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THE GEOLOGY OF THE COWETA AREA, WAGONER, MUSKOGEE, AND OKMULGEE COUNTIES, OKLAHOMA

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THE GEOLOGY OF THE COWETA AREA

WAGONER, MUSKOGEE, AND OKMULGEE COUNTIES,

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A THESIS

APPROVED FOR THE SCHOOL OF GEOLOGY

BY

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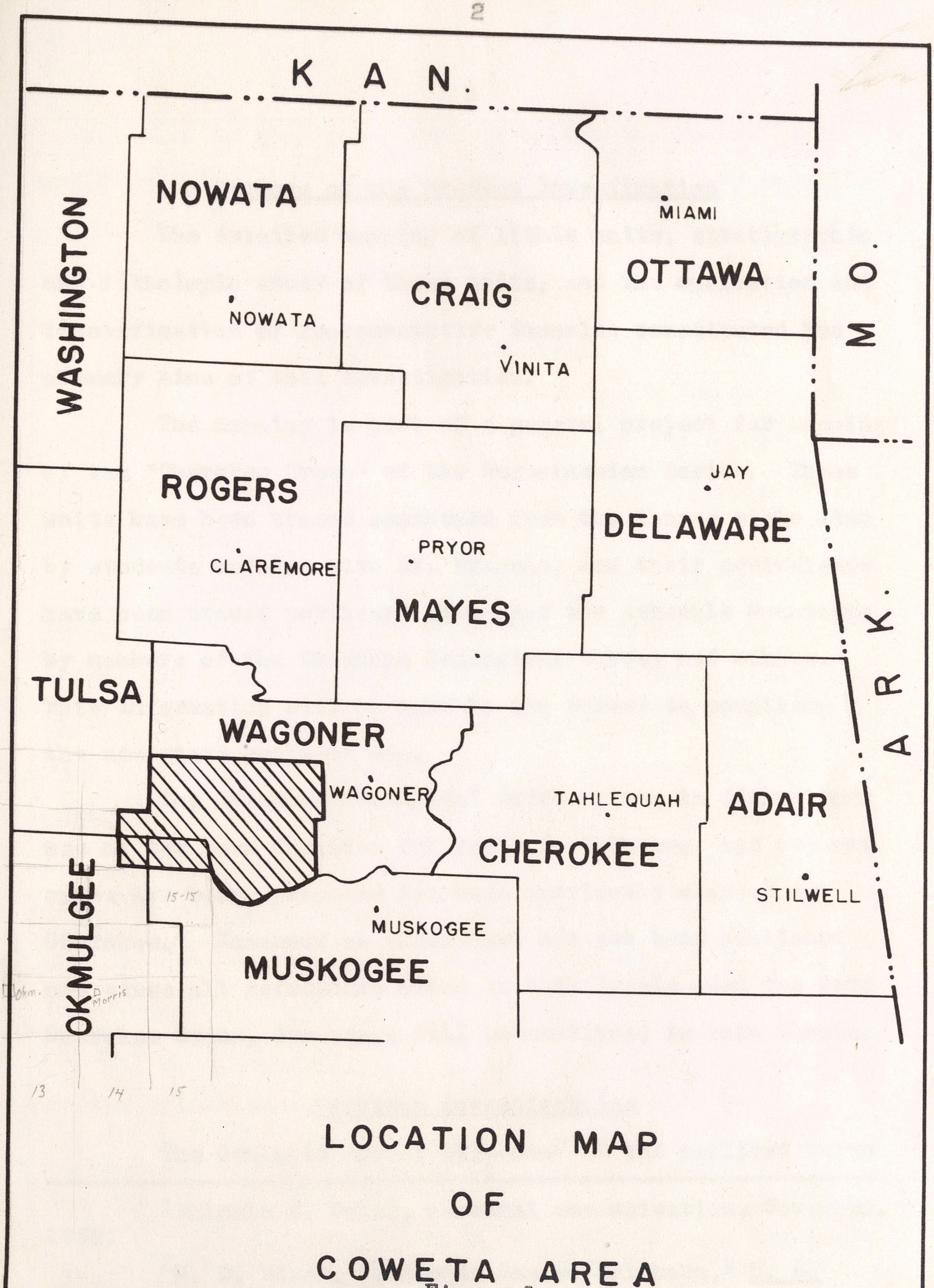
CHAPTER I

INTRODUCTION

Location and Description of Area

The area consists of approximately 250 square miles located about 25 miles southeast of Tulsa in Townships 15, 16, 17 North; Ranges 14, 15, 16, and 17 East (see figure 1). The town most nearly in the geographic center is Coweta. Other towns located within the area are Haskell, Redbird, and Porter. U. S. Highway 64, the only paved road of the area, traverses the southwestern part in a northwest-southeast direction. In addition, there are two state highways, Highway 72, a north-south road between Coweta and Haskell, and Highway 51, an east-west road connecting Coweta and Wagoner. Numerous section-line roads make about 75% of the area accessible by automobile. The area is also served by the Missouri-Kansas and Texas Railroad and by the Midland Valley Railroad.


KAN.
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DELAWARE
TULSA
WAGONER
WAGONER
TAHLEQUAH
CHEROKEE
ADAIR
STILWELL
OKMULGEE
MUSKOGEE
MUSKOGEE
LOCATION MAP
OF
COWETA AREA
Figure 1.

Purpose of the Present Investigation

The detailed mapping of lithic units, stratigraphic and lithologic study of these units, and the collection and identification of representative faunules constituted the primary aims of this investigation.

The mapping is part of a general project for mapping of the "Cherokee Group" of the Desmoinesian Series. These units have been traced southward from the Kansas state line by students working with Dr. Branson, and their equivalents have been traced northward from near the Arbuckle Mountains by members of the Oklahoma Geological Survey and others. This information will be used by the Survey in compiling the new state geologic map.

The Oklahoma Geological Survey plans to discontinue use of the term Cherokee for rocks in Oklahoma, and two new names are being proposed for beds previously classed as Cherokee.[1] Inasmuch as these have not yet been published and since all references cited in this thesis used the term Cherokee Group, its usage will be continued in this thesis.

Previous Investigations

The Geologic Map of Oklahoma[2] is the earliest known

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[1]Malcolm C. Oakes, personal communication, November, 1952.

[2]H. D. Miser, "Geologic Map of Oklahoma," U. S. Geological Survey, 1926.

publication of geological work in this area. Boyle[1] gave a brief description of the geology of Wagoner County in 1927, as did Clark[2] of Okmulgee County in 1926, and Soyster and Taylor[3] of Muskogee County in 1928.

Present Investigation

The field work for this report was conducted in the summer of 1952. This was an extremely dry summer, consequently several outcrops were found which had been previously overlooked.

The mapping was done on a scale of 3.1 inches to a mile, which is the average scale of the aerial photographs used. The photographs were used in stereoscopic pairs both in the field and the office. Sheets of transparent acetate were attached to the photographs; the geology and culture were recorded on these and later transferred to a base map.

Good exposures in the area are few and hard to find. The more resistant sandstones were easily followed on the aerial photographs, but the limestones were not so easily followed.

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[1]J. P. Boyle, "Geology of Wagoner County," Oklahoma Geological Survey, Bulletin 40-L, (1927), pp. 7-8.

[2]R. W. Clark, "Geology and Oil and Gas Development in Okmulgee County, Oklahoma," Oklahoma Geological Survey, Bulletin 40-F (1926), pp. 7-8.

[3]H. B. Soyster and T. G. Taylor, "Oil and Gas Geology of Muskogee County," Oklahoma Geological Survey, Bulletin 40-FF, (1928), pp. 15-16.

The regional dip was computed by the three point method using outcrop points. The elevations were taken from the topographic map of the Okmulgee Quadrangle. The strike is north-south and the dip is 35 to 40 feet per mile toward the west.

Sections were measured with the aid of a hand level and steel tape. It was impossible to measure continuous sections across the area. Overlapping sections were measured and correlated for a generalized section. The regional dip was disregarded in the measurement, as it would cause no more error than that inherent in the method.

Topography and Drainage

The area consists mostly of grass covered valleys developed on shale beds, separated by resistant sandstone cuestas. Since the regional dip is in a westward direction, the cuestas have eastward facing escarpments. The average height of these above the shale valleys is 100 feet. In the southwest part of the area a long continuous escarpment is 200 feet above the shale valley. This cuesta is called Conjada Mountain in Wagoner County and is named Concharty Mountain in Okmulgee County.

The total relief of the area is over 400 feet. Elevations range from more than 900 feet on top of Conjada Mountain to less than 500 feet where the Arkansas River leaves the area.

Two major rivers, the Arkansas and Verdigris Rivers, which flow in a southeastward direction, drain the area. Some principal creeks which flow into the Arkansas are: Cedar, Coweta, Concharty, Coal, and Yellow Water Creeks. Tributary streams which flow into the Verdigris are: Gar, Strawberry, and Billy Creeks.

CHAPTER II

STRATIGRAPHY

General Statement

The "Cherokee group", at the present, is best described in Kansas where it is predominantly shale. There the sandstones and limestones are few and are thin. Therefore, it has been commonly referred to as the "Cherokee shale." However in the Coweta Area, the sequence comprises thick sandstones and shales with a few coals and thin limestone.

As originally described, the "Cherokee group" includes the interval of beds lying above the top of the Mississippian system and below the base of the lower Fort Scott limestone. In the Coweta Area it is composed of the beds above the Atoka formation and below the lower Fort Scott limestone. It contains eleven sandstone and limestone members and three named coals.

The rocks of the "Cherokee group" belong to the Demoinesian series of the Pennsylvanian system. The Marmaton group is considered to be upper Desmoinesian, and the "Cherokee group" is lower Desmoinesian.

