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OIL AND GAS IN OKLAHOMA

OIL AND GAS GEOLOGY OF COAL AND PITTSBURG COUNTIES

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FOREWORD

In 1917 the Oklahoma Geological Survey issued Bulletin 19 part 2 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 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 Gological Survey has every confidence in 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 on Coal and Pittsburg counties has been prepared by W. W. Clawson, Jr., of the Indian Territory Illuminating Oil Company. Mr. Clawson has had wide field experience in this area, and in addition has had access to the data in the files of his company, so that this report represents accurate presentation of the oil and gas conditions of these counties.

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By

W. W. Clawson, Jr.

INTRODUCTION

During 1927 Coal and Pittsburg counties attracted unusual attention from the major oil producing companies. This interest is largely due to the activities of the Indian Territory Illuminating Oil Company, which, at the instigation of R. J. Riggs, has attempted to develop oil or gas production on the Coalgate anticline.

This paper does not contain a thorough treatment of the geology of these counties in all of its phases, but is limited to a discussion of the geology as affecting the oil and gas possibilities of the area.

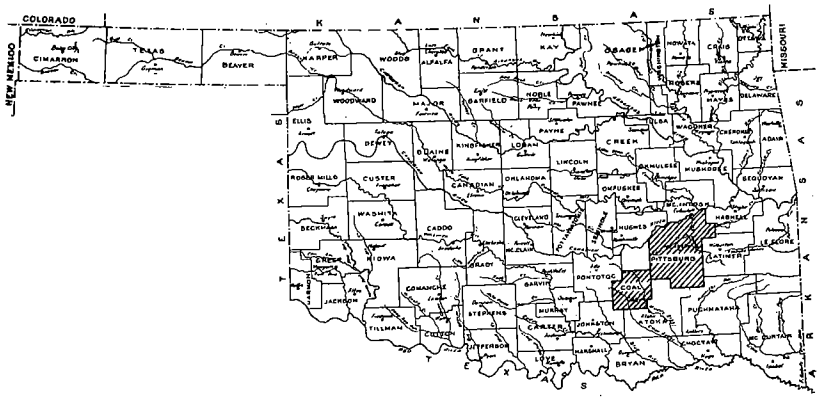


Figure 1. Index map of Oklahoma showing area covered by this report.

The geology of the area in southeastern Pittsburg County, which lies south of the Choctaw fault, has not been gone into in detail, since the geological features of this part of the county are typically of the Ouachita Mountain type and have been ably described in previous reports[1].

1. Honess, C. W., Geology of Atoka, Pushmataha, McCurtain, Bryan, and Choctaw counties, Oklahoma: Oklahoma Geol. Survey Bull. 40-R, 1928.

General Features

Coal and Pittsburg counties have a combined area of approximately 1,875 square miles and are located in the southeastern part of the State. The northern boundary of Pittsburg County is the South Canadian River.

These counties lie mainly in the western extension of the Arkansas Valley geosyncline. A small area in southeastern Pittsburg County is included in the Ouachita Mountain province.

Coal County drains into the Red River through the various Boggy Creeks and their tributaries. The drainage in Pittsburg County is largely into South Canadian River through Gaines Creek and tributary streams.

The topography in general is rather rugged, with a heavy growth of post and scrub oak timber marking the areas of sandstone outcrops. The steeply folded areas are characterized by anticlinal valleys developed in the softer shales and separated by ranges of synclinal hills. Farming is carried on rather extensively in the more accessible areas.

Two main railroads, the Missouri, Kansas and Texas, and the Chicago, Rock Island and Pacific, cross the area and serve the county seat towns of McAlester and Coalgate in Pittsburg and Coal counties respectively. Three branch line railroads, the K. O. & G., Oklahoma City, Ada & Atoka, and the Oklahoma Central, serve the small towns in western Coal County.

Acknowledgments

In the preparation of this report the literature on this and adjoining areas has been freely consulted and notations to that effect given in the text.

