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OIL AND GAS IN OKLAHOMA

GEOLOGY OF CLEVELAND AND McCLAIN 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. Anderson, the author of this report has made a special study of the sedimentation of the red beds of central Oklahoma, and is therefore well qualified to write on the geology of Cleveland and McClain counties. The discussion and cross-section of the subsurface formations will no doubt be of value to geologists working in these counties.

CHAS. N. GOULD,
Director

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INTRODUCTION

As the writer has prepared this preliminary report within a very limited time during which a full teaching schedule was carried, the discussion must necessarily be brief and many interesting problems have of necessity been left untouched. The work, therefore, is very incomplete. As no field work has been allowed for the purpose of this report hence nothing further is attempted than to assemble the existing knowledge of the geology of this area.

Within the last two or three years much attention has been given to red bed geology partly through the effort of Chas. N. Gould, Director of the Oklahoma Geological Survey and partly by the interest developed through oil discoveries in the Seminole area which has made large areas to the west covered by red beds potential oil territory. This recent study has resulted in the subdivision of the Enid Group, by Aurin, Officer and Gould,[1] and the correlation of one of its members, the Duncan sandstone from Texas through Oklahoma into Kansas. This work and the more detailed study of the members will result in definitely tracing their contacts. The eventual identification of these units in subsurface correlation is, in the writer's opinion, within our grasp. In the preparation of this report it is believed that the Hennessey-Garber contact at least, has been definitely established and accurately mapped through Cleveland County.

ACKNOWLEDGMENTS

The writer has drawn upon any and all sources of information available. The work of Gould, Aurin, Green and Dott should be particularly mentioned. The members of the staff of the school of geology have one and all given unstinted help and suggestions and many field geologists have been of great help.

CLEVELAND COUNTY

LOCATION

Cleveland County is located in the central part of the State on the north side of the South Canadian River. It extends from T. 6 N., to T. 10 N., inclusive, and from R. 4 W., to R. 1 E., inclusive. It includes 12 whole townships and parts of 7 others. The total area is approximately 585 square miles

1. Aurin, F. L., Officer, H. G., and Gould, Chas. N., The subdivision of the Enid formation: Bull. Amer. Assoc. Pet. Geol., Vol. 10, No. 8, 1926.

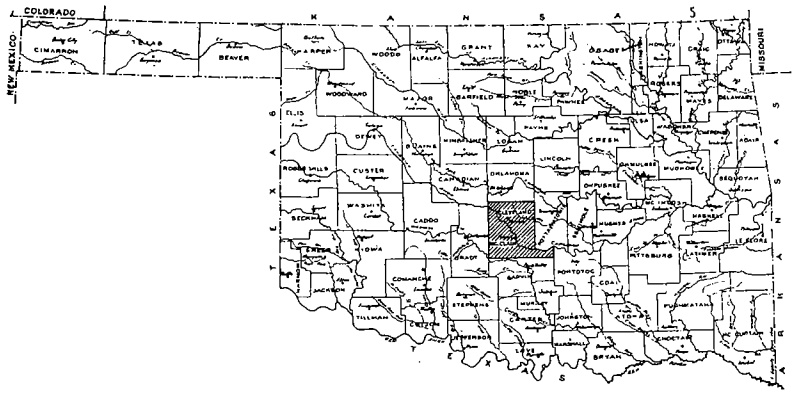

Figure. 1. Index map of Oklahoma showing location of Cleveland and McClain counties.

TOPOGRAPHY AND DRAINAGE

Cleveland County lies in the Sandstone Hills region with the exception of the western part, which is in the red beds plains. The western part of the county, in a strip from three to eight miles wide parallel to the Canadian River, is a rolling prairie, while all of the eastern portion is hilly and sandy, the streams having eroded narrow and deep valleys in many instances. The hills are in part due to erosional features in the shales and sandstones of the eastern part of the county, and in part to wind work, causing duning and ridging of the surface sands along the north bank of the Canadian River. The range in elevation is from 960 feet on Little River in sec. 1, T. 8 N., R. 1 E., to 1,320 feet on top of a hill 3½ miles northeast of Moore.