The sediments are made up of a series of sequences of alternating marine and non-marine units. These sequences are repeated many times, and some represent a nearly complete cycle of sedimentation. One reason that they do not show a complete cycle is that the disconformity above may include erosion of several of the uppermost stages of deposition of the underlying cycle.

This alternating sequence above is called a cyclothem. One sequence represents one complete advance and regression of the sea over a certain area. Each cyclothem is divided into two basic parts: a non-marine sequence, which was deposited at or near sea-level, was overlain by a marine sequence.

The non-marine sequence is represented by an estuary or stream-deposited sandstone on the erosional surface of the preceding cyclothem. Above this sandstone is a fluvial shale which may include lenses or beds of fresh water limestone. Next comes various thicknesses of unctuous clay which is called "under clay" since it underlies a coal seam. The coal seam was formed as vegetative matter accumulated and was later altered.

Further subsidence resulted in deposition of shale, the first bed of the marine sequence. This shale is black in the lower portion, where mixed with carbonaceous, coal forming matter. The upper part of the shale is brown where it is more calcareous. As the area continued to experience further subsidence a marine limestone was deposited. Regression of the sea resulted in deposition of a brackish water shale with clay-ironstone concretions.

After the area had emerged, a period of erosion began. This erosion was followed by the beginning of a new cycle of sedimentation.

Alluvium

Flood plain deposits along the Arkansas and Verdigris Rivers and their tributaries are composed of clay, silt, and sand. Their maximum thickness cannot be determined accurately. The streams overflow from time to time and add more material to these deposits.

Terrace Deposits

A deposit of sand, silt, and clay forms a mantle that covers the older rocks in a belt up to 3.5 miles wide along the north side of the Arkansas River and the Verdigris River in the Coweta Area. Part of the material was deposited by the rivers at a time when they flowed at a higher level, but much of it, especially the finer material, seems to have been deposited by the prevailing wind from the southwest. Most of this material was blown from the river beds during times of low water and high winds, but some of the very fine material may be of volcanic origin. Some speculation has been made as to the origin of these volcanics, but none has been proven conclusively. At places 70 feet of this terrace material was noted and it is probably thicker. It grades northward imperceptibly into material of local origin, and finally, into strictly residual soil. The age of these deposits is presumed to be Quaternary.

Fig. 2.--Peculiar erosional pattern of the terrace deposits.

Fort Scott Limestone

The Fort Scott limestone was named by Swallow[1] from an exposure in the vicinity of Fort Scott, Kansas. At Fort Scott the aggregate thickness is about 30 feet. At this locality the upper limestone member is called the Higgins-

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[1]G. C. Swallow, "Preliminary Report on the Geological Survey of Kansas," Kansas Geological Survey, Preliminary Report (1866), p. 25.

ville and the lower member is known as the Blackjack Creek.[1] The Houx limestone and the Summit coal are present in the interval between these limestones. The Mulky coal is below the Blackjack Creek.

It is thought by some that this formation maintains its tripartite character southward into Oklahoma, but the upper member does not extend south of northwestern Rogers County.[2] The lower limestone extends southwestward beyond the limits of the Coweta Area, and is overlain by the middle shale member. Within this shale member there is a thin crinoidal limestone bed about six inches thick. The lower Fort Scott attains a maximum thickness of 3.5 feet in the area.

The lower Fort Scott is a gray, medium crystalline, argillaceous, massive limestone containing few fossils in the area studied.

On the road leading up the hill near the center of the NE¼ of sec. 34, T. 17 N., R. 14 E., the lower limestone member of the Fort Scott and the section above and below are well exposed. Another exposure is found near the east boundary of sec. 6, T. 16 N., R. 15 E.

The lower Fort Scott can be traced almost continuously along Concharty and Conjada Mountains. The only places

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[1]Carl C. Branson, personal communication, December, 1952.

[2]Carl C. Branson, personal communication, December, 1952.

where it cannot be found are in areas covered by debris.

One identifiable fossil was collected from the Fort Scott limestone. Aviculopecten (Fasciculiconcha) providencesis (Cox) was collected in the NW$\frac{1}{4}$ of sec. 23, T. 15 N., R. 14 E.

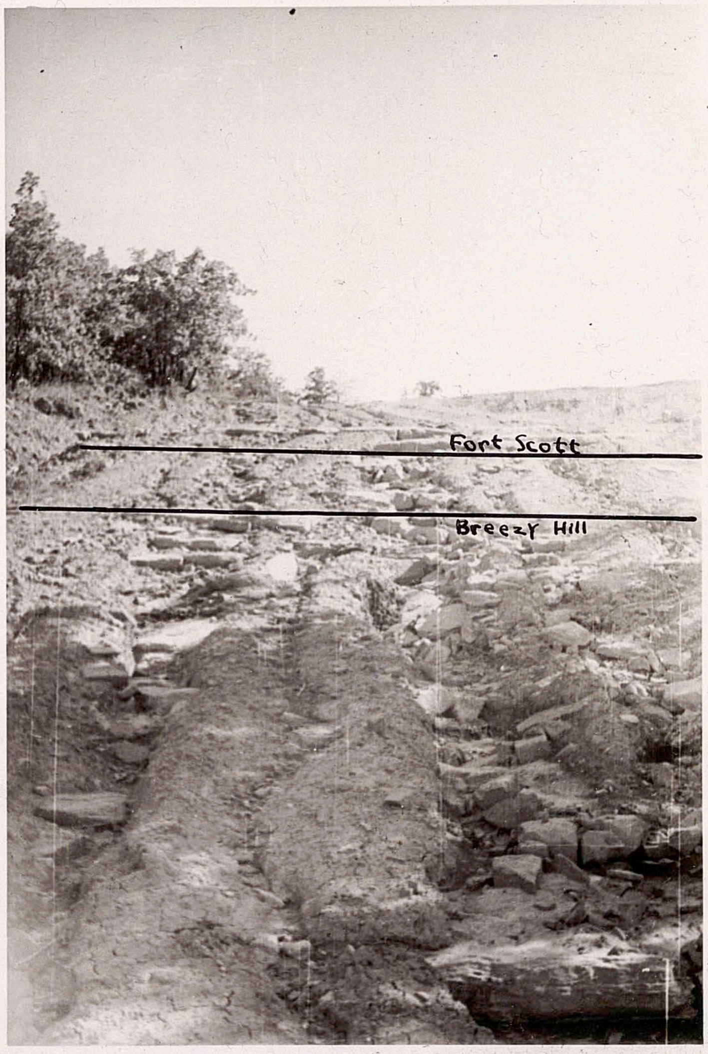

Fig. 3.--The interval between the Breezy Hill limestone and the lower Fort Scott limestone.

Interval From the Fort Scott Limestone to the Breezy Hill Limestone

Unlike the sequence in other areas, in the Coweta Area there is no black shale immediately below the Fort Scott limestone. A black shale with phosphatic nodules was found above the Fort Scott; below the Fort Scott there is a buff, micaceous shale varying in thickness from 2.5 to 7 feet.

Breezy Hill Limestone

The Breezy Hill Limestone was named by Pierce and Courtier[1] from the exposures at Breezy Hill, just southwest of Mulberry, Kansas. The Breezy Hill in southeastern Kansas is a gray, impure, limestone varying from six inches to two feet in thickness. In Kansas it is overlain by a foot or more of gray clay shale, and several feet of black fissile shale.

The Breezy Hill is a buff, dense, arenaceous, massive, non-fossiliferous limestone with dark gray chert splotches which contrast sharply with the overall color. There are three easily accessible outcrops of Breezy Hill in or near the area. A good exposure is in the road leading up the

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1W. G. Pierce and W. H. Courtier, "Geology and Coal Resources of the Southeastern Kansas Coal Field," Kansas Geological Survey, Bulletin 24 (1934), p. 33.

hill near the center of the NE$\frac{1}{4}$ of sec. 34, T. 17 N., R. 14 E. Another exposure is near the east boundary of the SW$\frac{1}{4}$ of sec. 6, T. 16 N., R. 15 E. It is also present in the road cut in the center of the SE$\frac{1}{4}$ of sec. 25, T. 16 N., R. 14 E. The Breezy Hill, where it is not covered by debris, can be followed continuously about the east face of the Conjada and Concharty Mountains.

<u>Interval from the Breezy Hill Limestone to the Verdigris Limestone</u>

Immediately below the Breezy Hill limestone is a persistent buff, thin-bedded sandstone about one foot thick. Below the sandstone is a 65 foot section of shale which is covered by debris. Where this shale was observed, it is gray, silty, and micaceous.

In a strip pit in the SE$\frac{1}{4}$ sec. 23, T. 16 N., R. 14 E., a black shale immediately above the Verdigris limestone contains a few plant and fossil remains. These include:

Fucoids
<u>Orbiculoidea missouriensis</u> (Shumard)

<u>Verdigris Limestone</u>

The name of this unit first appeared in a publication on a map of Rogers County by Smith[1] in 1928. Smith did not give a description nor cite the type locality. Later

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[1] E. G. Woodruff and C. L. Cooper, "Geology of Rogers County," <u>Oklahoma Geological Survey Bulletin No. 40 U</u> (1928), map.

Cooper[1] mentioned a conspicuous limestone 35-50 feet below the Fort Scott which is remarkably persistent from the Kansas line to the Arkansas River and beyond. This limestone is believed to be the Verdigris limestone that Smith mapped.

The name Ardmore[2] limestone actually has priority for this bed. Moore[3] points out that the Oklahoma name Verdigris has had more usage but not priority.

The Verdigris was found at only two localities within the Coweta Area. It is exposed only in strip pits. One locality is in a pit at SE¼, sec. 6, T. 16 N., R. 14 E.

