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OIL AND GAS IN OKLAHOMA

JOHNSTON AND MURRAY COUNTIES

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.

Dr. F. A. Melton, professor of geology in the University of Oklahoma, has compiled in this report the more important articles in the literature bearing on the oil and gas geology of these two counties. In addition Dr. Melton spent some time in the field gathering information to supplement data already on hand.

Norman, Oklahoma
February, 1930

CHAS. N. GOULD,
Director

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JOHNSTON AND MURRAY COUNTIES

Introduction

Johnston and Murray counties largely cover the area of the exposed Arbuckle Mountains, a folded and faulted mountain system in the second cycle of erosion. Due to its location near an important line of north-south travel, the splendid geological sections that are available in the Arbuckle Mountain system have been studied by many investigators. This report, prepared in one month's time, is therefore largely a compilation of the facts presented elsewhere by other men. In certain areas, however, additional field work was done when occasion demanded.

FORMATIONS AND GEOLOGIC HISTORY

Pre-Cambrian

The pre-Cambrian rocks of the Arbuckle Mountains have been described by Taff[1] and Taylor[2] in considerable detail. They are chiefly granites, basaltic and gabbroic dikes, and rhyolite. Two granites, the Tishomingo and the Troy, have been described, and a third may be revealed by additional work. The Tishomingo is a coarse-grained pink porphyritic granite, the phenocrysts of which are in places two or more

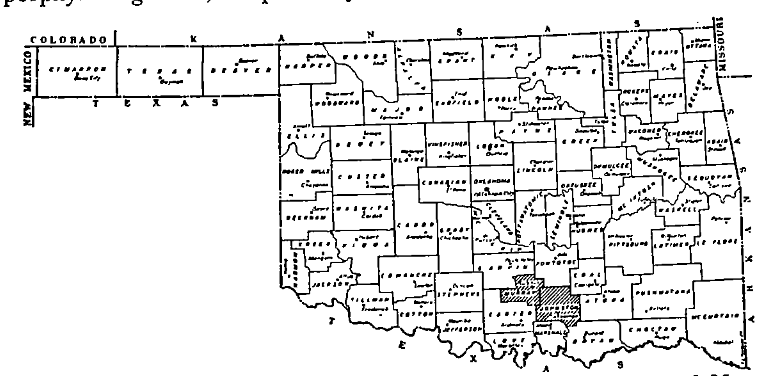

Figure 1. Index map of Oklahoma showing location of Johnston and Murray counties.

1. Taff, J. A., U. S. Geol. Survey Geologic Atlas, Atoka folio, (No. 79), 1902.
2. Taylor, C. H., Granites of Oklahoma: Oklahoma Geol. Survey Bull. 20, 1915.

inches long. At the large quarry southeast of Troy the phenocrysts are very numerous and are more closely packed than in some other localities. The granite used in the construction of the State Capitol Building was taken from this quarry. The Troy granite is likewise pink and fairly coarse-grained but it differs strikingly from the coarser phases of the Tishomingo granite in the absence of large phenocrysts of feldspar. Phenocrysts are in general inconspicuous in this granite. It contains biotite.

A large number of basic dikes cut both of these granites. Their width ranges from less than one inch to 50 feet and more. Many are so fine-grained that they are properly called basalts, while others are slightly coarser and appear to be gabbros in composition. Additional dikes of aplite and porphyritic rhyolite are also found. In the large area of pre-Cambrian rock north and east of Tishomingo a few rhyolite dikes appear to be the latest intrusive rocks present. Two other areas are known, however, where the porphyritic rhyolite is well exposed. These are the East Timbered Hills and West Timbered Hills in the western part of the Arbuckle Mountains. Here the oldest Cambrian formation overlies the rhyolite with a large unconformity. No other igneous rock is present to show the field relations of the rhyolite, but it is a fair supposition that the age is the same as that of the rhyolite dikes in the Tishomingo and Troy granites—that is, late pre-Cambrian.

The oldest overlying sedimentary formation is the Reagan sandstone which, on the basis of fossils, is believed to be upper Cambrian in age. The possibility cannot then be definitely excluded that the rhyolite and perhaps the basic dikes are early Cambrian in age. But analogy with other areas of pre-clastic-Cambrian rocks points definitely toward a pre-Cambrian age for all the igneous rocks just discussed.

Cambrian

REAGAN SANDSTONE

The pre-Cambrian igneous rocks of the Arbuckle area were exposed to erosion for a long period of time during which they were reduced to a surface of small relief. The highest hills were probably no more than a few hundreds of feet high. Because of the absence of land plants, which lessened the amount of chemical disintegration, the lower places were probably covered with arkosic material. During upper Cambrian time epicontinental seas invaded the area depositing a basal conglomerate of arkosic and granitic material followed by sandstone. This is the oldest Paleozoic sedimentary formation known in Oklahoma and is called the Reagan sandstone from the village of Reagan ten miles north of Tishomingo, Johnston County, Oklahoma, which has long been considered the type locality. The outcrops here, however, are similar to the other outcrops only in color and quartz content. The Reagan sandstone, due to its glauconitic content, which, in certain

beds reaches as much as sixty per cent, is characterized by a green color. A heavy coating of iron oxide on the sand grains gives the sandstone a brown color if the glauconite is not very abundant. The formation is variable both as to the nature of its material and as to thickness, which ranges from a few feet to more than 500 feet. The average is about 300 feet. It outcrops in three separate areas shown by the colored geologic map of Oklahoma published by the U. S. Geological Survey.

The following is a section of the Reagan sandstone exposed in the SE.¼ sec. 35, T. 1 S., R. 1 E.[3]

Section of Reagan sandstone, sec 35, T. 1 S., R. 1 E.