The author wishes to particularly acknowledge the help and suggestions of R. J. Riggs of the Indian Territory Illuminating Oil Company, under whose direction the field work in this area was carried on.

M. K. Jensen, chief draftsman of the Indian Territory Illuminating Oil Company, rendered valuable assistance in the drafting of maps and preparation of illustrations. John Fitts of Ada contributed freely from his intimate knowledge of this part of the State. Thanks are expressed to W. A. Clark, Jr., for the use of his maps on the Quinton-Kinta anticline.

Appreciation is expressed to the management of the Indian Territory Illuminating Oil Company, by whose permission this report is published.

GENERAL GEOLOGY

The formations outcropping in Coal and Pittsburg counties range in age from middle Ordovician to Pennsylvanian. This is exclusive of Pleistocene and Recent deposits, the most important of which is the Guertie sand, a deposit made up of alternating layers of sand, gravel, and silt, doubtless of stream origin.

Stratigraphically the lowest formation occurring at the surface in Coal and Pittsburg counties is the Viola limestone. This limestone outcrops in a small area in southwestern Coal County on the flanks of the Hunton anticline. Next in order of occurrence are the Sylvan shale, Hunton limestone, Woodford chert, Sycamore limestone, and Caney shale, the Caney representing the transitional zone between rocks of Mississippian and Pennsylvanian age. These formations have been studied and described in detail in previous publications[2], hence further description is omitted from this report.

WAPANUCKA LIMESTONE

The Wapanucka limestone overlying the Caney shale in southwestern Coal County is a massive white to light brown fossiliferous limestone, locally oolitic, and contains varying amounts of chert. This limestone also outcrops in long narrow ridges, repeated by faulting, south of and paralleling the Choctaw fault in southeastern Pittsburg County.

The Wapanucka is the equivalent of the upper part of the Morrow formation of northeastern Oklahoma and was arbitrarily chosen as the lower marker in the preparation of the convergence map (Fig. 2.) since it occurs at the approximate horizon of the group of producing sands to the north, known as the Cromwell-Papoose series. It is also the most persistent marker near the base of the Pennsylvanian.

ATOKA FORMATION

The Atoka formation is a series of alternating sandstones and shales ranging in thickness from 3,500 to 7,000 feet, the latter figure being the thickness represented on the Heavener anticline in central LeFlore County[3]. This formation outcrops in broad belts in southwestern Coal and southern Pittsburg counties, and is found in many wells drilled throughout the area. At the outcrop in southwestern Coal County the Atoka consists of four main sandstone groups separated by beds of brownish clay shales. The sandstones are usually light brown in color and of thin-bedded or platy structure. Some of the sands in the Atoka carry gas when found on structure, but to date no commercial oil production has been developed in this formation.

HARTSHORNE SANDSTONE

A thin series of sandstones and sandy shales, known as the Hartshorne, occurs as a narrow, sinuous outcrop above the Atoka. The character of this group of beds changes rapidly along the outcrop, massive beds often giving way to thin-bedded sands and sandy shales in the distance of one mile. This irregularity of deposition is borne out

2. Gould, Chas. N., Index to the stratigraphy of Oklahoma: Oklahoma Geol. Survey, Bull. 35, 1925.
3. Snider, L. C., Geology of east-central Oklahoma: Oklahoma Geol. Survey, Bull. No. 17, pp. 11-15, 1914.

by the rapid horizontal changes noted where this formation has been encountered in wells. In Pittsburg County the Hartshorne sometimes contains three beds of sandstone separated by shales[4]. The lower Hartshorne coal lies about 50 feet below the top of the formation and has been mined extensively in the vicinity of McAlester and Wilburton.

The Hartshorne ranges in thickness from 100 to 200 feet and is the main gas producing sand on the Quinton-Kinta anticline in northeastern Pittsburg County.

McALESTER SHALE

The McAlester shale lies directly above the Hartshorne sandstone and has an estimated thickness of from 1,300 feet on the Coalgate anticline to 2,500 feet[6] in southeastern Pittsburg County. It consists principally of bluish gray to black shales, lenticular sandstones and coal beds.