Little River and its tributaries drain the greater portion of the county especially the northeastern part. Canadian River drains the western and southern parts of the county. The tributaries of Little River head only about two miles from the north bank of the Canadian at Norman while Little River empties into the Canadian in T. 9 N., R. 6 E., some 60 miles to the east. This is in part due to dune sand accumulating on the north bank of the Canadian which has obstructed the Canadian tributaries on the north bank and the comparatively steeper gradient of the Little River tributaries and its headwaters on the north side of the dune sand accumulations. The Canadian River at this point is regarded as an overloaded stream though this condition is apparently recent since bed rock is reported to be at a depth of about 34 feet at the bridge south of Norman. The gradient of the river averages 9 feet per mile.

GENERAL GEOLOGY

STRATIGRAPHY

The rocks exposed at the surface within the county belong to the Enid[2] group of the Permian red beds. Unconsolidated gravels cap the hills, which probably represent outlying remnants of Tertiary gravels, and recent alluvium in the river flats and finally wind blown dune sands on the north bank of the Canadian River.

The upper portion of the Enid group has been recently subdivided by Gould[3] into the Chickasha formation and the Duncan sandstone in which the latter has been correlated with the Harper sandstone of Kansas and the San Angelo sandstone of Texas, and the entire Enid group was later subdivided and correlated by Aurin, Officer, and Gould[4] with the marine members of the lower Permian of northern Oklahoma and southern Kansas.

The latter discussion divides the Enid into six subdivisions as follows, reading from the oldest to the youngest: Stillwater, Wellington, Garber, Hennessey, Duncan, and Chickasha formations.

Within Cleveland County, as mapped by these writers,[5] should be exposed from east to west the upper portion of the Wellington, Garber, Hennessey, Duncan, and possibly the base of the Chickasha formations. All of these are running in approximately parallel belts from north to south through Cleveland and McClain counties and to the south of McClain into Garvin County. Dott[6] has recently subdivided the Enid in Garvin County into eight units below the Duncan based upon escarpment forming sandstones alternating with predominating units of shale.

In McClain, north of Garvin County, the upper five units of Dott grade laterally into predominating shales which render their mapping to the north very uncertain and probably impractical.

WELLINGTON FORMATION

The Wellington formation of Kansas has recently been traced south from its marine equivalent in Kay County, Oklahoma[7] through the red beds of Logan, Oklahoma, Cleveland, McClain and Garvin counties. It is the oldest sedimentary surface formation and forms the surface outcrop in the northeast corner of Cleveland County. Its

2. Gould, Chas. N., Geology and water resources of Oklahoma: U. S. Geol. Survey, Water Supply Paper No. 148, 1905.
3. Gould, Chas. N., The correlation of the Permian of Kansas, Oklahoma, and northern Texas: Bull. Amer. Assoc. Pet. Geol., Vol. 10, No. 2 pp. 144-153, 1926.
4. Aurin, F. L., Officer, H. G., and Gould, Chas. N., The subdivision of the Enid formation: Bull. Amer. Assoc. Pet. Geol. Vol. 10, No. 8. pp. 786-799. 1926.
5. Op. cit. p. 788.
6. Dott, Robert H., The geology of Garvin County: Oklahoma Geol. Survey Bull. 40-K, 1927.
7. Aurin, F. L., Officer, H. G., and Gould, Chas. N., Loc. cit., p. 793.

contact with the underlying Stillwater formation is placed approximately three miles east of the Cleveland County boundary. It consists of red gray and black massive, fine grained sandstones with interstratified shales. In Stella Township it forms rather prominent standstone ridges covered with timber. Small open places in the timber are characteristic over the shale outcrops, suggestive of park landscape. The sandstones are cross-bedded. The dark or black color where present is probably due to manganese. Such a stratum is formed in a sandstone ridge near the top of the formation in the NW.¼ sec. 4, T. 8 N., R. 1 E., and in several other places in lesser amounts. Barite rosettes are found in place in the sandstone strata of the formation in several places from east of Stella to the county line. The formation grades laterally into more shale to the southeast in Pottawatomie County on the north side of the Canadian River. Its upper contact is indefinite and is here placed as follows: Entering the county on the north boundary in sec. 1, T. 10 N., R. 1 W., thence south along Hog Creek to the east boundary of sec. 30, T. 9 N., R. 1 E., thence southwest to the eastern boundary of Cleveland County in SE. cor. sec. 24, T. 8 N., R. 1 W., one and one-half miles east of Etowah. The formation has a west dip of about 50 feet per mile and an approximate thickness of 400 feet.

