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OIL AND GAS IN OKLAHOMA

GEOLOGY OF ROGERS COUNTY

By
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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.

Mr. E. G. Woodruff, one of the co-authors of the report on Rogers County, a consulting geologist at Tulsa, Oklahoma, has had a number of years' experience in this and other counties in the northeastern part of the State. Mr. Woodruff collcted a considerable part of the data in this report, and Mr. C. L. Cooper, chief geologist of the Oklahoma Geological Survey, compiled this information and supplied additional data of his own. The contribution of detailed information on the subsurface stratigraphy of the eastern part of the county by Mr. Fredric A. Bush of the Sinclair Oil and Gas Company, has added greatly to the report.

CHAS. N. GOULD,
Director

March, 1928.

OIL AND GAS IN OKLAHOMA

GEOLOGY OF ROGERS COUNTY

INTRODUCTION

An earlier report[1] presents a discussion of the oil and gas industry in the county at the time it was published ten years ago. This report is intended only to review the situation since that time and to present a discussion of the geology and oil and gas resources in the light of the present knowledge.

LOCATION

Rogers County is a rectangular area in northeastern Oklahoma, thirty-six miles north-south, and eighteen miles east-west, with an additional township to the northeast and limited by Verdigris River to the southwest. It embraces approximately 704 square miles in Tps. 19-25 N., Rs. 14-18 E. Claremore, the county seat, is located near the center of the county and Chelsea, the principal center of petroleum activity, is to the northeast. The county is well supplied with railroad facilities by the St. Louis and San Francisco Railroad (Frisco) which

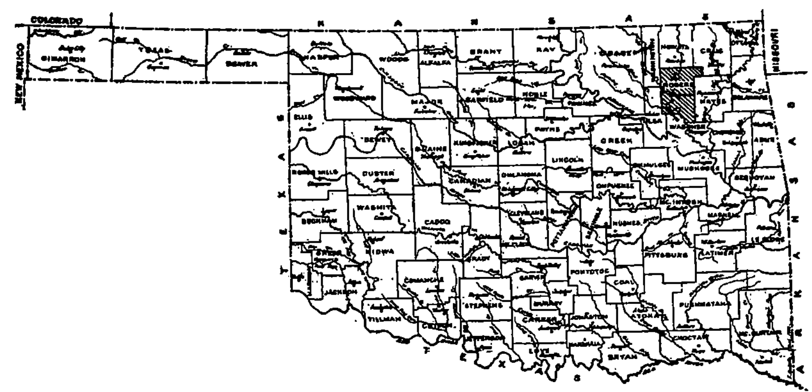


Figure 1. Index map of Oklahoma showing location of Rogers County.

crosses it from southwest to northeast, and by the Missouri-Pacific Railway running southeast-northwest. There are a number of hard surfaced highways, hence travel and haulage of supplies are not difficult in this region.

1. Shannon, C. W., Petroleum and Natural Gas: Oklahoma Geol. Survey Bulletin No. 19, Part 2, 1915.

TOPOGRAPHY

In a general way the county is moderately uneven. The details of its surface features are presented on the U. S. Geological Survey topographic maps of the Claremore, Nowata, Vinita, and Pryor quadrangles. There is a hilly area in the northeastern part, traversed by Dog Creek and its branches, and another rough section between Sageeyah and Talala.

Elsewhere the county is a succession of valley plains and moderately rounded hills which are the result of erosion on westward dipping strata which is made up of alternating beds of hard and soft material. Since the strike of the formations is northeast-southwest, the soft strata have been eroded to moderately broad valleys trending in that direction and hills with long gentle westward dip-slopes and steep eastward facing escarpments having the same trend as the valleys.

There are two major streams, Verdigris River and its largest tributary, Caney River. The location of these streams is shown on the accompanying map. The Verdigris River enters the county along the north line and flows in southwest course to the center of T. 20 N., R. 15 E., where it leaves its strike-valley and turns southeast, leaving the county near the southeast corner. Caney River enters the county near the center of T. 23 N., R. 14 E., and flows southeast to join Verdigris River near the center of the south line of T. 22 N., R. 15 E.

The main characteristics of these streams are their broad flood plains at places and the periodic, sudden rises of the streams that overflow these valleys. At times drilling and producing operations in low places must be abandoned because of high water.

GEOLOGY

Stratigraphy

SURFACE FORMATIONS

The formations exposed on the surface of Rogers County are shales, sandstones, and limestones of Pennsylvanian age, ranging from the Cherokee shales exposed in the eastern part of the county to the Coffeyville formation exposed in the northwestern part. The shales are by far the most abundant with sandstones second in amount. To the casual observer in the field the sandstones and limestones are the most conspicuous because they are hard and weather into prominent ridges and steep eastward-facing scarps. Although the Pennsylvanian formations thicken rapidly both laterally and vertically their thickness in Rogers County does not vary an appreciable amount. A study of the geologic map of Oklahoma[2] together with topographic maps of the county will bring out the relation between surface geology and topography. (See geologic map of Rogers County, Plate I).

2. Miser, H. D., Colored geologic map of Oklahoma: U. S. Geol. Survey, 1926.

Geologic Section of Rogers County

Age		Formation		Thickness	Character
PENNSYLVANIAN	CONEMAUGH	Coffeyville formation		225-435	Blue to green clay shales with sandstones in upper part, and Checkerboard limestone near base.
		Nowata shale		100-130	Shales, sandy in upper part and clayey in lower part.
	ALLEGHENY	Oologah limestone ("Big Lime")	Altamont ls., Bandera sh., and Pawnee ls. in NE. Rogers Co.	80	Thick beds of limestone in the upper and lower parts with a bed of shale between.
		Labette shale		60	Blue to green clay shales, sandy clays with brown shaly sandstones locally.
		Fort Scott limestone (Oswego lime or Wheeler sand.)		100	Limestone, thick bedded in upper part, with thin beds of limestone and limy shales below.
	POTTSVILLE	Cherokee shale (Including Bartlesville sand.)		450-500	Vari-colored shales, varying greatly vertically and laterally into sandy shale and sandstones. Bluejacket (Bartlesville) sandstone near base.
		Morrow Group		100	Brown limestone at top, micaceous sandy shale in middle, and brown oolitic fossiliferous limestone at base.
MISSISSIPPIAN	MARAMEC	Mayes limestone	Mississippi Lime	115	Light and dark gray, finely granular, platy, siliceous limestone.
	BURLINGTON-KEOKUK	Boone chert		50	Light gray chert with interstratified limestone.
		St. Joe (?) limestone		10	White coarsely crystalline crinoidal limestone.
	?	Grassy Creek (?) shale		10 ±	Light greenish gray flaky shale.
	KINDERHOOK	Chattanooga shale.		40-50	Black slaty bituminous shale of uniform texture.
ORDOVICIAN	CANADIAN	"Turkey Mt." (Sylamore) sand.		Variable	Highly crystalline, dolomitic sand, absent over most of area.
		Cotter dolomite (Arbuckle limestone or Siliceous lime)		400-500 on structure; 1,000-1,500 offstructure	Medium to fine, crystalline, dolomitic siliceous limestone with occasional thin beds of sandstone.
Pre-Cambrian.		Spavinaw granite			Dark red, mottled fine grained granite.

