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OIL AND GAS IN OKLAHOMA

GEOLOGY OF PONTOTOC 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.

Pontotoc County, which lies just south of Seminole County, has recently become the center of activity of oil men due to the discovery of several good wells. The present report by Mr. R. A. Conkling presents the most up to date information on the oil and gas possibilities of this area. As most of this county lies in the Stonewall quadrangle, the author has used the descriptions of the formations found in the report, "The Geology of the Stonewall Quadrangle", by Geo. D. Morgan, for this report. The structure map of the county was furnished by Mr. Frank Greene of the Skelly Oil Co.

CHAS. N. GOULD,
Director

December, 1927.

PONTOTOC COUNTY

By

R. A. Conkling

Introduction

The author, in attempting to write this report, has encountered many difficulties due to lack of sufficient data. It is practically impossible to get all the information together in the time available, so this report must be read with the understanding that much of the data will be enlarged upon or disproved. Although we have a fair grasp of subsurface conditions of the county, the area is near the Arbuckle Mountains which have undergone numerous orogenic movements with the resulting unconformities, so that every well encounters something new.

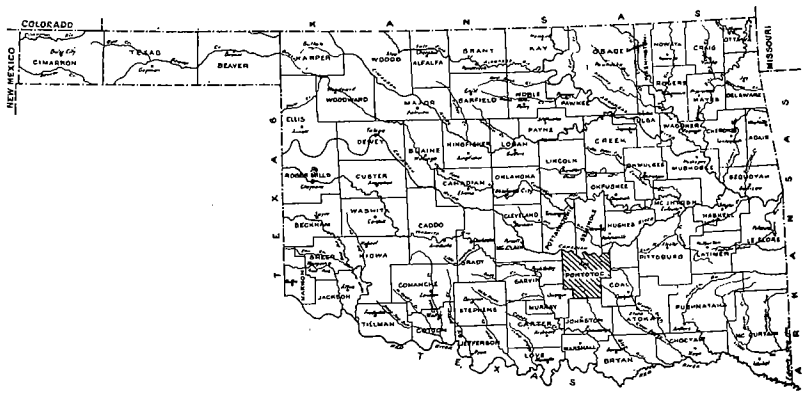


Fig. 1—Map of Oklahoma showing area covered by this report.

ACKNOWLEDGMENTS

The author wishes especially to acknowledge the work of Geo. D. Morgan in Bulletin 2, Bureau of Geology, from which the description of the formations has been copied verbatim, since the major portion of the Stonewall quadrangle lies within Pontotoc County. He also wishes to thank J. B. Umpleby, F. W. Dakin and John Fitts for information and assistance. Mr. Frank C. Greene of the Skelly Oil Co., has kindly furnished the structure map of the county.

LOCATION

Pontotoc County is in the south-central part of the State. Its northern boundary is the Canadian River. It extends from T. 1 N., to T. 6 N., inclusive, and from R. 4 E., to R. 8 E., inclusive. The

county contains 17 whole townships and parts of 6 others. The total area is 716 square miles.

TOPOGRAPHY[1]

Most of the county lies within the Sandstone Hills region. The extreme southern part lies within the Arbuckle Mountain region. The topography of the northern part of the county is the result of weathering of alternating sandstones and shales that have rather low dips. More or less parallel escarpments follow each other at great distances, which have been dissected by streams, giving to the whole surface a broken appearance. Most of the northern part of the county is wooded. Farther south limestones predominate, and flat or rolling prairie is the type of topography.

Canadian River forms the north boundary of the county, and together with its tributaries drains approximately the northern half. Blue River and Boggy Creek drain the southern half of the county.

The elevation of the surface in Pontotoc County ranges from 645 feet to 1,300 feet. The lowest elevation is found where Clear Boggy Creek crosses the eastern line of the county, in sec. 25, T. 2 N., R. 7 E. The highest elevation is found near the NE. cor. sec. 18, T. 2 N., R. 4 E., about 1½ miles north of Dolberg.

GENERAL AND HISTORICAL GEOLOGY

The strata exposed in Pontotoc County range in age from upper Cambrian to Recent. However, there are many gaps, due to either unconformities or faulting, so that the entire section is incomplete at the surface.

Because of the rapid variation of the formations both along the outcrops and beneath the surface and the absence of many at the surface, it is difficult to give any estimate of the average thickness of any of the formations or the total thickness of all the formations at any given place over the county.

At the southeast corner of Pontotoc County where the Arbuckle limestone outcrops, there is less than 4,000 feet of sedimentary strata while in the eastern edge of the county there is probably 10,000 to 15,000 feet of these formations. These formations are also quite thin near the town of Center where an anticline is imposed upon a northwest plunging subsurface high.

The sediments in general become very clastic toward the top of the section and also they become coarser toward the Arbuckle Mountains. The formations below the top of the Hunton Terrane are dominantly limestone while the succeeding Woodford and Caney formations are largely composed of black shale. The Wapanucka limestone, although shaly at the base, carries considerable limestone near the central portion, but from there the succeeding formations are largely shales, sandstones and conglomerates with very little limestone.

1. Oklahoma Geol. Survey, Bull. No. 19, Part II, p. 448.

The following description of regional structure and stratigraphy is by Morgan as published in Bulletin 2, Bureau of Geology, Norman, Oklahoma.

> The structure of the area is complex and is evidently the result of numerous movements that were quite variable both as to type and point of origin.
>
> The movements which resulted in the structure may be summarized as follows:
>
> 1. Slight warping movements initiated in the Arbuckle area at an early date, possibly in the later Cambrian or early Ordovician period.
>
> 2. Warping and slight oscillation continued through Ordovician time.
>
> 3. In early Silurian time arching movements in the Arbuckle area became more decided and the Arbuckle axis was defined.
>
> 4. Magnitude of periodic arching movements increased during the Devonian and Mississippian so that by Pottsville time the Hunton and possibly Viola, Simpson, and Arbuckle formations were exposed near the southeast end of the present mountains.
>
> The crustal movements of these four periods were not persistently upward throughout the area of the Stonewall quadrangle, as is indicated by the fact that during the time at which they were going on there were deposited in the Arbuckle area between 7,000 and 10,000 feet of sediments. It is probable that the movements during the Cambrian and Ordovician were very slight and irregular, and that during the time at which they were going on there was a gradual increase in the relief between the bottom of the Arbuckle basin and the surface of adjoining land masses. This relative vertical divergence (whether caused by sinking of the basin, uplift of the adjoining land areas, or by both processes) also continued through the Silurian and Devonian periods, but after the movements became decidedly positive with the resulting establishment of the Arbuckle axis, the axial area was probably more persistently above than below sea level.
>
> 5. Near the close of Atoka time there was uplift followed by peneplanation and subsequent overlapping deposition of the Hartshorne, McAlester, and at least part of the Savanna formations.
>
> 6. Toward the close of Savanna time the Stonewall quadrangle was subjected to a period of uplift and block faulting which resulted in the emergence of all the area with the possible exception of the Franks graben. Peneplanation of the uplifted area followed and all formations down to the Wapanucka and Caney formations were stripped off of it. The eastern part of the Franks graben, near the quadrangle line, was near or below base level during this time and was unaffected by erosion. Following this period of peneplanation the Boggy shale and later formations, to near the top of the Wewoka, were then laid down unconformably on the peneplaned surface and across the Franks graben. That a part of the Arbuckle axis remained above sea level during all the time from Wapanucka to near the close of the Wewoka is indicated by the fragments of Caney, Woodford, Hunton and Viola formations that are contained in the strata of the Wapanucka to late Wewoka formations inclusive.
>
> Progressive northward thrusting of the Ouachita area was initiated near the beginning of Devonian time, and it is probable that this area contributed largely to all the sediments of the Stonewall quadrangle that lie between the base of the Woodford and the top of the Vamoosa formations.

From Devonian time gradual uplift characterized the Arbuckle axis, and at the present time the older strata exposed there have a northward inclination that amounts to nearly 4,000 feet from the southern edge of the quadrangle to near its center.