		Feet
7.	Thin bedded limestones; this member is light gray in color composed of compact well crystallized limestone, containing as much as 5 per cent of glauconite, and some quartz. It is hard to differentiate from the overlying Arbuckle, but is not as blue in color	137.7
6.	Heavy bedded sandstone composed of well rounded quartz grains	28.5
5.	Alternating beds of shale and limestone with occasional beds of sandstone	95.0
4.	Calcareous sandstone; quartz is the chief constituent of this member with glauconite disseminated through it as stringers giving it a greenish hue. There are lentils or argillaceous material which are very fossiliferous in local areas	138.0
3.	Friable sandy beds containing lentils of calcareous and argillaceous material	171.0
2.	Quartzite, very hard resistant rock, pink in color, composed of quartz and feldspar grains	6.0
1.	Coarse conglomerate; this member is made up of rounded and angular boulders of the underlying Colbert Porphyry which range from 12 to 17 inches in diameter with finer quartz, glauconite, etc., filling the interspaces. The conglomerate becomes finer toward the top.	2.5-11.2

Cambro-Ordovician

The sea which invaded this area late in Cambrian time continued to spread and deepen through the early Ordovician, changing the conditions to such an extent that a great thickness of calcareous and dolomitic beds was deposited.

ARBUCKLE LIMESTONE

This great mass of limestone and dolomite rests conformably on the Reagan sandstone and grades from it. The area of its outcrop is a large part of the Arbuckle Mountains, from which it receives its name. In consequence of its thickness and resistance it is the chief formation to support the Arbuckle Mountain peneplane. It was first

3. Six, R. L., The Reagan sandstone: Unpublished thesis, Univ. of Oklahoma, 1929.

thought to be a very consistent limestone 4,000-6,000 feet in thickness but later work has shown it to be largely dolomite in the lower part and almost 8,000 feet thick. Fossils indicate that the lower part is upper Cambrian and the upper part is lower Ordovician (Beekmantown) in age.

Following is a generalized section along U. S. Highway No. 77, between Davis and Springer:[4]

Section of Arbuckle limestone along U. S. Highway north of Springer.

		Feet
7.	Medium bedded sandy and shaly limestone. This member contains seven thin conglomerates and breccia, algal beds, mud-cracks, worm trails. The uppermost 443 feet contain a large percentage of sand showing shallow water conditions. It contains five relatively thin beds of strongly dolomitic limestones	3,131
6.	Sand, interstratified with limestone. This member contains silicified fossils and a few beds of siliceous oolites	690
5.	Massive bedded limestone. There is a large amount of siliceous oolites in this member, also some massive chert nodules.	657
4.	Dolomitic limestone. Heavy bedded limestone with sandy dolomite, containing a few beds of sandy dolomite, and numerous fossils.	519
3.	Limestone. Numerous thin beds of limestone, interbedded with more massive beds.	639
2.	Dolomite and dolomitic limestone. The upper 286 feet of this member is composed of alternating beds of fine-grained dolomite and coarse-grained dolomite, the latter having the appearance of marble, although no evidence of recrystallization is shown. The remainder of the member is composed of thick beds of pure dolomite with thinner beds of dolomitic limestone. About 75 per cent of this member is composed of pure dolomite.	2,258
1.	Thin bedded gray to light chocolate limestone. This member rests conformably upon the calcareous portion of the Reagan sandstone.	98

SIMPSON FORMATION

The long period of relatively quiet sedimentation, during which the Reagan sandstone and the Arbuckle limestones were deposited, was ended by general warping of the entire region. The greater part of the Arbuckle Mountains was brought above water for a short time. During this short space of time the upper surface of the limestone was locally eroded. This unconformity is evidenced by a small band of oxidized material between the Arbuckle and the Simpson, and the irregular distribution of the basal sandstone. This sandstone is probably

4. Decker, C. E., and Merritt, C. A., Physical characteristics of the Arbuckle limestone; Oklahoma Geol. Survey, Circ. 15, 1928.

a beach or near shore deposit made in the valleys of the Arbuckle which were first filled by the invading sea.

Taff[5] gives the following generalized section, which is usually characteristic of the formation in this area:

Section of Simpson formation on south side of Arbuckle uplift, west of Washita River.

		Feet
11.	Thin limestone with green shales interstratified. In the lower part the limestone is sub-crystalline, resembling beds lower in the formation, while higher it becomes fine-grained and argillaceous, resembling that of the succeeding Viola formation.	400
10.	Sandstone	90
9.	Limestones and shales interbedded. Some of the limestones are highly fossiliferous: **Orthis tricenaria, O. deflecta, Monticuliporoid Bryozoa,** highly ornamented cystid plates, and species of **Ctenodonta.**	400
8.	Sandstone	100-200
7.	Shaly limestone. The lower 50 feet are highly fossiliferous, containing **Ostracoda** with numerous **Bryozoa** and bases of crinoid column, making a fauna sufficiently peculiar to be easily distinguished.	195
6.	Sandstone	33
5.	Thin bedded limestone and shale interstratified. Contains fossils in great abundance, chiefly **Ostracoda** of large and small species and numerous brachiopods, gastropods, pelecypods, and trilobites.	295
4.	Greenish shales with a few thin limestone layers and thin sandstone.	245
3.	Granular crystalline limestone in thin beds. Contains an abundance of **Ostracoda (Leperditia** chiefly) and other fossils.	350
2.	Thin limestone and shales interstratified with occasional thin sandstone.	29
1.	White to light brown sandstone, occurring locally.	0-100

The Simpson is correlated with the Black River, Upper Stones River, and Chazy formations of Ordovician age. It is exposed around the edge of the Arbuckle limestone. On the south side of the mountains the thickness varies from 2,000-2,400 feet. On the north side it is much thinner, averaging about 1,250 feet.

VIOLA LIMESTONE

The Viola limestone is 500-700 feet in thickness. As it is more resistant to weathering than either the preceding or the succeeding formations it outcrops usually in long narrow ridges or rounded hills. The limestone appears massive in fresh exposures, but upon weathering the beds are seldom more than one foot in thickness. No dolomite has been found. A division into three members has been made on the

5. Taff, J. A., Preliminary report on the geology of the Arbuckle and Wichita Mountains in Indian Territory and Oklahoma: U. S. Geol. Survey, Prof. Paper 31, 1904. (Reprinted as Oklahoma Geol. Survey Bull. 12, 1928).

basis of the fossil content. There is a gradual transition from the upper part of the Simpson up into the basal portion of the formation. The lowest member never exceeds 100 feet in thickness and in places is much less. It consists of light colored, coarse-textured, and usually roughly bedded limestone containing some nodular chert. The fossil content correlates this division with the latest Black River and earliest Trenton.