GARBER FORMATION

The Garber formation rests on the underlying Wellington apparently conformable in Cleveland County.

It has been subdivided into a lower shale, the Lucien shale, and an upper sandstone known as the Hayward sandstone member. The Lucien shale is considerably more sandy in Cleveland County than farther north which renders its boundaries indistinct and is here mapped with the upper sandstone as the Garber formation. It is characterized by sandy shales and interstratified, rather massive sandstone. In the lower fifty feet it is characterized by laminated sandstones and thin strata of pseudo-conglomerate associated with geoidal lime concretions. Above this is a zone of barite rosettes embedded in sandstone strata. In this locality these are mostly double barite rosettes though single and triple also occur. The Hayward sandstone member is characterized by massive bright red sandstone strata with minor amounts of interstratified shale. The upper contact of the Garber is readily traced by its jackoak covered surface in distinct contrast with the smoother prairie land on the Hennessey outcrop to the west. The upper contact is therefore easily traced by the west side of the timber which here makes a distinct cross timber belt similar to the jackoak belt on the Woodbine sandstone of Texas. The upper contact of the Garber strikes approximately southeast across the county entering at the north boundary of the west line of sec. 3, T. 10 N., R. 1 W., thence

8. Aurin, F. L., Officer, H. G., and Gould, Chas. N., Loc. cit.

east of Norman through NW.¼ sec. 36, T. 9 N., R. 2 W., through Maguire and Corbett and across the South Canadian River approximately one mile west of Pecan into McClain County. The sandstone is characterized by numerous barite rosettes found in place and as float upon the surface. These are more abundant near the top of the sandstone but are also distributed without any apparent regularity through the entire Garber formation. Pseudo-conglomerates similar to those found at the contact between the Garber and Wellington are also found in similarly thin sandstone strata about 100 feet below the top at a point about one and one-half miles northwest of Box in the SW.¼ sec. 23, T. 6 N., R. 1 E. These are similar to the pseudo-conglomerates described by Dott[9] but are found at two stratified horizons in the Garber formation. The Garber formation is the reservoir rock from which Norman obtains its water supply at depths from 240 to 618 feet. It has an approximate thickness in the county of 400 feet.

HENNESSEY FORMATION

The Hennessey shale rests upon the Garber formation with apparently conformable contact in Cleveland County. It is characterized by predominating red shales, thin and frequently laminated. It weathers to a dark comparatively rich loam which forms a prairie belt over its entire outcrop. It is therefore easily recognized and can be readily mapped. Its lower 50 feet contains several thin, rather resistant sandstone strata which form characteristic flat topped hills along the east border of the prairie. Aside from the above described sandstone the Hennessey forms a continuous shale outcrop in Cleveland County from its east boundary in sec. 3, T. 10 N., R. 2 W., through the town of Moore to the east boundary of sec. 17, T. 10 N., R. 4 W., where it is overlain by the Duncan sandstone. It has a thickness of approximately 600 feet in the county.

The towns of Moore, Norman, Noble and Lexington are all situated on the Hennessey shale.

DUNCAN SANDSTONE

The Duncan sandstone overlies the Hennessey shale and is exposed only in a strip one mile wide in the extreme western tier of sections in T. 10 N., R. 4 W. Its lower contact enters the county on the east line of section 6 and runs approximately due south and crosses the Canadian River into McClain County in sec. 20, T. 10 N., R. 4 W. The base of the Duncan sandstone which is the only part exposed in the county is characterized by massive red sandstone. In Canadian County to the west of Cleveland County boundary it forms rather subdued hills which topographically become more distinct escarpment-forming sand-

9. Dott, Robert H., The geology of Garvin County: Oklahoma Geol. Survey Bull. 40-K, 1927.

stones increasing in prominence to the south through McClain County and culminates in Flat Top Mountain of Garvin County where, according to Dott,[10] the entire Duncan sandstone is exposed in escarpments 150 feet high. Its thickness is approximately 150 feet, of which only the lower 50 feet are exposed.

