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OIL AND GAS IN OKLAHOMA

HASKELL, LATIMER, LEFLORE, AND SEQUOYAH COUNTIES

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FOREWORD

In 1917 the Oklahoma Geological Survey issued Bulletin 19, Part II, entitled "Petroleum and Natural Gas in Oklahoma." This volume was so popular that the supply was soon exhausted and for several years copies have not been obtainable.

The present Director has seen the need of a revision of this bulletin. On account of the lack of appropriations he has not been able to employ sufficient help to compile the data, and has called on some twenty representative geologists throughout the State to aid in the preparation of reports on separate counties. These gentlemen, all busy men, have contributed freely of their time and information in the preparation of these reports.

It will be understood that the facts as set forth in the various reports represent the observation and opinion of the different men. The Oklahoma Geological Survey has every confidence in the judgment of the various authors, but at the same time the Survey does not stand sponsor for all statements made or for all conclusions drawn. Reports of this kind, are at best, progress reports, representing the best information obtainable as of the date issued, and doubtless new data will cause many changes in our present ideas.

This report was originally written by Mr. J. A. Stone, assistant geologist of the Oklahoma Geological Survey, with the cooperation of the men and compaines operating in this area. Mr. Stone left the employ of the Survey before the report was entirely completed. The original development data and the structure map of the four counties have been revised and brought up to date of July, 1929 by Mr. C. L. Cooper of the Survey staff.

CHAS. N. GOULD,
Director.

Norman, Oklahoma
September, 1929.

OIL AND GAS IN OKLAHOMA

GEOLOGY OF HASKELL, LATIMER. LEFLORE, AND SEQUOYAH COUNTIES

LOCATION

Haskell, Latimer, LeFlore, and Sequoyah counties are located in the southeastern and central-eastern part of the State. The total area of the four counties is 3,719 square miles (Haskell, 616; Latimer, 732; LeFlore, 1,637; Sequoyah, 734).

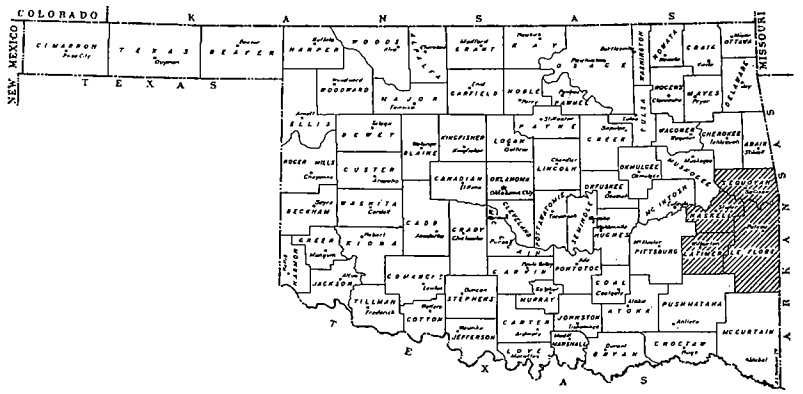

Figure 1. Index map of Oklahoma showing area covered by this report.

The four counties, Haskell, Latimer, LeFlore, and Sequoyah, comprise parts of three topographic regions. Southern Latimer and southern LeFlore counties are in the Ouachita Mountain region; northern Latimer and northern LeFlore counties, all of Haskell County, and most of Sequoyah County lie in the sandstone Hills region; the north central part of Sequoyah County is in the Ozark Plateau region.

ACKNOWLEDGMENTS

The authors have drawn freely from Oklahoma Geological Survey Bulletin 19, Pt. II,[1] for the geology and structure of the four counties contained in this report. Part of the stratigraphy was taken from Oklahoma Geological Survey Bulletin 35.[2] Data on develop-

1. Shannon, C. W., and others, Petroleum and natural gas in Oklahoma: Oklahoma Geol. Survey Bull. 19, Pt. II, 1917.
2. Gould, Chas. N., Index to the stratigraphy of Oklahoma: Oklahoma Geol. Survey Bull. 35, 1925.

ment were obtained in a personal canvass of the producers within the counties. Most hearty co-operation was received from Mr. James B. Millar of the LeFlore County Gas and Electric Company on LeFlore and Sequoayh counties, and Mr. L. P. Coblentz of the Quinton Spelter Company, on the Quinton and Kinta gas fields. Valuable information was also given by Judge C. R. Hunt and Mr. Carlton Weaver of Wilburton, Mr. A. A. Ash of Red Oak, and Mr. Robertson, Postmaster of Talihina, on the development in Latimer County.

Much constructive criticism and advice have been given by members of the Oklahoma Geological Survey Staff, Dr. C. W. Honess, Geologist of the Gypsy Oil Company, and Mr. Millar.

GEOLOGY

Haskell, Latimer, LeFlore, and Sequoyah counties are covered with formations ranging in age from lower Ordovician to lower Pennsylvanian. These formations will be described very briefly in this report, because they have been described fully in other reports in this series, and in other bulletins of the Oklahoma Geological Survey.[3]

STRATIGRAPHY

SOUTH OF CHOCTAW FAULT

STRINGTOWN SHALE

This formation outcrops in a narrow band paralleling the south side of the Choctaw fault in southern Latimer County. The Stringtown is made of black, bluish, greenish, and white cherts, clay shales, and thin lentils of blue limestone. The age is lower Ordovician.

TALIHINA CHERT

This formation outcrops in southeastern Latimer County. It is made up of black, bluish, greenish, and white cherts, cherty shales, and thin lentils of blue limestone near the bottom. The age of the Talihina is Ordovician, Silurian, and Devonian.