CHEROKEE SHALE

The Cherokee shales outcrop at the surface in approximately all of the eastern half of the county. The strike of the formation is approximately N. 20° E., so that the lowest beds of Cherokee are found in the southeastern corner of the county.

The Cherokee formation is made up of 450 to 500 feet of vari-colored hales from light gray and yellowish-brown to black in color, together with a number of lenticular sandstones, especially in the lower part. Shales and sandstones change both laterally and vertically and often grade into each other within comparatively short distances. The most important of the sandstones is the Bluejacket sandstone (the Bartlesville sand horizon), which outcrops from the northeastern part of T. 21 N., R. 17 E., southwest to the southeastern corner of T. 19 N., R. 16 E. This horizon produces oil and some gas in most of the fields of the county.

FORT SCOTT (OSWEGO) LIMESTONE

Immediately above the Cherokee shale is found the Fort Scott limestone, known to the drillers as the Oswego lime and in the Cushing field as the Wheeler sand. Its average thickness is approximately 100 feet in this area. It consists of thick bedded limestone in the upper part, grading into alternating thin beds of limestone and limy shales in the lower part. Immediately below this limestone but in the Cherokee shale is found the Fort Scott coal which is mined at a number of places for local consumption. The outcrop of the Fort Scott forms a very prominent scarp running northeast-southwest through the center of the county just west of Claremore.

LABETTE SHALE

Immediately west of the Fort Scott limestone scarp the Labette shales crop out in the valley of the Verdigris River. These shales consist of blue to green clay shales and sandy clays with brown shaly sandstones of local occurrence. The Labette shale is approximately 60 feet thick in Rogers County.

OOLOGAH LIMESTONE

The Oologah limestone consists of thick beds of limestone in the upper and lower parts with a bed of shale in the center, and has an aggregate thickness of about eighty feet. The formation outcrops in a belt from the north-central part of the county southwest and forms the limestone country just east of Talala and Oologah. In the northeastern corner of T. 23 N., R. 15 E., just west of Talala, the formation is divided into the Altamont limestone at the top, the Bandera shale in the center, and the Pawnee limestone at the base. The Pawnee and Altamont both thicken from north to south while the Bandera shale thins rapidly in the same direction. The Oologah is known as the "Big Lime" of the drillers.

NOWATA SHALE

The Nowata shale forms a fairly broad valley in the northwestern part of the county. It consists of 100 to 130 feet of shales which are sandy in the upper part and clayey in the lower part. A small seam of coal is found in the type locality near Nowata just north of Rogers County.

COFFEYVILLE FORMATION

The youngest formation in Rogers County outcrops in the extreme northwestern corner. The formation is made up of blue to green clay

shales, a number of thin sandstones in the upper part, and limestones in the lower part. Near the base is a very persistent thin limestone 2½ to 3 feet thick, known as the Checkerboard limestone. It is very fine grained, fossiliferous, and yellowish-white in color on weathered surfaces.

SUBSURFACE FORMATIONS

The subsurface formations encountered in deep wells drilled in Rogers County, range from the Spavinaw granite of pre-Cambrian age up to and including the lower formations of Pennsylvanian (early Pottsville) age. The entire geologic section is not present as may be seen by a study of the chart on page 7. Uplift and erosion has removed all Cambrian sediments, if they were ever deposited. Upper Ordovician, all of Silurian and Devonian formations are also absent.

SPAVINAW GRANITE

The basement rock, or the floor upon which all of the sedimentary rocks were deposited is the Spavinaw granite of pre-Cambrian age. It is fine grained, dark red granite of mottled appearance due to large amounts of deep red feldspar, black hornblende, and white quartz. A number of wells in this and surrounding counties have encountered the Spavinaw granite and a number of them have drilled several hundred feet into it.

ARBUCKLE LIMESTONE

The Arbuckle limestone underlies all of Rogers County and is a medium to fine grained, crystalline dolomitic siliceous limestone, with occasional thin beds of sandstone. Its thickness varies according to the topography of the underlying granite surface being 400 to 500 feet on top of the hills and 1,000 to 1,500 feet in the valleys. The upper part of this formation is a highly crystalline dolomite having a very porous or spongy texture in places, probably caused, at least in part, by the erosion of the higher beds. This truncated upper surface of the Arbuckle is known as the Turkey Mountain sand, while the main part of the Arbuckle is referred to by oil men as the Siliceous lime. Ulrich[3] has correlated this part of the Arbuckle with the Cotter dolomite of Arkansas.

It is thought that the entire thickness of Arbuckle present in this area is Ordovician in age as no evidence has been found to show the presence of Cambrian beds similar to those found in the Arbuckle Mountains. There has not been a single instance recorded of the presence of a sandstone between the limestone and the sandstone of Cambrian age.

CHATTANOOGA SHALE

The Chattanooga is a black bituminous shale of very uniform texture and attains a thickness of 40 to 50 feet in this area. The shale

3. Ulrich, E. O., Fossiliferous boulders in the Ouachita "Caney" shale and the age of the shale containing them: Oklahoma Geol. Survey, Bull. 45, p. 31, 1927.

is remarkably persistent in lithologic character and thickness in Rogers and the surrounding counties. This shale, originally thought to have been Devonian in age, is now definitely known to be Mississippian.

BOONE CHERT

Following the persistent Chattanooga shale a series of interstratified limestones, cherty limes, and cherts, known as the Boone chert was deposited. The formation thins rapidly to the west from the outcrop so that its maximum thickness in eastern Rogers County is 50 feet, disappearing altogether a few miles west of the county. This disappearance is thought to be due to the absence of the Boone sea in this area. The St. Joe (?) limestone is a definite faunal horizon about 10 feet thick found at the base of the Boone. The St. Joe (?) occurs at the same horizon as a subsurface formation of the same thickness and character found in Seminole County. It is there called the Sycamore limestone (Kinderhook) and the two are thought to be equivalent by many Tulsa paleontologists. For this reason the Kinderhook-Keokuk boundary in the geologic section, page 7, is questioned.

MAYES FORMATION

The Mayes formation is made up of approximately 100 feet of dark gray to black argillaceous limestone, forming a large part of the "Mississippi" lime of this area. The lithologic boundary of the Mayes is rather definitely known, but its age equivalent is somewhat uncertain.

The Pitkin limestone, Fayetteville shale, Batesville sandstone, and Moorefield shale do not occur in the geologic section of Rogers County. The data of those most intimately connected with this problem strongly indicates that there is no Pitkin anywhere in Oklahoma; the beds which were formerly called Pitkin are now placed in the Morrow group (basal Pennsylvanian). This change will probably be questioned by many since it places the upper part of the "Mississippi" lime in the Pennsylvanian system.