7. A little before the close of Wewoka time the Ouachita area was strongly uplifted. This movement resulted in the Choctaw fault which borders that area; it caused a general northwestward tilting of all the Pennsylvanian strata of the Coalgate and Stonewall quadrangles, and was accompanied by some faulting in the latter area. The fault along the northern side of the Lawrence uplift was formed at this time and the one along the southern side was renewed so that the intervening area was lifted high above the surrounding region. The uplift of the Lawrence block was differential, being greatest toward the west. This general period of uplift and faulting was followed by peneplanation, which at the western or highest part of the Lawrence uplift stripped off all the beds down to the lower part of the Boggy formation, and in the western end of the Franks graben removed all strata down to near the top of the Boggy. On the less uplifted eastern portion of the Lawrence area, in the low lying region to the north of this area, and in the eastern part of the Franks graben peneplanation was only slightly effective.

The period of erosion was followed by the transgression of the sea and the later Wewoka beds (about 30 feet thick) and subsequent strata, including the Vamoosa formation, were laid down. At the western end of the Lawrence uplift the Wewoka strata were deposited on the eroded edges of lower Boggy beds, and in the western end of the Franks graben the upper part of the Wewoka was laid down, probably on upper Boggy strata. Throughout all this period of deposition a great deal of angular chert conglomerate was brought into the Stonewall quadrangle. This type of sediment also characterizes the formations eastward toward the Ouachita Mountains and is thought to have been derived from that region. Portions of the Arbuckle axis were maintained above sea level during this period of deposition as is indicated by the limestone conglomerates in the Wewoka, Holdenville, and Francis formations, especially in their outcrops over the area of the Franks graben.

8. Near the close of Vamoosa time there was an unusual uplift of the Arbuckle axis that affected all the area embraced in the Stonewall quadrangle. The uplift resulted in slight renewal of movements along the already established fault lines and formed several new ones. The flexing and slight faulting of the late Wewoka, Holdenville, Seminole, and Francis formations along the northern side of the Lawrence uplift occurred at this time. The block faults that cut the Hunton and overlapping Holdenville formations in the northwest quarter of section 34, west of Franks, were probably also caused by the movements as were the block faults east of Byng.

The first result of this uplift was the peneplanation of much of the Stonewall quadrangle. This was followed by unconformable deposition, over most of the area, of a mantle of clastic sediments, largely composed of limestone conglomerates (Ada formation). The source of the conglomerates was the Arbuckle Mountains.

The removal of this large amount of material from the Arbuckles exposed the granite core of the mountains which thereafter, to the close of Pontotoc time, contributed an abundance of arkosic material to the formations being deposited in the Stonewall quadrangle. After the granite of the Arbuckles was exposed it apparently eroded faster than did the bordering limestone to the north so that near the time at which the sandstone at the base of the Asher formation was deposited the granite surface had been reduced below the level of the bordering limestone. The granite then no longer contributed arkosic material to the sediments that were being laid down to the north of the mountains.

The uplift at the close of deposition of the Vamoosa formation, and the subsequent peneplanation of the area occurred in late Pennsylvanian time. The Permian period began during the subsequent time of deposition. The base of the Permian system is placed at the bottom of the Hart limestone member of the Stratford formation and, northeastward from he point at which that member is thought to be overlapped at the base of the Konowa formation.

9. All of the Permian formations of the Stonewall quadrangle have been slightly folded indicating movements in the area during or subsequent to that period.

Mesozoic and Tertiary strata are not represented in the Stonewall quadrangle.

During the Pleistocene the Guertie sand was laid down, probably as a river deposit.

In recent time a thick sand deposit has been laid down in the Valley of Canadian River.

STRATIGRAPHY

ARBUCKLE LIMESTONE

In the northwest corner of sec. 25, T. 1 N., R. 6 E., near the top of the formation, is a thin chert conglomerate which carries pebbles up to three inches in length. Most of the pebbles are angular, but a few appear to be waterworn. A cross-bedded, conglomeratic sandstone was also observed in the north-central part of sec. 29, T. 1 N., R. 7 E. The pebbles here contained are mostly chert and sandstone, and ordinarily are not more than two inches in length.

Taff[2] also noted conglomerates in the basal part of the Arbuckle limestone. The lower conglomerates were not observed by the writer. It is possible that all the clastic beds represent reworked portions of the Arbuckle itself. The fragments which constitute the higher conglomerates, however, indicate a source outside of the immediate area. The variation in sedimentation shown by the occasional conglomerates suggests warping movements within the area during the time at which the formation was being deposited.

SIMPSON FORMATION

The thickness of the Simpson has been given[3] as ranging from 1,200 to 2 000 feet.

The variation in thickness is explained by Taff as being the result of the local absence of the basal portion of the formation, so that here again there is evidence of a probable early warping movement of the Arbuckle Mountain area.

Near the center of the formation is a thick sandstone member (100 to 200 feet) which is more persistent than the others.

Regarding the general character of the formation Taff[4] says:

2. Taff, J. A., U. S. Geol. Survey, Prof. Paper No. 31, p. 22,1904.
3. Taff, J. A., U. S. Geol. Survey, Geol. Atlas, Tishomingo Folio (No. 92) 1903.

In the northern portion of the region, and especially on the northern side of the Arbuckle mountains west of Washita River, the Simpson formation is found to be much thinner than in the southern portion. This is due chiefly to the absence of the lowest beds, which have an aggregate thickness of several hundred feet. The upper division of the formation is found to become thinner northward, owing to the decrease in the quantity of lime and clay. With the decrease in the amounts of lime and clay northward there is a general increase in the abundance of sand, the whole formation becoming more siliceous.

The absence of the lower portion of the formation toward the north and the more clastic nature of subsequent portions of the formation in that direction, suggest an Ordovician land mass to the north of the Arbuckle area over which the Simpson sea gradually encroached. The possibility of a land mass in that same general region is again suggested by a similar northward variation in the formations comprising the Hunton terrane.

VIOLA LIMESTONE

The thickness of the Viola is between 500 and 750 feet. The following section was measured across portions of secs. 12 and 13, T. 1 N., R. 6 E.

Section of the Viola limestone as exposed in secs. 12 and 13, T. 1 N., R. 6 E.

	Feet
Blue and white limestone with some chert	100
Gray and blue limestone with little or no chert	90
Massive limestone bed	10
White argillaceous limestone	3
Massive blue limestone bed	10
Medium to thin-bedded limestone	35
Limestone with sand lentils	15
Limestone with interbedded shale lentils. The limestone in this portion is white or whitish-gray on fresh exposures, but weathers to a dark gray and through differential weathering develops a rough pitted surface	35
Fossiliferous limestone with some chert	25
Thin-bedded limestone with chert	95
Thin-bedded limestone without chert	30
Massive blue limestone	4
Granular white limestone. This portion of the formation is platy near its upper limit and there weathers more rapidly so that streams and gullies often mark the zone.	120
Shale with thin beds of limestone	45
Very fossiliferous limestone bed	2
Argillaceous limestone	5
Thin-bedded limestone and shale	10
Dense white limestone (Base of formation)	3
	637

No other sections of the Viola limestone were measured, but the evidence afforded by wells drilled in the western and northern

4. Taff, J. A., U. S. Geol. Survey Prof. Paper, No. 31, p. 24, 1904.

portions of the quadrangle indicates that the formation thins in that direction. In the well at Vanoss (sec. 34, T. 4 N., R. 4 E.) there is apparently 660 feet of limestone assignable to the Viola, while in the Dean well (sec. 20, T. 5 N., R. 5 E.) there seems to be only 190 feet of the formation.

SYLVAN SHALE

The thickness of the Sylvan, according to Taff[5] increases from 60 feet at the east end of the Arbuckle uplift to approximately 300 feet west of Washita River.

In the quarry, just east of Lawrence a full section of the Sylvan is exposed and here totals approximately 120 feet. Complete sections are also available from the logs of two wells drilled in the Stonewall quadrangle. In the first of these located in the center of sec. 12, T. 3 N., R. 7 E., the Sylvan has a thickness of 151 feet and in the other, situated in the northeast quarter of sec. 20, T. 5 N., R. 4 E., it is 145 feet thick.