STANLEY SHALE

This formation is exposed at the surface in the southern part of Latimer and LeFlore counties, south of the Choctaw fault. It is made up of thin-bedded, fine-grained, dark-colored, hard sandstones, and blue clay shales and slates. The Stanley also contains a bed of tuff, a layer of cone-in-cone concretions, and a bed of black chert. The age of this formation is Mississippian.

3. Shannon, C. W., Petroleum and natural gas in Oklahoma: Oklahoma Geol. Survey Bull. 19. Pt. II, 1917.
Gould, C. N., Index to the stratigraphy of Oklahoma: Oklahoma Geol. Survey Bull. 35, 1925.
Honess, C. W., Geology of the southern Ouachita Mountains of Oklahoma: Oklahoma Geol. Survey Bull. 32, 1923.
Honess, C. W., Oil and gas in Oklahoma, Atoka, Pushmataha, McCurtain, Bryan, and Choctaw counties: Oklahoma Geol. Survey Bull. 40-R, 1927.

Correlation Table

AGE	SOUTHEASTERN OKLAHOMA	CENTRAL-EASTERN OKLAHOMA
PENNSYLVANIAN	Absent	Absent
	Boggy shale 2000-3000 Savanna ss. 750-2000	
	McAlester sh. 1150-2500 Hartshorne ss. 100-200 Atoka fm. 2000-7800	Winslow fr. 1050-1100
	Wapanucka ls. 0-800	Morrow fm. 100-120
MISSISSIPPIAN	Caney shale 800-1600	Pitkin ls. 0-80 Fayetteville sh. 20-200 Batesville ss.
	Jackfork ss. 3800	Moorefield sh.
	Stanley sh. 6100	Boone ls. 100-450
	?	Chattanooga sh. 0-100
DEVONIAN	Talihina chert 1150-1200	Absent
SILURIAN		St Clair marble 0-100
ORDOVICIAN		Absent
		Not exposed
	Stringtown sh. 600	
CAMBRIAN	Not exposed	Not exposed

JACKFORK SANDSTONE

The Jackfork is the mountain-forming formation of southern Latimer and LeFlore counties, south of the Choctaw fault. It is made up of heavy-bedded, massive gray sandstones, interbedded with dark shales. The age of the Jackfork is Mississippian.

CANEY SHALE

This formation is exposed in various places in southern Latimer and LeFlore counties. It is made up of black shales and slates with limestone lentils, and lighter colored blue and greenish-blue shales with sandy members. The Caney is of upper Mississippian and lower Pennsylvanian in age.

WAPANUCKA LIMESTONE

The Wapanucka formation is exposed in southern Latimer County, paralleling the north flank of the Ouachita Mountains. It is com-

posed of light-brown limestones, sometimes oolitic, with cherts, sandstones, and shales. The Wapanucka is lower Pennsylvanian in age.

ATOKA FORMATION

The Atoka formation is exposed at the surface in two small areas in Haskell County, and across the central part of Latimer and LeFlore counties north of, and parallel to, and south of, the Choctaw fault. It is made up of beds of shales and sandstones. This formation contains the gas producing sands in the Mansfield (Fort Smith) gas field in Arkansas. It is lower Pennsylvanian in age.

NORTH OF CHOCTAW FAULT

ST. CLAIR MARBLE

The St. Clair marble is exposed just north of Marble City in northern Sequoyah County. It is a pinkish-white, coarsely crystalline rock. This marble has been quarried near Marble City for building stone. It is of Silurian age.

CHATTANOOGA SHALE

The Chattanooga outcrops in northern Sequoyah County. It is a black, slaty, bituminous shale, usually non-calcareous. This formation is probably a transition between the Devonian and Mississippian ages.

BOONE FORMATION

The Boone shales, limestones, and cherts outcrop in northern Sequoyah County. This formation is Mississippian (Fern Glen to Warsaw) age.

FAYETTEVILLE SHALE

There are scattered outcrops of Fayetteville shale near the northwestern corner of Sequoyah County. This is a dark bituminous shale with a few sandstone and limestone lentils. The age of the Fayetteville is upper Mississippian (Chester).

PITKIN LIMESTONE

The Pitkin limestone is exposed to the surface in the same areas with the Fayetteville shales, in northwestern Sequoyah County. This formation varies from brown, earthy, shaly limestone, to fine-textured, massive, bluish limestone. Oolitic types are common. It is upper Mississippian in age.

MORROW FORMATION

This formation outcrops in the northwestern part of Sequoyah County. The Morrow is made up of sandstones, shales, and limestones. It is lower Pennsylvanian in age, and correlates with the Wapanucka.

HARTSHORNE SANDSTONE

The Hartshorne outcrops in a narrow strip just above the Atoka in Latimer, Haskell, LeFlore, and the south part of Sequoyah counties. This formation consists of sandstones, shales, and coal beds. It is of lower Pennsylvanian age.

McALESTER SHALE

The McAlester outcrops over most of Haskell, the north-central and northeast parts of Latimer, northwestern and eastern LeFlore, and most of Sequoyah counties. The beds mapped as Winslow in northern Sequoyah County are McAlester. It is made up of shales, with some lenticular sandstones and coal beds. The age of the McAlester is lower Pennsylvanian.

SAVANNA FORMATION

This formation is exposed irregularly over areas in Haskell, Latimer, and LeFlore counties, between the McAlester and Boggy shales. It is made up of three massive sandstone beds divided by sandy shales. The age of the Savanna is lower Pennsylvanian.

BOGGY SHALE

The Boggy shale forms the surface rocks of west-central and southeastern Haskell County, north-central Latimer County, and the southwestern part of LeFlore County. This formation is made up of great thicknesses of shales with thin sandstone lentils. The age of the Boggy is lower Pennsylvanian.