Luther H. White[4] states:

> I have been of the opinion for more than a year that the upper part of the ''Mississippi'' lime in Oklahoma is directly equivalent to what is known as the Lyons limestone which occurs and is well known in the Okmulgee-Henryetta territory, and especially in the Lyons-Quinn pool in T. 11 N., R. 11 E. I have been inclined to believe that this limestone is equivalent to Pitkin. However, paleontologists agree that this limestone is Pennsylvanian in age and is to be correlated with the Morrow and the Wapanucka. * * * In my opinion it is apparent that in any event there is a tremendous unconformity, particularly with reference to sediments cutting out at this horizon, in the ''Mississippi'' lime. In the southern part of Oklahoma there are many hundreds of feet of shale between what I refer to as Lyons limestone and what is certainly identified as Mayes limestone below.

4. White, Luther H., Personal communication.

> I think it pertinent to make this further observation. In all probability it is this horizon which is known as the first break in the ''Mississippi'' lime in northern Oklahoma which occurs about 50 feet, more or less, below the top of the formation. In the southwestern part of Rogers County, as well as in certain localities in Osage County, there is another horizon about 200 feet below the top of the ''Mississippi'' lime, but still within the formation which also produces oil. I very strongly suspect that this horizon is that of the unconformity at the base of the Mayes limestone.

MORROW FORMATION

The Morrow formation, which is found immediately below the Cherokee shales, consists of 100 feet of shale, limestone, and sandstone. The basal member, the Hale sandstone (not everywhere present) contains a number of fossiliferous limy horizons. The middle portion of the formation is a hard blue limestone grading into shale at the top. The upper member of the formation is mainly shale, blue to black in color.

The series of beds just described, [St. Joe (?), Boone, Mayes, and the lower part of the Morrow] aggregating from 250 to 300 feet of strata, is known as the "Mississippi" lime to drillers. These beds form a conspicuous and easily recognizable horizon in drillers' logs and makes one of the best key horizons for correlation in this county.

Sample Determination on the Well in NW.¼ NE.¼ NE.¼ Sec. 17, T. 21 N., R. 18 E.[5]

Altitude 713 feet

PENNSYLVANIAN SYSTEM

Des Moines Group

Cherokee Formation

		Top	Bottom
(1)	Intercalated, light gray, finely arenaceous, flaky shale and finely micaceous grit shells	85	95
(2)	Intercalated, finely micaceous and finely laminated light and dark gray shale with some minute spherical siliceous concretions	95	100
(3)	Black, finely laminated, finely micaceous shale. Some dark brown, evenly crystalline limestone shells	135	140
(4)	Intercalated, dark gray, platy and thinly laminated micaceous grit shells. FAUNA: **Triticites secalica, Sphaerodoma** sp., **Tolypamina** sp.	140	145
(5)	Black slaty, finely micaceous shale. **FLORA: Pyritic replacements of plant remains.** FAUNA: Ostracoda and foraminifera.	145	150

5. Bush, Frederic A., Paleontologist, Sinclair Oil & Gas Co., Tulsa, Oklahoma. Personal communication.

		Top	Bottom
(6)	Same as from 145 to 150	150	160
(7)	Intercalated, finely arenaceous, black, platy shale and micaceous grit shells	160	165
	FAUNA: Abundant ostracoda.		
(8)	Light gray, micaceous grit	165	170
(9)	Black, platy, finely micaceous shale	185	190
(10)	Intercalated, light gray, flaky shale and finely micaceous platy, black shale. Some fine, crystalline brown colored lime shells	205	220
	FAUNA: Ostracoda and foraminifera (**Triticites** sp.)		

Morrow Group

Formations Undifferentiated

		Top	Bottom
(1)	Drab, coarsely crystalline limestone with included granules of glauconite and some large sand grains. Very finely granular buff matrix in the interstices between the coarse calcite crystals	220	225
	FAUNA: Abundant ostracoda.		
(2)	Black, platy, finely micaceous shale	225	230
(3)	Same as from 225 to 230 with some intercalated, finely arenaceous, flaky, light and dark gray clay shale	230	252
(4)	Subangular, well assorted, free and included sand grains in a light gray argillaceous matrix	252	256
(5)	Oolitic, finely granular, drab, dolomitic limestone. Oolites, light gray, sub-spherical, 7 mm. in average diameter	260	280
(6)	Highly fossiliferous, finely granular, drab, dolomitic limestone, intercalated with light gray, flaky shale	280	291
	FAUNA: Abundant crinoidal and echinoderm remains.		
(7)	Same as from 280 to 291 with abundant ostracoda fauna	291	295
(8)	Light gray, calcareous grit. Finely subangular sand grains of good assortment set in a fine white calcareous matrix	290	330
(9)	Black, finely arenaceous, somewhat platy, carbonaceous shale. Quartz and mica particles set in a fine white calcareous matrix	330	340

MISSISSIPPIAN SYSTEM

Meramecian Group

Mayes Formation

		Top	Bottom
(1)	Light and dark gray, very finely granular, platy, siliceous limestone. A stain test shows the calcite to be very finely disseminated in a siliceous matrix having the texture of powder, and in places altered to chert. There are some inclusions of fine sand and mica particles. The lithology is remarkably even throughout, but contains some included glauconite granules at the base. The formation is almost unfossiliferous, excepting for an occasional fragment of a brachiopod	340	454

Burlington-Keokuk Group

Boone Formation

		Top	Bottom
(1)	Light gray, massive chert with some minute pyritic inclusions. Some white chert with disseminated rhombohedra of dolomite and some white chalcedony	454	460
(2)	Light gray chert and partly silicified, finely crystalline buff limestone. Some small fissure lines with chalcedony and agate	460	501

St. Joe (?) Formation

		Top	Bottom
(3)	White, coarsely crystalline limestone, highly crinoidal	501	509

Kinderhook Group

Grassy Creek (?) Shale

		Top	Bottom
(1)	Light, greenish-gray flaky shale	509	518

Chattanooga Formation

		Top	Bottom
(2)	Black lithohumic, slaty shale, containing much free and associated pyrite	518	571
	FLORA: **Sporangites huronense**		
	FAUNA: Abundant conodonts		

ORDOVICIAN SYSTEM

Arbuckle (?) Formation

		Top	Bottom
(1)	White, evenly crystalline, dolomitic limestone with many included subangular sand grains of fair assortment. Some chert and some sand grains tightly bonded with a white calcareous cement (T.D.)	571	615

GENERAL DISCUSSION

The geological section as shown by the cuttings of this well is worthy of further note because of its relation to the general stratigraphy and paleogeography. Some further explanation of the correlations set forth is due also.

The well starts in the Cherokee formation just below the outcrop of the Bluejacket sandstone member. The section of intercalated argillites, grits, sandstones, and coal are normal with the general lithology of the lower Cherokee, as observed elsewhere. This portion of the formation is the equivalent of the upper Winslow of Arkansas, and the microfauna is remarkably similar to that observed in the McAlester formation of south-central Oklahoma.

A series of limestones, calcareous grits, and argillites comprise the section assigned to the Morrow from the cuttings examined. This section is consistent over a large part of north-central and eastern Oklahoma and is correlative, at least in part, with the Wapanucka limestone of south-central Oklahoma. A thickness of 100 feet in this well compares favorably with thicknesses measured at the outcrop which vary from 110 to 130 feet. A highly arenaceous zone at the base of the group seems fairly persistent and may be the approximate equivalent of the sand series at the base of the Wapanucka in south-central Oklahoma. It is probably representative of the Hale sandstone member of Arkansas.