This limestone varies somewhat at the two exposures. At the northernmost exposure it is about two feet thick; the lower half is extremely fossiliferous, and the upper part is sandy and almost barren of fossils. At the other crop it consists of two lenses separated by a one foot shale. The lower limestone is about six inches thick and is dark gray with very few fossils. The upper lens is a brownish red, sandy limestone about 1.5 feet thick. This is the southernmost exposure of the Verdigris limestone known today. It grades rapidly into sandstone and probably cannot be

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[1]C. H. Cooper, "The Correlation of Coals in Oklahoma and Kansas," Proceedings of the Oklahoma Academy of Science, Vol. 7 (1928), p. 161.

[2]C. H. Gordon, Missouri Geological Survey, Sheet Report No. 2, Vol. 9 (1893), p. 20.

[3]R. C. Moore, "Stratigraphic Classification of the Pennsylvanian Rocks of Kansas," Kansas Geological Survey, Bulletin 22 (1936), p. 56.

recognized as the Verdigris limestone any farther to the south.

The following fossils were collected from the Verdigris limestone in the strip pit on the SE¼ sec. 6, T. 16 N., R. 15 E.

Crinoid stem ossicles
Marginifera muricatina Dunbar and Condra
Nucula (Nuculopsis) girtyi Schenck
Astartella concentrica (Conrad)
Anthraconeilo taffiana Girty
Bellerophon crassus Meek and Worthen
Nuculana bellistriata (Stevens)
Euphemites carbonarius (Cox)
Cymatospira montfortianus (Norwood and Pratten)

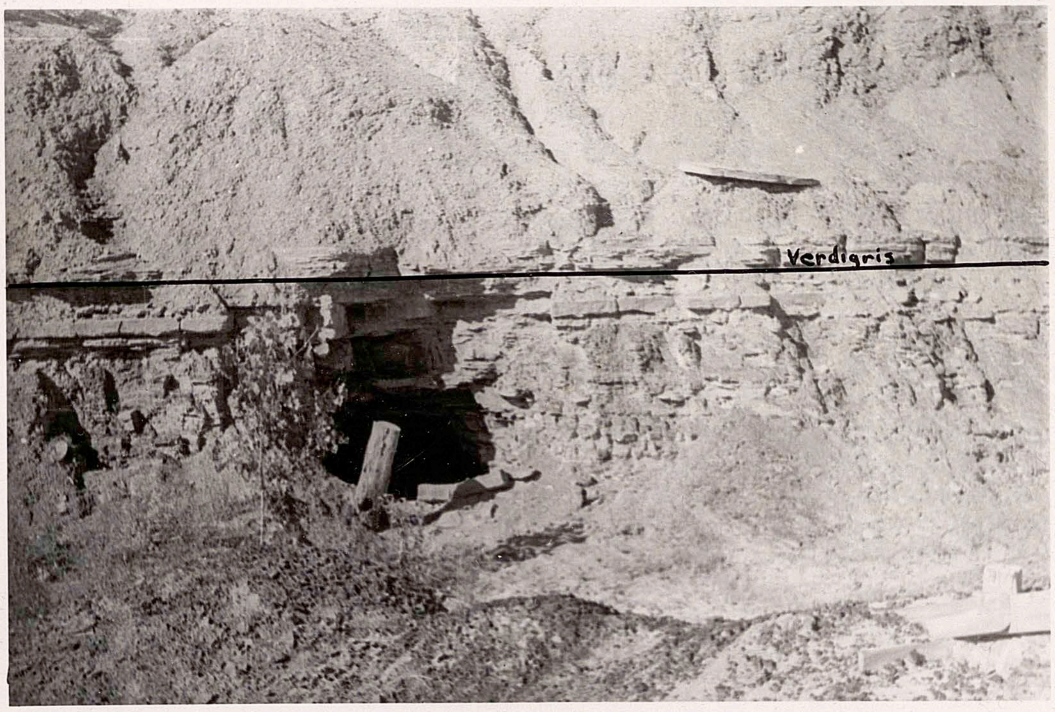

Fig. 4.--Broken Arrow coal strip pit in sec. 6, T. 16 N., R. 15 E., with an exposure of Verdigris limestone and the intervening shale.

Interval from the Verdigris Limestone to the Chelsea Sandstone

Below the Verdigris is about eight feet of black fissile shale. Midway within this shale is a six inch bed of calcareous concretions. Upon close examination this shale was found to contain a few fossils.

The interval between the Verdigris limestone and Broken Arrow coal narrows considerably as compared to the same interval farther north. The total maximum thickness of this interval in the Coweta Area is eight feet, but in Rogers County it is about 35 feet.

The Broken Arrow Coal is a consistent unit which has been mined where economically feasible. It is a fairly good grade of coal about 20 inches thick. For more information on the Broken Arrow coal the reader is referred to the work of Oakes.[1] He does not describe the coal south of T. 18 N., but since it is fairly uniform throughout, the detailed analyses can be assumed to be correct.

Locally, above this coal are large, black, silty, limestone concretions. They are dense and have a high specific gravity. In thin-section marcasite was noted; this may account for the high specific gravity.

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[1]Malcolm C. Oakes, "Broken Arrow Coal and Associated Strata," Oklahoma Geological Survey, Circular 24 (1944).

Below the Broken Arrow coal lies a foot or two of underclay. The interval below the underclay is covered over much of the area. One good exposure was found in the SE¼ of sec. 36, T. 17 N., R. 14 E. Measured in this deep cut was over 70 feet of gray, argillaceous, shale overlying 1.5 feet of coal. This coal had an underclay of about 1 foot. Below the underclay there is a 25 foot interval of thin-bedded sandstones and shales.

All of the interval described thus far was on the escarpment formed by the Conjada Mountain. No measurement was attempted from here to the top of the Chelsea sandstone since the interval is covered by debris. It was estimated to be about ten feet to the top of the Chelsea.

<u>Chelsea Sandstone</u>

The Chelsea sandstone was named by Chern from outcrops three miles east of Chelsea.[1] The name first appeared in print in 1927.[2] This sandstone forms a prominent escarpment in the area north of the Arkansas River. South of the river it caps several outliers.

The Chelsea is a medium to coarse grained sandstone which attains a maximum thickness of about 60 feet. It has

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[1]D. W. Chern et al., "Geology of the Nowata and Vinita Quadrangles," Unpublished Manuscript on file at the office of the Oklahoma Geological Survey (1914), p. 29.

[2]G. D. Clark and C. L. Cooper, "Geology of Kay, Grant, Garfield, and Noble Counties," Oklahoma Geological Survey, Bulletin 40-H (1927), Fig. 3.

two types of sedimentary origin. The lower part is cross-bedded while the upper portion is massive with very little cross-bedding noted.

The lower Chelsea supports a dense growth of trees as is witnessed along the escarpment west of Coweta. Most of the outliers also support dense vegetation.

The upper portion of the Chelsea forms a gently sloping, grass-covered prairie. A subsequent stream, which developed near the top of the outcrop of the Chelsea, aided in mapping the upper limits of this sandstone. Cedar Creek in secs. 10, 15, 22, of T. 17 N., R. 15 E. cuts deeply into the Chelsea and good exposures were studied along its bank.

At places, where the base is well exposed, a coarse pebble conglomerate was noted. The best exposure of the base is along the road cut in the SW¼ of sec. 2, T. 16 N., R. 15 E.

In the southwestern part of the area two sandstone lenses were noted above the Chelsea. These may be a part of this sandstone body or separate unnamed beds. It was impossible to follow them continuously because they were, in part, covered by debris from Concharty Mountain.

Interval from the Chelsea Sandstone to the Tiawah Limestone

An accurate measurement of this interval could not be made since only one exposure of the Tiawah limestone was found. It is a fairly long distance to the crop of the base of the Chelsea; a vertical measurement indicated about 20 feet. This interval included a buff, silty shale.

Fig. 5.--Top of Chelsea as seen along Cedar Creek in sec. 11, T. 17 N., R. 15 E.

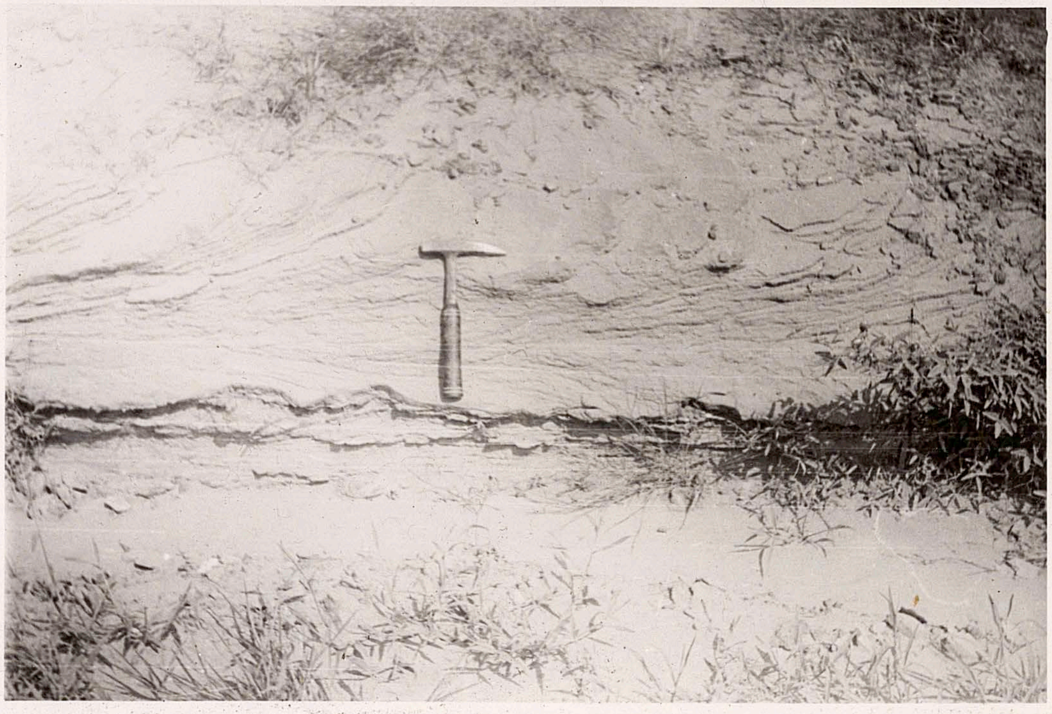

Fig. 6.--Cross-bedded Chelsea in sec. 12 T. 17 N., R. 15 E.