ALLUVIUM AND TERRACE DEPOSITS

The sands and gravels along the streams are of Recent age.

HASKELL COUNTY

Structure

The relation of the structure to topography is intimate. All of the larger hills or mountains are synclinal, and many of the smaller features are also related to structure. Several folds of importance are found in this county, the general courses of which are in a northeast-southwest direction.

The principal folds named in order as they occur across the county, from the northwest corner to the southeast corner, are as follows: The Porum syncline; the Enterprise anticline, which forks in the eastern part of T. 9 N., R. 19 E.; the Vian anticline; the Kanima

anticline, which bears to the south of Stigler and passes through Kanima, Gans, Muldrow, Rowland, and east to the Arkansas River; the Cowlington syncline, which extends entirely across the county, dividing it into almost equal parts; the Kinta anticline, which comes in at the west side of the county, passes through Kinta and extends northeastward for a distance of 18 miles and is lost near Ironbridge; the Siloam syncline along the south side of Sansbois Creek in the central part of the county; the Milton anticline begins near Lequire and extends past McCurtain, through LeFlore County into Sequoyah County at or near Milton, Redland, Cottonwood, and ends 4 miles southeast of Ft. Smith (SE. cor. 36, T. 11 N., R. 26 E.) to the Arkansas River; and the Sansbois syncline through the southeastern corner in Sansbois Mountain. The axis of the Brazil anticline passes parallel to the other lines of structure just to the southeast of the corner of the county. (See pl. II, in pocket).

Development

Many wells have been drilled in Haskell County, with important production only in the southwestern part.

The east end of the Quinton gas field is in Haskell County, between Quinton and Kinta. The Kinta gas field extends from southwest to northeast of Kinta.

The Quinton Spelter Company of Quinton owns all the production in those fields. They furnish gas for their zinc smelter at Quinton, and for the cities of Quinton, Kinta, Whitefield, and Stigler in Haskell County, and for Featherston, Blocker, and McAlester in Pittsburg County.

Two wells drilled in sec. 4, T. 9 N., R. 18 E., near Brooken, were dry.

A well drilled in SE. ¼ sec. 15, T. 8 N., R. 18 W., was dry.

A well drilled in sec. 4, T. 9 N., R. 20 E., northeast of Whitefield was dry.

A dry hole was drilled in sec. 35, T. 10 N., R. 22 E.

In 1920 a well was drilled in the NW.¼ NW.¼ SW.¼ sec. 8, T. 8 N., R. 17 E.

KINTA FIELD

In 1927 an 880,000 cubic foot gasser was drilled in SW.¼ NE.¼ SE.¼ sec. 23, T. 8 N., R. 20 E., at 904 feet. The rock pressure was 260 pounds.

A well drilled in 1927 in NE.¼ NE.¼ sec. 24, T. 8 N., R. 20 E., had an initial flow of 304,320 cubic feet of gas at 880 feet. The rock pressure was 265 pounds. The same year a well drilled in NE.¼ NE.¼ NW.¼ sec. 28, T. 8 N., R. 20 E., had an initial flow of 550,000 cubic feet of dry gas at 899 feet, and a rock pressure of 260 pounds.

Two wells, each with an initial capacity of 1,040,000 cubic feet, were drilled in sec. 32, T. 8 N., R. 20 E., in 1926. The rock pressure was 295 pounds. The largest well in the Kinta field was the Quinton Spelter Company's No. 1 Aldridge, in SE.¼ SW.¼ sec. 6, T. 7 N., R. 19 E. Its initial flow was 8,922,000 cubic feet of dry gas, at 1,460 feet. The well was completed in August, 1919.

In the Quinton and Kinta gas fields the sand becomes thicker, the production greater, and the rock pressure higher, from east to west. The average rock pressure in the Kinta field is 250 pounds. In the Quinton field, near the Pittsburg-Haskell county line the rock pressure is 530 pounds. Farther west in the Quinton field in Pittsburg County it is 596 pounds.

The Quinton Spelter Company's No. 1 Curry, in sec. 9, T. 7 N., R. 18 W., was estimated at 50,000,000 cubic feet of wet gas. The sand 12 miles west of the Curry well, near Blocker is 325 feet thick. The same company, which owns all the production in the Quinton and Kinta fields, has several producers in the area of the Curry well of 33,000,000 to 40,000,000 cubic feet capacity.

The depth of the gas sand ranges from 771 feet in sec. 32, T. 8 N., R. 20 E., to around 1,740 feet along the Pittsburg-Haskell county line, and to 3,200 feet near Blocker in Pittsburg County.

Summary

Haskell County can be considered as lying entirely in probable gas territory. The general geology and structural conditions are favorable for the finding of gas, with some possibilities for oil.

Several anticlinal folds of importance occur in the county, and many smaller favorable structures may be found by detailed work. It is highly probable that the less prominent structures may prove most productive in this area. The folding has been very intense and deep-seated in some of the large structures and is perhaps too steeply tilted and too much broken to permit the accumulation of oil. It seems, however, that the county may be considered very favorable for the finding of gas. The miscellaneous drilling which has been done in the county has not necessarily condemned the territory for further prospecting and conditions warrant further investigation.

LATIMER COUNTY

Structure

CHOCTAW FAULT

The greatly folded belt of the south half of the county is limited abruptly on the north by a very extensive fault zone. This great displacement is called the Choctaw fault and separates the more gently

folded northwestward-dipping rocks on the northwest side from the overthrust southeastward-dipping older rocks of the southeast side. Instead of this being called a distinct fault it will be better to term the immediate locality of displacement of rocks as a fault zone in which the line of displacement known as the Choctaw fault is the principal line in breaking. There are many minor faults closely associated with the principal displacement. This zone enters the county near the center of the east side and bears west and southwest entirely across the county. The amount of displacement is very great, and in the folded regions on both sides of the main fault line the rocks are steeply folded and contain many minor faults, many of which have no doubt been concealed by intense folding and overthrust faulting. In practically all cases the overthrust is to the north and northwest.