The middle member has a thickness of approximately 300 feet. It is composed of a white to light-blue, thin-bedded limestone. There are two zones near the base that contain an abundance of graptolites, and a third zone near the top that contains numerous trilobites belonging to the genus *Trinucleus*. These fossils indicate that the middle member beds were deposited during the last half of Trenton time.

The highest member resembles the lowest in physical characteristics. The limestone at the top is more crystalline and usually lighter in color, being light gray and occasionally pink. This member is approximately 300 feet in thickness, but only in the upper 25 feet is it abundantly fossiliferous. It contains the same fauna that occurs in the Fernvale formation farther north and east.

Silurian

SYLVAN SHALE

This formation is found in narrow timbered valleys between the Viola and Chimneyhill limestones. The shale varies in thickness from 60-300 feet. It is thinner in the eastern than in the western part of the mountains. The basal portion of the formation is a greenish-gray to nearly black, calcareous, bituminous shale, which weathers on exposure to blocks and fissile plates. It contains an abundance of graptolites and shells which are upper Ordovician in age. The middle and upper portions are composed of soft, greenish, fissile shales, which weather easily to a fine soft earth.

Section of Chimneyhill limestone.

	Feet Min.	Max.	Average
3. Pink Crinoidal member; thin-bedded, compact, earthy to crystalline limestone with numerous crinoidal fragments, which are stained pink by infiltrated iron.	9	39	15
2. Glauconitic member; white to gray, granular to crystalline, limestone containing disseminated grains of green glauconite.	0	26	15
1. Oolitic member; limestone which for the most part is composed of calcareous oolites. In a few places where bands and stringers of chert appear, the oolites are siliceous.	0	12	5

CHIMNEYHILL LIMESTONE

This formation corresponds to the lower part of Taff's Hunton formation. It rests, possibly with an unconformity, upon the Sylvan shale. It varies in thickness from 0-53 feet. From a lithologic standpoint it is divisible into three members.

Locally a shale member occurs between the oolitic and glauconitic members.[6] It is correlated with the lower Silurian of eastern North America.

HENRYHOUSE SHALE

This formation rests unconformably upon the Chimneyhill limestone. It varies in thickness from 0 in the eastern portion of the uplift to 223 feet in the western portion, with an average thickness of 90 feet. This formation is quite variable, but generally consists of alternating beds of yellow and pink earthy limestones and shales.

Section at Henryhouse Creek three miles east of Woodford[7]:

Section of Henryhouse shale at type locality.

	Feet
21. Brown limestone conglomerate	30
20. Blue to gray limestone	25
19. Shale and shaly limestone	44
18. Limestone	10
17. Shale	31
16. Limestone	10
15. Red to brown thin-bedded limestone	16
14. Limestone	8
13. Red sandy limestone	12
12. Limestone	17
11. Shale	36
10. Limestone	12
9. Shale	9½
8. Limestone	1
7. Shale	5
6. Red, sandy limestone	6
5. Shale	10½
4. Limestone	1
3. Shale	4
2. Limestone	1
1. Shale	10

This formation is thought to be of Niagaran age on the basis of the contained fossils.

Devonian

HARAGAN SHALE

The Haragan shale is composed of alternating bluish and gray shales and thin-bedded earthy limestones topped by a 0-18-foot bed of

6. Posey, E., and Armour, M., Unpublished data, 1929.
7. Posey, E., and Armour, M., Unpublished data, 1929.

hard, fine-grained limestone containing a few chert nodules. The beds weather to a yellowish color on long exposure.[8] The formation varies in thickness from 0-166 feet, but on the average is near 100 feet thick. The fossils indicate a lower Devonian age (Helderbergian).

BOIS D'ARC LIMESTONE

The Bois d'Arc limestone is the upper part of the Hunton formation, defined by Taff in 1902. It varies in thickness from 0-90 feet and averages 60 feet. It is composed of thin-bedded, bluish to white, crystalline limestones. In the Cool Creek and Goose Creek regions a 6-foot bed of yellowish shale occurs near the middle. In places the limestone is overlain by several feet of cherty limestone which weathers into angular boulders. The age is Oriskany.

WOODFORD CHERT

This formation has been commonly considered upper Devonian in age but it may eventually be called early Mississippian. The Woodford chert has an average thickness of 250-450 feet in the Arbuckle Mountains. It seems to thin to the north, as Morgan did not find outcrops in the Stonewall quadrangle with a greater thickness than 350 feet. It varies somewhat in lithologic character. In places massive chert beds rest directly on the Bois d'Arc, while in others a brownish black shale is found. As a whole it is composed of this strata of dark chert, cherty shale, and black bituminous shale; the chert being more abundant in the lower and middle portions. In the western part of the region bluish shales are interstratified with the black shales near the base. At places, especially in the chert beds, numerous small round, marble-like, calcareous concretions are found. Occasionally, however, they occur as elongate bodies as much as a foot in diameter. Marine fossils are present but rather scarce.

The Woodford outcrops in the southern part of the region in irregular valleys between ridges of Bois d'Arc and Sycamore limestone. Where the Sycamore is absent it occurs as rough, woodland slopes bordering the ridge of Bois d'Arc.

It correlates approximately with the Chattanooga shale of doubtful Devonian-Mississippian age farther east.

Mississippian

SYCAMORE LIMESTONE

The Sycamore formation is a lenticular or wedge-shaped mass of siliceous limestone occurring above the Woodford chert and below the Caney shale. It varies in thickness from 100 feet in the western part of the region to less than five feet in the Stonewall quadrangle, pinching out entirely farther east. The limestone varies in color from slate-

8. Posey, E., and Armour, M., Unpublished data, 1929.

blue to bluish-brown when fresh; on weathering it changes to a brownish-yellow color due to inclusions of small amounts of iron. It is a dense, even textured, tough limestone which often breaks with a conchoidal fracture. The bedding of the formation causes the rock to separate into layers six inches to two feet in thickness. Often there is a distinct shale break six to twenty feet in thickness almost in the center of the limestone.[9] The age, which is doubtful, is probably lower Mississippian (Kinderhook).

