
Shale, light	11	1216	
Lime	1	1217	
Shale, light	9	1226	
Shale, dark	6	1232	
Lime	2	1234	
Shale, dark	15	1249	

LOG OF QUITMAN OIL AND GAS COMPANY—Continued.

	Thickness, Feet.	Depth, Feet.	
Shale, light	11	1260	
Lime	1	1261	
Shale, dark	4	1265	
Lime	10	1275	
Shale, gray	1	1276	
Lime	3	1279	
Shale, gray	5	1284	
Lime	4	1288	
Shale, sandy	12	1300	
Sand	9	1309	Rainbow, good oil showing.
Shale, black	36	1345	
Shale, blue	10	1355	
Shale, light	5	1360	
Shale, sandy	29	1389	
Shale, black	15	1404	
Lime	5	1409	
Shale, black	26	1435	
Lime	4	1439	
Shale, dark	2	1441	
Lime	2	1443	
Shale, sandy	3	1446	
Lime, gray	9	1455	
Shale, sandy	10	1465	
Shale, black	5	1470	
Lime	3	1473	
Shale, dark	13	1486	
Lime, black	10	1496	
Shale and lime, black	12	1508	
Shale, broken, gray	9	1517	
Lime	1	1518	
Shale, light	3	1521	
Lime	2	1523	
Shale, dark	11	1534	
Shale	9	1543	
Shale, dark	19	1562	
Shale, black	11	1573	
Shale and lime	5	1578	
Lime and shale	12	1590	
Shale, broken	4	1594	
Lime and shale	25	1619	
Shale, dark	4	1623	
Lime	1	1624	
Shale, dark	20	1644	
Sand	55	1699	Water.
Lime	1	1700	(Mississippian.)

Casing Record.

66 feet.....12½ inch
725 feet.....10 inch
1215 feet..... 8 inch
1485 feet..... 6¼ inch

LOG OF CONNETT NO. 1, NEAR SAXTON, MO.

SW. cor. NW. ¼ NW. ¼ sec. 21, T. 57 N., R. 34 W., Buchanan County.
Diamond Drill Hole, Drilled May 3-June 26, 1900.
Elevation, 836 feet.

	Thickness.		Depth.		
	Ft.	*In.*	*Ft.*	*In.*	
Clay	23		23		
Sand	2		25		
Gravel	4		29		
Shale, blue	1		30		
Limestone	1		31		
Shale, blue	1		32		
Limestone	20		52		(Stanton.)
Shale, blue	4	6	56	6	
Limestone	16	6	73		(Plattsburg.)
Shale, blue	6		79		
Limestone	1		80		
Sandstone	17		97		
Shale, blue	1		98		
Limestone	2		100		
Shale, blue	9		109		
Limestone	4		113		
Shale, blue	4		117		
Limestone	1		118		
Shale, blue	38		156		
Limestone	7	6	163	6	(Iola.)
Limestone, fossiliferous	4		167	6	
Shale	5		172	6	
Limestone		6	173		
Shale	9		182		
Limestone	4		186		
Shale, blue	8		194		
Limestone	6		200		
Shale, blue	1	6	201	6	
Limestone	1		202	6	
Shale, blue	3	6	206		
Limestone	5		211		
Shale, blue	13		224		
Limestone	2		226		
Shale, blue	7		233		
Limestone	5		238		
Shale, blue	6		244		
Limestone	8		252		
Shale, blue	1		253		(Winterset.)
Limestone	20		273		
Shale	6		279		
Limestone	21	6	300	6	(Bethany Falls.)
Shale, blue	2		302	6	
Limestone	18	6	321		(Hertha.)
Shale, black	1		322		
Coal		1	322	1	(Ovid.)
Blue shale		11	323		
Sandy shale	40		363		(Knobtown.)
Blue shale	53		416		

LOG OF CONNETT NO. 1, NEAR SAXTON, MO.—Continued.