The McAlester is typically exposed along the tops of the Major folds in this area, where it constitutes broad valleys and prairie lands bordered by the precipitous wooded hills of the overlying Savanna sandstone. A characteristic feature of the McAlester is the occurrence of numerous hummocks or low mounds irregularly spaced over the area of outcrop. "These mounds are usually less than 100 feet in diameter and stand on an average of 5 feet above the general level of the flats"[7]. In cross-section there is no observable change in the physical character of the shales and the reason for their occurrence has not been fully explained.

The upper Hartshorne coal forms the lower limit of the McAlester. Another workable coal bed known as the Lehigh or McAlester coal occurs near the top of the formation.

SAVANNA SANDSTONE

As previously stated the Savanna sandstone occurs immediately above the McAlester shale, forming rugged topography heavily timbered with post and scrub oak. The Savanna has been estimated to range in thickness from 1,000 to 1,750 feet. In the vicinity of Coalgate measurements have been made by several different field parties and a thickness of from 1,600 to 1,750 feet was found. Accurate measurement is made difficult if not impossible by the occurrence of strike faults of unknown magnitude and by the indefinite limits of the formation.

BOGGY SHALE

The Boggy shale outcrops in broad rolling, sparsely timbered areas throughout the northern part of Coal and Pittsburg counties. It consists mainly of shale with scattered thin sandstone beds. Impure limestones occur locally near the top of the formation and thin lignitic coal beds are found near the base in northeastern Pittsburg County.

4. Oklahoma Geol. Survey Bull. 19, Part II, p. 425, 1917.
5. Op. cit. p. 426.
6. Op. cit. p. 426.
7. Sanders, C. W., Jr., Personal communication.

*Correlation Table**

AGE	CENTRAL-SOUTHERN OKLAHOMA	SOUTHEASTERN OKLAHOMA	
RECENT	Stream deposits and alluvium	Stream deposits and alluvium	
PLEISTOCENE	Terrace deposits, including Guertie sand	Terrace deposits	
PENNSYLVANIAN	Senora formation 50-500 Stuart shale 90-280 Thurman sandstone 80-280	Absent	
	Boggy shale Savanna sandstone	Boggy shale 2,000-3,000 Savanna sandstone 750-2,000	
	McAlester shale Hartshorne sandstone Atoka formation	McAlester shale 2,000-3,000 Hartshorne sandstone 750-2,000 Atoka formation 2,000-7,800	
	Wapanucka limestone	Wapanucka limestone 0-800	
——— ? ———			
MISSISSIPPIAN	Caney shale 800-1,600 Sycamore limestone 0-500 Woodford chert 500-650	Caney shale 800-1,600 Jackfork sandstone 3,800 ± Stanley shale 6,100	
		Arkansas novaculite	
DEVONIAN	Bois d' Arc limestone 0-90 Haragan shale 0-166		
SILURIAN	Henryhouse shale 0-223	Missouri Mt. sl.	Talihina chert 1,150-1,200
	Chimneyhill limestone 0-53 Sylvan shale 50-300	Blaylock ss.	
		Polk Creek sh.	
	Viola limestone 500-800		
ORDOVICIAN (Ulrich)	Bromide (?) formation - - - - -?- - - - -	Bigfork chert Womble sandstone	Stringtown sh. 600 ±
	Simpson formation 1,200-2,000	Blakely ss.	
CANADIAN (Ulrich)	Arbuckle limestone 4,000-8,000	Mazarn shale	
		?	
OZARKIAN		?	
CAMBRIAN	Reagan sandstone 0-500	?	
		Crystal Mountain sandstone Collier shale	
PRE-CAMBRIAN	Granites, etc.		

*Partly after Ulrich (Oklahoma Geol. Survey, Bull. 45, figs. 3 and 4, 1927.)