CANEY SHALE

The Caney shale[10] rests unconformably upon the Sycamore limestone and the Woodford chert. The Caney, as defined, includes about 2,000 feet of black, bituminous, fissile shales containing ferruginous, calcareous, and phosphatic concretions. The upper part of the formation is generally lighter in color, being composed of bluish shales. Fossils are fairly numerous in the lower 200-500 feet of the formation, where they are believed to be of late Mississippian age. The upper part may be Pennsylvanian. The Caney outcrops in fertile lowland belts of cultivated fields and grassy pastures at the south foot of the Arbuckle Mountains in Johnston County and at the east end of the Arbuckle Mountains in eastern Johnston County.

Section of Springer formation.

		Feet
7.	Primrose member, calcareous, hard, semi-crystalline, thin-bedded sandstone with numerous shale partings	150-250
6.	Shale.	250-500
5.	Lake Ardmore sandstone	15- 20
4.	Shale	500
3.	Overbrook sandstone. Medium fine grained white and massive, asphaltic sandstone, practically free from shale partings	45-100
2.	Shale	1,000
1.	Rod Club member. Sandy zone containing four or more ledges of sandstone 2-25 feet in thickness, greenish to buff in color, and fine-to medium-grained in texture.	250-400
CANEY SHALE		

The Pennsylvanian of the Ardmore Basin

SPRINGER FORMATION

The Springer[11] is composed of 3,000 to 3,500 feet of black shales, very similar to the Caney, except for the presence of several persistent

9. Cooper, C. L., Sycamore limestone: Oklahoma Geol. Survey, Circ. 9, 1926.
10. Taff, J. A., U. S. Geol. Survey Geologic Atlas Atoka folio; (No. 79), 1902.
———, U. S. Geol. Survey Geologic Atlas, Tishomingo Folio; (No. 98), 1903.
Tomlinson, C. W., The Pennsylvanian system in the Ardmore Basin: Oklahoma Geol. Survey Bull. 46, 1929.
11. Tomlinson, C. W., The Pennsylvanian system in the Ardmore Basin: Oklahoma Geol. Survey Bull. 46, 1929.

sandstone members. Diagnostic fossils are scarce, but a small collection made from a sandstone near the middle of the formation indicates early Pennsylvanian (Morrow) age. This formation is the lowest subdivision of the Glenn formation as defined by Taff in 1903. It is further subdivided as shown in the table on page 13.

DORNICK HILLS FORMATION

The Dornick Hills[12] formation is composed of a series of bluish, tan, and rarer, reddish and brown shales, with limestones, limestone conglomerates, and sandstones, 1,500-4,000 feet in thickness. It is subdivided as follows:

Section of Dornick Hills formation.

	Feet
PUMPKIN CREEK MEMBER	
9. Coarsely granular, cross-bedded, sandy gray limestone interbedded locally with shale.	70
8. Shale containing interbedded fossiliferous limestone	1,000
LESTER LIMESTONE MEMBER	
7. White, coarsely crystalline, fossiliferous limestone.	20
6. Shale	400-1,000
BOSTWICK MEMBER	
5. Massive limestone conglomerate, with associated limestone and sandstone. May correlate with the conglomerate mapped as Franks in Mill Creek	0-300
4. Shale.	750
OTTERVILLE LIMESTONE	
3. Ledge of ferruginous, oolitic, locally conglomeratic limestone.	25
2. Shale.	300-1,000
JOLLIFF	
1. Tan, fossiliferous limestone, locally associated with a little conglomerate at the base.	4- 15
SPRINGER FORMATION	

DEESE FORMATION

The Deese formation northwest of Ardmore[13] is composed of about 6,000 feet of sandstone beds and chert conglomerate separated by blue, tan, and red shales with a few limestone members. About 800 feet above the base is the Devil's Kitchen member some 500 feet thick and composed of two massive buff sandstones separated by a shale interval containing approximately ten feet of fossiliferous limestone and impure calcareous shale. The Arnold member near the middle of the Deese formation contains a bed of fossiliferous limestone and a massive buff sandstone, each about fifty feet thick and separated by about 50 feet of shale. The sandstones are locally saturated with asphalt.

12. Tomlinson, C. W., The Pennsylvanian system in the Ardmore Basin: Oklahoma Geol. Survey Bull. 46, 1929.
13. Tomlinson, C. W., The Pennsylvanian system in the Ardmore Basin: Oklahoma Geol. Survey Bull. 46, 1929.

HOXBAR FORMATION

The Hoxbar formation comprises about 4,000 feet of shales interbedded with limestone and sandstones. At the top it is overlain with a profound unconformity by the Pontotoc formation and by the Trinity sandstone. It has been subdivided into several members which are not of great importance in the discussion of Murray and Johnston counties.

Pennsylvanian East and North of the Mountains

WAPANUCKA LIMESTONE

The Wapanucka formation outcrops near the town of Wapanucka in northeastern Johnston County. Because of its more resistant character it forms long narrow ridges between the shale valleys on either side. In the type locality it conformably overlaps the Caney shale, although evidences of unconformities have been found elsewhere. The formation consists of one or more beds of massive white to light brown limestone, which is oolitic in places, together with chert, sandstone, and shale strata. The formation varies in thickness from 100-800 feet with an average thickness of 300 feet. In this area, however, the thickness is seldom more than 100 feet. It is early Pennsylvanian in age.

Section in sec. 22, T. 2 S., R. 8 E.[14]

	Feet
7. Oolite	5
6. Massive, light brown limestone	25
5. Ferruginous sandstone	10
4. Fossiliferous limestone	10
3. Brown sandstone	5
2. Hard limestone	2
1. Shale to base	?