The Pitkin limestone and Fayetteville shale are not found in this well. The Pitkin limestone as exposed in Arkansas has a maximum thickness of 40 feet and is typically a fine blue-gray fossiliferous limestone. It is separated from the Morrow limestone by the Hale sandstone, and so is quite distinct by virtue of its stratigraphic position. In Oklahoma, however, the formations of the Morrow group are no longer perceptible enough to warrant separate mapping. The faunas of the Pitkin and Morrow groups are very similar, the Pitkin being classified as Chester in age, and the Morrow as lowermost Pennsylvanian. It must be noted though, that the latter group has a decided Mississippian facies, together with Pennsylvanian. The Pennsylvanian elements of this fauna are termed proemial and the Mississippian, residual by Mather [6] who has made a careful study of them. Then on the basis of lithology, and faunas also, the Morrow and Pitkin limestones are not rapidly distinguishable, and where the stratigraphic position of each may be clear in Arkansas, it is not in Oklahoma. The fact that the Morrow is resting directly on the Mayes formation in this well, suggests that the Pikin-Fayetteville formations may be absent entirely in this area, and that what has often been mistaken for Pitkin in both well records and outcrop is part of the Morrow.

The Mayes formation is typically represented in the cuttings, the lithology showing but little variation over a widespread area in the eastern part of the State. In general, the formation becomes more argillaceous and more arenaceous to the south, but the texture and appearance vary but little. A Moorefield age has been assigned to the Mayes fauna by most of the paleontologists who have studied it.

Because of its stratigraphic position, lithology, and one fragmentary fossil, we are placing the chert and dolomitic limestone at depths from 454 to 501 feet in the Boone formation. At the outcrop the Boone has a maximum thickness of 250 feet in Oklahoma, while it is represented by 47 feet in the well under consideration, and is entirely missing in the area a few miles west of this point, as shown by well records and cuttings. This thinning suggests a profound unconformity at the top of the Boone, which is probably erosional and depositional. The erosional phase is suggested by the more marked silicification in the upper part of the formation and the heterogeneous character of the sediments in a thin zone on top of it. The fact that there are no reported outliers of rocks above the Kinderhook group and below the Mayes formation that might be classed as Boone, west of the sub-areal limits, is highly indicative that this was also approximately the depositional limit. It might be noted that there is a distinct faunal break between the Mayes and Boone formations, the former being assigned to the Maramec stage, and the latter to the Burlington-Keokuk as age equivalents.

6. Mather, K. F., The fauna of the Morrow group of Arkansas and Oklahoma; Bull. Sci. Lab. Denison Univ., vol. XVIII, art. 3.

The section of intercalated coarsely crystalline white limestone is probably the St. Joe limestone, which has been considered lower Burlington in age. The St. Joe limestone does not contain a microfauna which may be used for correlation purposes in every locality, but its lithology and highly crinoidal character are remarkably consistent.

The aggregate Morrow, Mayes, Boone, and St. Joe limestone comprise the "Mississippi" lime of the driller. In the well records of Rogers County, these are generally inseparable, but it is hoped that the above detailed descriptions and discussion may be of some value in stimulating the identification of these widely differing groups and formations in further drilling development. The scientific and economic importance of this is immediately evident, and therefore, the saving of well cuttings cannot be too strongly urged upon the various operators.

The light gray argillite, overlying the black shale of the Chattanooga formation, and, in some localities, apparently intercalated with it, bears the same microfauna and flora as the latter and it is here suggested that these two are intergradational. The gray argillite is present in well cuttings over a remarkably widespread area, and in Kansas attains a maximum thickness of over 100 feet[7].

In south-central Oklahoma, it is probably correlative with the series of sediments included in the Sycamore limestone, the microfauna and flora being remarkably similar. It is suggested that the Grassy Creek shale may be the Missouri equivalent, though the microfauna and flora have not been determined.

The Chattanooga shale is typically represented, both as to lithology and microfauna and flora.

The heterogeneous mixture of sand, arenaceous dolomitic limestone, and chert in the last sample taken, has the aspect of an erosional zone. This is probably the zone immediately overlying the Arbuckle limestone in this general area. There was no faunal evidence to support this, but the stratigraphic position and lithology are enough to strongly suggest it.

The microfaunas and floras obtained from the cuttings of this well are mounted and filed in the Micro-paleontological Collection of the Sinclair Oil and Gas Company, and are available for inspection upon application.

Geologic History

The geologic section of Rogers County, including both surface and subsurface formations, ranges in age from pre-Cambrian to Pennsylvanian. However, the complete section is by no means present, as there are numerous unconformities representing times of no deposition and erosion.

The oldest sedimentary rock, the Arbuckle limestone, was deposited on a very irregular surface of pre-Cambrian granite. Consequently

7. Eakin No. 1, sec. 15, T. 21 S., R. 3 W., McPherson County, Kansas; Grassy Creek (?) shale—2,665-2,830 feet.

the thickness of this formation varies greatly from place to place as a result of the structural and topographic highs on the granite surface, which were islands in the early Arbuckle sea. That some of these highs were structural is shown by the fact that subsequent uplift has occurred at these points, resulting in structures in younger formations as high as the Cherokee shale. The uplift and erosion immediately following this deposition tilted the rocks to the southwest and greatly reduced the original thickness of the Arbuckle, which probably reached at least 2,000 feet in places. No mention has been made of the Reagan sandstone since this formation has not been encountered in any of the deep drilling in this area.

Following the erosion of the Arbuckle limestone the Simpson sea trangressively overlapped the truncated beds of the older formation. The nature of this deposition resulted in the omission of the older beds of the Simpson formation in a northeast direction. Subsequent uplift and erosion has pushed the boundaries of the various members of this formation farther to the southwest, so that the two members of the Simpson (Tyner and Burgen) are now found southwest of Rogers County. The paleogeography of this area has been described in detail by White.[8]

After the erosion of the Simpson formation the Viola, Sylvan, and Hunton formations were deposited, all of which were later removed from the area of Rogers County by a pre-Chattanooga interval of uplift and erosion. The subsequent deposition of the Chattanooga shale occurred in a very widespread sea which covered most of the central interior of the United States, followed by the deposition of the gray shale here referred to as the Grassy Creek (?). The "Mississippi" lime [St. Joe (?), Boone, Mayes, and lower Morrow] was then deposited conformably upon the Grassy Creek (?) followed by the deposition of the remainder of the Cherokee shales of Pennsylvanian age. The Morrow beds are separated from the Mayes limestone by an unconformity of considerable extent.

Structure

Like all of this general region the formations of Rogers County dip generally westward. The formation which is on the surface at the east line of the county is approximately 850 feet deep on the west line, giving an average dip to the west across the county of about 37 feet per mile. A conception of the general geology of the whole region is essential to understand the structure of the area here discussed. This part of the earth's surface was approximately horizontal when the strata of this region were deposited. (See cross-section, Plate II).