On fresh exposures the Sylvan shale is generally green or greenish-blue in color. Because of the lack of resistant beds within the formation it weathers rapidly, resulting quite commonly in under-cutting of the succeeding Chimneyhill limestone, so that an abrupt escarpment often marks the contacts of the two formations. This is the case east of Lawrence.

Hunton Terrane

CHIMNEYHILL LIMESTONE

This formation takes its name from Chimneyhill Creek (South Fork of Jack Fork Creek on most maps). The type section is at the confluence of three small creeks in sec. 4, T. 2 N., R. 6 E. The formation is easily recognized by its pink-crinoidal and oolitic members. The Chimneyhill limestone is especially well exposed in the region east of Lawrence where it caps a westward-facing escarpment of Sylvan shale. The contact is one of unconformity. Good exposures of the limestone are also common farther southeast where the several formations of the Hunton terrane extend along the northeastern flank of the main mass of the Arbuckle Mountains.

HENRYHOUSE SHALE

According to Reeds the Henryhouse shale rests unconformable upon the Chimneyhill limestone. It is thickest in the western part of the Arbuckle Mountains and thins eastward so that in the Stonewall quadrangle it is entirely absent between Canyon Creek and the southeast corner of the quadrangle. Thinning toward the north is apparently less rapid because the fossils secured from the well in sec. 4, T. 4 N., R. 5 E., indicate its presence at that point.

As is indicated by its name the Henryhouse shale consists largely of shales. Within these, soft marly limestones are interbedded, and there are occasional resistant limestone beds which, due to differential weathering, stand out as small ridges.

HARAGAN SHALE

In the Stonewall quadrangle the Haragan shale is apparently absent on the Lawrence uplift, but is very well exposed in the outcrop of the Hunton formations in the southeastern part of the quadrangle.

5. Taff, J. A., U. S. Geol. Survey Prof. Paper No. 31, p. 28, 1904.

Lithologically the Haragan greatly resembles the underlying Henryhouse shale and in the absence of fossils it is very doubtful whether the two could be distinguished.

BOIS D' ARC LIMESTONE

The Bois d'Arc is locally absent and in such places the succeeding Woodford formation rests directly upon the older formations of the Hunton terrane. Reeds[6] mentions such a place in the vicinity of Honey Creek near Washita River. Other localities in which such absence has been observed are sec. 22, T. 1 N., R. 7 E., at which point the Woodford apparently rests directly upon the Haragan shale, and along the northern flank of the Lawrence uplift in secs. 29 and 30, T. 3 N., R. 6 E. A well drilled in the center of sec. 16, T. 3 N., R. 6 E., indicates that there is only 80 feet of Hunton there. It appears, therefore, that in addition to absence of the Haragan shales from the Lawrence uplift, most of the Henryhouse is also absent. The well log indicates 40 feet of Chimneyhill and 40 feet of Henryhouse with the Woodford chert resting on the latter.

WOODFORD FORMATION

In the southern and western parts of the Arbuckle Mountains the Woodford contains near its base a considerable thickness of cherty strata. These are apparently entirely lacking in the Stonewall occurrences which may constitute an explanation of the lesser thickness of the formation here. In the present investigation the formation was found, in the majority of cases, to consist of brown and black slate and shale with local bands carrying concretions of varying size. The greatest number of concretions are round and about the size of a marble. Some, however, are elongate and variation in size up to a diameter of a foot was noted. As a rule the lower part of the formation is darker and more slaty than the upper portion. In some places the upper strata are quite shaly and on exposure weather to a grayish or greenish-blue color. Such occurrences closely resemble portions of the Caney shale. In fact, the general lithologic similarity of the two formations is so close as to make it quite difficult to distinguish between them where only this criterion is used.

SYCAMORE LIMESTONE

In the Stonewall quadrangle the formation has not been observed to have a thickness of more than five feet. The average, however, is less than this and probably does not exceed two feet. In view of the extreme thinness of the formation in the Stonewall quadrangle, as compared with the occurrence in the southern and western portions of the Arbuckles, it might be expected to have a considerable variation in character in the two localities. This is not the case, however, as Taff's original description agrees very closely with the character of the Stonewall exposures. For the most part the formation is a tough, hard limestone, slate-blue on fresh exposure, and weathering to a very characteristic bright yellow. Where the formation is as much as four or five feet thick the lower portion is generally slightly sandy and in some places it seems to grade laterally into shale.

6. Reeds, Chester A., Amer. Jour. Sci., vol. XXXII, p. 264, Oct. 1911.

CANEY SHALE

Taff[7] states that: "On account of the level and poorly exposed surface of the Caney shale the structure cannot be made out with sufficient accuracy to determine correctly the thickness of the formation. It is roughly estimated, however, to be 1,600 feet thick." In the Stonewall quadrangle an average thickness for the formation is thought to be nearer 800 feet. In its lower portion the Caney consists of black shales and slates, some of which closely resemble the average strata of the Woodford formation. At places there occur bands of dense, blue limestone nodules which vary greatly as to size and shape. Such limestone masses sometimes attain a length of several feet and are usually fossiliferous.

The upper part of the formation consists of lighter colored blue and greenish-blue shales, within which are interbedded occasional strata that are quite sandy. At one zone near the top of the formation sandy strata are often predominant. The upper Caney of the Lawrence uplift is especially sandy.

WAPANUCKA FORMATION

The Wapanucka exposed in the Stonewall quadrangle consists of a shale member at the base which is succeeded upward by strata of yellowish-white limestones, brown sandstones, and interbedded dark shales.

The following sections beginning at what was considered the top of the formation was measured at the point in sec. 8, T. 1 N., R. 7 E., where Canyon Creek crosses the outcrop:

Section of Wapanucka formation

	Feet
Yellowish-white limestone, very fossiliferous	13
Shale	30
Yellowish-white limestone	5
Shale with thin layers of limestone	50
Oolitic limestone	3
Blue and gray-blue calcereous shale. (Very fossiliferous)	50
	151

That the Wapanucka has a greater downward extension than is here given, and that all the underlying strata which have been referred to the upper or Pennsylvanian Caney are in reality to be considered a part of the Wapanucka is suggested by the position of the oolite which occurs only 50 feet above the base of the Canyon Creek section. In the region to the southeast, beyond the limits of the Stonewall quadrangle, an oolitic member of the Wapanucka becomes quite prominent. On Delaware Creek near Bromide it has a thickness of 70 feet. Speaking of this member Wallis[8] says: "the oolite is to be considered as a local phase of the massive limestone member that occurs at the top of the formation." In the Canyon Creek section, however, the yellowish-white limestone which occurs 83 feet above the oolite carries a characteristic Wapanucka fauna. From the evidence thus afforded, the conclusion is drawn, that the oolitic members of the two localities are not the same, the Canyon creek stratum being lower in the formation than the one at Delaware Creek.

7. Taff, J. A., U. S. Geol. Survey, Geol. Atlas, Tishomingo Folio (No. 98), p. 5, 1903.

8. Wallis, B. F., Oklahoma Geol. Survey, Bull. No. 23, 1915.

The shale at the bottom of the Canyon Creek section has a lithologic appearance somewhat similar to that of the underlying Caney, but the two were easily distinguished by the following features:

1. The basal shale of the Wapanucka carries a very prolific fauna which is characteristic of the formation.
2. The Caney shale is less calcareous and slightly the darker of the two, also it is often more sandy.
3. The upper part of the Caney shale, although fossiliferous and although carrying a fauna somewhat similar to that of the Wapanucka—in that they are both Pennsylvanian—has a barren zone of some 60 feet at its upper limit.
4. Ironstone concretions, characteristic of the upper Caney, occur in this barren zone.
5. The fauna of the fossiliferous portion of the upper Caney has only a few forms which are common to the Wapanucka formation.

ATOKA FORMATION

The Atoka consists of alternating sandstones and shales with a few impure limestones near its base. The latter are to be observed on Canyon Creek, a short distance north of the Wapanucka outcrop. A chert bed known as the Chickachoc chert lentil occurs in the lower part of the formation where it outcrops in the southern part of the Coalgate and the northern part of the Atoka quadrangle. This chert lentil was not observed in the Stonewall exposure. Taff mentions another type of strata which occurs within the Atoka formation. In describing these beds he says:

"Prominent local beds of conglomerate composed of fine brown sand and sub-angular chert pebbles make high ridges and hills immediately west and southwest of Stringtown. Conglomerate beds of similar nature occur also in the upper part of the formation west of North Boggy Creek and north and west of Atoka. A peculiar feature of this chert conglomerate is that its limit in range north and south corresponds with the occurrence of Silurian chert (mapped as Talihina Chert) in Black Knob Ridge."