ATOKA FORMATION

The shale member of the basal Atoka succeeds abruptly the limestone of the Wapanucka at the eastern side of the Arbuckle Mountains. The formation as a whole has an estimated thickness of 3,000 feet, but is much thinner in Johnston County. The Atoka is composed of very thick shale members which outcrop as broad valleys and which are separated by the narrow, prominent ridges of sandstone. The sandstone which occurs as lentils is ferruginous, massive, and in places conglomeratic. The shales are dark blue to black clays weathering to shades of blue and yellow. The Atoka is early Pennsylvanian (Pottsville) in age.

Pennsylvanian-Permian

PONTOTOC FORMATION

This formation is far above the Atoka formation, just considered,

14. Wallis, B. F., The geology and economic value of the Wapanucka limestone of Oklahoma: Oklahoma Geol. Survey, Bull. 23, 1915.

in stratigraphic position. The intermediate beds of Pennsylvanian age, however, are not exposed in the area covered by this report.

By late Pennsylvanian time the strata of this region had been folded into approximately their present attitudes and marked relative uplift had occurred stimulating erosion. As a result of this uplift and rapid erosion the beds of the Pontotoc formation were deposited around the mountains. They rest with a profound unconformity on all older strata found in the main mass of the Arbuckle Mountains down to and including the Reagan sandstone of middle Cambrian age. The Pontotoc is subdivided into the following units in Pontotoc County near the north end of the mountains. Elsewhere the Pontotoc has not yet been satisfactorily subdivided.

VANOSS FORMATION[15]

The Vanoss formation is composed of alternating sandstones, conglomerates, shales, and a few thin limestones. It is characterized by its arkosic nature, some of the sandstones being so much so that they resemble granite. The shales are usually green or gray, although occasionally red ones are found. A bed of conglomerate resembling that found in the Vanoss on the north side of the Arbuckle Mountains has been traced around the western extension of the mountains to the south side where it is covered by younger formations. The thickness on the north side of the mountains (in the Stonewall quadrangle) varies from 250-650 feet, the formation thinning to the north. On slight fossil evidence the Vanoss is thought to be uppermost Pennsylvanian in age.

STRATFORD FORMATION

The Stratford formation may be divided into two members. The basal one, named the Hart limestone, consists of grayish white, chalky to hard, possibly reworked limestone, interbedded with and grading into red shales and gray arkosic sandstones. Where the limestone is in contact with the shale it has a cellular structure which is probably due to a chemical precipitate in the veins of the shale from perculating calcareous waters.

The upper part of the formation consists predominantly of red shales with a few beds of brown to gray arkosic material, limestone nodules, and beds of limestone. The Hart limestone has been traced entirely around the western end of the Arbuckle Mountains, but the shale has been overlapped in places by the succeeding formation. The exposed thickness in the Stonewall quadrangle is about 400 feet.

KONAWA FORMATION

The Konawa formation consists of typically red shales and sandstones with no limestones. This formation may be a northern gradational facies of the Vanoss and Stratford formations. It is not exposed in the area under discussion.

15. Morgan, G. D., Geology of the Stonewall Quadrangle: Bur. Geol. Bull. 2, Norman, Oklahoma, 1924.

The extremely coarse limestone conglomerates of the Pontotoc formation which are found in a sharp Pennsylvanian valley in the Arbuckle limestone south of Davis, are a local alluvial fan phase of the formation. Since the formation advanced up the mountain slopes in Permo-Carboniferous time as erosion of the mountains and deposition of the fan proceeded, the lowest beds well up in the mountains must be considerably younger than the lowest beds farther from the mountains. The coarse conglomerates may have been deposited during Vanoss time or later. Information is lacking on this point.

Comanchean

The Comanchean rocks of Johnston County lie unconformably upon the pre-Cambrian igneous and the Paleozoic sedimentary rocks. After the formation of the Arbuckle Mountains in Pennsylvanian time and after the deposition of the Permian strata on its flanks, erosion continued uninterruptedly during most of Triassic and Jurassic time. The erosion was so great that this entire area, and in fact most of eastern North America, was reduced to a peneplane. In the Arbuckle Mountains the maximum relief was probably no more than a few tens of feet. Toward the end of the Jurassic period this peneplane was silghtly tilted. The Comanchean sea advanced over the land from the southeast and deposited sediments in a nearly horizontal position on the upturned and eroded edges of the older rocks. They have remained in their nearly horizontal position to this time, having been only slightly tilted. These beds dip gently to the southeast. Their uniform slope is interrupted by only a few minor folds in the area covered by this report.

TRINITY SANDSTONE

The Trinity sand is the beach or near shore deposit of the Comanchean sea which encroached upon the land from the southeast. The lower part of the formation, from the vicinity of Ravia eastward to the border of the county where it rests upon the granite, is composed of sand which has been produced from the granite. Westward from Ravia, where the lower part approaches the limestone formations of the Arbuckle Mountains, it is composed of a very coarse limestone conglomerate. Above the basal conglomerate is 300-400 feet of fine, white to yellow pack sand with lentils of clay. The clays are variable in thickness from a few inches to 30 feet and vary widely in color. Occasionally a few thin beds of oyster shells are found though parts of the formation contain silicified and carbonized wood.

The Trinity sand outcrops in southern Johnston County as gentle, forest-covered slopes.

GOODLAND LIMESTONE[16]

The Goodland limestone lies conformably above the Trinity sandstone. It is a white, semi-crystalline limestone about 25 feet in thickness. The beds at the base where they are in contact with the Trinity sand are somewhat siliceous. In the middle the limestone is massive. At the top it is thinner bedded and passes by transition into the overlying clay shales. Marine shells are rather abundant in the limestone. The shell substance, however, has been very largely replaced by crystalline lime.

The Goodland limestone outcrops as a bluff or escarpment projecting above the friable, underlying Trinity sand which is easily eroded. Soft shales follow above, which are also easily eroded, leaving exposed broad flat tablelands of the limestone. The limestone weathers by solution into irregular boulders or slabs.