	Thickness.		Depth.		
	Ft.	*In.*	*Ft.*	*In.*	
Sandy shale	13		429		(Wayside.)
Blue shale	11		440		
Limestone	1		441		
Shale, blue	8		449		
Limestone	3		452		
Shale, sandy	6		458		
Limestone	2		460		
Shale	23		483		
Limestone, conglomeratic	2		485		
Shale, black	3		488		
Limestone	1		489		
Sandstone	6		495		
Shale, black	11	6	506	6	
Limestone, blue	1	6	508		
Shale	2	5	510	5	
Coal		7	511		(Lexington.)
Shale, blue	8		519		
Limestone	7		526		
Shale, blue	9		535		
Limestone	3		538		
Shale, mixed with limestone	5		543		
Limestone	4	6	547	6	
Shale	5	6	553		
Sandstone	5		558		(Top of Squirrel.)
Shale, clayey	4		562		
Sandstone	3		565		
Shale, blue	22		587		
Sandstone	3		590		
Shale, blue	6		596		
Sandstone	2		598		
Shale, blue	16		614		
"Cap rock"	1		615		
Coal	1	8	616	8	(Bedford.)
Sandstone	11	4	628		(Bottom of Squirrel sand.)
Shale, blue	17		645		
Coal	1	9	646	9	(Bevier.)
Shale, blue	3	3	650		
Limestone	3		653		
Shale	14		667		
Sandstone	8		675		
Shale	13	4	688	4	
Coal	1	5	689	9	
Shale	28	9	718	6	
Coal	1	6	720		
Shale	22	9	742	9	
Coal	1	6	744	3	
Shale	12	9	757		
Coal slaty		3	757	3	
Shale, blue	11	9	769		
Sandstone	11		780		
Shale, blue	4		784		
Sandstone	2		786		

LOG OF CONNETT NO. 1, NEAR SAXTON, MO.—Continued.

	Thickness.		Depth.		
	Ft.	*In.*	*Ft.*	*In.*	
Shale, blue	80		866		
Sandstone	1		867		
Shale, blue	3		870		
Sandstone	12		882		
Conglomerate	5		887		
Shale, blue	22		909		
Sandstone	9		918		
Shale, sandy	1		919		
Sandstone	9		928		
Coal		6	928	6	
Shale, blue	20	6	949		
Coal		7	949	7	
Shale, sandy	6	5	956		
Shale, blue	4	4	960	4	
Coal	1	4	961	8	
Sandstone	3	4	965		
Shale, blue	7		972		
Limestone	3		975		
Shale, blue	7		982		
Sandstone	2		984		
Shale, sandy	9		993		
Coal		10	993	10	
Sandstone	3	2	997		
Shale, sandy	1		998		
Sandstone	5		1003		
Shale	43		1046		
Sandstone	4		1050		
Shale, blue	1		1051		
Sandstone	26		1077		
Limestone	39		1116		(Mississippian.)

LOG OF MISSOURI INDEPENDENT OIL AND GAS COMPANY.

W. O. Bishop No. 1.

NW. ¼ sec. 20, T. 65 N., R. 41 W., Atchison County.

Completed Dec., 1928.

Elevation, 1,096 feet.

	Thickness, Feet.	Depth, Feet.	
Soil	90	90	
Sand, red	28	118	
Blue mud	3	121	
Clay, blue	32	153	
Lime	2	155	
Clay, blue	15	170	
Lime, gray	1	171	
Shale, black	23	194	(Small amount of water.)