These conglomerates are important in that others of a very similar character are common in practically all the formations later than the Atoka which are present in the Stonewall quadrangle. Their greatest development, however, is in the formations above the Wetumka shale.

The thickness of the Atoka in the Coalgate and Atoka quadrangles, as given by Taff in the folios covering those areas, is 3,000 feet. In the Stonewall area, however, the exposed section is very much less and is estimated to be only 800 feet.

HARTSHORNE SANDSTONE

From the western edge of the Coalgate quadrangle, to which point the formation was mapped by Taff, there is a continuation into the Stonewall quadrangle of several brown sandstones with interbedded shales. This group of strata resists erosion somewhat better than the more shaly beds above and below it and for that reason is generally expressed as a low, rounded ridge. It is thought that these strata represent the westward extension of the Harshorne sandstone.

Farther east the Hartshorne sandstone has a thickness of as much as 200 feet, but in the portion of its outcrop here discussed the formation is only about 100 feet thick. It consists of brown or yellowish-brown sandstones with interbedded shales.

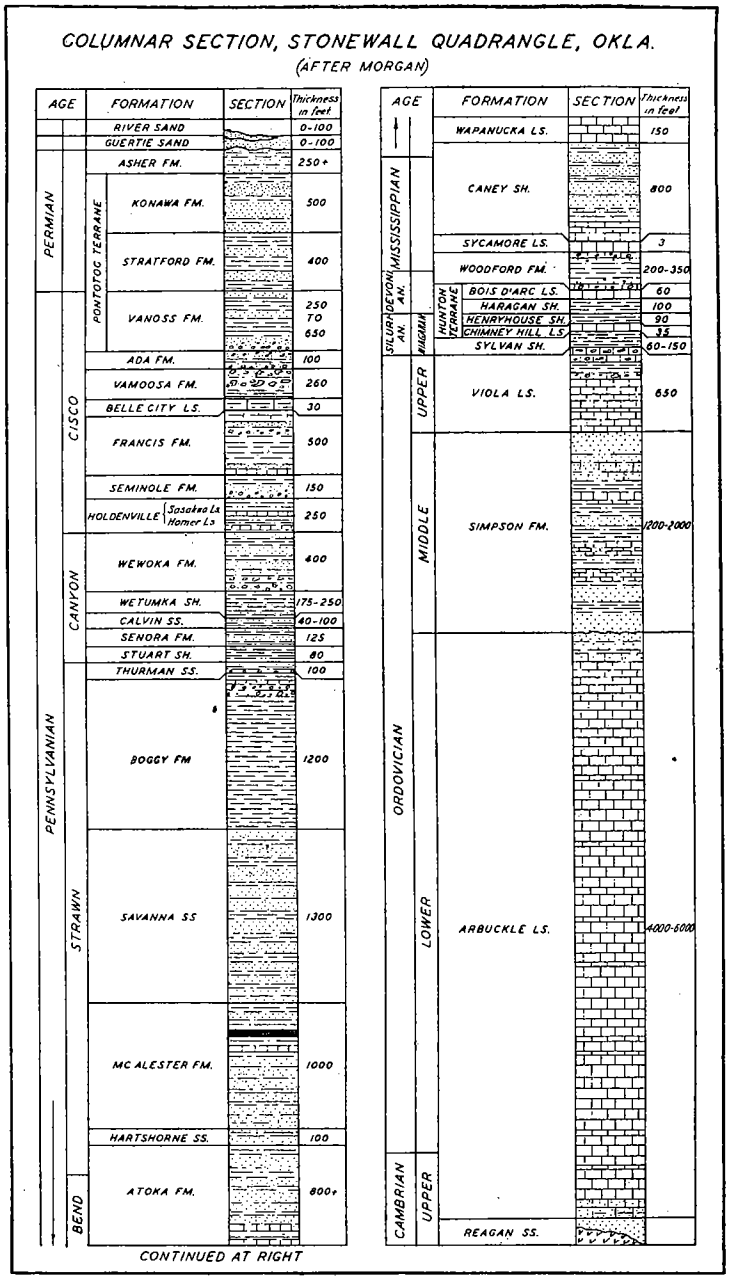


Figure 2.

McALESTER FORMATION

In its Stonewall exposure the upper part of the McAlester consists very largely of dark colored shales, which, however, carry a few thin beds of sandstone. In the portion below the coal, sandstone is prominent, but even here the strata consists largely of shales. The most important bed, geologically, in the McAlester formation is a thin red limestone which occurs 15 feet below the Lehigh Coal. This bed was traced almost continuously along the outcrop mapped in the present survey and contributes quite conclusive evidence as to the relation of the McAlester with the formations above and below it. Where the red limestone outcrops just south of the strip pit in section 14, it is approximately 2,000 feet above the Wapanucka limestone, but at its last observed western exposure, along the eastern edge of sec. 1, T. 7 N., R. 6 E., it is only 465 feet above the Caney shale; the Wapanucka, Atoka, and Hartshorne formations being there absent. This condition is taken to indicate (1) that the McAlester is an overlapping formation; (2) that the top overlaps the base, probably thus accounting for at least part of the supposed westward thinning mentioned by Taff; and (3) that in the Stonewall quadrangle the overlap of the upper part of the formation continues to such an extent that it projects across the beveled edges of the older formation and, in the region just south of Franks, rests on the Caney shale.

In its western extent the exposed portion of the McAlester formation carries numerous beds of conglomerates. On the west bank of Canyon Creek there is such a stratum which rests unconformably on limestone beds of the lower part of the Atoka formation. This conglomerate is largely composed of reworked fragments from the Caney and Woodford formations, but also carries a few pieces of the uppermost exposed limestone of the Atoka. The absence from the conglomerate of fragments of Arbuckle strata older than the Woodford suggests that the older formations were not exposed in the immediate vicinity at the time the conglomerate was deposited. The importance of his observation lies in the fact that in the Atoka quadrangle, at a point some 15 miles to the southeast of the Canyon Creek locality, Wallis[9] found at the top of the Wapanucka formation a conglomerate which carried fragmental limestone very similar to that of the Viola and Arbuckle formations. The natural conclusion, therefore, is that the Arbuckle Mountains were first uplifted at some point to the south of their present highest portion. This conclusion is substantiated by the fact that at the southeastern edge of the mountains all of the thick section of early Paleozoic rocks has been removed, thus exposing granite, while in the area just south of the point at which the McAlester conglomerate bed is exposed in Canyon Creek, several thousand feet of these older rocks are still present above the granite.

Farther west, later conglomerates in the McAlester carry fragments of Hunton limestone and numerous well preserved specimens of **Camarocrinus** which were very probably derived from either the Henryhouse or Haragan shales. The red limestone which occurs below the Lehigh Coal also becomes more clastic westward and just north of the road and house, one-half mile south of the NW. cor. of sec. 6, T. 1 N., R. 7 E., contains limestone pebbles up to an inch in length. Fragments of coal were also observed in the limestone at this place. The conglomerates in the western extension of the McAlester formation were included by previous workers as part of the Franks conglomerate.

9. Wallas, B. F., Okla. Geol. Survey, Bull. 23, 1915.

SAVANNA SANDSTONE

A section measured along the east line of T. 1 N., R. 7 E., shows a thickness of Savanna amounting to approximately 1,300 feet. Westward, however, the exposed portion of the formation is greatly decreased because of the combined effect of two overlaps. A section measured about two miles southeast of Franks shows only 400 feet of Savanna.

The formation consists of alternating shales and sandstones, with occasional thin, impure limestones. Toward the western end of the outcrop conglomeratic beds become prominent. These carry fragments of oolitic and pink-crinoidal limestone from the Chimneyhill formation. Other limestone fragments included in the conglomerates closely resemble strata from the Viola and Arbuckle. The conglomeratic phase is a part of the Franks conglomerate of previous investigators of the Arbuckle area.