KIAMICHI FORMATION[17]

Upon the Goodland limestone are platy layers of siliceous limestone interbedded with thin layers of shaly marl. These transition beds are only a few feet in thickness and are not usually well exposed in the flat lands above the resistant Goodland limestone. About 30 feet of blue clay marl succeeds the basal shaly strata. The top of the formation is marked by two or three thin ledges of yellowish limestones made up principally of oyster shells.

The Kiamichi outcrops on the slopes above the Goodland escarpment, or on the sides of hills capped by the lower Duck Creek limestone. Since the Kiamichi lies between two escarpment-forming limestones, its outcrop is narrow and tortuous.

DUCK CREEK FORMATION[18]

The Duck Creek formation consists of approximately 100 feet of limestone and gray to bluish-gray shale. In the lower 30 to 40 feet of the formation the limestone and the shaly clay layers alternate. The limestone ranges from a yellowish marly limestone to a hard white limestone. The latter is similar to the Goodland in unweathered appearance. The shales are very calcareous, and bluish gray colors predominate. In the white limestone bed very large shells and ammonites are found. In the upper 50 to 60 feet of the formation the limestones are thin, separated by thick layers of shale. This upper portion is practically barren of fossils.

FORT WORTH LIMESTONE

The Fort Worth limestone may be divided into three parts. The lower division consists of 10-15 feet of alternating beds of a yellowish

16. Taff, J. A., U. S. Geol. Survey Geologic Atlas, Atoka folio; (No. 79), 1902.
17. Bullard, F. M., Geology of Marshall County, Oklahoma: Oklahoma Geol. Survey, Bull. 39, 1926.
18. Bullard, F. M., Geology of Marshall County, Oklahoma: Oklahoma Geol. Survey, Bull. 39, 1926.

white limestone and a gray to blue shaly clay. The middle division is about the same thickness and is chiefly shale. The upper division is predominantly limestone separated by thin layers of shaly clay. The limestone is hard and cream colored very similar to the more massive beds of the lower Duck Creek. These harder limestones at the top project as ledges and in some places as bluffs.

The Arbuckle Orogeny

The diastrophism which constituted the formation of the Arbuckle Mountains was a combination of faulting and folding. There is evidence for believing that it started somewhat to the southeast of the exposed Arbuckle Mountains and slowly appeared farther and farther toward the northwest. It is possible that the earliest phases of the orogeny were manifested at the surface a hundred or more miles south of east from Johnston County in late Mississippian time, thus furnishing the chief source of the clastic sediments of the thick Stanley and Jackfork formations of southeastern Oklahoma and southwestern Arkansas. The orogenic disturbance appeared in the area of the presently exposed Arbuckle Mountains by early Pennsylvanian time and after intermittant movements of greater or less importance, it ceased near the early part of Permian time. All additional movements up to the present have been insignificant from the orogenic standpoint in comparison with the earlier movements. Contemporaneously with the faulting and folding of the Paleozoic rocks now exposed in the Arbuckle Mountains proper, deformation was also taking place to the south in the so-called Ardmore Basin and the Criner Hills. It is noteworthy that at no time until the end of the Pennsylvanian period did the mountains rise very high above sea level. This was especially true in the southern part of the mountains around Ardmore, where, in spite of recurrent movements, the sea was not eliminated.

As a generalization it may be stated that faulting has been the chief mode of deformation of strata in the Arbuckle Mountains. Furthermore there is a strong suggestion that the main exposed axis of the mountains—the Arbuckle anticline of Murray and southern Johnston counties—is a fault block which has been tilted upward at the north edge in spite of, or in addition to, the folding which has taken place. This could explain the greater abundance and coarseness of the conglomerates on that side as opposed to those south of the Arbuckle anticline. The abrupt slopes on the north side of this main Arbuckle axis constitute a "fault-line-scarp". The conglomerates are likewise very abundant, and a similar but higher scarp is also present farther west on the north side of the Wichita Mountains. This suggests that the main granite area of the Wichita Mountains, too, may have been a block mountain in Pennsylvanian or earliest Permian time. The "fault-line-scarp" there is very prominent. The block-mountain nature of this diastrophism, the author believes, has been too little considered.

PRESENT PHYSIOGRAPHIC DEVELOPMENT

Good evidence is at hand that the Jurassic peneplane in the Arbuckle Mountains was an exceptionally perfect one. An occasional monadnock rises a few tens of feet above the even surface at the edge of the overlying Trinity sandstone. But the irregularities of surface, it is noteworthy, are not valleys. The East and West Timbered Hills rise between 25 and 50 feet above the projected upland surface of the Arbuckle Mountains today, and it is believed that they were monadnocks of similar height in late Jurassic time.

In early Comanchean time this entire peneplaned area in the western Gulf Coastal Plain was gradually tilted and warped, allowing the Comanchean sea to invade a large area in western Oklahoma and surrounding states. Additional slight tilting, sea invasion, and deposition of sediments kept the Arbuckle Mountains covered, it is believed, until near the end of the Cretaceous period. At this time the mountains and surrounding regions were elevated vertically a considerable distance above sea level, partaking of the elevation which was so general in eastern and southern North America. Stream erosion then began to remove those clastic and other beds so lately deposited. There has been a renewal of folding or uplift along the axis of the Arbuckle anticline at some time since the Jurassic period. This movement was slight but of sufficient magnitude easily to be detected. It caused a reversal of slope in the peneplaned surface of the mountains amounting to about 100 feet. This revival of the old movements probably took place at the end of the Cretaceous period also, though this is not a certainty. It rests on analogy with other areas of similar history in North America.

Through most of the Tertiary era the mountains and surrounding regions underwent erosion, and by late Tertiary time a new peneplane had been developed on the soft, unmetamorphosed strata of the surrounding plains. The older Paleozoic rocks of the mountains are in general more resistant than the Pennsylvanian, Permian, and Comanchean rocks which surround them. Hence, this mountainous area was left standing above the "Tertiary" peneplane as a broad and complicated monadnock. The great thickness of the Arbuckle limestone is the chief cause of the greater resistance of these beds.