THURMAN SANDSTONE

The Thurman sandstone represents a marked change in deposition from the fine shales and soft sandstones of the underlying Boggy to the conglomerate and coarse sands at the base of the Thurman. This formation outcrops in a belt of very rugged land, from two to four miles wide in the northern part of Coal and northwestern Pittsburg counties. The dip is normally north and northwest at a rate of approximately 100 feet per mile.

STUART SHALE

The Stuart shale forms a narrow belt of sparsely timbered country in the extreme northern part of Coal County and northwestern Pittsburg County. The formation consists mainly of shale with a few thin sandstone beds.

SENORA FORMATION

The Senora consists of bluish clay shales, interstratified with sandy shales and sands. It outcrops in a broad belt in northwestern Pittsburg County and southern Hughes County, attaining a maximum thickness of 500 feet[8]. The Senora and the underlying Stuart shale and Thurman sandstone all thicken and become more shaly toward the northeast.

STRUCTURE

Considered structurally, Coal and Pittsburg counties can be divided into two parts; first, the area of steep folding and wavelike structure of the northern Ouachita and adjacent country, and second, the area of more gentle folding on the northwestward dipping monocline in the northern part of these counties. The surface structure of these areas is of a distinctly different type both in magnitude and direction or trend of folding and they will be treated separately in this report. For convenience they are designated as the Coalgate-McAlester and the northern areas.

Coalgate-McAlester Area

The major structural features of the Coalgate-McAlester area, named in order as they occur from north to south are: Canadian anticline, Porum syncline, Enterprise anticline, Cowlington syncline, Kinta anticline, Kiowa syncline, Coalgate anticline, and Lehigh syncline. These folds are all approximately parallel with the Choctaw fault and are shown in their respective position on the map (Plate I). Since the essential features of these folds are very similar, only those which have been studied in detail are described in this paper. Conclusions drawn regarding structural features, sedimentary conditions, and productive possibilities can be applied in general to all similar folds in this area.

8. Taff, J. A., U. S. Geol. Survey, Geol. Atlas, Coalgate Folio, (No. 74) 1901.

COALGATE ANTICLINE

Detailed mapping of the Coalgate anticline in the vicinity of Coalgate verifies in detail the description of this fold as given in the following paragraph[9]:

> This anticline is a peculiar structural feature. From Coalgate southwestward this fold is broad and very obtuse. The strata below the Lehigh coal bear westward around the south end of the Lehigh basin and then northward toward Coalgate. Southwest of Coalgate these beds curve gradually westward and then southwestward into the boggy swamps of Clear Boggy Creek. The Lehigh coal bed in its outcrop emphasizes the character of this anticlinal structure more strongly. From Lehigh the strike of the coal bears nearly due north, with low east dip to Coalgate, where it turns abruptly southwestward. One mile northeast of Coalgate this coal rises and is exposed for nearly 8 miles in an elongated dome bearing northeastward. The Lehigh coal and the sandstones and shales for several hundred feet above the coal dip 10° to 15° from the axis of this dome. From a point about 7 miles northeast of Coalgate the rocks upon the axis of the Coalgate anticline pitch rapidly northeastward. This pitch gradually grows less until the anticline is lost as a structural feature in the center of the Kiowa syncline near the west end of the Kiowa hills, southwest of Kiowa.
>
> Three to five miles northwest of the axis of the Coalgate anticline there is a parallel shallow syncline whose axis is nearly parallel to that of the Coalgate. The axis of this syncline rises toward the northeast and the syncline dies out or coalesces with the Kiowa syncline opposite the northeast end of the Coalgate anticline.
>
> From a wide indistinct fold at the southern border of the quadrangle the Coalgate anticline contracts and pitches toward Coalgate and then rises beyond in an elongated dome-like arch in Coal Creek Valley. Beyond Coal Creek it pitches rapidly northeastward for 2 miles and then the axial portion becomes nearly level and continues so to near the end of the fold, where it is lost in the south limb of the Kiowa syncline in the McAlester quadrangle. The rocks on the northern side of this arch also have steeper dip than on the southern side. This is especially the case west of Coal Creek.