The uplift of the central Ozark region carried upward with it the strata on all sides, but the amount of uplift decreased as distance

8. White, Luther H., Subsurface stratigraphy of northeastern Oklahoma: Oklahoma Geol. Survey, Bull. 40-B, 1926.

from the mountains was attained. As a result of these big earth movements the strata slope from the mountains and since the mountains are east of this region the slope is westward and at the rate noted above.

Smaller upward foldings or structures resulted from these general movements of the strata. These small structures are the ones of prime importance to the petroleum industry because they are where the oil and gas accumulate. Descriptions of some such structures in Rogers County are given in the following paragraphs.

SENECA FAULT

One of the most extensive faults in Oklahoma enters the State near the northeast corner in T. 27 N., R. 25 E., and trends southwest to T. 18 N., R. 17 E., where it breaks into a series of faults. It therefore is in the southeast corner of T. 19 N., R. 17 E., Rogers County. It has no direct bearing on the petroleum resource but is a geological feature of considerable interest.

WISENHUT STRUCTURE

(Named from Wisenhut School)

The most pronounced anticline in the county trends southwest from the eastern part of sec. 4, T. 22 N., R. 15 E., to the southeastern part of sec. 8, T. 21 N., R. 15 E. It raises to a considerable crest in sec. 21, T. 22 N., R. 15 E., but is apparently lower where it is crossed by Caney River and then raises to a very pronounced anticline in the northern part of T. 21 N., R. 15 E. This structure has produced a considerable quantity of gas which was used at the smelters at Collinsville and some oil but in general it has been a disappointment. Generally a structure of the shape and extent of this one is abundantly productive.

FOYIL STRUCTURE

There has been considerable production in sec. 6, T. 22 N., R. 17 E., just south of the village of Foyil. This structure is known to be small but the exact form and extent has not been determined by the writers and no maps are available.

There is a small structure in sec. 16, T. 22 N., R. 17 E., which has not been tested and another in sec. 36, T. 22 N., R. 17 E., only partially developed.

OIL AND GAS DEVELOPMENT

History of First Drilling in Oklahoma[9]

In 1882 the Cherokee Council passed a law providing for leasing of lands for the mining of all minerals except gold and silver. A blanket oil and gas lease was made by the Cherokee Nation in 1886 to Ed-

9. Hedrick, Robt. F., Extract from article in Tulsa World, June 6, 1926.

ward Byrd. The lease comprised 94,000 acres, and was signed and approved by Chief Bushyhead and Robert Ross, treasurer, but it was not approved by the Secretary of the Interior Department at Washington, so development did not officially start until the summer of 1889.

The first well was drilled at this time on what was known as the Laura Taylor land, sec. 5, T. 23 N., R. 17 E., on the south prong of Spencer Creek to the west of Chelsea. This well was drilled by a contractor by the name of Sam Frances. He used a horse-power outfit and could not go very deep. This well was completed in August, 1889, at a depth of 36 feet, and made one-half barrel of fine green oil. A power house was put up over the well and an upright boiler and engine used to do the pumping. This was done for several months, there being a 50 barrel tank used to receive the oil. This well was drilled to test the oil spring known to almost every old Cherokee citizen. This spring was used for many years by the Indians before anyone thought about oil being worth anything, or was any good for any purpose than for greasing an old wagon or for softening leather.

The second well was put down 150 feet due west of No. 1, and was drilled to a depth of 86 feet. This well made 3 barrels a day on the pump. No. 3 was started 200 feet west of No. 2. This well was drilled to 120 feet where the tools were lost, causing the abandonment of the well. The rig was moved one mile north on Spencer Creek and in November, 1889, another well was started. This well was drilled to 96 feet and 5 barrels of oil were found.

At this time the United States Oil Company was formed for deep drilling. A contract was let to drill 2,000 feet on the Martin Bill lands, down Spencer Creek some two and one-half miles. A standard rig was built and the well drilled to 1,200 feet where the hole was lost due to crooked hole, cavings and salt water. The rig was skidded eight or ten feet and another hole drilled to 1,230 feet where similar trouble again developed in the "Big Lime" and the hole was again lost.

The United States Oil Company then made a deal with a man named Lynn to take over and develop the property for an interest. Another standard rig was built 900 feet east of the old well. A bad fishing job developed and the well was never completed due to the death of Lynn. The well was plugged in the spring of 1893 with three strings of tools in the hole.

The company then secured J. B. Phillips of Pennsylvania, who took charge and cleaned up the old property before starting new wells. The first new well, completed in 1896, was shot with 500 pounds of gunpowder.

A few years later Phillips formed the Cherokee Oil and Gas Company which brought in the first Star drilling machine (about 1903). The first well drilled by this machine was on the Jane Byrd land and came in for 10 barrels. The machine was kept running steadily and

a well a week was completed. These wells made from 10 to 40 barrels a day and many are still producing, averaging one-fourth barrel per day.

Just before statehood the Secretary of Interior granted a lease to the Cherokee Oil and Gas Company covering 12 sections of land on the basis of a lease on a full section of land for each well drilled under the old blanket lease. The boundary lines of the 94,000 acres comprising the old lease are as follows:

Beginning at the Frisco depot, running northeast one mile to water tank, or Pryor Creek bridge, thence northwest to Coody's Bluff, then following the Verdigris River to what is known as the old Claremore Mounds, thence due east to Sequoyah, then northeast up the Frisco Railway to the place of beginning.[10] (See figure 2).

Producing Sands

Most of the oil and gas accumulation in Rogers County is controlled by sand conditions as well as by structure. This is due to the lenticular character of the sand bodies forming the reservoir rocks. The largest producing area of the county is in the vicinity of Chelsea. This is the southeastern extension of the great Nowata field, which is limited to the northwest by small fields to the south of Wann in Washington County, and on the southeast by the fields of Chelsea, two points 35 miles apart. This area is not an anticline though there is local evidence of structure, so it is thought to be an old stream bed in which the sands now bearing oil were deposited. Occasionally "new leads" from the main trend are found, which were evidently branches of the main stream. This condition closely parallels the accumulation of oil in the "shoe string" sands of southeastern Kansas. The surface structure at Sageeyah is a monocline where production is found, hence it is inferred that lenticular sands hold the petroleum there.

Some of the sands above the Bartlesville which are productive in the fields west of Tulsa occur in Rogers County but either outcrop or are so shallow that they are not oil bearing. Therefore, only the Bartlesville and lower sands need be considered. The Bartlesville underlies all of the county except the southeast corner, where it outcrops in Tps. 19-21 N., R. 17 E. It is productive in the Sageeyah, Foyil, and Chelsea-Alluwe fields where it averages 20 feet thick. It has also been found productive to a considerable extent in a few small scattered groups of wells.

The "Mississippi" lime has produced a considerable amount of gas in several of the fields of the county. The Boone averages about 40 feet thick, and is found from 450 to 1,350 feet below the surface.

10. The facts as set forth in the above sketch have been substantiated by a son of J. B. Phillips who is now living at Chelsea and is one of the active operators in the Chelsea district.
C. L. C.