Oil and Gas Possibilities

There is only one locality in Johnston and Murray counties in which the possibility that oil exists is not remote. This is in the northern end of Murray County, north of Sulphur and Davis and south of Wynnewood. Several wells have been drilled into the red beds of the Pontotoc series and some have gone through them into older Paleozoic strata without more than an occasional showing of oil or asphalt. It seems unlikely that the sandstones and conglomerates of this formation will ever yield oil in paying quantities within the area under con-

sideration. The uniform dip away from the mountains and the high porosity of some of these layers should allow quick dissipation of any oil in these strata. The unconformity at the base of this series of red beds is to be considered less favorable than other porous horizons, unless a pronounced buried hill should furnish a local reversal of the surface and hence a local trap. If such a feature can be located by geophysical or other means several miles distant from the edge of the Pontotoc strata, further exploration should be attempted.

Most of the showings of oil, which have been reported in wells already drilled in this area, have come from such a depth and from such beds that the source is believed to be the various sandstone horizons of the Simpson formation. The well on Scott's (Vine's) Dome in the SW.¼ of sec. 34, T. 1 S., R. 2 E., has produced asphalt since its completion in 1919. The horizon is a sandstone about 430 feet below the top of the Simpson formation, and it seems to be approximate equivalent of the uppermost sandstone in this formation as exposed on the main highway crossing the mountains south of Davis. From this well and from showings in several other wells northwest of the mountains, it is concluded that the sandstones of the Simpson formation here are potential oil horizons. In the opinion of the writer they are the most favorable strata for exploration.

It may not be claimed, however, that prospects are good for commercial production of a high quality of oil from the Simpson formation. The difficulty of locating a suitable anticlinal or fault structure where the beds are sufficiently deep to be free from the probability that the more volatile constituents have evaporated, is quite formidable. The pronounced angular unconformity at the base of the Pontotoc red beds and the concealment of the mountainous structure by this series of strata introduce obstacles that it will be very difficult to surmount. It is not unlikely that oil in commercial quantities is present along the buried northwestward extension of some of the long faults to be seen on the colored geologic map of Oklahoma. But so far as known exploratory work could be accomplished only by random drilling.

The following logs are of interest in connection with the oil possibilities in the area of the Pontotoc outcrop northwest of the exposed mountains:

Choate Oil Corporation's No. 2 Mat Wolf, sec. 16, T. 1 N., R. 2 E.
Drilling commenced, Jan. 1922; completed, April, 1924.

Formation	Top	Bottom	Formation	Top	Bottom
Clay	0	10	Pack sand	136	151
Sand and gravel	10	30	Sand and gravel	151	181
Gravel hard	30	42	Sand rock, hard	181	191
Sand rock	42	52	Lime shell hard	191	197
Sand and gravel	52	110	Pack sand	197	210
Sand rock hard	110	125	Sand rock, hard	210	214
Sand and shale	125	136	Gumbo	214	217

(Continued on page 22)

Formation	Top	Bottom
Sand rock	217	253
Boulders	253	294
Sand and gravel	294	300
Gumbo	300	316
Sand rock, hard	316	320
Shale and gumbo	320	341
Sand rock, hard	341	349
Sand and gravel	349	355
Shell	355	422
Shale	422	432
Sand rock, hard	432	444
Rock	444	448
Shell	448	496
Shale, sandy	496	507
Lime hard	507	514
Gumbo	514	524
Lime hard	524	526
Shale	526	563
Gyp rock	563	574
Boulders	574	589
Lime hard	589	591
Gumbo	591	631
Lime	631	643
Sandrock hard	643	651
Chalk rock	651	683
Lime hard	683	687
Hard shell	687	695
Sand	695	701
Lime	701	721
Pack sand hard	721	732
Sandy lime	732	742
Lime hard	742	747
Gumbo and lime	747	750
Lime hard	750	753
Gumbo	753	761
Lime	761	784
Shale	784	795
Gumbo and shale	795	819
Lime	819	832
Gumbo	832	840
Lime	840	843
Gumbo	843	851
Lime hard	851	857
Gumbo	857	860
Sand (show of oil)	860	867
Lime	867	878
Gumbo	878	885
Broken lime	885	890
Gumbo	890	902
Lime and shells	902	984
Gumbo and shale	984	998
Lime	998	1001
Shale	1001	1012
Lime	1012	1015
Hard lime	1015	1017
Sand rock	1017	1022
Shale	1022	1058

Formation	Top	Bottom
Sand rock, hard	1058	1074
Sandy lime	1074	1082
Shale	1082	1084
Lime hard	1084	1086
Sandy lime	1086	1114
Gumbo and shale	1114	1116
Sandy gravel	1116	1136
Shale	1136	1148
Sand	1148	1156
Lime	1156	1159
Broken sand	1159	1209
Sandy lime	1209	1225
Lime	1225	1237
Sand	1237	1241
Sandy lime	1241	1248
Sand	1248	1254
Shale and boulders	1254	1261
Sand rock	1261	1266
Lime	1266	1287
Shale	1287	1295
Shale and sand	1295	1309
Lime hard	1309	1335
Shale	1335	1349
Gumbo	1349	1364
Lime	1364	1366
Rock hard	1366	1398
Lime	1398	1475
Gumbo	1475	1480
Broken lime	1480	1485
Lime	1485	1501
Gumbo	1501	1506
Shale and sand	1506	1516
Shale and gumbo	1516	1541
Lime	1541	1545
Gumbo and boulders	1545	1554
Lime hard	1554	1562
Gumbo and boulders	1562	1565
Hard shale	1565	1570
Measurement corrected steel line, drilling standard tools		1562
Rock hard	1562	1565
Gumbo	1565	1578
Shale gray	1578	1598
Shale brown	1598	1608
Sand	1608	1610
Sandy shale	1610	1618
Sand	1618	1628
Shale gray	1628	1708
Lime soft	1708	1710
Red bed soft	1710	1730
Lime hard	1730	1740
Lime hard and gravel	1740	1820
Shale, some gravel	1820	1890
Shale soft 4b. w.	1890	1910
Red beds soft	1910	1913
Sandy lime, gray	1913	1919