The map (Plate II) shows the magnitude and general shape of the portion of this fold in the vicinity of Coalgate and Cairo in Coal County. Approximately 700 to 800 feet of McAlester shale remains on the crest of this ancline, the basal coal bed and underlying Hartshorne sand being found between these depths in several wells drilled near the top of the structure.

SAVANNA ANTICLINE

The axis of the Savanna anticline in Pittsburg County trends in a northeasterly direction from the southwestern corner of sec. 18, T. 3 N., R. 13 E., to a point about 2 miles east of the town of Krebs where it joins the McAlester anticline. In Coal County the fold pitches rapidly east and west from an elongated dome-like uplift near the Coal-

9. Taff, J. A., U. S. Geol. Survey Geol. Atlas, Coalgate Folio (No. 74) p. 5, 1901.

Pittsburg County line. Information available from logs of gas wells drilled on this portion of the anticline indicates very steep dips on the flanks of the structure with a possibility of minor faulting in the surface rocks. The steeper dips on the northwest side of the structure are associated with some faulting in the Savanna sandstone.

Shallow wells drilled near the top of this structure encountered gas bearing sands at approximately 400 and 1,300 feet. The sand at 400 feet is doubtlessly the Hartshorne, as total thickness of the McAlester at this point is about 1,000 feet.

CHILES ANTICLINE

Some development has taken place on the Chiles ranch north of the western end of the Savanna anticline. The axis of the structure in this vicinity runs nearly east and west, passing through the cen. S.½ secs. 29 and 30, T. 3 N., R. 10 E., and sec. 25 T. 3 N., R. 9 E. The dips are much more gentle in this area than on the Savanna anticline proper, averaging 200 to 250 feet per mile.

Gas was obtained on this structure in the basal Boggy or upper Savanna at depths of approximately 300 feet.

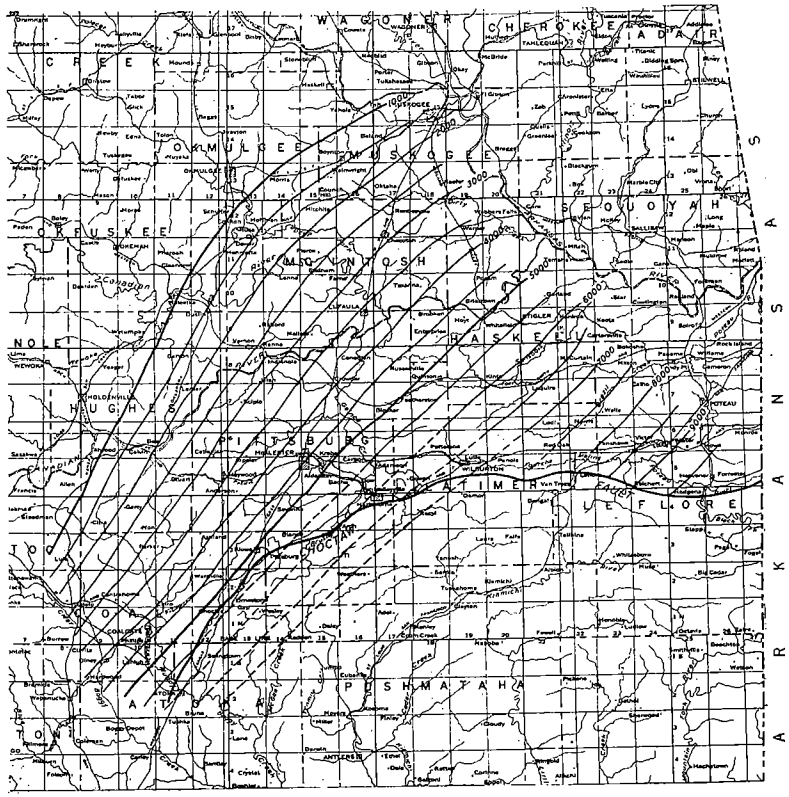
KINTA ANTICLINE

The axis of the Kinta anticline runs in a direction about N. 60° E. from a point near the town of Blocker, Pittsburg County, to a point approximately one mile south of Quinton, where it leaves the county, continuing in a more easterly direction and crossing the Fort Smith and Western Railroad at Kinta. This is an asymmetrical fold, dips on the south flank averaging about 7 degrees and those on the north around 11 degrees. The axis of the anticline as shown by subsurface contours on the gas producing sand (Hartshorne), follows very closely that on the surface.