STRUCTURE NORTH OF THE CHOCTAW FAULT

The northern half of the county is much folded and faulted. Most of the stream valleys are anticlinal, and the rough, mountainous regions of massive sandstones comprise the synclinal areas. The dip of the rocks is in most cases steep, and most of the folds are asymmetrical, and in many cases have been broken by overthrust faulting. In addition to being sharply folded and faulted the formations are badly broken throughout the entire region.

The numerous occurrences of asphalt indicate that oil was present at some time in these formations, but this is also proof that the lighter oils have escaped, leaving behind the asphaltic base. It is probable that, on account of the great thicknesses of shales, some of the oil may have been sealed in. However, the chances for successful development are very slight.

The axis of the Cavanal syncline extends from about Panola in the center of the county, eastward north of Red Oak, Denman, and Barton, to the county line. From this point the axis extends in an almost direct northeast direction entirely through LeFlore County. The broad trough of the syncline is marked by a line of abrupt hills and mountains.

The Brazil anticline is a low fold, the axis of which is from 2 to 4 miles to the north of the axis of Cavanal syncline. The same structure extends into LeFlore County, where the axes of the anticline and syncline grow farther apart. From the county line the anticline continues in a northeastward direction until it merges with the Backbone fault and anticline. The entire course of Brazil Creek is approximately on the axis of the structure.

The LeFlore County Oil and Gas Company has some gas production on this anticline, about 4 miles north of Red Oak. The presence of the gas found and the character of the structure indicate that the area along the axis is favorable for prospecting.

The McAlester anticline extends from Pittsburg County into Latimer County for a distance of about 5 miles, where it forks—one branch extending northeast for a distance of about 3 miles—the other branch extending a little south of east for a distance of about 4 miles, where it dies out or enters the Choctaw fault zone about 2 or 3 miles southwest of Wilburton. The fold is not symmetrical, the north slope being much steeper than that on the south. In fact, in places the rocks on the north side are almost vertical.

The Sansbois syncline crosses the northwestern part of the county. It enters the west side of the county in sec. 27, T. 6 N., R. 17 E., and the axis extends in a direct line to the northeast, crossing the county line in sec. 3 T. 7 N., R. 21 E., running a distance of about 25 miles across the county. The syncline is broad and the area embraced in the structure is occupied by the Sansbois Mountains.

Development

The first production in the county was from the Glady-Bell Oil and Gas Company's well in sec. 10, T. 6 N., R. 21 E., north of Red Oak in 1912. This well furnished gas to Red Oak until 1915 when it caved in and was abandoned. The offset to that well, the Latimer County Oil and Gas Company's Gallagher well, was drilled in 1913, with a good showing of gas. The hole was lost by caving, but gas from the well is still used for heating and lighting the farmhouse on the property. A second offset to the Gladys-Belle well was drilled later, but the hole was lost because of caving. No casing was used in these three wells.

The P. & F. Petroleum Company drilled a well on the C. R. Hunt farm in SE.¼ NW.¼ sec. 7, T. 5 N., R. 18 E., the C. R. Hunt No. 1. It had a showing of oil and gas at 325-328 feet, at 1,160-1,178 feet, and at 1,360-1,515 feet. It also had gas showings of 1,860-2,128 feet, at 2,335-2,800 feet, and at 2,800-3,002 feet. The test was abandoned at 3,600 feet, and the rig moved about 1½ miles southeast, where a dry hole was drilled. If they had moved east along the trend of the anticline there would have been a better chance for production.

There is a gas spring about one-half mile north of the Hunt well which has been known since the early days. It has been used for heat in cooking by soldiers and campers since Civil War days.

A well near Wilburton in sec. 8, T. 5 N., R. 18 E., was drilled below 1,800 feet. It was a dry hole.

Summary

A part of Latimer County is probable oil and gas territory. The rocks of those of the Pennsylvanian area south of the Arkansas River in the northern part of the county. The Ouachita Mountain region

cannot be considered as probable oil and gas territory, although it is possible that some deposits of small extent may be found. The northern part of the county is in the probable oil and gas area. The rocks are the Pennsylvanian shales and sandstones, and the structure is favorable for the accummulation in some localities.

All the structural features in the county are very prominent and the geological formations are readily differentiated. All locations for tests may readily be located from a geological and structural standpoint, and future prospecting in this county should produce some good results.

LEFLORE COUNTY

Structure and Stratigraphy

The structure in this section of the State is more complex than in any other portion. The folding and faulting is more intense south of the Choctaw fault than to the north, due to the large amount of thrusting in the Ouachita uplift. The almost prominent structural features are discussed under separate headings.

Snider[4] in his report on the geology of east-central Oklahoma has discussed the various structures, and a part of his information is incorporated in the following pages, along with additional data dealing with the structural features of LeFlore County.

CHOCTAW FAULT

The Choctaw fault enters LeFlore County about a mile northwest of the town of LeFlore and extends in an east-southeast direction to Hodgens, paralleling Fourche Maline Creek and Poteau River. From Hodgens it extends northeastward to the Arkansas line. Prospecting for oil and gas in the near vicinity of the Choctaw fault has brought only failures.