(Continued on page 23)

Formation	Top	Bottom
Sand gray (small amt.)	1919	1922
Broken lime (liquid)	1922	1925
Mixed shale and lime (asphalt)	1925	1950
Blue shale soft	1950	1972
Broken sand, gray	1972	1980
Shale, soft	1980	1987
Lime and sand (small amt. black oil)	1987	1999
Red beds soft	1999	2002
Lime and sand, oil (4 to 5 bbls)	2002	2017
Blue and brown shale (little gas) HFW	2017	2032
Sand	2032	2042
Lime gray hd.	2042	2060
Sand brown soft	2060	2065
Red beds 1 b.w.hr.	2065	2070
Lime and sand, gray, show asphalt	2070	2075
Chalk and lime	2075	2100
Lime hard	2100	2125
Lime white hard	2125	2155
Mixed lime and shale (alt. thin stratas)	2155	2210
Blue shale soft	2210	2230
Water sand HFW	2230	2240
Sandy lime	2240	2245

Formation	Top	Bottom
Sandy lime gray	2245	2250
Sandy lime	2250	2255
Pure lime	2255	2265
White slate	2265	2275
Sand white HFW	2275	2285
Lime white	2285	2309
Sand—show oil and gas	2309	2314
Caving lime	2314	2330
Water sand HFW	2330	2345
Lime	2345	2355
Sand water	2355	2375
Lime	2375	2385
Broken lime and sand	2385	2420
Sand and water	2420	2440
Black lime	2440	2450
Water sand	2450	2475
Lime and sand shell	2475	2500
Pure lime	2500	2506
Sand wtr.	2506	2520
Brown shale and shells	2520	2530
Brown sand	2530	2540
White sand	2540	2562
Slate and mud caving	2562	2594
Sand, little show oil	2594	2602
Slate and shells	2602	2624
Hard sand, TD-water running over top at 2630 to 2654	2624	2654

Scott's Dome Oil Company's No. 1 Ellis Price, sec. 34 T. 1 S., R. 2 E.

Drilling Commenced, Mar. 17, 1929; completed, Nov. 16, 1929.

Formation	Top	Bottom
Lime	0	750
Water sand at 174′ and 385′		
Shale green	750	788½
Set 12″ pipe at 788′6″		
Hard sand	788½	798½
Gray shale	798½	801½
Lime	801½	805
Gray shale	805	813
Lime	813	821
Sandy shale	821	826
Lime	826	848
Green shale	848	866
Carried some gas		
Salt water sand	866	881
Small showing oil		
Lime	881	895
Shale	895	900
Sand	900	905
Shale	905	910
Lime	910	925
Salt water sand	925	934

Formation	Top	Bottom
Shale	934	937
Sandy shale	937	980
Lime	980	988⅓
Sandy shale	988⅓	1000
Underreamed and set 12″ at 1001′		
Sand	1000	1035
Showing oil		
Shale	1035	1053
Sandy shale	1053	1070
With gas and small show oil		
Lime	1070	1072
Set 10″ at 1077′		
Sandy shale	1072	1127
Underreamed and set 10′ pipe at 1125′		
Lime	1127	1130
Sandy shale	1130	1184
Sand producing	1184	1269
TOTAL DEPTH		1269

Stuyvesant Oil Company's No. 1 Ashton, sec. 7, T. 1 N., R. 3 E.

Drilling Commenced, May 12, 1920; completed, Jan. 15, 1921.

Formation	Top	Bottom
Soil	0	5
Clay	5	20
Conglomerate	20	23
Clay	23	70
Sand quick	70	85
Lime	85	95
Shale	95	110
Lime	110	113
Shale	113	123
Sand	123	150
Shale	150	160
Sand	160	165
Shale	165	185
Red rock	185	200
Shale	200	210
Red rock	210	215
Slate	215	225
Conglomerate	225	228
Shale	228	300
Lime	300	310
Shale	310	335
Red rock	335	350
Shale	350	384
Lime	384	389
Shale	389	399
Red rock	399	408
Lime	408	410
Broken sand	410	435
Red rock	435	444
Shale	444	494
Slate	494	506
Sand	506	516
Slate	516	580
Red rock	580	595
Sand	595	615
Shale	615	635
Sand	635	640
Slate	640	702
Red rock	702	710
Shale	710	740
Lime	740	745
Sand	745	750
Slate	750	760
Sand	760	765
Slate	765	805
Sand	805	815
Shale very soft	815	835
Slate	835	845
Red rock	845	945
Shale	945	965
Shale	965	1000
Sand	1000	1020
Red rock	1020	1125
Lime	1125	1130
Shale	1130	1150
Lime sandy	1150	1155
Slate	1155	1160
Lime	1160	1180
Slate	1180	1190
Lime	1190	1200
Slate	1200	1205
Lime	1205	1225
Slate	1225	1227
Lime	1227	1237
Slate	1237	1240
Sand	1240	1245
Lime	1245	1255
Shale	1255	1275
Lime hole full water	1275	1280
Sand	1280	1310
Slate	1310	1312
Lime	1312	1319
Slate	1319	1321
Sandy lime	1321	1335
Slate	1335	1340
Lime	1340	1348
Slate	1348	1380
Lime sandy	1380	1390
Shale	1390	1395
Lime	1395	1402
Sand-water	1402	1412
Slate	1412	1427
Sand, wtr.	1427	1575
Lime	1575	1595
Sand-hole full water	1595	1605
Lime	1605	1674
Sand	1674	1688
Shale	1688	1690
Lime sandy	1690	1700
Sand	1700	1778
Shale	1778	1788
Sand	1788	1800
Shale	1800	1820
Sandy lime	1820	1840
Lime	1840	1855
Shale	1855	1863
Lime	1863	1873
Shale	1873	1969
Lime	1969	1975
Slate	1975	1980
Sand wtr.	1980	2040
Shale	2040	2060
Sand—water	2060	2085
Shale	2085	2228
Sand water	2228	2280
Shale	2280	2390
Sand	2390	2540