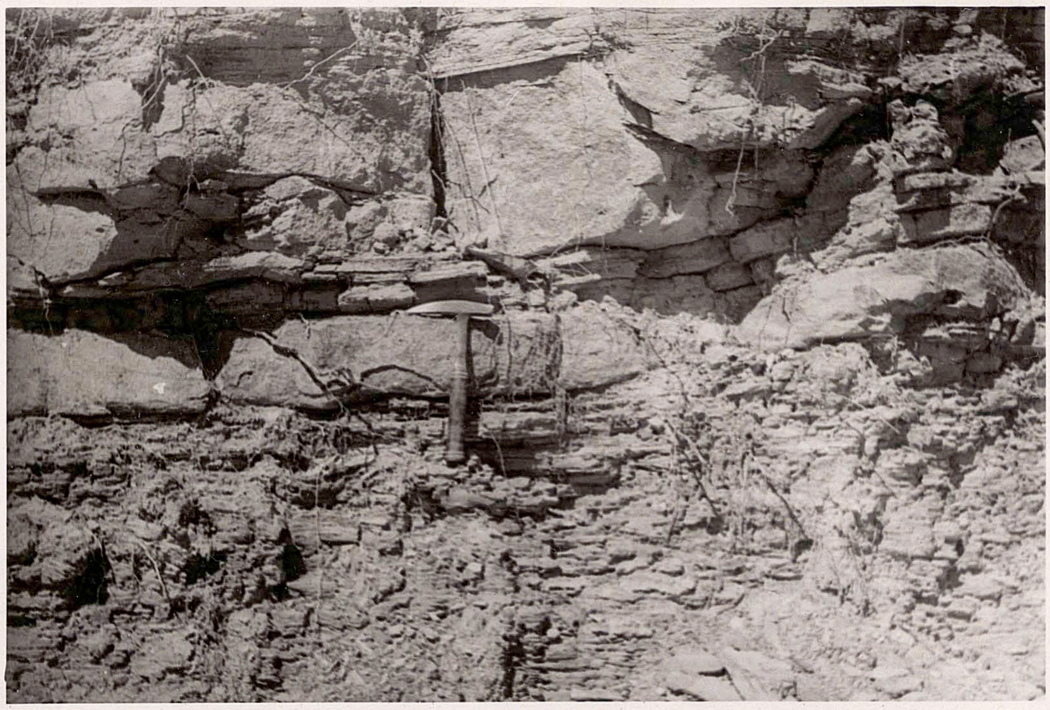

Fig. 7.--Base of Chelsea sandstone in sec. 2, T. 16 N., R. 15 E.

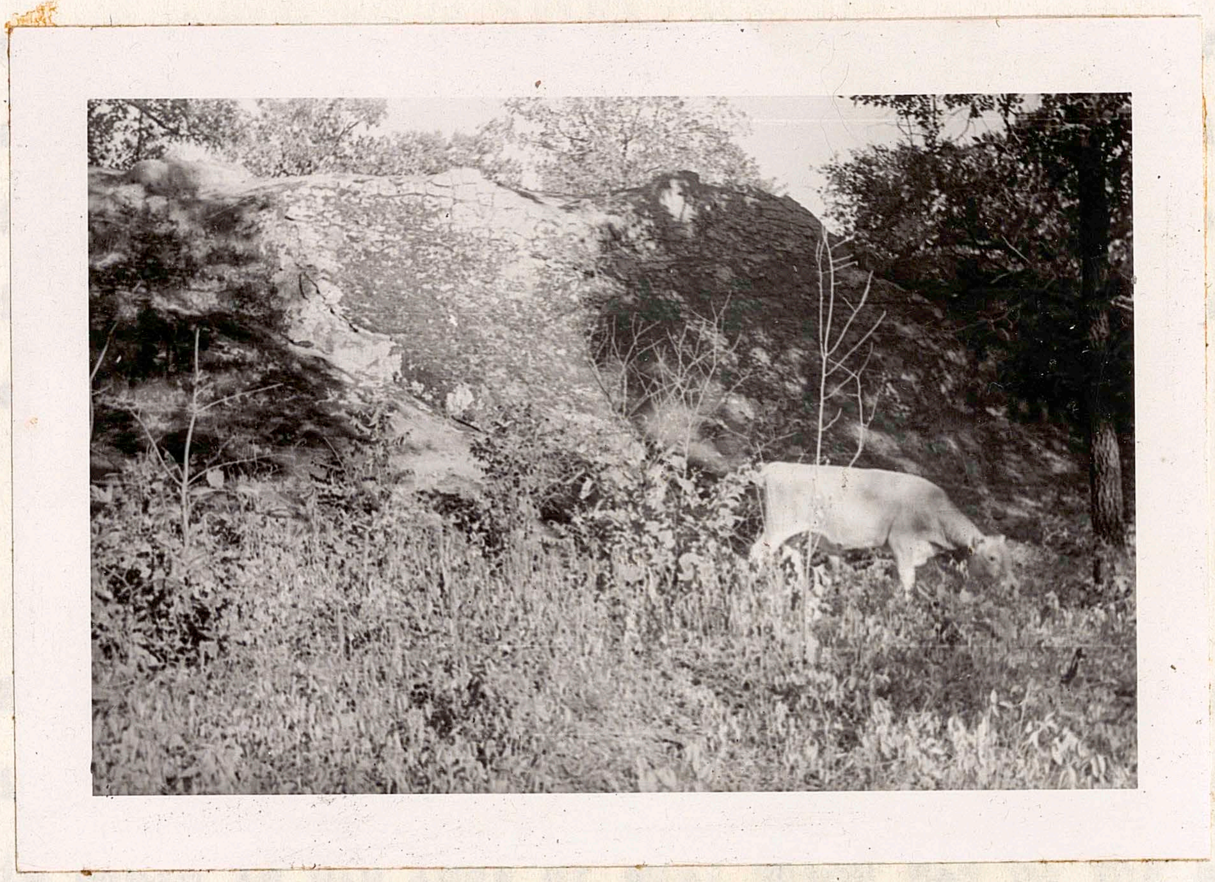

Fig. 8.--Sandstone lentil above Chelsea sandstone in sec. 18, T. 16 N., R. 15 E.

Tiawah Limestone

The Tiawah limestone, as found in the Coweta Area, is a dirty, bituminous, Myalina "coquina." Thin sections were made of this limestone, and in these a few ostracods and small gastropods were noted. Secondary recrystallization of the calcite has begun in the larger specimens of Myalina. The limestone is about three feet thick and is exposed along the eastern boundary of sec. 2, T. 16 N., R. 15 E.

The Tiawah was named by Lowman[1] from exposures in the

[1] S. W. Lowman, "Lower and Middle Pennsylvanian Stratigraphy of Oklahoma East of the Meridian and North of the Arbuckle Mountains," Tulsa Geological Society Digest, (1932), unnumbered page.

hills about the town of Tiawah (southeast of Claremore). The Tiawah at this locality is a hard, gray, fossiliferous limestone about six feet thick. Because pink calcite is present in quantity this limestone is referred to as the "Pink" limestone in subsurface, and is a wide-spread marker in northern Oklahoma.

Interval from the Tiawah Limestone to the "Boynton" Sandstone

Below the Tiawah there is five feet of badly weathered shale which appears to have been buff colored and silty. Below this shale is 0.5 foot of coal which may be the equivalent of the Tebo coal of areas to the north. This coal has an underclay about one foot thick. Below the underclay is a gray to buff shale.

"Boynton" Sandstone

The term "Boynton" is only colloquial and has been used by workers in the area for convenience. It is a prominent sandstone in Coweta and in the area immediately to the south. The base can be followed easily from the Coweta Area as far south as Boynton, the town from which it takes its name.

This sandstone is light gray, thin-bedded, highly micaceous and very fine-grained. It is so fine in places that it might be classed as siltstone. A fairly good measurement of the thickness was made in the town of Coweta along a high creek bank in the southern part of sec. 18, T. 17 N., R. 16 E. It was found to be about 25 feet thick.

Interval from the "Boynton" Sandstone to the Taft Sandstones

This interval is mostly covered by weathered material in the Coweta Area. It includes approximately 35 feet of buff to gray silty shales.

Taft Sandstones

The Taft was named by Wilson[1] from exposures south of Taft in sec. 19, T. 15 N., R. 17 E. He described it as a massive gray to light brown sandstone containing pebbles of quartz, sandstone, and shale. He stated that the quartz pebble conglomerate was not found north of the Arkansas River and hence might represent the near-shore phase of the member.

The Taft sandstone of the Coweta Area resembles that near Taft. However, here it consists of three separate sandstone lenses separated by shale. The complete interval referred to the Taft is about 150 feet thick. It includes shales interfingering with sandstones, and one coal has been located about 20 feet below the upper Taft sandstone. In

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[1] C. W. Wilson, Jr., "Age and Correlation of Pennsylvanian Surface Formations, and of Oil and Gas Sands of Muskogee County, Oklahoma," Bulletin of the American Association of Petroleum Geologists, Vol. 19 (1935), p. 510-511.

sec. 9, T. 17 N., R. 16 E. this coal is mined for local consumption. Beds of clay-ironstone were noted above the coal.