There is between 150 and 200 feet of closure on this structure near Kinta. However, the best gas production is not obtained within this higher portion of the structure, but comes from wells located on the westward plunging dip just south of the axis in secs. 10 and 11, T. 7 N., R. 18 E. Some of the wells in these sections have an initial daily capacity of 30 to 40 million cubic feet of dry gas. This fact together with information obtained locally indicates that sand conditions play an important part in the localization of gas in this area.

Northern Area

The structure of the area lying northwest of the steeply folded Coalgate-McAlester region is typically a northwestward dipping monocline with a normal dip of approximately 100 feet per mile. Northward and northwestward plunging noses occur at intervals on this monocline. Closures on the surface are very rare in this area. However, the rapid convergence of the Pennsylvanian sediments toward



Isopachous Map showing Interval between Base of Savanna-Salt Sand and Wapanucka-Morrow limestone.
Contour Interval=500'

Figure 2.

the northwest might cause noses of the type found here to assume some closure on the lower formations. Emphasis is given to the fact that the structures developed in the upper Boggy and younger formations trend north and northwest, a direction diametrically opposite to that of the folds in the older rocks to the south.

The northwest surface dip in this area is not a reflection of the attitude of the formations in the lower Pennsylvanian and below. The tremendous thickening of the lower Pennsylvanian sediments toward the southeast is shown on the map (Fig. 2). Development to the north in Pontotoc, Seminole, and Hughes counties indicate that the lower horizons which are productive there are dipping southeastward in northern Coal County.

CONCLUSIONS REGARDING AGE OF FOLDING

A study of the structure in Coal and Pittsburg counties and the adjacent region to the northwest leads to the conclusion that two periods of deformation differing widely in intensity and direction of forces are represented in this area.

In the writer's opinion, the large steeply folded structural features typical of the Coalgate-McAlester area and associated with the Ouachita overthrust were well developed by middle or late Boggy time, subsequent folding consisting more of a tilting and gentle warping with compressive forces acting from the northeast and southwest, rather than from the direction of the Ouachita mass to the southeast. A minor oscillation no doubt took place in this area during the deposition of the Boggy as suggested by Morgan in his discussion of the Boggy overlap.[10]

The small Chiles gas structure probably represents the closing effect of this period of deformation, as folds developed in younger rocks have a different trend.

The following observations are suggested as evidence tending to confirm this belief:

1. The sudden termination of the steeply folded structural features near the middle of the Boggy shale. If the sediments above the Boggy were present during the development of the closely folded, wave-like structure typical of the Coalgate-McAlester area, it would be logical to expect a series of more or less parallel folds gradually diminishing in size toward the northwest. This condition is represented farther east where beds younger than Boggy are not involved. However, this does not seem to be the case, since the Savanna anticline, a very closely folded structure, and the McAlester anticline of only slightly less magnitude abruptly terminate this type of folding and the structures developed in the Thurman sandstone and younger beds to the north are of an entirely different nature and follow an almost diametrically opposite trend.

Subsurface studies to the north[11] indicate that some of the larger anticlines extend westward under the cover of upper Boggy and Thurman sediments beyond their limits as discernable on the surface.

2. Rapid change of dip between Savanna and Boggy and again at the base of Thurman sandstone. Field evidence suggests that the sudden decrease in rate as well as change in direction of dip noticeable near the contact of the Boggy shale and Savanna sandstone and again at the base of the Thurman sandstone is not merely a normal flattening but due, in part at least, to deposition on a previously folded surface.