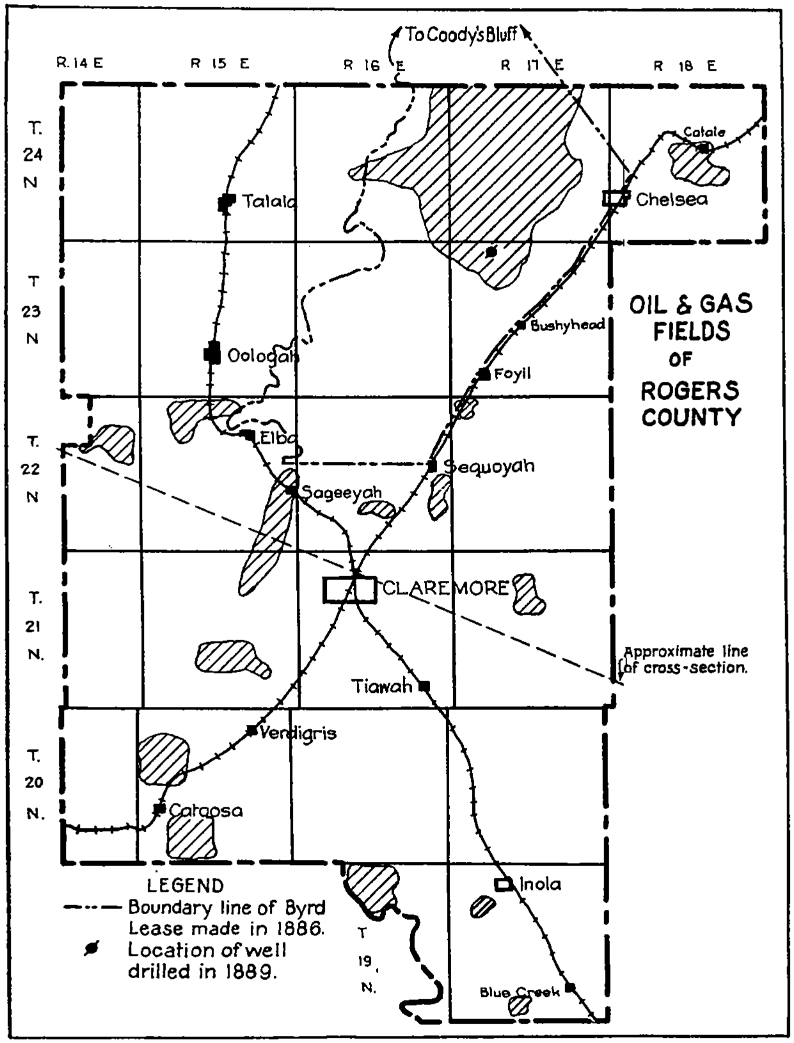


Figure 2. Map of Rogers County showing location of oil fields, boundry of original Byrd lease, and approximate location of first well drilled.

Many of the wells which have been drilled below the "Mississippi" lime have reported the "Wilcox" sand. The true Wilcox sand does not underlie this county. It was probably present at one time in the area of Rogers County but was eroded away before the Mississippian formations were deposited. There are sands in the basal Morrow beds and just above the "Siliceous" lime or in the top of it which have been designated the "Turkey Mountain" or Sylamore sand.

Most of the oil is high grade, ranging from 34° to 43° B., with an average of 38° B. Most of the gas is too dry or in too small quantities to give commercial quantities of gasoline at the casinghead. The Gladys Belle pool, near Inola, has yielded an appreciable amount of natural gasoline, but is nearly exhausted now.

Producing Areas[11]

CATOOSA

The Catoosa field, located in secs. 7, 8, 17, 18, 28, 29, 32, and 33, T. 20 N., R. 15 E., is principally a gas field having wells with an initial production of 2 to 10 million cubic feet. The gas comes from two horizons, the Booch sand, which is the equivalent of the Tucker, found at a depth of 850 feet and the "Mississippi" lime at 900 feet. The field was opened in 1913, by a well drilled by Kansas Natural Gas Company.

CHELSEA

The Chelsea field, the oldest producing field in Oklahoma, is located in the northern part of the county in T. 24 N., Rs. 16-17 E. The whole area, containing several thousand wells, is now completely developed. The age of the wells now producing is from 3 to 30 years old. The principal producing horizon, the Bartlesville sand, is found at a depth of 460 feet, though some oil is found in the Burgess sand at 600 feet. Most of the wells now have a production of ½ to 20 barrels per day. Many of the properties in this district are using various methods to increase recovery, the air pressure method being the one most used. The oil produced ranges from 34° to 38° B.

CLAREMORE

There are a number of small, scattered areas of production in the vicinity of Claremore in T. 21 N., Rs. 15, 16, and 17 E. The most important of these areas is located six miles east of the town in sec. 9, T. 21 N., R. 17 E. The first oil well, located SE.¼ SE.¼ section 9, was completed in May, 1925, with a production of 70 barrels. Additional wells have had an initial production of as high as 160 barrels, though there is no regularity of their initial output. Dry holes are found as close as 300 feet from producers. This area has been producing gas since 1913, from a sand which is probably correlative with

11. The authors of this paper are indebted to Mr. R. L. Lee of Claremore for a careful check on and addition of much new data to this part of the report.

the Tucker sand, at about 700 feet. This pool now has 20 producing wells with a settled production of 2 to 5 barrels of 43° B. oil each, and 8 gas wells making 1½ to 3 million cubic feet of gas. Six additional wells were either dry holes or abandoned because of small production. The production is mainly from the Burgess sand which has an average thickness of 22 feet. There is now about 20 million cubic feet of gas and a settled production of 100 barrels of oil from 4 leases in this area.

GLADYS BELLE POOL

The Gladys Belle Oil Co. developed one of the most profitable shallow oil pools in the whole region in secs. 3, 4, and 9, T. 19 N., R. 16 E. Wells with an initial production as high as 500-2,000 barrels were brought in from a depth of 600 feet. This field has produced steadily since it was brought in in 1914 and is still yielding oil. The field has yielded a large quantity of gas and a compression plant of 250 gallons capacity was erected for the purpose of recovering the natural gasoline. The pool now has about 13 producing wells which together make 18 to 20 barrels of oil per day. Gas under pressure is used to increase the recovery.

INOLA POOL

The Inola pool is a small area producing oil and gas south and west of the town of Inola. In the main Inola pool (T. 19 N., R. 17 E.) there are 70 producing wells and approximately 20 dry or abandoned wells. The pool averages 32 barrels of oil a day from the 70 wells. Many of the wells had an average initial production of 250 to 300 barrels, one making as high as 2,000 barrels. The producing horizon (the Burgess sand) is about 20 feet in thickness and is found at a depth of 500 feet. The recovery is increased by using air pressure at 160 pounds per sq. in. This air is introduced through 13 scattered wells on the lease, much of it being lost through faulty sand conditions and channeling.

OOLOGAH POOL

The Oologah pool located in secs. 3, 4, 5, and 8, T. 22 N., R. 15 E., produces gas from the Oswego and the "Mississippi" limes at 700 and 1,355 feet respectively. These horrizons are 20 and 45 feet in thickness, and the wells have an initial production of one to 3 million cubic feet. The pool was opened about 1906.