The three separate lenses of sandstone were found to be continuous or nearly so. They are hard to distinguish from one another, the one distinguishing criterion being their position. Three major faults cut the area where the Taft is exposed and this adds to the problem of distinguishing the different lenses.

The Taft has been referred to in subsurface as the Red Fork sand. This name was applied to the upper sand of the series to which the name Bartlesville sand was formerly applied.

Lithologically, the sandstone beds closely resemble each other. They are tan, medium-grained, massive-bedded and weather to dark brown. The Taft is highly ferruginous and resembles the Bluejacket.

Fig. 9.--Taft outlier on boundary line between sec. 16 and 21 in T. 17 N., R. 16 E.

Fig. 10.--Lower Taft fault line scarp in sec. 14, T. 17 N., R. 16 E.

Interval from the Taft Sandstones to the Inola Limestone

From the lower Taft sandstone to the top of the Inola limestone there is about 30 feet of sediments. About ten feet below the Taft is an 18 inch coal which may be the equivalent of the Weir-Pittsburg coal of Kansas.

Fig. 11.--Weir-Pittsburg (?) coal strip pit in east half of sec. 5, T. 16 N., R. 17 E.

Above this coal there is a concretionary bed with plant remains. In sec. 1, T. 16 N., R. 16 E. the following plant remains were collected.

Annularia stellata (Schlotheim) Wood
Mariopteris muricata (Schlotheim) Zeiller
Calamostachya sp.
Alethopteris serlii (Brongniart) Goeppert
Neuropteris rarinervis Bunbury
Neuropteris decipiens Lesquereux

Below the coal is about 20 inches of underclay. The remainder of the interval to the Inola limestone is composed of gray to buff shales with some thin concretionary beds.

Inola Limestone

The Inola limestone was named by Lowman[1] from an exposure east of the town of Inola. He gave no description other than that it is a limestone between two sandstones, the Bluejacket and Taft.

Tillman[2] suggested a new type section for the Inola limestone, in a fresh road-cut on Highway 20 a few yards east of the northwest corner of sec. 18, T. 21 N., R. 18 E. At this exposure he found four limestone beds which he believes to be the Inola sequence in its entirety.

In the Coweta Area the Inola sequence includes three limestones and one coal bed. The latter was found in the creek bed of the SW¼ of sec. 11, T. 16 N., R. 16 E. The upper Inola is a fairly resistant and thick limestone with numerous fossils. This bed is irregularly massive in bedding, finely crystalline, light gray on fresh exposure, and weathers to a reddish-brown. It was difficult to get a faunal collection from this bed.

A faunule from the upper Inola limestone in sec. 11, T. 16 N., R. 17 E. includes:

Crinoid stem ossicles
<u>Composita subtilita</u> (Hall)
<u>Marginifera muricatina</u> Dunbar and Condra

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[1]Lowman, <u>op. cit.</u>, unnumbered page.

[2]Jack L. Tillman, Unpublished Masters Thesis, University of Oklahoma, 1952.

Phricodothyris perplexa (McChesney)

A highly ferruginous limestone is present in the creek bed just south of the road along the north central part of sec. 9, T. 16 N., R. 16 E. This limestone is about 2.5 feet thick and quite resistant. It is about 30 feet below the base of the Taft which should make it upper Inola.

A faunule from the upper Inola limestone in sec. 9, T. 16 N., R. 17 E. includes:

Aviculopecten (Fasciculiconcha) sp.
Composita subtilita (Hall)
Neospirifer cameratus (Morton)

About five feet below the upper Inola limestone is the middle Inola. This is a weak bed which weathers to clay upon exposure. Below this lime there is a coal about nine inches thick. This horizon has a faunule of only one species of brachiopod and numerous crinoid stems.

A faunule from the middle Inola limestone in sec. 11, T. 16 N., R. 17 E. contains:

Crinoid stem ossicles
Marginifera muricatina Dunbar and Condra

A good fossil collecting locality was found near the pond in the SW¼ of sec. 24, T. 17 N., R. 16 E. This limestone is presumed to be the middle Inola because it caps a coal. Other exposures were found in a north-south line from this point.

Faunule collected from the Inola limestone in sec. 24, T. 17 N., R. 16 E. includes:

Crinoid stem ossicles
Fenestrate bryozoans
Ramose bryozoans
Chonetes granulifer Owen
Mesolobus mesolobus (Norwood and Pratten)
Composita subtilita (Hall)
Neospirifer dunbari King
Marginifera muricatina Dunbar and Condra
Dictyoclostus portlockianus (Norwood and Pratten)

About three feet below the middle Inola limestone in sec. 11, T. 16 N., R. 17 E., another limestone is present. This one foot limestone bed is thought to be the lower Inola. It is exposed in the creek bed and not too much detail could be seen because of the mud accumulated on top.

Faunule from the lower Inola limestone in sec. 11, T. 16 N., R. 17 E. includes:

Chonetes granulifer Owen
Mesolobus mesolobus (Norwood and Pratten)
Marginifera haydenensis Girty
Marginifera muricatina Dunbar and Condra
Juresania ovalis Dunbar and Condra
Neospirifer cameratus (Morton)

Interval from the Inola Limestone to the Bluejacket Sandstone

The rocks of this interval are covered over much of the area. From what could be seen of this interval, it is believed to be occupied by a buff, sandy shale approximately ten feet thick.

Bluejacket Sandstone

The Bluejacket was named by Ohern[1] from the hills

[1]Ohern, *op. cit.*, p. 28.

west of the town of Bluejacket where he thought its typical development is found. Upon study of the type section proposed by Ohern, Howe[1] found at least three well defined sandstone beds. After numerous conferences with authorities on this area he redefined the limits of the member at the type section.

The Bluejacket sandstone is perhaps the most important member of the "Cherokee group." It extends from Kansas to the Coweta Area as a more or less uniform massive sandstone of an average thickness of 50 feet. In subsurface the Bluejacket sandstone is commonly known as the "Bartlesville." A considerable portion of the oil produced in northeastern Oklahoma is from this horizon.

In the Coweta Area, this sandstone is massive where it is best seen; however, it grades laterally into thin-bedded sandstone. The massive phase forms prominent escarpments across the area, and caps several outliers in T. 16 N., R. 17 E. The best exposure is in the rock quarry in sec. 11, T. 16 N., R. 16 E. where a measurement indicated a thickness of about 45 feet.

The Bluejacket is medium to coarse-grained, buff colored on fresh exposure, and weathers to a brown. Because of continued percolation of water the outer extremities of

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[1]W. B. Howe, "Bluejacket Sandstone of Kansas and Oklahoma," Bulletin of the American Association of Petroleum Geologists, Vol. 35 (1951) pp. 2088-2090.

some points of the Bluejacket take on the characteristics of a quartzite. The lower portion is characteristically thin-bedded while the upper portion is massive.

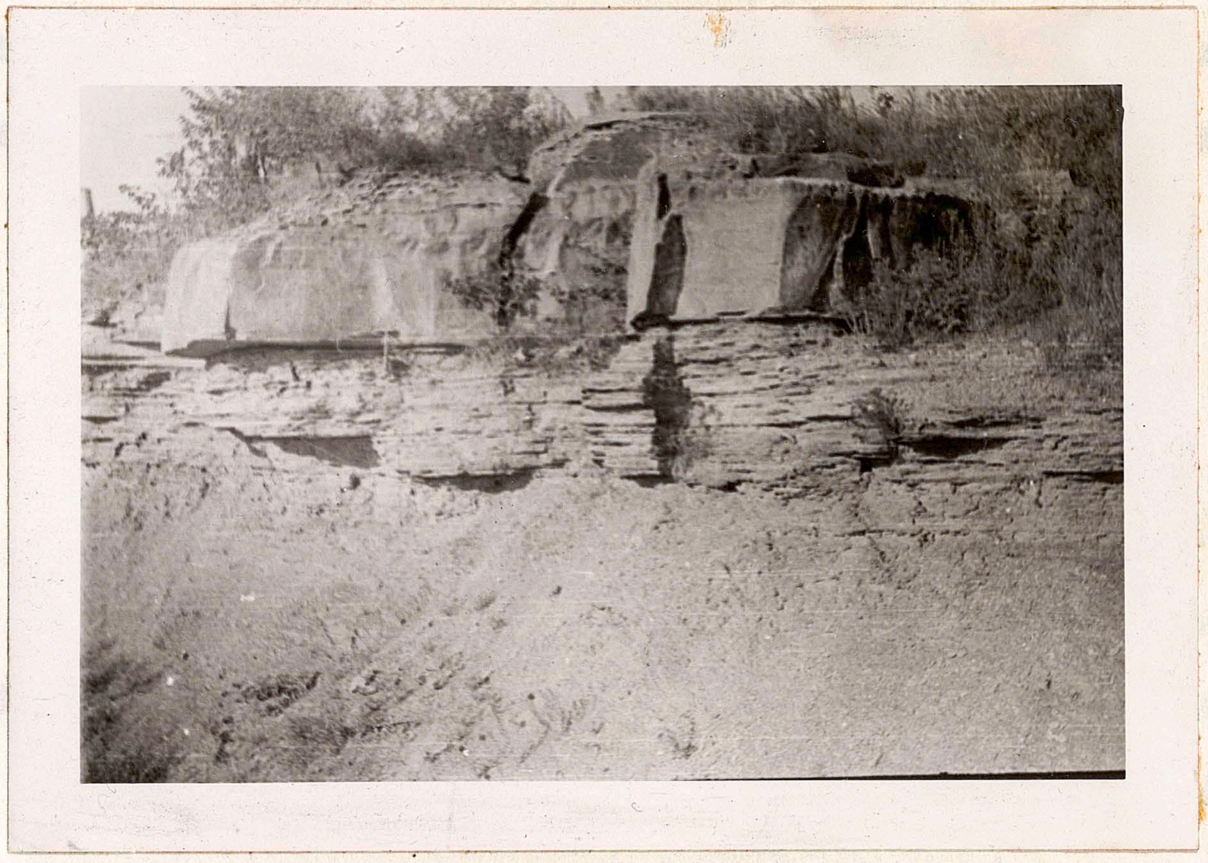

Fig. 12.--The upper massive portion of the Bluejacket Sandstone as compared to the lower thin-bedded portion as found along road in sec. 20, T. 17 N., R. 17 E.