MESOZOIC

No Mesozoic is known or has been definitely recognized in Cleveland County.

TERTIARY

Tertiary pebbles, water worn and rounded, are found in isolated places as float capping hills.

RECENT

Recent alluvium has accumulated on the Canadian River flats and along the larger streams valleys forming narrow flood plains.

Wind blown sand has accumlated on the north side of the Canadian River due to the prevailing south winds and form in places rather conspicuous dunes 20 to 30 feet high. Some of the finer wind-carried materials are found incorporated with the soil several miles from the river. This material forms a light brown loess-like soil 3 feet thick in the southwestern part of the city of Norman.

McCLAIN COUNTY

STILLWATER FORMATION

The Stillwater formation is now regarded as the lowest subdivision of the Enid Group and is oldest sedimentary rock outcropping in this county. In eastern McClain County, Morgan[11] has mapped this as the Konawa formation. At least the upper part of the Konawa and the Asher will here be considered as time equivalents of the Stillwater formation as mapped farther north. Unit 1 of Dott[12] is included and forms the top of the Stillwater formation in McClain County. The strike of the Stillwater changes from northwest-southeast on the north side of the Canadian to southwest-northeast on the south side of the river in McClain County. Only the upper part of the formation is exposed in the county. This has a thickness, including 140 feet of Dott's Unit 1, of 390 feet.

WELLINGTON FORMATION

The Wellington formation changes laterally from predominating sandstone in northeastern Cleveland County to shale in southwestern Pottawatomie and eastern McClain counties. It is the opinion of the

10. Dott, Robert H., Op. cit.
11. Morgan, Geo. D., Geology of the Stonewall Quadrangle: Bureau of Geology, Bull 2, 1924.
12. Loc. cit.

writer that only the lower part of Dott's Unit 2 is in reality time equivalent of the Wellington. It has been rapidly reduced in thickness from north to south in McClain County has an approximate thickness of 100 feet. The surface outcrop in the county is characterized by gray shales weathering into light gray soil. Its upper contact grades without apparent change in sedimentation into the Garber.

GARBER FORMATION

The Garber formation is characterized by massive red sandstone lenses in the upper portion grading into shale below. The sandstone of the Garber is covered with jackoak timber at the Canadian River by means of which it can be traced across the Canadian River at Pecan in Cleveland County, passing one and one-half miles west of Rosedale and south to the county line through the SW. cor. sec. 31, T. 5 N., R. 1 E. The top of the Garber should thus correspond to the top of Unit 3 as mapped by Dott in Garvin County. Its thickness is approximately 200 feet.

It will be noted that the Wellington and Garber both thin rapidly to the south from a total thickness of 800 feet in northern Cleveland County to about 300 feet in McClain County, a distance of about 35 miles. This may be due to an overlap in deposition to the south or to a somewhat different source for the sediments on the south side of the river where less sediments were available. The area of the river would thus be the area of less deposition being the area of confluence of two subareal fans the larger of which was to the north and consequently formed thicker sediments. This condition would in part account for the change in strike of the sediments forming a depression which also is probably structural in part.

HENNESSEY FORMATION

West of the cross timber belt and east of the outcrops of the Duncan sandstone is a prairie belt all of which is here regarded a sthe outcrop of the Hennessey shale. It weathers to a rather dark soil in contrast to the usual red soils of the red beds. It is predominately shale in McClain County with a few sandstone lenses which rapidly grade laterally into shale, any of which cannot be definitely traced for more than a mile or two along the strike. The most notable of these is the sandstone bluff on the south side of Canadian River immediately north of Purcell. Another such sandstone lense forms a rather high bluff in sec. 21, T. 8 N., R. 2 W., on the north side of the Canadian and still another, though less prominent, two miles west of Purcell on the north line of sec. 16, T. 6 N., R. 2 W. All of these are apparently at different stratigraphic horizons within the shale and probably due to local variation in the conditions of sedimentation during the deposition of the shale. The Hennessey forms a broad belt many miles wide

and has a rather uniform thickness of approximately 650 feet. This is in marked contrast to the rapid convergence to the south of the Garber and Wellington.