SAGEEYAH POOL

The Sageeyah pool located in secs. 24, 25, and 36, T. 22 N., R. 15 E., has a number of small wells with a settled production of 2-3 barrels per well. The oil is 38° B. and is produced from the Bartlesville sand at about 650 feet. There are also some small gas wells in the Burgess sand at 970 feet. This pool was opened in 1918.

CATALE POOL

A small pool in secs. 15, 16, 21, and 22, T. 24 N., R. 18 E., produces a litle oil and gas from the Burgess sand found at a depth of 400 feet. The oil wells had an initial production of 3 to 10 barrels and the gas wells from 1 to 2 million cubic feet. The pool was opened in 1910.

TUTTLE-KEPPEL POOL

In secs. 24, 25, T. 22 N., R. 16 E., known as the Tuttle-Keppel pool, there are 18 wells averaging 2-3 barrels of 43-44° B. oil on settled production from first break in limestone at 715 feet. Some of these wells have an initial production of as much as 20 barrels, but settle to two or three barrels, where the production remains stationary for a long time. There are now about 40 wells with settled production in this area.

MISCELLANEOUS OCCURRENCES

Some 2 million foot gas wells found in Bartlesville sand in secs. 27 and 28, T. 22 N., R. 16 E.

Gas field (secs. 21, 22, N.½ 27 and 28, and SE.¼ 26, T. 21 N., R. 15 E.) Wells in Bartlesville, Tucker, and Burgess found at 600, 800, and 980 feet respectively. Gas is taken by Oklahoma Natural Gas Co.

A well in sec. 3, T. 21 N., R. 16 E., northeast of Claremore produces 1½ million cubic feet of gas, used by Unity Gas Co. NE.¼ SE.¼ NE.¼ sec. 4, T. 21 N., R. 16 E., one million cubic feet of gas. Gas used by Unity Gas Co. This area now has a 25 barrel well in the Burgess sand.

Secs. 11, 12, 13, and 15, T. 22 N., R. 14 E., 50 wells in Bartlesville at 800 feet making 38° B. oil.

Ten wells averaging 2-3 barrels production of 38° B. oil from Bartlesville sand are located in secs. 6, T. 22 N., R. 17 E., one mile south of Foyil. This production comes from Burgess sand at 600 feet.

To the south of Inola there is a structure in sec. 33, T. 19 N., R. 17 E., partially tested. This structure parallels the large Seneca fault.

POSSIBILITIES OF NEW POOLS

There are very few untested structures in Rogers County but no doubt there are many places which have not been tested where lenticular sands that contain oil may be found. In fact sand lenses are so prevalent that any well not too near a dry hole may have considerable possibility of small production. There are some wells, though mostly small, in every township in the county. Large wells cannot be expected due to sand conditions and because the depth is not sufficient for large ones.

Increased Recovery Methods

Vacuum and pressure have been used in Rogers County to secure increased oil recovery. The vacuum seems to have secured an increase in production for a short time followed by a gradual decline which soon dropped below the amount of production which was obtained before the vacuum was started.

The shallow depth at which the sands are found offers very favorable conditions for the application of pressure where the sands are sufficiently porous to respond to this method of increased production. In general, the Bartlesville and Tucker sands are porous enough to respond to this method of production, and, in general, the Burgess is too "tight" for good results. However, there is no broad rule which is dependable for universal application, as the porosity of the sand on each lease must be considered separately.

Air, gas, and a mixture of air and gas have been used in the pressure method. Which to use, the volume necessary, and the amount of pressure required varies between wide limits. Almost every "air" well is a problem in itself, and there is, as yet, no criteria for determining just how the well is to be operated.

Figure 3 is a curve showing the results of recovery on a property in the Chelsea field on which both the vacuum and pressure methods have been used. At the beginning of 1917 when the vacuum was applied the production was 19,000 barrels per year. The increase due to the vacuum was over 1,200 barrels at the end of the year, when the lease started to decline. The low point of production was reached at the end of 1924 at 7,000 barrels. Pressure was then applied, increasing the production to such an extent that at the end of two years, the lease was producing more oil than the peak production reached by vacuum at the end of 1917. The expense curve is plotted with the production curve and shows the remarkably low increase in operating costs incident to maintaining the pressure on the lease. The lease represented has a total of 57 wells.