Interval from the Bluejacket Sandstone to the Doneley Limestone

The rocks of this interval consist predominantly of gray to buff, silty, micaceous shale about 30 feet thick. Several clay ironstone beds were noted.

Doneley Limestone

The Doneley limestone, named by Chrisman,[1] is found

[1]Louie P. Chrisman, Unpublished Masters Thesis, University of Oklahoma, 1951.

about 30 feet below the Bluejacket. This limestone was not found in place but is exposed in a field in the west central portion of sec. 18, T. 17 N., R. 17 E. No conclusive evidence was found for identification, but because of its position and lack of evidence of faulting, it is assumed to be the Doneley. It is a gray, massive, fossiliferous limestone about five inches thick.

<u>Interval from the Doneley Limestone to the Sam Creek Limestone</u>

This interval consists predominantly of shale. The upper portion comprises gray to buff shales while the lower includes black, fissile shales with several clay-ironstone beds. The thickness of this interval is approximately 70 feet.

<u>Sam Creek Limestone</u>

The Sam Creek limestone was named by Lowman[1] from an exposure in sec. 15, T. 14 N., R. 18 E.[2] along the south bank of Sam Creek in Muskogee County. Newell[3] redefined it

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[1] Lowman, op. cit., unnumbered page.

[2] S. W. Lowman, Unpublished Manuscript. Charles W. Wilson, "Age and Correlation of Pennsylvanian Surface Formations, and of Oil and Gas Sands of Muskogee County, Oklahoma," Bulletin of the American Association of Petroleum Geologists, Vol. 19 (1935), p. 510.

[3] C. W. Wilson and N. D. Newell, "Geology of the Muskogee-Porum District, Muskogee and McIntosh Counties, Oklahoma," Oklahoma Geological Survey, Bulletin 57 (1937), p. 49.

as being nine inches of reddish-brown limestone, nine inches of silty, gray, and buff shale, and five inches of sparsely fossiliferous, rusty, and silty limestone.

This limestone was not found within the area under discussion but was found in sec. 6, T. 16 N., R. 18 E. along the banks of the Verdigris River. At this locality it is about four inches thick and is just as Lowman described it, with fissile black shale, above and below.

The following fossils were collected in sec. 6, T. 16 N., R. 18 E.:

Crinoid stems, spines, and plates
Delocrinus sp.
Mesolobus mesolobus (Norwood and Pratten)
Juresania ovalis Dunbar and Condra
Schizodus affinis Herrick
Strobeus sp.

Fig. 13.—Sam Creek limestone in bank of Verdigris River in sec. 6, T. 16 N., R. 18 E.

Interval from the Sam Creek Limestone to the Spaniard Limestone

This interval is predominantly shale and was estimated to occupy about 25 feet. A light gray sandstone that weathers brown occurs midway in this shale section. Accurate measurement of this sandstone was not possible, but the thickness was estimated to be about four feet.

Spaniard Limestone

The Spaniard limestone was named by Lowman[1] from an exposure along the bank of Spaniard Creek in sec. 11, T. 13 N., R. 18 E.

In the Coweta Area this limestone is well exposed in sec. 1, T. 17 N., R. 17 E. and in sec. 36, T. 18 N., R. 17 E. It is almost entirely made up of corals and is sometimes referred to as the "coral limestone." It is a dark gray, dense, and highly resistant bed about four feet thick.

Immediately below the limestone is a thin coal and underclay. Little can be seen below this underclay, but at a few exposures a black shale was noted.

Caninia torquia (Owen) was collected from the Spaniard limestone.

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[1]S. W. Lowman, "Cherokee Structural History in Oklahoma," *Tulsa Geological Society Digest* (1933), p. 31.

Fig. 14.--Exposure of
Spaniard limestone in SE¼ of
sec. 36, T. 18 N., R. 17 E.

CHAPTER III

REGIONAL GEOLOGY

Historical Geology

During Pennsylvanian time, the Coweta Area was situated near the northern margin of a vast sedimentary trough. This trough existed in southern Oklahoma and Arkansas as the Ouachita Geosyncline. The axis, or line of greatest subsidence, is believed to be south of McAlester. The common name for the area between the shelf margin and the Ouachita Geosyncline is the McAlester Basin. The Cherokee shelf area was situated in northeastern Oklahoma, southeastern Kansas, and southwestern Missouri. The McAlester Basin received thick deposits of the Cherokee sea, which advanced toward the north and northwest into Kansas, Nebraska, Missouri, and Iowa.

Cherokee time was marked by a complete submergence of the Ozark Dome, and a spreading of the sea to the west as far as Alfalfa and Major Counties.[1]

A complete sequence of Pennsylvanian was deposited

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[1]R. H. Dott, "Pennsylvanian Paleogeography," Oklahoma Geological Survey, Bulletin 40-J (1927), p. 15.

in the Coweta Area, but subsequent erosion has removed the overlying Missourian and Virgilian rocks. Perhaps the area had been covered by later Paleozoic seas but the evidence is absent and it would be of no value to state such a hypothesis since only a small portion of the over-all area involved was studied by the author.

However, some believe that the area was covered by later Paleozoic and Mesozoic seas. It is possible that the area may have experienced a periodic subsidence and covering by shallow seas. Either there was no deposition of Permian and Mesozoic sediments, or possibly erosion during subsequent time removed all traces of any such deposits.

A large proportion of the terrace material was deposited at a time when the Arkansas River flowed at a higher level and the drainage system was much less pronounced. Much of the finer material seems to have been deposited by the prevailing wind from the southwest, and probably was blown up out of the river bed during times of low water and high winds.

The terrace sand deposits resemble the Gerty[1] sand in appearance, and have the same topographic relationship to the Arkansas River as the Gerty sands have with the Canadian River. Prior to the deposition of these terrace

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[1] J. A. Taff, "Geology of the McAlester-Lehigh Coal Field, Indian Territory," United States Geological Survey, 19th Annual Report, Part 3 (1899), p. 439.

sands, the Arkansas River probably flowed toward the southeast across a broad, nearly level plain and was not cutting downward but was migrating laterally and forming a wide alluvial plain. Late in the Cenozoic the erosive power of the river was increased and it began cutting downward through the alluvium and into the Pennsylvanian rocks below. When stable gradient was established, the stream migrated laterally, building up a wide flood plain underlain by gravel, sand, and clay. This flood plain is the terrace deposits.

Correlations with Kansas

Many units of the Coweta Area are traceable into Kansas. The same name is applied in most instances. The differences in the Cherokee between the two places are in the greater percentage of sandstones, fewer and less well developed cyclothems, and a general thickening of sediments in the Coweta Area.

Continuous units include the Lower Fort Scott limestone (Blackjack Creek), Breezy Hill limestone, Verdigris (Ardmore) limestone, Broken Arrow (Croweburg) coal, Tiawah (cap-rock of Tebo coal) limestone, Bluejacket sandstone, and the "Doneley" (cap-rock of Rowe coal) limestone.

Correlations with McAlester Basin

The Savanna formation of the area north of the Arbuckles is present in the Coweta area as a sequence of

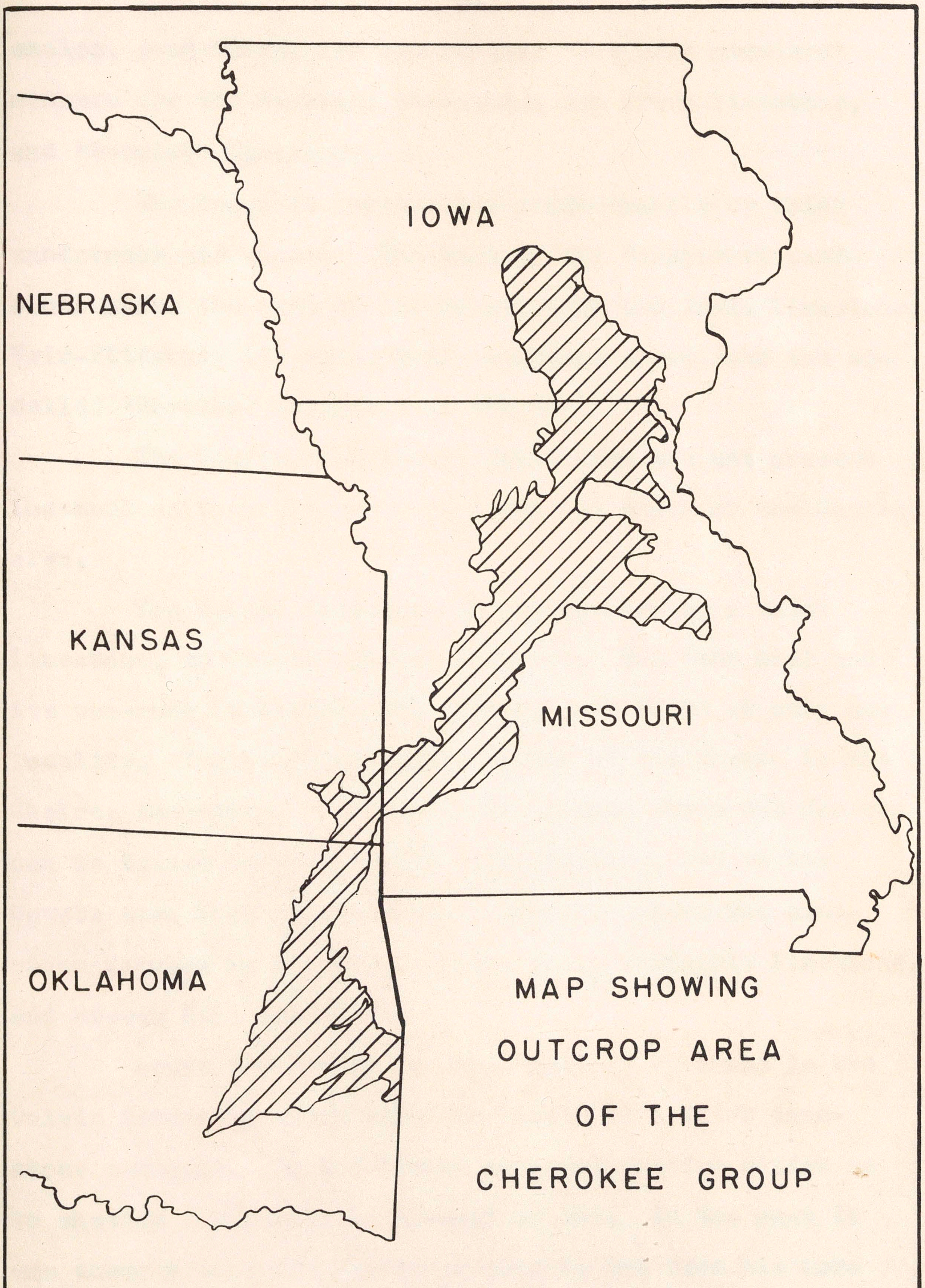
IOWA
NEBRASKA
KANSAS
MISSOURI
OKLAHOMA
MAP SHOWING
OUTCROP AREA
OF THE
CHEROKEE GROUP