3. Different trend of structures developed in Thurman and younger beds from those in the older rocks to the south. Folding exhibited at the surface in the Thurman sandstone and younger rocks immediately to the north consists of gently north and northwestward plunging noses indicating compressive forces from the northeast and southwest and showing very little effect of thrusting from the direction of the Ouachita Mountains.

4. Thin section of Savanna found at Centrahoma and on Chiles anticline. Correlation of well logs shows an unusually small thickness of the Savanna in the gas wells drilled on a small structure near Centrahoma in sec. 34, T. 2 N., R. 9 E., and again on the Chiles ranch in sec. 30, T. 3 N., R. 10 E. The wells drilled at Centrahoma started a considerable distance above the base of the Boggy shale and encountered the McAlester at less than 900 feet after penetrating not more than 500 or 600 feet of Savanna. Similar conditions are found on the Chiles ranch in sec. 30, T. 3 N., R. 10 E. This is taken as evidence of thinning of the section over structure and doubtlessly will be found to apply to the lower formations as well.

10. Morgan, George D., Bureau of Geology, Bull. 2. 1924.
11. Clark, Robert W., Geology of McIntosh County, Oklahoma: Oklahoma Geol. Survey Bull. 40-W, p. 9, 1927.

DEVELOPMENT

Coal and Pittsburg counties, up to the present time, have produced some gas but no oil in commercial quantities. The well of the McCraw Oil and Gas Company in the SE.¼ NE.¼ NW.¼ sec. 35, T. 1 N., R. 8 E., Coal County, recently encountered a favorable showing of high gravity oil in a lime formation topped at 1,838 feet and correlated as basal Wapanucka. The production from this well has not been fully tested.

Small gas wells have been drilled on several of the large folds throughout the area and commercial gas production has been obtained on the Kinta anticline near Quinton, Pittsburg County. Wells in the Quinton field yielded as high as 40 million cubic feet per day. The total open flow of the field at the present time is approximately 200,000,000 cubic feet per day. The Quinton Spelter Company and the towns of Quinton and McAlester are supplied with gas from this field.

Other gas wells drilled throughout these counties have not yielded gas in sufficient quantities to justify transportation to a market and their production has not been utilized.

During 1927 the Indian Territory Illuminating Oil Company of Bartlesville, assembled a large block of acreage on the Coalgate anticline in the northern part of T. 1 N., R. 11 E., and are now preparing to drill a deep test in sec. 10, to test the lower marine horizons.

A well being drilled by Pattison & Phillips on the McDuff farm, cen. NW.¼ SE.¼ sec. 32, T. 9 N., R. 16 E., Pittsburg County, has reached a depth of 5,300 feet at the time of writing and is drilling in a white lime topped at 5,268. The section encountered in the lower part of this well indicates that this lime is probably the Viola. Definite correlation is made difficult by the distance to other wells penetrating these rocks and the changes which may have taken place in that distance. Gas estimated at 15,000,000 cubic feet per day was found in the Cromwell sand at approximately 4,500 feet.