The Poteau syncline extends from west of Heavener eastward to the State line and for a considerable distance into Arkansas. West of the end of the mountains the axis of the syncline crosses Kansas City Southern Railway between Heavener and Petros Switch and soon turns a little to the north of west and continues across the southern part of T. 5 N., R. 25 E., and T. 5 N., R. 24 E. The syncline ends in a basin-shaped structure near the west line of the latter township. The chances for the occurrence of oil or gas in the area of this syncline are not very favorable.

The Heavener anticline lies to the north of the western portion of the Poteau syncline. The axis extends eastward along Fourche Maline. From this point eastward the fold rises very rapidly for a

4. Snider, L. C., Geology of east-central Oklahoma: Oklahoma Geol. Survey, Bull. 17, pp. 11-15, 1914.

distance of about 4 miles and then plunges just as rapidly to a point about 2 miles west of Heavener. The Hartshorne sandstone and coal outcrop around the north side and east end of the anticline and make a pronounced loop to the westward on the south side. The rocks exposed in the anticline belong to the Atoka formation. Measurements across the upturned edges of the rocks indicate that a thickness of 6,000 to 7,000 feet of this formation have been removed from above the axis of the anticline and the bottom of the formation is not yet exposed. The dips from the axis of the Heavener anticline are quite steep. The general dip to the south is about 30° and to the north and east is from 20° to 40°. The steepest dip observed is about one mile directly south of Glendale post-office, where there is a dip of about 65° almost directly south. This is very near the axis of the anticline since one-fourth mile to the north there is a dip of 40° to the north. The rocks exposed in the axis of this anticline are the lowest in the entire area under consideration.

More detailed work in the vicinity of Howe and Poteau has changed the structural mapping first done by Taff. It is now known that the Poteau anticline, the structure of the Poteau gas field, is a distinct structure separated from the Hartford anticline running south of Sugarloaf Mountain. The Hartford and Howe structures are really one continuous fold, beginning just east of Howe, and running northeast into Arkansas. The Poteau axis, instead of turning south to join the Howe structure, has a distinct northward curve on both the east and west ends, so that it has the shape of an arc of a circle.

The Hartford anticline has been described by Collier[5] and by Smith[6] and the northward branch by Smith as the Poteau anticline. These names are used in this report and the name Howe will be discontinued for the portion of the Hartford anticline between Howe and Monroe.

As has been said, the east branch of the Howe anticline is known as the Hartford anticline from Hartford, Arkansas. The Hartford occupies the eroded valley in the McAlester shale so that it is difficult to locate the axis accurately, but it is almost coincident in Oklahoma with the course of Sugarloaf Creek. Farther east, in Arkansas, the Atoka formation is exposed near the axis of this anticline and gas has been produced from sands in the Atoka near Mansfield. A dry hole the Am. Ind. O. & G. Co. No. 6, SW.¼ sec. 19, T. 6 N., R. 27 E., was drilled in 1918 to a depth of 2,916 feet.

The Poteau anticline, referred to above, is found mostly in the south-central part of T. 7 N., R. 26 E., extending only to the center of sec. 19, T. 7 N., R. 27 E. The rocks exposed in the Poteau anti-

5. Collier A. J., The Arkansas Coal Field: U. S. Geol. Survey Bull. No. 326, 1907.
6. Smith, Carl D., Structure of the Fort Smith-Poteau gas field, Arkansas and Oklahoma: U. S. Geol. Survey Bull. No. 541-B, 1913.

cline are those of the McAlester shale. The dip of the rocks away from the axis of the Poteau anticline is not very steep; the dip to the northwest being 3° to 5° and less to the southeast. The highest part of the fold is found just south of the center of sec. 26, T. 7 N., R. 26 E. Gas in considerable quantities has been found in the Hartshorne sandstone on this structure.

The Sugarloaf syncline lies between the Hartford and Poteau anticlines and is named from Sugarloaf Mountain which forms a very conspicuous topographic feature southeast of Poteau. The mountain is composed of the Savanna formation, topped by the Boggy shale. The dip of the rocks into the syncline is low, not exceeding 5° and usually considerably less than that. The strata in the mountains near the axis are practically level. The syncline extends from near the junction of the Hartford and Poteau anticlines northeastward across the State line and for several miles into Arkansas.

The Cavanal syncline is a broad trough which extends from the vicinity of Red Oak eastward and northeastward across the State line and for many miles into Arkansas. Potato Peaks and Cavanal Mountain lie in this syncline.

The Brazil anticline enters LeFlore County from Latimer County, about a mile west of Walls and extends in a northeast direction to about a mile southeast of Bordeaux. The McAlester shale is the lowest formation exposed. There is a dip from 5° to 8° on the southeastern limb of the anticline and from 12° to 18° on the northwestern limb.

The Backbone anticline extends eastward from a point about two miles south of Bokoshe, past Panama and north of east as far as Greenwood, Arkansas. The anticline is faulted for a considerable portion of its length, the beds on the south side of the fault being thrust over younger beds to the north. The Atoka formation is brought to the surface in the axial portion of the anticline, and the Hartshorne sandstone and coal outcrop around it. The dips in both directions from the axis of this anticline (or the fault) are rather steep, ranging from 12° to 20° or even more.

The Bokoshe syncline extends north of east from Bokoshe to Spiro. From Spiro eastward and northeastward to Arkansas River the country is sand-covered and the axis of the syncline cannot be definitely located.

The Lequire anticline, differentiated from Taff's western end of the Milton anticline, begins near the southwest corner of T. 8 N., R. 21 E., runs east just north of Lequire, almost parallel to the range line until it reaches the west line of R. 22 E., from where it trends northeast almost to the town of McCurtain. It ends in an area where the strata is distinctly flat thus forming a saddle between this structure

and the Milton anticline. In this flat area the rocks are considerably disturbed and there are several local faults which are shown by the displacement of the coal in the mines, but which are seldom noticeable on the surface.