Fig. 15

shales, sandstones, and limestones. The more prominent members are the Spaniard limestone, Sam Creek limestone, and "Doneley" limestone.

The Boggy is represented predominantly by thick sandstones and shales. The base of the Bluejacket sandstone marks the base of the Boggy, with the Inola limestone, Weir-Pittsburg (?) coal, Taft sandstone above, and the so-called "Boynton" sandstone at the top.

The Thurman and Stuart formations are not present inasmuch as they are known to pinch out south of the Coweta area.

The Senora formation is represented by a thick limestone, sandstone, shale, sequence. The Tebo coal and its cap-rock limestone, the Tiawah, were found at only one locality. The thick sandstone member of the Senora is the Chelsea sandstone. Two sandstone tongues above the Chelsea can be traced southward with some accuracy, but in the Coweta area they are covered by debris. Above the sandstone tongues is the Broken Arrow coal, Verdigris limestone, and Breezy Hill limestone.

Above the Senora in South Central Oklahoma is the Calvin formation which consists mostly of a thick sandstone sequence. In the Coweta area authorities differ as to whether the Calvin is present or not. In the past it was thought that the Calvin is absent, but from his more recent studies, Oakes[1] believes that a Calvin sandstone is present above the Fort Scott limestone. If this is true, the sandstone immediately above the Fort Scott limestone on Concharty Mountain is the Calvin. In the past, this sandstone was thought to be Wewoka. If it is Calvin, then certainly the Fort Scott must be the time equivalent of part of this sandstone sequence; therefore, the base of the Marmaton must be somewhere within the Calvin formation, and not at the top as had been believed.

Structure

The outcrop belt of the Cherokee rocks extends north and south across the Coweta Area. In this area the dip is to the west. North of the area the dip is toward the northwest, and southward the dip is toward the southwest.

The dip of the beds is between 35-40 feet per mile. There is local variation due to fault drag and some small anticlinal structures.

Numerous faults of pre-Tiawah--post-Taft age were mapped in the Boggy and Savanna rocks. These have a general northeast-southwest strike, following closely the direction of the Seneca fault. These faults are assumed to be normal. They were mapped on the basis of fault drag or interruption

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[1]Malcolm C. Oakes, personal communication, November, 1952.

of the outcrop pattern. An accurate amount of displacement could not be measured in the field, but could be estimated. Numerous small displacements were noted in the field, but only those large enough to show displacement on the aerial photographs were mapped.

A rather narrow low anticline was mapped in sec. 1, T. 17 N., R. 17 E. The Spaniard limestone has an east dip in the eastern half of sec. 1 and has a west dip in the west half. The strike is in a north-south direction.

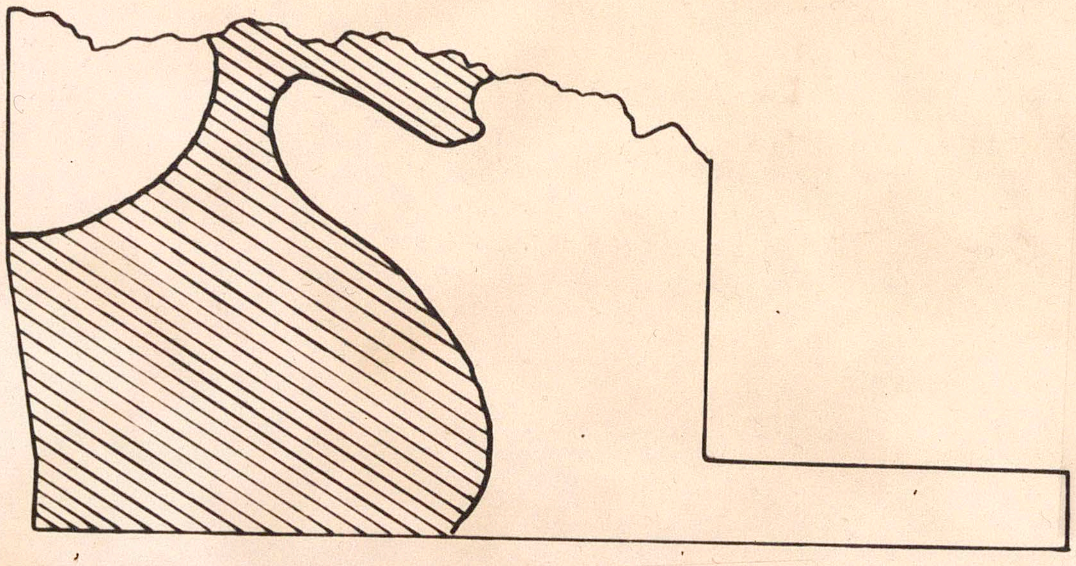

Fig. 16.--Extent of Cherokee Sea in Oklahoma.

CHAPTER IV

ECONOMIC GEOLOGY

Coal

Much coal has been strip-mined from the area, and at two localities there is still active stripping. Most of the coal is picked up at the pits by local distributors and sold in nearby towns. There is a small amount of rail transportation available for the coal; the Missouri-Kansas and Texas Railroad transports coal from Porter north to Coweta and south to Muskogee. The other commercial coal strip pit is not near rail transportation. This coal is sold only by local distributors in the immediate vicinity.

The most important coal of the Coweta Area is the Weir-Pittsburg (?) coal. It is being stripped near Porter in the S.W.¼, sec. 5, T. 16 N., R. 17 E. There are numerous abandoned pits in sections 6, 8, 17 of T. 16 N., R. 17 E. The reason this coal is of greater importance is that it has an easily removable overburden.

Of lesser importance is the Broken Arrow Coal. This coal is about 1.5 to 2 feet thick and is capped by the Verdigris limestone. Locally this coal contains hard silty limestone nodules which are as much as 2 feet in diameter. This overburden makes this coal much less profitable to mine than the Weir-Pittsburg (?). There is only one known active strip pit in the area, N.E.$\frac{1}{4}$, sec. 26, T. 16 N., R. 14 E. An abandoned mine is in S.W.$\frac{1}{4}$, sec. 6, T. 16 N., R. 15 E.

There are several other coal beds present in the area which are mined by individuals for home consumption. The coal below the middle Inola, a coal within the Taft, and a coal below the Broken Arrow coal are those individually mined.

Oil and Gas

The subsurface geology of the Coweta Area, from the standpoint of oil and gas production, may be divided into two distinct divisions---those horizons above the Mississippi limestone and those between the Chattanooga shale and the top of the Arbuckle limestone.

All of the known production north of the Arkansas River is from the Dutcher sands of Atoka age. These sands are not continuous throughout the area or even within a township; they lense in and out with no set pattern. The depths of the wells to the Dutcher vary from 1,400 feet in the western part of the area to about 500 feet in the extreme eastern part. Initial production of these sands varied from very small to a phenomenal 1,500 barrels per day.

Most of the production, in the Coweta Area, south of the Arkansas River is from the interval between the Chattanooga shale to the top of the Arbuckle limestone. There is some production from the Dutcher but it is small compared to that of the deeper units. These lower units have been drilled, in the majority of cases, by major oil companies and the wells have had better production practice. Thus they continue to produce fairly well, while those of the Dutcher are owned by small independents who have ruined many good wells by poor upkeep. This deeper production is predominantly from the Wilcox of lower Ordovician age.

The future of the oil industry in the Coweta Area is limited. There is still much minor production to be found, but the percentage of dry holes will be high.

<u>Other Economic Resources</u>

In the past, sandstone was used as a building stone. There are two abandoned rock quarries within the area. One of these is the Bluejacket sandstone and the other is the Taft sandstone. Another possible resource is volcanic ash which occurs in the township east of the Coweta area.