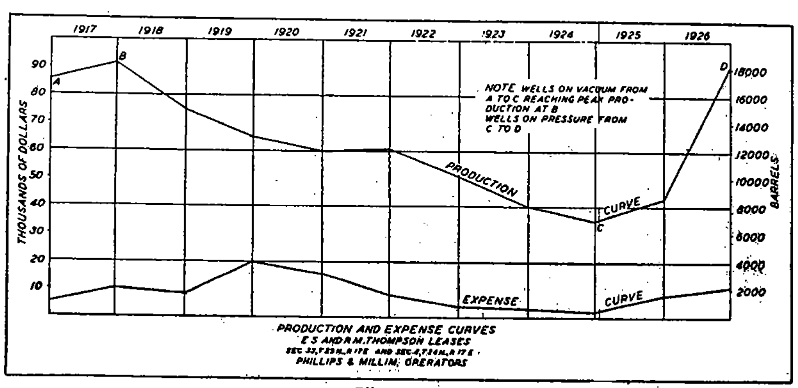
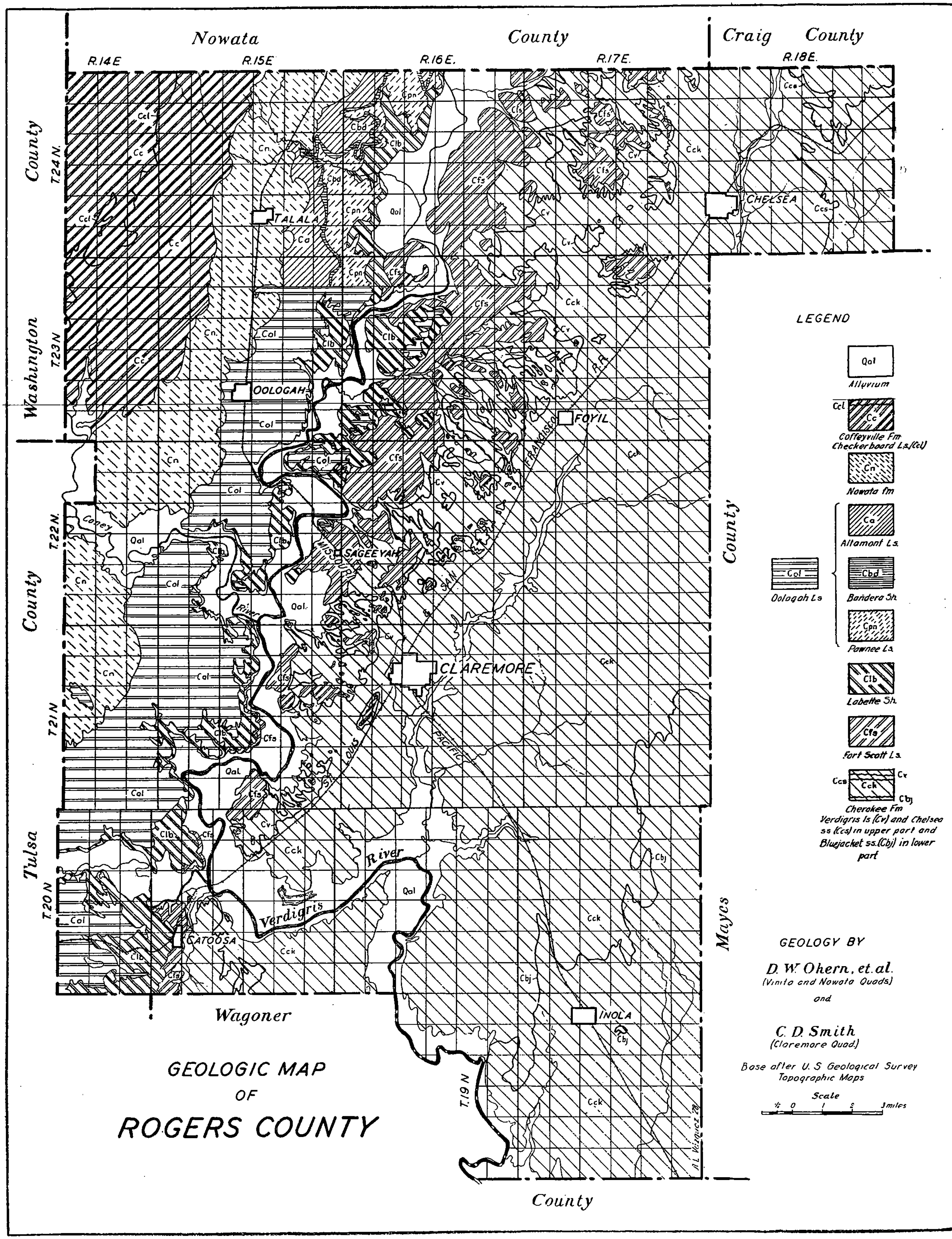
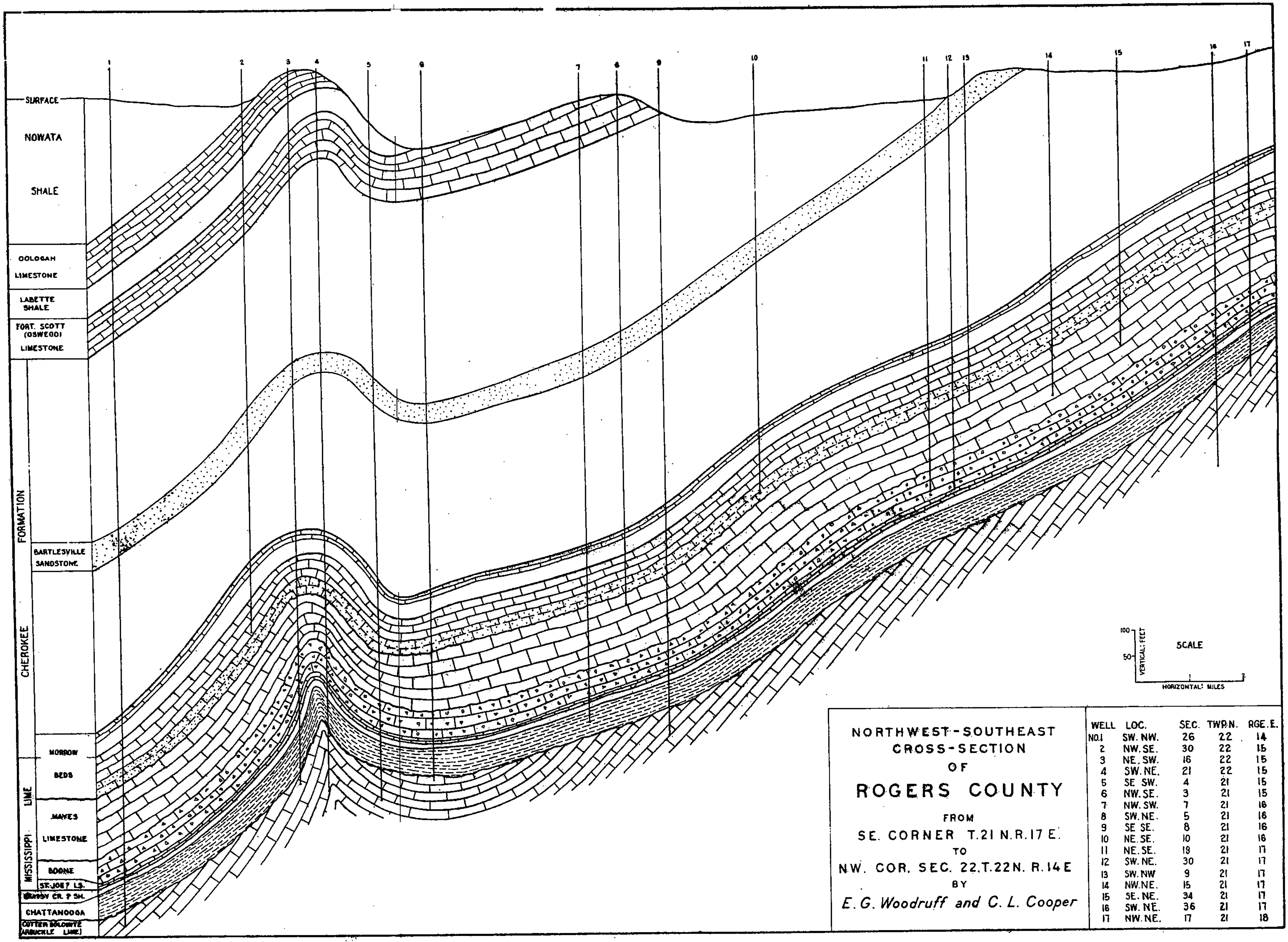


Figure 3.



GEOLOGIC MAP OF ROGERS COUNTY



NORTHWEST-SOUTHEAST
CROSS-SECTION
OF
ROGERS COUNTY
FROM
SE. CORNER T.21 N.R.17 E.
TO
N.W. COR. SEC. 22.T.22N. R.14 E
BY
E. G. Woodruff and C. L. Cooper

WELL	LOC.	SEC.	TWP.N.	RGE.E.
NO.1	SW. NW.	26	22	14
2	NW. SE.	30	22	15
3	NE. SW.	16	22	15
4	SW. NE.	21	22	15
5	SE SW.	4	21	15
6	NW. SE.	3	21	15
7	NW. SW.	7	21	16
8	SW. NE.	5	21	16
9	SE SE.	8	21	16
10	NE. SE.	10	21	16
11	NE. SE.	19	21	17
12	SW. NE.	30	21	17
13	SW. NW	9	21	17
14	NW. NE.	15	21	17
15	SE. NE.	34	21	17
16	SW. NE.	36	21	17
17	NW. NE.	17	21	18