DUNCAN SANDSTONE

The Duncan sandstone forms the hilly area in the western part of the county. Unlike the sharp escarpment which characterizes the Duncan farther south it forms rather less prominent hills. Its base forms an irregular outcrop crossing the Canadian River in NW. ¼ sec. 29, T. 10 N., R. 4 W., thence in a generally southwesterly course to sec. 13, T. 8 N., R. 4 W., thence west to Blanchard, then southeast to SE. ¼ sec. 18, T. 6 N., R 2. W., about four miles west of Purcell; thence west through Criner and southwest from there crossing the west line of the county in sec. 18, T. 5 N., R. 4 W.

The Duncan is a massive red sandstone, rather crumbly, and less resistant to erosion in this county than farther south. It has an approximate thickness of 150 feet, and is the youngest Permian in the county.

MESOZOIC

No Mesozoic is known in Cleveland or McClain counties although to the south in Garvin County Dott[13] reports unconsolidated sand underlain by cemented yellow sand which is in turn underlain by shales, all of which are regarded as of probable Trinity age. These are formed in the southern part of Garvin County and none are known farther north.

CENOZOIC

Unconsolidated gravels and in places cemented, rounded, waterworn pebbles up to two inches in diameter are found, usually capping the hills in Cleveland and McClain Counties. Similar gravels have been reported over a large part of Oklahoma and which have long been regarded as of Tertiary age.

GUERTIE SAND

The Guertie sand is found as a surface deposit in the extreme eastern part of McClain County as far west as Byars. It is composed of fine yellow unconsolidated sand and in isolated patches resting unconformably on the Stillwater formation. According to Taff[14] it was deposited by the Canadian River. It is probably of Pleistocene age.

RIVER AND DUNE SAND

River sand is now accumulating along the Canadian River and its tributaries. Some of this is carried up by the wind along the north

13. Loc. cit.
14. Taff, J. A., U. S. Geol. Survey, 19th Ann. Rept. pt. 3, p. 439, 1899.

side of the river, forming dunes near the river, while the finer sand and dust is carried farther and mingles with the soil for several miles from the river. The southwestern part of Norman is covered with this material in patches of from two to three feet. Alluvium covers the flood plain of the river and its tributaries.

SURFACE STRUCTURE

The surface strata in these two counties are composed of Permian red beds, being subdivisions of the Enid group. In northern Cleveland County they are all apparently conformably resting one upon the other. In eastern McClain County it is believed by the writer that the Wellington and the Garber overlap southward, rendering the former unconformable with the underlying Stillwater and similarly the Garber overlaps the Wellington so that only the upper portion of the Wellington and Garber outcrop at the surface in McClain County.

While the general regional dip is to the west, the strike of the strata in Cleveland County have an increasingly northwestern trend from the lower to the upper. Thus the strike of the base of the Stillwater formation in Pottawatomie County is slightly east of north while the strike of the top of the Hennessey is decidedly west of north. The strike of the formations thus arrange themselves spreading apart to the north with an approximate hub-like center on the Canadian River in eastern McClain County. Thus the strata on the north side of the river have a dip to the south of west.

On the south side of the river in McClain County and south into Garvin County the outcrop strikes southwest with a corresponding northwest dip. The change in direction of the strike of the strata is comparatively sharp especially is this the case with the Stillwater and the Wellington formation and becoming less pronounced in the Garber and Hennessey. This condition results in a major downfolding forming a syncline with an approximate west pitching axis passing south of Purcell. The axis has a comparatively steep pitch on the river west of Asher which flattens out to the west. The structural depression thus outlined is believed to merge into the Anadarko Basin to the west. The Anadarko Basin is thus split into a north extension as above outlined and a south branch which, as suggested by Dott,[15] is co-extensive with the Mill Creek syncline.