Jolly Limestone Member

Near the bottom of the Savanna there is a thin limestone bed which is important in that it shows clearly the overlapping nature of itself, and the strata above it, across the basal beds of the formation. This bed is very well exposed in the road in front of J. S. Jolly's house, 300 yards east of the northwest corner of sec. 8, T. 1 N., R. 7 E.

BOGGY FORMATION

The formation consists of sandstones, shales, and a few limestones. Of the three kinds of strata the shales constitute by far the greatest thickness, but at the top of the formation clastic beds are quite prominent. These grade from sandstones and fine grained conglomerates at the eastern edge of the area to coarse limestone conglomerates near the town of Franks. In the latter area Boggy strata constitute a large part of what has previously been called the Franks conglomerate.

The maximum thickness of the formation along the border of the Stonewall and Coalgate quadrangles amounts to less than 1,300 feet. If the upper part of the formation were present in the region south of Stonewall, however, it is probable that the thickness there would amount to as much as 1,500 feet.

In the vicinity of Franks only the upper part of the formation is exposed, but it is thought that wells drilled there would encounter a full section of possibly 1,500 feet. On the eastern end of the Lawrence uplift the lower part of the Boggy is in unconformable contact with the Caney shale and the Wapanucka limestone. On the northern flank of the uplift, near Lawrence, it overlaps all lower formations from Caney to Viola, inclusive.

THURMAN SANDSTONE

A complete section of the Thurman formation in the Stonewall quadrangle is about 100 feet. Several beds of conglomerate and conglomeratic limestones occur in the basal part of the section. The pebbles in these beds are waterworn and consist of chert and limestone. Some of the limestone fragments greatly resmble the pink crinoidal member of the Chimneyhill limestone and are thought to have been derived from that formation.

Brown and yellowish-brown sandstones are very prominent in the formation and alternate with dark colored chales.

Fifteen feet below the base of the formation occurs the very characteristic **Campophyllum**-bearing limestone mentioned in the discussion of the Boggy formation.

This bed is easily traceable and clearly defines the base of the Thurman. The top of the formation, however, is not so easily determined. In the Coalgate folio the upper limit cincides with the outcrop or rather a heavy sandstone, and although there are other sandstone beds above this one, it was taken as the top of the formation and mapped westward into the Stonewall quadrangle as the upper limit of the Thurman.

STUART SHALE

The thickness of the Stuart shale is approximately 80 feet. It consists of dark shales ranging through shades of green, blue, and black, and near its top and bottom also carries a few thin beds of sandstone. About 15 feet below the top of the formation is generally a zone of brown concretions, which were of assistance in mapping.

SENORA FORMATION

In a section measured through the central part of secs. 3 and 10, T. 3 N., R. 7 E., the Senora was found to be 125 feet thick. At the base of the formation there is about 35 feet of sandstone with only a few thin beds of interstratified shale. This series of beds is much more resistant than the underlying Stuart shale and the differential weathering of the two results in the formation of a steep, southward facing escarpment. The Stuart shale occupies the steep face of the escarpment and the basal Senora beds extend along the crest.

Above the basal sandstone, to the top of the formation, shales are prominent, but interbedded with these are brown and yellowish-brown sandstones.

In the basal sandstones there is locally a thin, arenaceous limestone that is quite fossiliferous. This bed is of assistance in mapping as is also the zone of concretions fifteen feet below the base of the formation.

CALVIN SANDSTONE

A section measured in the central part of sec. 3, T. 3 N., R. 7 E., near the western end of the outcrop shows a thickness of only 40 feet for the Calvin.

Where this section was taken the beds assigned to the Calvin consist of coarse-grained, brown and grayish-brown sandstones. With these are interbedded a few thin layers of shale. The beds are slightly more resistant than the shales of the upper Senora and lower Wetumka, and for that reason weather out as a low, rounded ridge.

Farther northeast, and typically in the northeast corner of sec. 36, T. 4 N., R. 7 E., some of the sandstones are very thin bedded. Associated with these are occasional red shales. Such a red shale occurs in the road one-half mile south of the corner just mentioned.

WETUMKA SHALE

In sec. 24, T. 4 N., R. 7 E., the Wetumka shale has a thickness of between 150 and 175 feet, while a section measured in sec. 3, T. 3 N., R. 7 E., shows a total of 250 feet. As pointed out in the discussion of the Calvin formation this apparent difference in thickness is probably due to the fact that in section 3, some of the upper shaly strata of the Calvin have been mapped as basal Wetumka. The contact between the two formations is gradual and, at least in the Stonewall quadrangle, it would probably be more advisable to map the formations together. They extend only a short distance into the area, however, and in an endeavor to preserve the stratigraphic subdivisions used in the Coalgate folio a separation of the formations has been attempted.

There are a few thin sandstones near the top and bottom, but for the most part the formation consists of almost unbroken shale.

The slight resistance offered to erosion by this shale results in its being undercut from beneath the resistant sandstones in the base of the overlying Wewoka formation, and in the formation of a prominent southeastward-facing escarpment.

WEWOKA FORMATION

Several sections measured in the Stonewall quadrangle show a total average thickness of 400 feet for the Wewoka. The top and bottom of the formation are marked by definite sandstone ledges that were mapped without difficulty. The basal sandstone, as well as several other members locally grades into chert conglomerate.

HOLDENVILLE FORMATION

The Holdenville formation consists largely of shale, but also contains numerous sandstone beds and two mappable limestone members. Some of the sandstones locally develop into massive chert conglomerates that are lithologically identical with the conglomerate at the base of the Seminole in the type area of that formation.

In the northeastern part of the quadrangle the Holdenville is approximately 235 feet thick. It thins southward, however, and at its southern extremity, where it is overlapped by the Seminole, does not exceed 100 feet.

Sasakwa Limestone Member

The upper of the two limestones occurs 35 feet below the top of the formation. Its outcrop passes through the town of Sasakwa and the member is named after that town. The bed is especially well exposed in the railroad cut and quarry about one-fourth mile south of Sasakwa.

Homer Limestone Member

This limestone lies below the Sasakwa limestone and is also best developed in the northeastern part of the quadrangle.

In the northeastern part of the quadrangle the Homer limestone is approximately three feet thick. It occurs 70 feet below the Sasakwa limestone and there constitutes a reef of **Chaetetes**. The color of the limestone in this area is dark gray or almost black. The reef-like character of the stratum is maintained southward to the vicinity of Homer school where the quantity of **Chaetetes** begins to diminish and a few specimens of **Fusulina** appear.

SEMINOLE FORMATION

Although defined by Taff the upper limit of the Seminole was not mapped by him. In order to establish what he considered as the limits of the formation his brief description and definition of the formation is here quoted in full. He says:

"About 50 feet of the lower part of the Seminole conglomerate is exposed in a small area in the northwestern corner of the Coalgate quadrangle. This part of the formation is composed of

laminated or stratified subangular chert, with a sprinkling of quartz pebbles from three inches in diameter to small grains in a cement of fine brown and usually ferrunginous sand. The coarser conglomerate in the beds at the base is loosely cemented and on weathered surfaces it breaks down into rounded boulders and loose gravel. Forty to 50 feet from the base the conglomerate grades into brown sandstone which continues upward about 100 feet to the top of the formation. The Seminole formation crops in a rugged hilly country northwestward in the Seminole Nation, making rough timbered lands."

By definition then, the Seminole of the type area has a thickness of "about" 150 feet. Since no definite bed is named as marking the top of the formation there can be no question as to the original measurement and the definition must be taken literally.

FRANCIS FORMATION

In the type area and northward the Francis formation has a thickness of 500 feet. In the vicinity of Ada and southward only the lower part of the formation is exposed, the upper part being overlapped by the Ada formation.