From McCurtain to Milton the railroad is approximately one-half mile south of the axis of the Milton anticline. At Milton the axis swings somewhat to the north and passes nearly midway between the old and new towns of Bokoshe, and extends northeastward about one-half mile west of the Redbank Creek to the confluence of that stream with Cache Creek, and to the Arkansas.

The Cowlington syncline cuts through the extreme northwestern corner of the county, north of Cowlington, entering from Haskell County and extending into Sequoyah County from LeFlore County. The features of this syncline are discussed in more detail under the heading of "Structure" of Haskell County.

Development

POTEAU-GILMORE FIELD

The Poteau-Gilmore gas field is located about 4 miles east of Poteau in LeFlore County. The field so far developed includes an area of about 15 square miles, secs. 19-36 inclusive, (excepting sec. 31, 32, and 33) T. 7 N., R. 26 E., (Poteau) and secs. 19 and 30, T. 7 N., R. 27 E. (Gilmore).

The surface rocks are the McAlester shale, which varies in thickness throughout the area on account of erosion having removed some of the upper part of the formation. All of the gas wells in the Poteau field are located on or near the axis of the Poteau anticline.

The first well in the Poteau field was finished in August, 1910. The initial flow was 4,500,000 cubic feet of dry gas, with rock pressure of 365 pounds. The well has flowed continually since 1912, and made an average of 469,750 cubic feet per day during 1927. The rock pressure on September 1, 1927 was 88 pounds. The initial capacities of the wells in the Poteau field ranged from 250,000 cubic feet to 8,000,000 cubic feet. The initial rock pressure ranged from 118 to 365 pounds. The main production is from the Hartshorne sandstone in both the upper and lower part. However, wells that produce from the lower sands find little or no gas in the upper part of the formation and vice versa. There is little production from the Atoka formation which is very short lived.

The average daily production of the Poteau field in June, 1929, was 3,431,000 cubic feet from 34 wells. The rock pressure ranged from 52 to 80 pounds, average about 65 pounds. The open flow volume from these wells is estimated at 22,341,000 cubic feet.

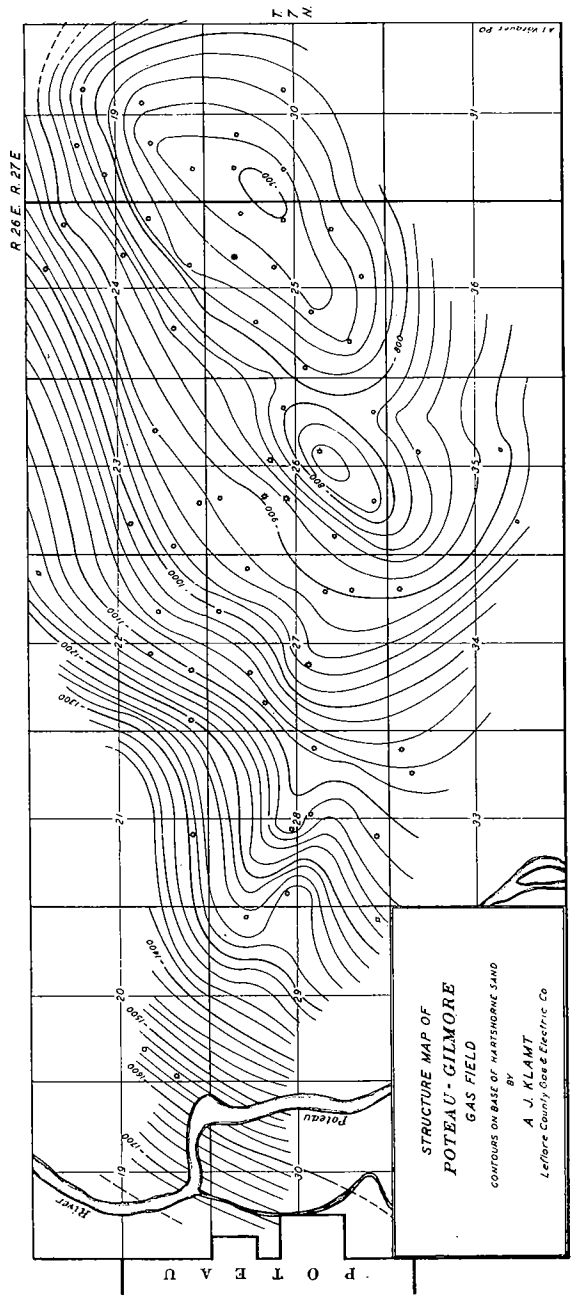

Figure 2

The LeFlore County Gas & Electric Company started a deep test in the Poteau field, which was abandoned at 5,000 feet in the Atoka formation, because of losing tools in the hole.

Many industries, such as glass plants, garment factories, and a handle factory have located in Poteau because of the nearby supply of gas piped in from the Poteau, Gilmore, Cameron, and Rock Island fields. Some gas from these fields is piped to Fort Smith, Arkansas. The Poteau gas field is now very well defined, all development for the future being within the proven area. (See fig. 2.)

There are about 25 wells now producing in the Gilmore area. The average daily production of the field in June, 1929, was 931,000 cubic feet from 19 wells. The first producing well in the field was finished in June, 1924, for 2,071,000 cubic feet of dry gas, at 200 pounds rock pressure. It averaged 1,368,985 cubic feet per day during 1927, with rock pressure of 113 pounds. The initial rock pressure ranged from 135 to 293 pounds. The rock pressure in June, 1929, ranged from 83 to 206 pounds.