LOG OF MISSOURI INDEPENDENT OIL AND GAS COMPANY—Continued

	Thickness, Feet.	Depth, Feet.	
Lime, brown, sandy	2	196	
Shale, dark	4	200	
Lime, gray, very hard	4	204	
Coal	1	205	
Shale, green to light gray	19	224	
Lime	7	231	
Shale, dark	3	234	
Lime and shale	3	247	
Shale, dark	2	249	
Red bed	7	256	
Shale, blue to dark	15	271	
Lime	3	274	
Shale, dark	56	330	
Shale, light green to white	21	351	Salt water.
Shale, dark pyrite	19	370	
Lime and shale	10	380	
Lime, gray	30	410	
Shale, sandy	13	423	
Lime	7	430	
Sand (oil showing)	3	433	
Coal	1½	434½	
Shale, dark	17½	452	
Lime	8	460	
Shale, dark	3	463	
Lime, hard	46	509	
Shale, white	10	519	
Shale, green	9	528	
Lime	2	530	
Shale, dark	3	533	Light water; salty.
Lime varied	20	553	
Shale, dark	3	556	
Lime, hard	2	558	
Shale, green	15	573	
Shale, brown	2	575	
Shale, light	41	616	
Lime, white	4	620	
Shale, light	5	625	
Shale, dark	6	631	
Lime	9	640	
Shale, light	4	644	
Lime, very hard	11	655	
Shale, light	11	666	
Lime and sand	34	700	
Shale, black	1	701	
Lime	2	703	
Shale, dark to blue	8	711	
Red bed	19	730	
Shale	68	798	
Shale, dark	3	801	
Sand	2	803	
Shale, dark	3	806	
Lime	1	807	
Red bed	7	814	
Shale, dark	6	820	

LOG OF MISSOURI INDEPENDENT OIL AND GAS COMPANY—Continued

	Thickness, Feet.	Depth, Feet.	
Lime, hard	16	836	
Shale, dark	2	838	
Lime	10	848	
Lime, sandy	3	851	
Lime, white	37	888	
Shale, dark	8	896	
Lime, coarse white chalky	14	910	
Shale, dark	3	913	
Lime	33	946	
Shale, blue	10	956	
Lime	11	967	
Shale, green	3	970	
Lime	16	986	
Shale, dark	9	995	
Lime	1	996	
Shale, blue	2	998	
Lime, black sandy	4	1002	
Shale, dark	5	1007	
Lime, gray	21	1028	(Winterset.)
Shale, dark black	3	1031	
Shale, light	7	1038	
Lime	34	1072	(Bethany Falls.)
Shale, dark	3	1075	
Lime	2	1077	
Slate, dark	3	1080	
Lime, gray	15	1095	(Hertha.)
Shale, dark	2	1097	
Lime	4	1101	
Shale, light blue	17	1118	
Shale, black	18	1136	
Lime	2	1138	
Shale, dark	12	1150	
Shale, light, blue, sandy	21	1171	
Shale, green	33	1204	
Shale, green	15	1221	
Shale, brown	20	1241	
Shale, gray	6	1247	
Shale, black	3	1250	
Shale, dark	15	1265	
Lime	1	1266	
Shale, light	10	1276	
Shale, black	6	1282	
Shale, light	38	1320	
Sand	10	1330	Water (top of Squirrel).
Shale, sandy and gray	10	1340	
Shale, dark	20	1360	
Shale, black and slaty	2	1362	
Shale, light and sandy	14	1376	(Bottom of Squirrel sand.)
Shale, black	2	1378	

LOG OF MISSOURI INDEPENDENT OIL AND GAS COMPANY—Continued

	Thickness.	Depth.	
Lime	2	1380	
Shale, dark	10	1390	
Lime	1	1391	Rich Hill
Shale	5	1396	or
Lime	7	1403	Ardmore.
Shale, dark	3	1406	
Lime	2	1408	
Sandy shale, black	1	1409	
Shale, dark	39	1448	
Sandstone	2	1450	
Shale, blue to black, sandy streaks	17	1467	
Sand	6	1473	
Shale, brown	2	1475	
Shale, gray	37	1512	
Limestone	2	1514	
Sandstone	2	1516	
Shale	4	1520	
Sandstone	5	1525	
Shale, light, gray	5	1530	
Sandstone	5	1535	
Shale, light, gray	15	1550	
Sandstone	30	1580	Salt water showing.
Shale, white	10	1590	
Shale, white	20	1610	
Sandstone	25	1635	
Lime, soft	20	1655	
Lime, hard	5	1660	
Shale, brown	15	1675	
Lime	10	1685	
Lime, soft	5	1690	
Sandstone, bottom of hole	23	1713	