At the base, but within the Francis formation, is the DeNay limestone member, the lower part of which marks the top of the Seminole formation. Above this limestone is an interval of about 30 feet that is represented by dark blue and black shales. These grade upward into sandstones which on the creek bluff northwest of Sasakwa have a thickness of nearly 20 feet. This is the sandstone that outcrops in the railroad cut below the viaduct in the northeastern part of Francis and is also correlated with the sandstone ledge in the road cut just north of the brick plant and railroad crossing near the southeast corner of Ada. Above the sandstone member is a series of thick, dark and sometimes calcareous shales. The average thickness of this part of the formation is 250 feet.

Above the shale series is a thickness of almost 100 feet within which coarse brown sandstones and chert conglomerates predominate.

The upper part of the Francis formation is a shale that is about 100 feet thick. This part carries a few thin sandstone and one rather persistent conglomeratic limestone.

Denay Limestone Member

The DeNay limestone has an average thickness of a little more than one foot. In the region north of the Canadian River the bed is rather dense and breaks out in longated blocks. In the road about one-half mile east of Francis the bed is slightly crinoidal. Crinoid stems become more abundant in the stratum toward the southwest and in the region south of Ada it is often almost entirely composed of these organisms. In the northeastern part of T. 3 N., R. 5 E., the crinoids become less abundant and the limestone develops a bright yellow color. The latter characteristic must be used with discretion, however, because there are in the area several beds of this color.

FRANKS CONGLOMERATE

In the vicinity of Franks, conglomeratic strata are exposed through a section of approximately 1,500 feet. Many of the beds are fossiliferous, and (contrary to Taff's statement, as given above, that the Franks conglomerate of this area is nearly flat) all are highly folded and localy faulted. The conglomerates are largely composed of limestone fragments which vary in size up to a diameter of four or five inches. Toward the east and northeast the fragments diminish in size and quantity within any given stratum; the beds becoming sandy or grading into shale in these directions.

BELLE CITY LIMESTONE

The formation has an average thickness of 30 feet. It is composed of two limestones of varying thickness with an intervening shale. The upper lime is generally thicker and much more massive than the lower. Its range in thickness is from one foot as just south of Byng, to as much as 15 feet near Canadian River. The bed is white or light gray in color and is often characterized by well developed styliolites. Pronounced weathering along joint cracks is common and in the eastern part of sec. 24, T. 6 N., R. 6 E., results in the formation of small sink-holes at the intersection of a few of the prominent joints.

The lower limestone bed is buff colored. Its range in thickness is from one foot, as in the vicinity of Byng, to as much as five feet near Canadian River and northward. At variance with the massive character of the upper member of the formation the bedding of this stratum is relatively thin.

The interval between the upper and lower limestones is composed of shale that ranges in color through shades of green, blue and black. Its average thickness is 12 feet.

VAMOOSA FORMATION

Where all of the formation is exposed the entire section has an average thickness of 260 feet. At the base is about 30 feet of dark shale that might easily be mapped as a separate formation. No collections were made from this member, but it is very probably fossiliferous. The main mass of the formation is above this shale and has a maximum thickness of about 230 feet. It consists in large part of chert conglomerates, of massive, coarse, red and brown sandstones, and red shales. The clastic material is finer near the top and the red coloration is there also less pronounced.

ADA FORMATION

The average thickness of the Ada formation is about 100 feet. Limestone conglomerates and coarse sandstones are very prominent along the greater portion of the outcrop. Clastic material becomes less toward the north, however, and in the vicinity of Vamoosa is very scarce. With the decrease in the amount of clastic material northward the formation becomes thinner and at the northern edge of the sheet has a total thickness of only about 60 feet.

One very characteristic feature of the formation is the asphalt which it contains. This is always associated with the conglomerates or coarse sandstones many of which are often highly saturated. One mile west of Ada, asphalt-bearing sandstones and conglomerates are quarried for paving purposes.

VANOSS FORMATION

The Vanoss formation consists of alternating sandstones, conglomerates, shales and a few thin limestones. All the strata are arkosic, some of the sandstones so much so that at the first glance a few of them might be mistaken for true granites.

Near the center of the formation there are several thin limestone beds. These were not observed north of Canadian River, but appear intermittently along the outcrop to the south of that stream. They are generally argillaceous and are subject to rapid

gradation into shale. Where freshly exposed the limestones are light gray in color and relatively soft, but on weathering become hard and white. Several of these beds are well exposed at the eastern edge of the town of Center. Good exposures are also common in the region about one mile east of Vanoss. The limestones are less arkosic than the associated sandstones, but some of them carry an appreciable amount of feldspathic fragments.

In the upper part of the Vanoss formation sandstones are less prominent than they are near the base. The shales which constitute the greater part of this upper portion are generally of light color, ranging through shades of green and gray. Occasional red shales are also present. With the decrease in sandstone there is also a decrease in the quantity of the arkose. Locally, however, there are beds that are almost entirely composed of this material.

The upper limit of the Vanoss farmation is marked by the base of the Hart limestone member of the Stratford formation. The thickness of the Vanoss formation increases southward. The exposed portion east of Konawa totals only about 250 feet, while near the southwest corner of the quadrangle there are about 650 feet of strata within the formation.

STRUCTURE

The structure of Pontotoc County is very complex due to the fact that it lies on the north flank of the Arbuckle Mountains and is sharply folded and faulted, especially in the older formations. (See Map, Plate I). In general it might be stated that beds younger than Boggy dip to the northwest while the regional dip of the lower beds is to the northwest, north, northeast and east as controlled by the northward plunging axis of the Hunton arch[10].

There are many minor changes in this general dip and important ones, so far as the possibility of oil and gas is concerned, will be pointed out in the following statements.

First, there are three general lines of subsurface "highs" which affect the oil possibilities of Pontotoc County. One is a subsurface "nose" which seems to be an offshoot of the Arbuckle folding running in a northwestward direction and passing just west of the town of Center and plunging to the northwest. The second is an east-west subsurface fold beginning on the eastern edge of the county just north of Allen in T. 5 N., R. 8 E., and extending westward through T. 5 N., Rs. 6-7 E. This fold plunges toward the east. The exact trend of the axis of this fold is not definitely defined as yet. For a better understanding see the map of Pontotoc County on which is given the depths at which the Hunton and Simpson formations were encountered in many wells over the area. The third is the Lawrence uplift running through the northern part of T. 2 N., and the southern two-thirds of T. 3 N. The big basin lies between this and the second high mentioned above.

10. Dott, Robert H., Pennsylvanian paleogeography: Oklahoma Geol. Survey, Bull. No. 40-J, 1927.

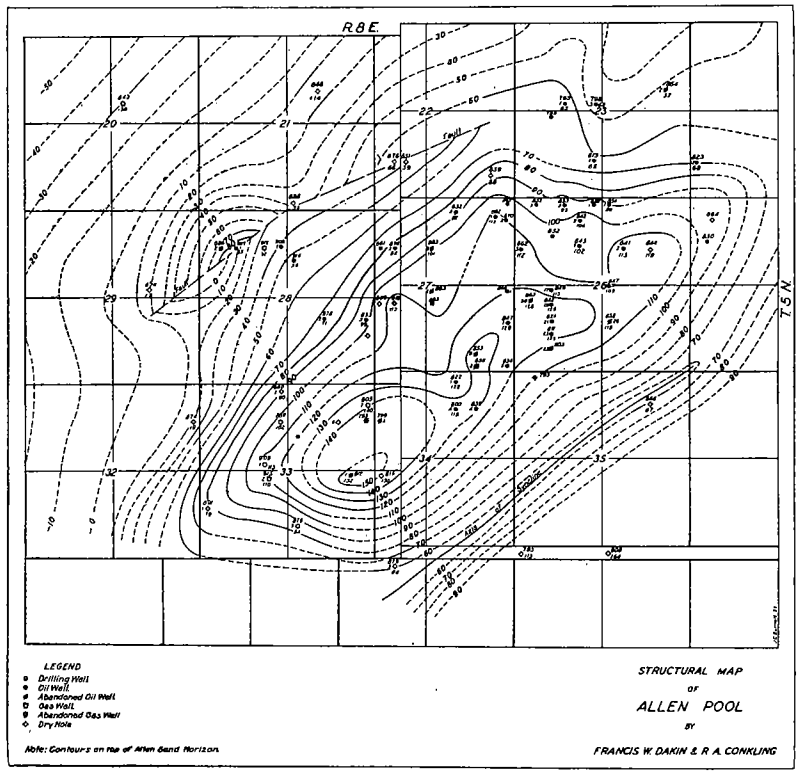


Figure 3.