Local surface flexures of the strata have been reported[16] but owing to the cross-bedded nature of the formation, discontinuous outcrops, lensing, etc., their proper evaluation is rendered very difficult. Comparatively reliable horizon markers are to be found and with more de-

15. Loc. cit.
16. Shannon, C. W., and Trout, L. E., Petroleum and natural gas in Oklahoma: Oklahoma Geol. Survey, Bull. 19, 1915.

tailed study at least one of these, it is believed, may show sufficient flexure to reflect favorable subsurface structure.

SUBSURFACE STRATIGRAPHY

In an area entirely covered by later geological formations as is the case in the area here under discussion, it is necessary to study adjacent areas where the underlying formations may approach the surface and thus be reached in drilling or better still where the underlying formations may actually outcrop on the surface. East of Cleveland County much information of the underlying formations has been uncovered in the intensive drilling campaign which has taken place in the Seminole area. Also to the southeast in the Arbuckle Mountains many of the earlier Paleozoic sedimentary formations outcrop, and from their character the geologist is able to reconstruct the physical condition of their deposition.

EARLY PALEOZOIC

The Paleozoic sediments are found in many places of Oklahoma and adjacent states to rest on igneous rock usually termed granite and in a few mountainous areas as the Arbuckles such igneous rocks are actually exposed on the surface due to the erosion of the overlying sediments which once covered them. In the intervening lower areas of the igneous floor the sedimentary rocks are protected from erosion.

In mid-Cambrian or early-upper Cambrian the sea advanced over this area depositing sands along the shoreline, the Reagan sandstone and out beyond the sea, limestone. This is now known as the Arbuckle limestone. Its thickness in the Arbuckle Mountains has been stated at 6,000 feet of which the upper 2,000 feet has been shown to be of Ordovician age, probably equivalent to the Beekmantown. Its thickness in this area would probably only measure in hundreds of feet.

Following deposition of the Arbuckle limestone the area was uplifted during the St. Peter retreat of the sea. The upper surface of the Arbuckle limestone was then eroded. This was followed by the advance of the sea and depostion, during several minor oscillations, of shale, sandstone (Burgen), shale, Tyner sand, Wilcox and dolomite (post Wilcox) during the Simpson time in the area. A retreat of the sea resulted in the erosion of the upper surface of the dolomitic sandstone. The total thickness of these formations in this area is estimated at 800 feet. The sea again advanced over the irregular eroded surface of the sandy dolomite of late Simpson time and deposition of approximately 100 feet of limestone (Viola) took place in this area. In the deeper part of the submergence the Viola is much thicker (up to 800 feet). A shoaling of the sea caused the deposition of shale (Sylvan) approximately 100 feet in thickness. This was followed by submergence and deposition of the Hunton limestone. Only the lower 200 feet, more or less, remains as the upper part was eroded.

The seas again advanced over the eroded surface of the Hunton and the Woodford interstratified chert and dark shale was deposited, and finally predomiating dark organic shale (Chattanooga) was spread over a very extensive area in a compartively thin blanket. It rests on what apparently was a peneplaned surface of beveled earlier Paleozoic formations over an extensive area in northeastern Oklahoma. Probably continued submergence which covered nearly the entire State followed the Chattanooga deposition. This resulted in clear water and the deposition of the Boone limestone and chert. At this time dark organic sediments, the Caney shale, were carried into the sea from the southeast thinning rapidly seaward to the northwest. An emergence followed during which erosion cut deeply into the Boone and locally to the southeast removed it entirely. A reinvasion of the sea followed with the deposition of the Pitkin and Mayes limestone and Fayetteville shales. Following Mississippian time a complete emergence of this sea was attendant upon elevation in the Ouachita area and the beginning of the Jackfork deposition. Up to this time there appears to have been no local organic disturbances other than gentle oscillations of the sea level shown in the alternate deposition and erosion of successive sediments without strong angular unconformities. There is, however, a marked convergence of the sediments to the northeast so that while the Arbuckle limestone and the Chattanooga shale are separated by approximately 1,000 feet of sediments at Wewoka, the Chattanooga rests directly on the Arbuckle limestone at Collinsville, approximately 100 miles to the northeast.[17] This convergence is due in part to the erosional unconformities at the base of the Simpson, the Viola, and the pre-Chattanooga and in part due to the lesser amount of deposition in early Paleozoic over the northeastern area of the State.