CAMERON

The Cameron field occupies secs. 3 and 4, T. 7 N., R. 26 E., and secs. 33, 34, 35, and 36, T. 8 N., R. 26 E. There are now 10 wells producing in this field. The daily average of 10 wells for June, 1929 was 433,000 cubic feet. The first producing well in the field was finished in March, 1923, at a depth of 1,505 feet, with an initial production of 1,243,000 cubic feet, and rock pressure of 355 pounds. Seven producing wells were drilled in this field in 1923 and three in 1924.

ROCK ISLAND

The Rock Island field occupies sec. 18, T. 8 N., R. 27 E. There are now only three wells producing. In June, 1929, the production of three wells averaged 86,500 cubic feet per day, with an average rock pressure of 115 pounds and an estimated open flow volume of 647,000 cubic feet. The initial rock pressures ranged from 200 pounds to 250 pounds.

The first well in the field was drilled in 1917, to 2,030 feet. The initial flow was 68,000 cubic feet, and rock pressure was 250 pounds.

CEDARS

The Cedars field is located in sec. 9, T. 9 N., R. 27 E. The first well of this field was finished in 1924, and produces from two horizons. The total depth was 3,419, being the deepest well drilled in LeFlore County up to 1928. The upper sand had an initial flow of 936,000 cubic feet and rock pressure of 240 pounds. The lower

sand had an initial flow of 1,108,000 cubic feet, and rock pressure of 225 pounds.

The other well in NW.¼ NW.¼ SE.¼ sec. 9, T. 9 N., R. 27 E., was finished in April, 1925, for 1,360,000 cubic feet and initial rock pressure of 200 pounds. It was also a deep well, having a total depth of 3,350 feet.

SPIRO

The Spiro field is in sec. 8, T. 9 N., R. 25 E. It has four or five producing gas wells making very little gas at the present time. A well drilled in NE.¼ NE.¼ NE.¼ sec. 24, T. 9 N., R. 25 E., in the Bokoshe syncline northeast of Spiro, finished in October, 1926, was dry after several oil and gas showings.

MISCELLANEOUS DEVELOPMENT

A well near Bokoshe in sec. 5, T. 8 N., R. 24 E., showed gas but no oil. It was located about one-half mile south of the axis of the Milton anticline.

Near Panama a well was drilled. A show of gas was found, but the well was off structure, being north of the Backbone anticline and fault.

In the southwestern part of the county, south of the Choctaw fault, in the region of Talihina, three wells have been drilled. One well was drilled in the middle of sec. 16, T. 3 N., R. 22 E., 3 miles southeast of Talihina, in 1925. It had an initial flow of 1,250,000 cubic feet of wet gas, with rock pressure of 57 pounds, at 1,180 feet. The gas tested 1½ gallons of gasoline per 1,000 cubic feet of gas. The hole caved at 1,480 feet and was lost.

A dry hole was drilled one mile west of Talihina near the county line.

C. B. Shaffer drilled a well in sec. 15, T. 5 N., R. 24 E. A show of gas and oil was found in a 90 foot sand at 2,520 to 2,610 feet. The total depth was 3,200 feet. This well was south of the axis of the Heavener anticline.

In 1928, W. G. Twyman drilled a well on the Hartford anticline which was a dry hole, SW.¼ NW.¼ sec. 21, T. 6 N., 26 E.

In Massard Prairie, 5 miles southeast of Ft. Smith, Arkansas, the gas wells range in depth from 1,312 to 2,845 feet, but not all were productive. The most productive sands are between 1,000 and 2,100 feet. The wells vary in capacity from 140,000 to 4,250,000 cubic feet of gas, and show rock pressure from 145 to 280 pounds to the square inch. All of the wells start in or near the Hartshorne sandstone, and the gas is obtained from the Atoka formation.

It is impossible, however, to draw even an approximate conclusion as to possibilities for oil from the dip. In case any wells are drilled for oil, it will be necessary to drill deeper in order to reach the proper horizon, since the rocks dip away from the axis of the anticline 260 to 300 feet to the mile. It will probably be best under such circumstances to drill just a short distance down the dip from the farthermost producing gas well, as it is easily possible where rocks have such a high angle of dip, to begin too near the syncline.

Summary

The northern half of LeFlore County, the area north of the Choctaw fault, is considered probable territory for oil and gas. The production so far has been gas, and only a few showings of oil have been reported from the wells drilled in this county. It is thought that many locations along the Heavener, Howe, Poteau, Hartford, Milton, and Backbone anticlines might produce gas. However, the Backbone anticline has been faulted, and the resultant fracturing of the strata may have furnished a means of escape for the gas.

In the region to the south of the Choctaw fault, little is known concerning the prospects for the occurrence of oil and gas in commercial quantities. From the available data at hand the area does not appear to be favorable, because of the severe folding and faulting. The oil and gas, if present in the rocks, would have escaped. The presence of known asphalt deposits in the area indicate that some of the petroleum has escaped. Whether or not it is all gone is a fact which cannot be determined.

SEQUOYAH COUNTY

Structure

In general, the Pennsylvanian strata lie in a rather low northwest-dipping monocline. Locally there are variations in this general northwest dip. The axis of an anticline extends from a point near the center of sec. 34, T. 12 N., R. 23 E., almost due east of the E.¼ cor. sec. 36, T. 12 N., R. 23 E., a distance of 2½ miles. The strata on the south limb of this anticline dip at angles from 10° to 15°. The strata on the north limb of this anticline dip at angles from 8° to 10°.