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APPENDIX

MEASURED STRATIGRAPHIC SECTIONS

Bed		Feet
	I. Sec. 34, T. 17 N., R. 14 E. Measured in road leading up hill in the northeast ¼.	
12	Sandstone, medium-grained, brown, massive-bedded, top eroded........................	24.1
11	Sandstone, medium to fine-grained, buff, thin-bedded................................	4.3
10	Shale, gray to buff, arenaceous, with clay-ironstone beds...........................	29.6
9	Sandstone, buff, thin-bedded, silty............	1.8
8	Shale, black, fissile, with phosphatic nodules..............................	1.2
7	Limestone, gray, crinoidal....................	0.8
6	Shale, gray, argillaceous.....................	1.1
5	FORT SCOTT limestone, gray, dense, with few fossil remains....................	3.4
4	Shale, buff, argillaceous.....................	2.5
3	BREEZY HILL limestone, gray, silty, compact, with dark gray splotches...............	0.7
2	Sandstone, buff, fine-grained, thin-bedded....	1.1
1	Shale, buff to gray, silty, micaceous: measured.....................................	38.0
	II. Sec. 6, T. 16 N., R. 15 E. Measured along road leading to top of hill in the southwest ¼.	
7	Sandstone, clean, white, medium-grained, (Calvin) weathers to brown, top covered.........	5.5
6	Shale, covered................................	6.2
5	FORT SCOTT limestone, gray, massive...........	0.8
4	Shale, weathered, phosphatic nodules..........	16.8
3	BREEZY HILL limestone, buff, silty, with minor chert zones........................	0.7
2	Sandstone, buff, thin-bedded, micaceous, fine-grained................................	1.1

Bed		Feet
1	Shale, covered..	63.8
	III. Sec. 6, T. 16 N., R. 15 E. Measured in strip-pit in southeast ¼.	
8	Shale, buff, sandy: measured......................	34.8
7	Sandstone, fine-grained, thin-bedded, buff to gray....................................	1.1
6	VERDIGRIS limestone, gray, weathers tan, bottom part hard and resistant, top is silty and weak, fossiliferous......	1.9
5	Shale, black, fissile............................	3.0
4	Clay-ironstone bed..............................	0.5
3	Shale, black, fissile............................	4.5
2	BROKEN ARROW coal............................	1.2
1	Underclay......................................	not measured
	IV. Sec. 26, T. 16 N., R. 14 E. Measured in strip-pit in northeast ¼.	
6	Shale, gray, with clay-ironstone concretions, measured..	10.0
5	VERDIGRIS limestone, top is brown, silty, lower is dark gray to black, dense, almost non-fossiliferous, 1.1 feet shale break 1.2 feet from top.........	2.7
4	Shale, black, fissile............................	1.3
3	Clay-ironstone bed..............................	0.3
2	Shale, black, fissile, with phosphatic nodules	5.8
1	BROKEN ARROW coal............................	1.4
	V. Sec. 26, T. 16 N., R. 14 E. Measured in same strip-pit as above, farther north.	
3	Shale, black, fissile, fossiliferous.........	4.4
2	Nodules, black, silty, carbonaceous, very dense, high specific gravity..........	1.8
1	BROKEN ARROW coal............................	1.6
	VI. Sec. 36, T. 17 N., R. 14 E. Measured in deep cut in southeast ¼.	
7	Shale, gray, micaceous, argillaceous.........	70.1
6	Coal..	1.5
5	Underclay......................................	1.8
4	Interbedded shales and siltstones, gray to buff..	8.9

Bed		Feet
3	Shale, gray, argillaceous........................	1.4
2	Sandstone, gray, micaceous, thin-bedded, fine-grained................................	8.3
1	Shale, gray, clay-ironstone beds.............	5.2

VII. Sec. 31, T. 17 N., R. 15 E. Measured up mountain just south of U. S. Highway 64 and east of Mountain Creek.

Bed		Feet
4	Shale, gray: measured..........................	12.8
3	Coal..	0.8
2	Underclay......................................	2.0
1	Interbedded shale and sandstone..............	44.0

VIII. Sec. 2, T. 16 N., R. 15 E. Measured west from road to outlier in central part of section.

Bed		Feet
8	CHELSEA sandstone, thin-bedded at base, massive higher, medium-grained, buff...	48.6
7	Shale, covered..................................	14.2
6	TIAWAH limestone, dark gray, bituminous, highly fossiliferous.....................	2.6
5	Shale, deeply weathered.......................	5.0
4	TEBO coal..	0.5
3	Underclay..	0.8
2	Shale, dark gray, sandy, micaceous...........	3.5
1	"BOYNTON" sandstone....................	not measured

IX. Sec. 18, T. 17 N., R. 16 E. Measured along creek bank and south along road in the south central part of sec. 18, in the town of Coweta.

Bed		Feet
2	"BOYNTON" sandstone, thin-bedded, very fine-grained, micaceous, gray to buff.......	23.8
1	Shale, gray......................................	4.6

X. Sec. 13, T. 16 N., R. 15 E. Measured along abandoned road east of present road in northeast part of sec. 13.

Bed		Feet
4	Upper TAFT sandstone, medium-grained, weathers to brown, thin-bedded to massive, on fresh exposure is buff.....	22.4
3	Shale, gray, silty.............................	19.2
2	Middle TAFT sandstone, massive medium-grained, brown..............................	23.5

Bed		Feet
1	Shale, gray, clay-ironstone beds..............	15.4
	XI. Sec. 18, T. 16 N., R. 16 E. Measured in gully in southwest part of sec. 18.	
3	Sandstone, buff, thin-bedded, fine-grained, micaceous..................................	14.4
2	Shale, gray to buff, silty, micaceous, clay-ironstone beds.......................	25.3
1	Shale, gray, argillaceous......................	2.2
	XII. Sec. 9, T. 17 N., R. 16 E. Measured up "Outlaw" hill in south central portion of sec. 9.	
4	Upper TAFT sandstone, weathers brown, massive, medium grained, ferruginous............	16.7
3	Shale, dark, clay-ironstone beds, a coal has beed strip mined in lower portion......	28.5
2	Middle TAFT sandstone, weathers in joints, not well exposed.......................	21.0
1	Shale, buff, clay-ironstone beds.............	15.0
	XIII. Sec. 9, T. 16 N., R. 17 E. Measured up creek bank in north central portion of sec. 9.	
8	Lower TAFT sandstone..................	not measured
7	Shale, gray to brown, sandy....................	8.0
6	Sandstone, buff, very fine-grained, thin-bedded...................................	5.0
5	Shale, gray, micaceous, sandy..................	17.4
4	Sandstone, thin-bedded, gray, fine-grained....	9.1
3	Shale, black, fissile..........................	22.8
2	Limestone (Inola ?), brown to red, massive, dense, fossiliferous....................	2.3
1	Shale, clay-ironstone bed......................	6.0
	XIV. Sec. 13, T. 16 N., R. 16 E. Measured in ditch along road near north central portion of sec. 13.	
6	Shale, gray to brown..................	not measured
5	INOLA limestone, dark gray, highly fossiliferous	0.3
4	Coal..	0.1
3	Clay parting....................................	0.2
2	Coal..	0.8

Bed		Feet
1	Underclay..	1.2
	XV. Sec. 11, T. 16 N., R. 17 E. Measured in creek bed in southwest ¼ of sec. 11.	
11	Upper INOLA limestone, gray, weathers to buff, hard, resistant, fossiliferous...	1.7
10	Shale, gray, argillaceous, weathered..........	3.2
9	Sandstone, thin-bedded, fine-grained, resistant, buff........................	1.2
8	Shale, gray, micaceous........................	0.7
7	Middle INOLA limestone, gray, weak, thin-bedded, fossiliferous..................	0.5
6	Coal...	0.7
5	Underclay......................................	0.4
4	Shale, buff, sandy............................	1.3
3	Sandstone, buff, thin-bedded, fine-grained....	1.5
2	Lower INOLA limestone, highly fossiliferous, weak, gray, weathers buff.............	1.2
1	Shale, covered.................................	12.8
	XVI. Sec. 5, T. 16 N., R. 17 E. Measured in coal strip-pit in central part of sec. 5, and in ditch along road in central part of sec. 8.	
5	Shale, buff, micaceous, with clay-ironstone beds containing plant remains..........	11.3
4	Shale, gray, argillaceous.....................	8.8
3	WEIR-PITTSBURG (?) coal.......................	1.6
2	Underclay......................................	1.7
1	Sandstone, fine-grained, micaceous, gray......	2.0
	XVII. Sec. 36, T. 16 N., R. 17 E. Measured along creek bank, eastward up a deep gully, south across road, then up the hill.	
7	BLUEJACKET sandstone, buff, weathers brown, medium-grained, massive................	23.2
6	Shale, buff, dark gray in places..............	75.4
5	Limestone (Sam Creek ?), highly ferruginous, fossiliferous, brown to red............	1.0
4	Shale, gray....................................	0.6
3	Limestone, fossiliferous, thin-bedded, brown..	0.2
2	Shale, black, fissile, to dark brown, has a 5 inch limestone near base...........	83.0
1	Coal...	0.9

Bed		Feet
	XVIII. Sec. 6, T. 16 N., R. 18 E. Measured along the bank of the Verdigris River in west part of sec. 6.	
8	Shale, buff, sandy, covered....................	3.6
7	Shale, dark gray to black, clay-ironstone.....	7.2
6	Sandstone, buff to gray, calcareous, thin-bedded, fine-grained....................	2.2
5	Shale, black, fissile..........................	2.1
4	Shale, dark gray to buff, sandy................	0.6
3	Shale, black, fissile, contains some fossils in lower portion, clay-ironstone.......	3.1
2	SAM CREEK limestone, highly fossiliferous, dark gray to brown, resistant..........	0.3
1	Shale, dark gray to black, fissile............	4.3
	XIV. Sec. 36, T. 18 N., R. 17 E. Measured in road cut on east boundary of sec. 36.	
6	Shale, covered..........................	not measured
5	Sandstone, thin-bedded, fine-grained, buff to brown.....................................	5.7
4	SPANIARD limestone, gray, highly resistant made up almost completely of corals....	3.5
3	Coal..	0.04
2	Underclay.....................................	0.5
1	Shale, black, covered..................	not measured