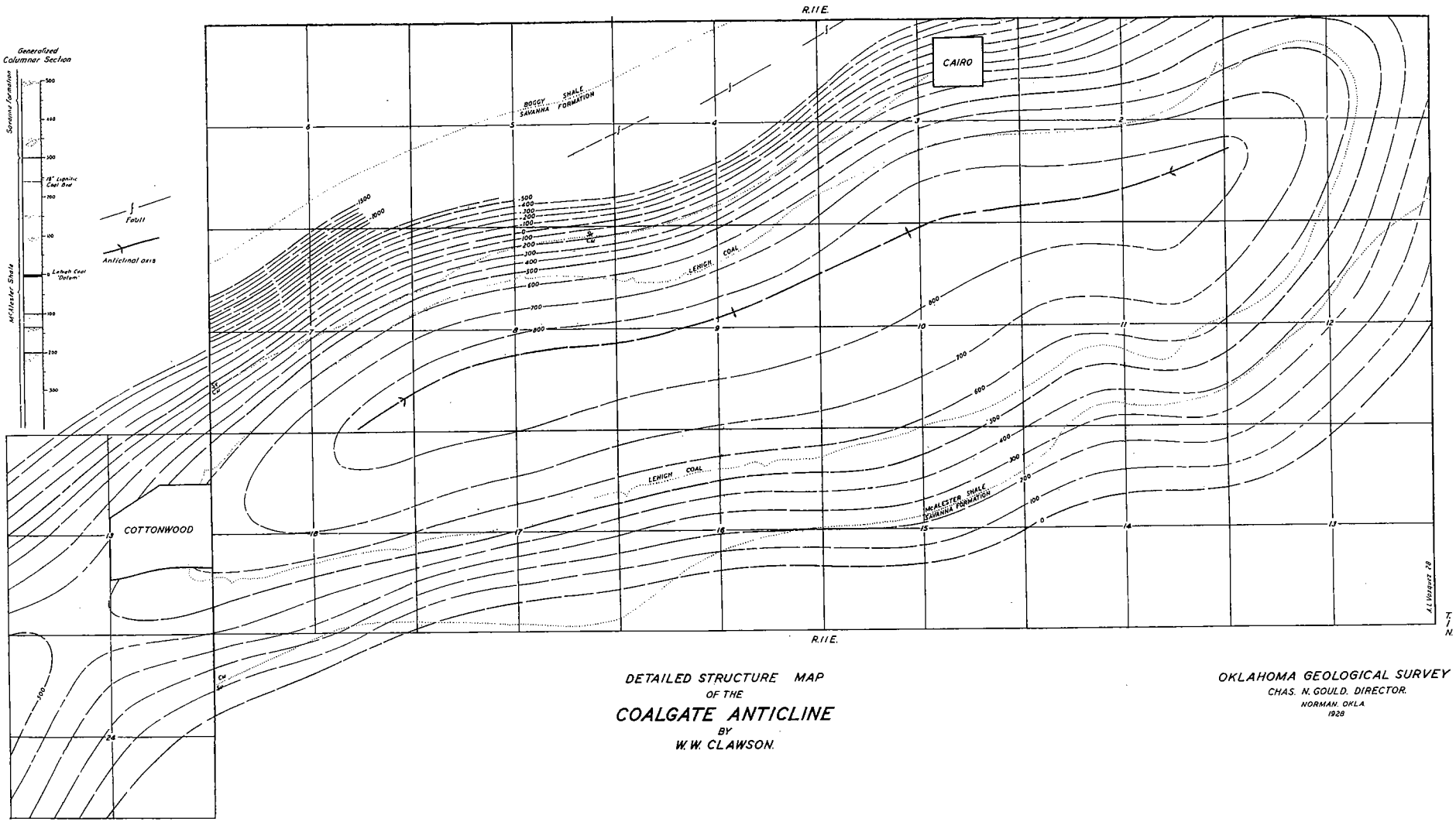
The map (Plate I) shows the location and depths of the scattered tests in Coal and Pittsburg counties and the locations of groups of gas wells by cross-hatching.

Oil and Gas Prospects

Exploration on the large anticlines in Coal and Pittsburg counties has been disappointing from a standpoint of oil production. Gas has been found at various points although the wells in general have been small and the producing area spotted.

The apparent absence of oil in commercial quantities in the Pennsylvanian beds throughout this area has been generally explained on the basis of the carbon ratio theory. It has been suggested, particularly by Tarr, that the finding of gas only may be in part due to the fact that the Pennsylvanian beds are largely non-marine or at least shallow water deposits.

The lower horizons, of more typical marine origin, have not been tested in this area, mainly on account of the depth at which they occur. Consequently their productive possibilities are unknown.



DETAILED STRUCTURE MAP
OF THE
COALGATE ANTICLINE
BY
W. W. CLAWSON.

OKLAHOMA GEOLOGICAL SURVEY
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NORMAN, OKLA.
1928