The axis of an anticline extends from the center of the NE.¼ sec. 33, T. 12 N., R. 24 E., northeast to the center of sec. 27, T. 12 N., R. 24 E., where it swings to almost due east and extends to the center of the NE.¼ sec. 29, T. 12 N., R. 25 E. The linear extent of the axis of this anticline is approximately 5 miles. The strata on the south limb of the anticline dip at angles from 8° to 10°; those on the north limb from 3° to 5°.

There is a small anticline in T. 11 N., R. 25 E., whose axis extends from a point near the center of the SE.¼ section 32, northeast to a point near the center of section 27, a distance of 2 miles.

The axis of an anticline extends from a point near the W.¼ cor. sec. 26, T. 11 N., R. 25 E., northeast to a point about one-fourth mile north of the NE. cor. sec. 20, T. 11 N., R. 26 E., a distance of 4 miles. The strata on the south limb of this anticline dip from 7° to 20°; those on the north limb from 5° to 12°.

It is noteworthy that in all the above anticlines the steeper dips are found on the south limb of the anticline in each case. There may be other anticlinal folds, but the short time given for field work in Sequoyah permitted the mapping of only those noted above.

A fault enters Sequoyah County from Cherokee County at the NE. cor. T. 13 N., R. 23 E., and extends southwest to a point near the center of T. 12 N., R. 22 E., a distance of approximately 15 miles. This fault has brought Silurian, Devonian, and Mississippian strata in contact with Pennsylvanian.

Development

There are a number of locations made, and a wildcat well, Hunt et al., No. 1, SE. cor. NW.¼ SW.¼ sec. 12, T. 12 N., R. 23 E., is now (July, 1929) drilling at 900 feet.

Gas was found many years ago in the Vian anticline, a branch of the Enterprise anticline southwest of Vian. The well was the Nigger Creek Oil and Gas Company's No. 1, drilled to a depth of 1,000 feet.

A well was drilled in SW.¼ SE.¼ NE.¼ sec. 5, T. 11 N., R. 24 E., near Sallisaw, which was a dry hole. Another well, just west of that one had some gas.

A well drilled in sec. 19, T. 11 N., R. 26 E., near Muldrow, encountered a gas sand at about 1,200 feet, making half a million cubic feet. It was turned over to the owner of the land who put tubing in it and used the gas.

Three gas wells and one dry hole were drilled in sec. 10, T. 11 N., R. 26 E.

A dry hole was drilled in sec. 23, T. 11 N., R. 25 E.

A dry hole was drilled in SE.¼ sec. 8, T. 10 N., R. 26 E.

A dry hole was drilled in NW.¼ NW.¼ sec. 5, T. 10 N., R. 24 E., about ½ miles southwest of Brent.

A well drilled in NE.¼ NW.¼ sec. 25, T. 10 N., R. 25 E., by the LeFlore Co. Gas & Electric Co., northeast of the town of Redland was dry. This well was drilled on the Milton anticline, and close to the Arkansas River.

Three gas wells and one dry hole were drilled southeast of Gans in sec. 32, T. 11 N., R. 25 E. Another gas well was drilled in SW.¼ sec. 33, T. 11 N., R. 25 E.

A well drilled in NW.¼ sec. 30, T. 12 N., R. 21 E., has gas. This well is just south of Upson, and three miles southwest of Vian, on the Vian anticline.

Gas was found in two wells in sec. 17, T. 10 N., R. 26 E., near the Arkansas River. They were on the Milton anticline.

The Citizens Gas Company's No. 1 Johnson, NE.¼ SW.¼ NE.¼ sec. 33, T. 12 N., R. 27 E., near the Arkansas line, made 1,500,000 cubic feet of gas at 1,215-25 feet and was shut in. Another gas well was drilled just south of this well in the same section.

Summary

All the production to date in Sequoyah County has been gas, found in the eastern part of the county. This puts the county in proved gas territory. There are known anticlines in the county, but the fact that there is faulting within the area, and that the Pennsylvanian rocks may be of comparatively small vertical section has caused some hesitancy in drilling otherwise favorable looking structures.

FIXED CARBON THEORY

A discussion of David White's Fixed Carbon Ratio Theory, at this time, may throw some light on the possibilities of gas or oil production in the area south of the Choctaw fault.

In regions where progressive devolitization of organic material has passed a certain point, marked by a fixed carbon content of 65 per cent in associated coals, no commercial oil pools are present, nor in formations directly underlying them, but gas may occur.[7]

The quality of oil and the presence or absence of oil is determined by the amount of heat and pressure by which it has been affected. The quality of coals is also affected by heat and pressure. With an increase of heat and pressure gases and impurities are driven from the coal, leaving a larger percentage of pure carbon. With an increase in the heat and pressure the gases and more liquid parts of oil are driven off. It is easy to see that there should be a close relationship between the effects of heat and pressure on oils and on the associated coals.

The fixed carbon ratio of coals increases with the increase of heat and pressure, as does also the gas content of the oils.

7. White, David, Some relations in origin between coal and petroleum: Jour. Washington Acad. Sci., vol. 5, no. 6, pp. 185-212, 1915.

It has been found that where the amount of pure carbon is 50-60 per cent of the associated coals there was both oil and gas. Where the pure carbon content of the associated coals was 60-65 per cent, there was gas, but no oil. The occurrence of 65-70 per cent of pure carbon in the associated coals establishes a deadline for oil and gas in commercial quantities. This is particularly the case in the Appalachean fields and holds without question in the gas fields of southeastern Oklahoma.[8]

In southeastern Oklahoma the Choctaw fault is the deadline. South of the fault there should be neither oil nor gas in commercial quantities. North of the Choctaw fault there might be gas, but no oil. Drilling, up to this date, has shown these conditions of the fixed carbon theory to be true.

8. Hager, Dorsey, Practical oil geology, McGraw-Hill, p. 21, 1926.