ALLEN ANTICLINE

The Allen anticline in T. 5 N., R. 8 E., trends a little northeast-southwest from the east-west line and lies in a subsurface trough just south of the subsurface high north of Allen. For a better understanding of this anticline see the subsurface map (Fig. 3) which is mapped on the shallow oil and gas sand. It will be noted that this anticline has a closure of 80 feet and has had shallow production of both oil and gas for many years. Some of the wells have been producing for ten years or more and the wells are still making from two to five barrels. The sands are very lenticular and are likely to be missed entirely in the distance of one location. In the main part of the field, however, if one sand is missed, another is usually picked up so that there are comparatively few dry holes in the producing area. A well was drilled on this structure by the Homaokla Oil Company in the NW.¼ SW.¼ NE.¼ sec. 33, T. 5 N., R. 8 E., to a depth of 4,812 feet. Samples show that the Hunton lime was reached at 4,629-4,649 feet, with Sylvan shale to 4,796 and the Viola to 4,812 feet. The hole was lost at 4,812 feet,

still in the Viola. It will be noted from the above that the Hunton and Viola were found at very great depths although the well was drilled near the top of the surface fold. It is extremely unlikely that the Simpson will produce oil in paying quantities under this anticline.

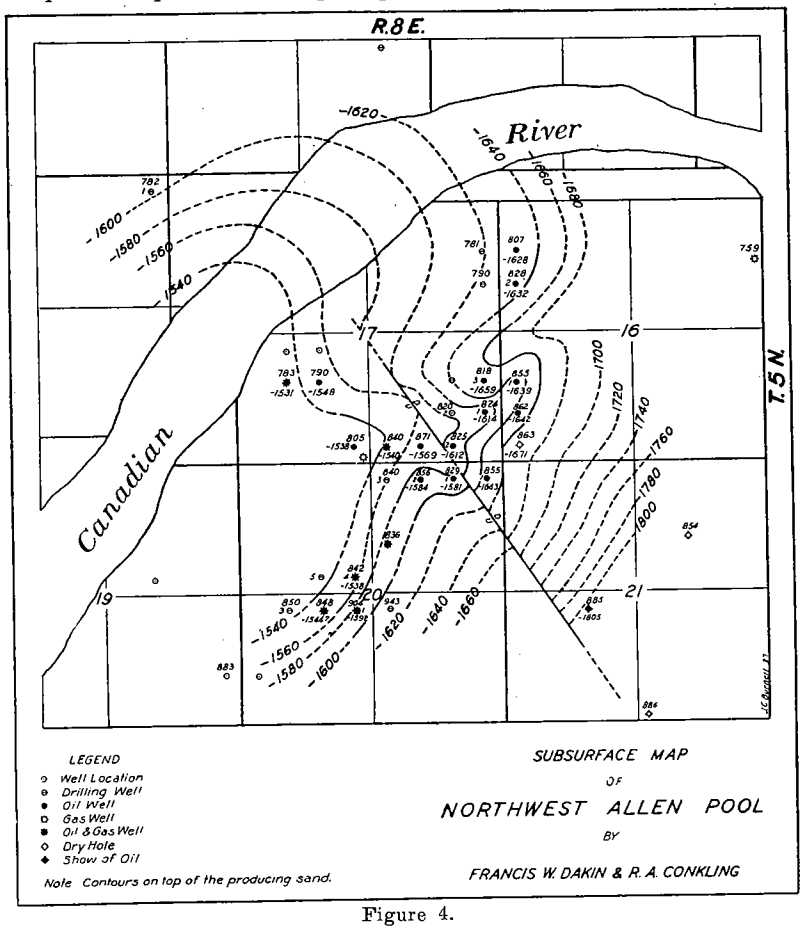


Figure 4.

NORTHWEST ALLEN POOL

Another pool has been discovered recently by the Homaokla Oil Company in sec. 16, T. 5 N., R. 8 E. The pool has been extended far across the western edge of sec. 16 and to the west across the south half of section 17 and through section 20 by some 17 or 18 wells. C. B. Shaffer has also brought in a well in sec. 36, T. 5 N., R. 7 E., but as yet it is impossible to say whether this is a separate structure or an extension of the northwest Allen pool. A subsurface map showing the

structure as far as the author is able to work it out from wells drilled will be noted in Figure 4. The author believes that the production here is coming from the basal Wapanucka or the upper part of the Caney[11]. In other words, there are several good sands in the next two or three hundred feet below which should produce considerable quantities of oil. There are many who believe that this is the Savanna horizon, in which case the Wapanucka and upper Caney series are still to be penetrated with very good possibilities for oil. This pool should be the most important pool in Pontotoc County.

BEEBE ANTICLINE

The axis of this fold extends from the southeastern part of sec. 36, T. 4 N., R. 5 E., to the southeastern part of sec. 28, T. 4 N., R. 5 E. This is not a closed structure on the surface, being open to the northwest. The production here comes from what is thought to be the base of the Boggy from 1,600 to 1,750 feet, and the Caney shale is penetrated at about 1,800 feet. A little farther to the northeast, in sec. 28, a well was drilled to the Hunton lime at 2,195 feet on what is thought to be a separate structure from that at Beebe. At 2,346 feet a production of 135 barrels was had and the well has held up remarkably well although both direct offsets were dry. One of these was drilled to the Simpson and found it contained water.

CENTER ANTICLINE

The Center anticline lies just west of the town of Center and is about five miles southwest of the Beebe anticline. This anticline shows a closure at the surface and a well drilled in the NE. ¼ sec. 24, hit the Hunton lime at 1,400 feet and the Simpson at 1,940 feet. Although the wells had small showings in two or three of the Simpson sands, these sands were found to contain a heavy hydrostatic head of sulphur water and no commercial production was had. It is not certain, however, since this is the only well drilled on the structure, that this was on the highest point in the subsurface, and although we belive that it is doubtful that the Simpson will ever produce commercial quantities of oil from this structure yet no definite statement can be made.

FAULTING EAST OF BYNG

Morgan mapped two surface faults just east of the town of Byng. This is thought to account for the accumulation of the oil and gas in sec. 34, T. 5 N., R. 6 E.

11. Below the Thurman sandstone and near the top of the Boggy shale is a persistent red shale member. There is often included in the shale a fine grained angular gray sandstone bed whose thickness ranges from one to twenty feet. In the old Allen field this sandstone is found at a depth of 750 feet to 800 feet and is known locally as the Allen producing sand.
To the northwest of the old Allen field a new field has been recently discovered. Here the Allen sand is found at a depth of 900 feet or more. A study of the samples from the producing horizon in the new field is not the Allen sand, however, but a sandstone that is found at a depth of 2,300 or 2,400 feet. This sandstone is approximately 100 feet thick and can be quite definitely correlated with the Savanna sandstone which outcrops to the southeast of Allen in Coal County, Oklahoma. It is likely that this new field is not far from the northwestward limits of Savanna deposition.
GEO. S. BUCHANAN.

STRUCTURE OF THE ADA GAS FIELD

The Ada gas field is located in secs. 8, 9, 16 and 17, T. 4 N., R. 6 E. The subsurface structure is shown in Figure 5. There have been wells drilled on this dome to the Simpson formation which found the sands to be water-bearing.