PENNSYLVANIAN

In early Pennsylvanian time the sea again invaded this area, depositing the Wapanucka limestone, while the Morrow shales were deposited to the northeast and the upper Caney in the Arbuckle Mountain area. This was followed by a retreat brought on by the uplift which formed the Hunton Arch and the Ozark Arch.[18]

This uplift confined the sea to the coal basin on the eastern side of the high area produced by the Hunton Arch and the Ozark Arch of Dott during the deposition of the Atoka, Hartshorne and McAlester. Following the McAlester time the sea overspread the Ozark Arch and progressively encroached upon the Hunton Arch but did not cover

17. White, Luther H., Subsurface distribution and correlation of the pre-Chattanooga ("Wilcox" sand) series of northeastern Oklahoma: Oklahoma Geol. Survey, Bull. 40-B, 1926.
18. Dott, Robert H., Pennsylvanian Paleogeography: Oklahoma Geol. Survey, Bull. 40-J, p. 12, 1927.

Cleveland and McClain counties until Calvin time or immediately following. The early Pennsylvanian formations from Atoka to Calvin time are accordingly not present in this area.[19] Preceding the buckling up of the Hunton Arch the Wapanucka shoreline extended westward probably to central Cleveland County. The Hartshorne to Calvin convergence is well shown in well logs from Seminole to Earlsboro. This represents the time of deposition of the Cherokee to the north which submerged the Ozark Arch in northeastern Oklahoma. The sediments intermingled with the more clastic sediments from the southeast and spread westward to Grant County over Cleveland and McClain, and progressively overlapped the west side of the Hunton Arch.

The arch was continuously submerged probably with minor oscillations from Ft. Scott to Seminole time during which the Ft. Scott, Oolagah and Lenapah limestone deposition probably reached this area.

This was probably initiated in Wewoka time. The Ouachita overthrust from the southeast, which elevated southeastern Oklahoma and resulted in the Choctaw fault and the folding of sediments on the east side of the Hunton-Ozark Arch area into a large geosyncline extending e st into Arkansas. The continuous sedimentation was taking place west of the Hunton Arch giving little if any evidence of this disturbance other than shoaling of the water and the westward migration of the sea as shown in the more sandy character of the sediments. This condition continued during Kansas City time while the Francis formation of Morgan [20] was deposited on the northwestern side of the Ouachita uplift. Even during the Arbuckle uplift, which was initiated in the latter part of Kansas City time, no major disturbance of this area took place, though predominating sands and sandy shales were deposited from Francis to Ada time or Lansing to lower Wabaunsee time of the Kansas section.

During mid-Wabaunsee time an extensive area in southeastern Oklahoma, Arkansas and northwestern Lousiana was uplifted causing the rapid shift of the sea westward into northwestern Oklahoma. This caused rapid erosion of the uplifted area and the deposition, upon the northwest flank of the uplifted area, of large quantities of clastic sediments known generally as red beds.

During the early stage of the uplift, which was rather continuous in time, the Pennsylvanian red beds, the Stillwater, Wellington and Garber formations were deposited. In the sea to the west their marine equivalents interfingered with the red sediments during minor oscillations of the sea. During Stillwater and Wellington time a depression in the uplifted area was being filled in Pottawatomie County and westward in Cleveland County which caused these sediments to overlap the

19. See accompanying cross-section.
20. Op. cit.

higher area on the south in McClain and Garvin counties where consequently their equivalents are much thinner. This formed a rather featureless plain, a gradational partly marine, peneplain upon the surface of which was deposited the Hennessey shale. This was followed by slight uplift and the deposition of the Duncan sandstone upon the smoothed gradational surface of the Hennessey shale.

From this interpretation of red bed deposition it is evident that the later red beds progressively overlap marine sediments westward and that due to the uplift of Llanoria and the earlier red beds on the northwest flank of this uplift the upturned edges of the early red beds may have furnished the source for the later red sediments. The volume of total red beds materials may therefore be very considerably less than is indicated by their thickness. Furthermore, if the red beds deposition is the result of deposition in part at least by overloaded streams with constantly changing courses the red beds are essentially confluent delta deposits upon an aggradational plain with stream channelling and resulting slight unconformities common throughout the entire deposits. This condition renders the separation of the red beds by unconformities uncertain if not impossible.

SUBSURFACE STRUCTURE

Drilling in the area has scarcely more than penetrated the red beds, which have a depth of approximately 1,950 feet in northeastern Cleveland County and over 3,000 feet in depth in southwestern McClain County. The westward dip of the red beds is approximately 50 feet to the mile. The Pennsylvanian sediments from Cherokee to Ada inclusive approximate 2,000 feet in thickness, and should include limestones equivalent to the Pawhuska, Oologah and Ft. Scott. The Wapanucka may have extended this far west.

The pre-Pennsylvanian and post-Arbuckle interval in this area is approximately 1,500 feet in thickness, and may include Pitkin, Boone, Caney-Chattanooga, Woodford, Hunton and Simpson formations. Unconformities exist between the Pitkin and Boone; probably smaller unconformities between Caney, Chattanooga and Woodford; on the top of the Hunton and probably within it; on top of the Simpson and at its base. Each unconformity might reasonably involve topographic "highs" or hills at the time, which were covered by subsequent sediments, thus producing the buried hill type of structure as have been discovered in Robberson, Garber, Tonkawa, and many other areas in Oklahoma. Aside from this type of structure no marked folding of the strata is thought likely in this area with the exception of the basin in the southeastern part of the area on the Canadian River, which is probably reflected at least into the Pennsylvanian. Compacting of sediments and minor folding and faulting may have produced suitable storage basins.

DEVELOPMENT

No oil or gas have been discovered in this area so far, though immediately west of McClain in Grady County oil is found at approximate depths of 2,800 feet probably in the Stillwater formation. Also in the Chickasha area gas is found in a rather prominent fold in the Garber formation. It is interesting to note that this is located near the axis of the Anadarko Basin. On the east side of this area the recent discoveries at Seminole and farther west at Pearson in Pottawatomie County, has inaugurated a drilling campaign to the west which has reached eastern Cleveland County. The object of the drilling seems to be to reach these lower horizons without much attention to possible sands which are probably present in the Pennsylvanian. The estimated depth of the Hunton in eastern Cleveland County is probably not less than 4,600 feet; the Wilcox should be encountered at approximately 5,100 feet and the Burgen around 5,500 feet.

LOCATION OF DRILLING WELLS

Six wells are now drilling in Cleveland County, located as follows:

The Wirt Franklin-Cromwell well drilling SW.¼ sec. 22, T. 10 N., R. 2 W. Wirt Franklin.

The Cosden Oil and Gas Company in SW.¼ sec. 20, T. 8 N., R. 1 E.

Galt Brown in NW.¼ sec. 7, T. 9 N., R. 1 W.

The Sooner State Oil Company, in SW.¼ sec. 15, T. 7 N., R. 1 W.

The Magnolia Petroleum Company, in SW.¼ sec. 11, T. 6 N., R. 1 W.

The Wiser Oil Co., in NW.¼ sec. 25, T. 6 N., R. 1 E.

All of these have penetrated the red beds but are not known to be definitely through the Pennsylvanian.

Several test wells have been drilled in McClain County. Hall and Briscoe of Chickasha drilled a well in sec. 3, T. 5 N., R. 4 W., to a total depth of 3,002 feet. It penetrated only about 500 feet of probable Pennsylvanian. A well was drilled in sec. 16, T. 8 N., R. 4 W., to a depth of 3,000 feet and in sec. 1, T. 5 N., R. 2 W., was drilled to a total depth of 3,325 feet, with red beds to approximately 3,000 feet. Earlier development therefore, has hardly more than penetrated the red beds with the underlying Pennsylvanian and earlier Paleozoics entirely unexplored.