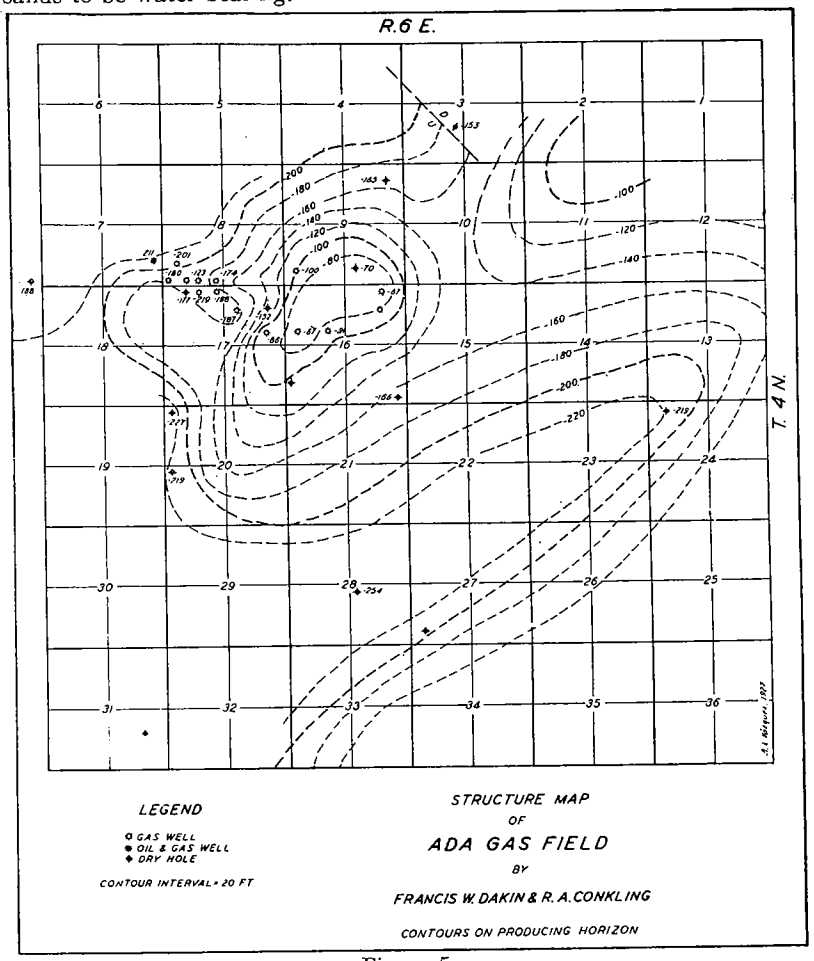


Figure 5.

STRUCTURE IN T. 3 N., R. 8 E.

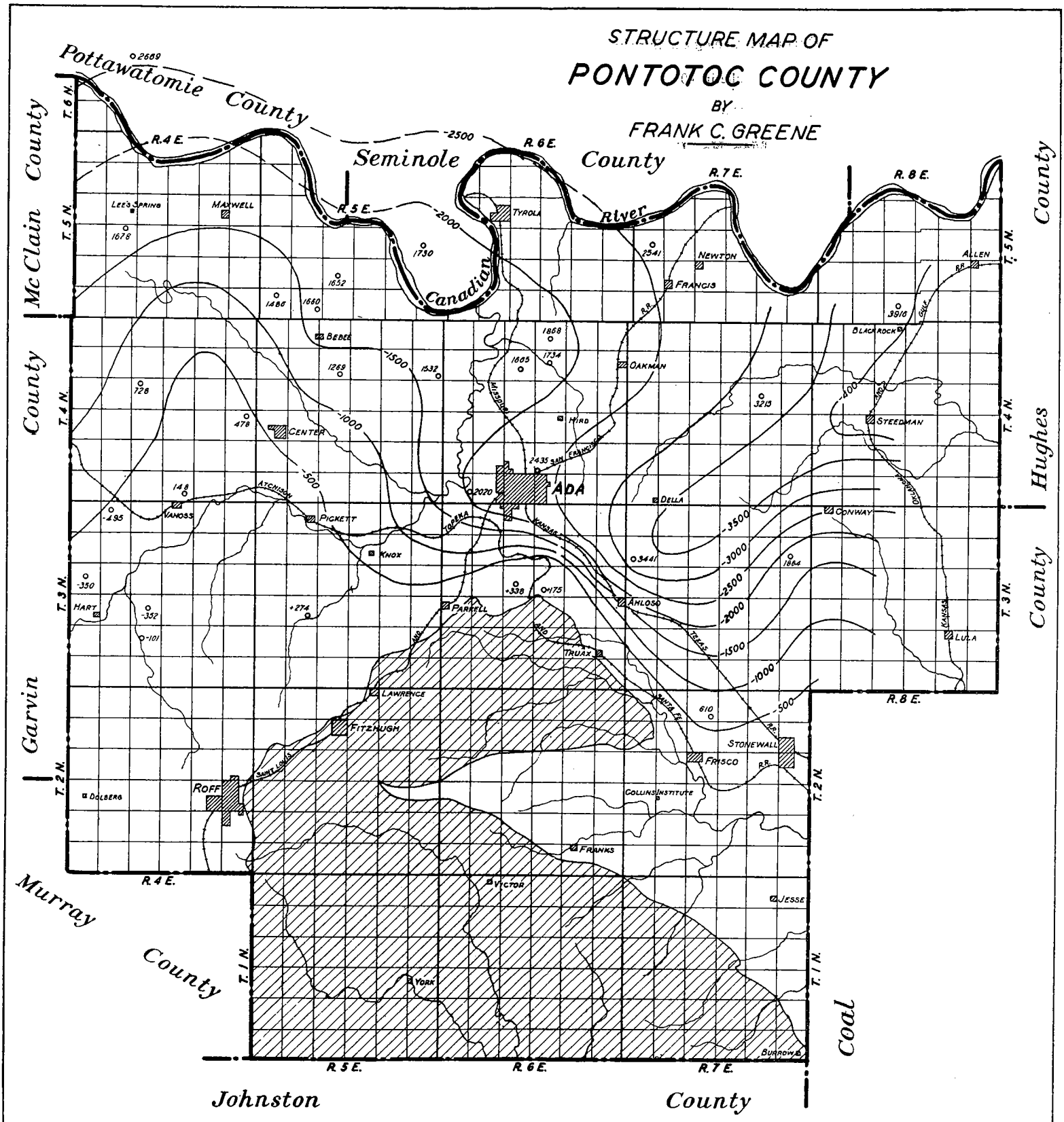
There is a terrace in secs. 9, 10 and 15, T. 3 N., R. 8 E., with a considerable flat area in section 10. There may be a little south dip, but the author believes that this does not close. It is worthy of mention, however, as no doubt it will be tested before long.

THE SLICK WELL IN SEC. 21, T. 5 N., R. 6 E.

This well came in for some four or five thousand barrels in the Hunton limestone which was reached at 2,555 feet and penetrated to a depth of 138 feet. As yet it cannot be stated as to whether this is a closed subsurface structure or not, but the author is inclined to believe that it will not have much closure, and therefore, believes the possibility of Simpson production below is very slight.

FUTURE POSSIBILITY OF OIL AND GAS OF NORTHWEST ALLEN STRUCTURE

The striking of oil at 2,500 feet in sec. 16, T. 5 N., R. 8 E., by the Homaokla Oil Company has caused a revival of interest in Pontotoc County, especially in the northeastern part. If the author's correlation is correct, the production from this well was found in the basal part of the Wapanucka formation or the very top of the Caney formation and it shows an uplift of approximately 800 feet from the center of sec. 33, T. 5 N., R. 8 E., to sec. 16, T. 5 N., R. 8 E. (See footnote, page 25). As there has not been enought development to the west as yet to show whether this has a large closure in that direction, it is hard to state what the possibilities in the Simpson formation below might be. There are undoubtedly very great possibilities in the lower sands above the Simpson, however, and this structure would be worthy of a Simpson test should closure be found to the west. If this does not produce in the Simpson, the author does not believe there is any very great possibility of future production from this series. There will be many shallow pools developed, no doubt, some of which will have a considerable commercial value, and it is likely that the Hunton will produce over a considerable area. However, the history of the Hunton production is that it is more or less spotted.


STRUCTURE MAP OF
PONTOTOC COUNTY
BY
FRANK C. GREENE
Pottawatomie County
Seminole County
McClain County
Garvin County
Murray County
Johnston County
Coal County
Hughes County
Canadian River
ADA
OKLAHOMA GEOLOGICAL SURVEY
CHAS. N. GOULD, DIRECTOR.
NORMAN, OKLA.
1927
OUTCROP OF WOODFORD AND OLDER FORMATIONS.
CONTOUR INTERVAL - 500 FT.
DATUM - TOP OF VIOLA LIMESTONE.