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GEOLOGY OF THE FOYIL AREA, ROGERS AND MAYES COUNTIES, OKLAHOMA

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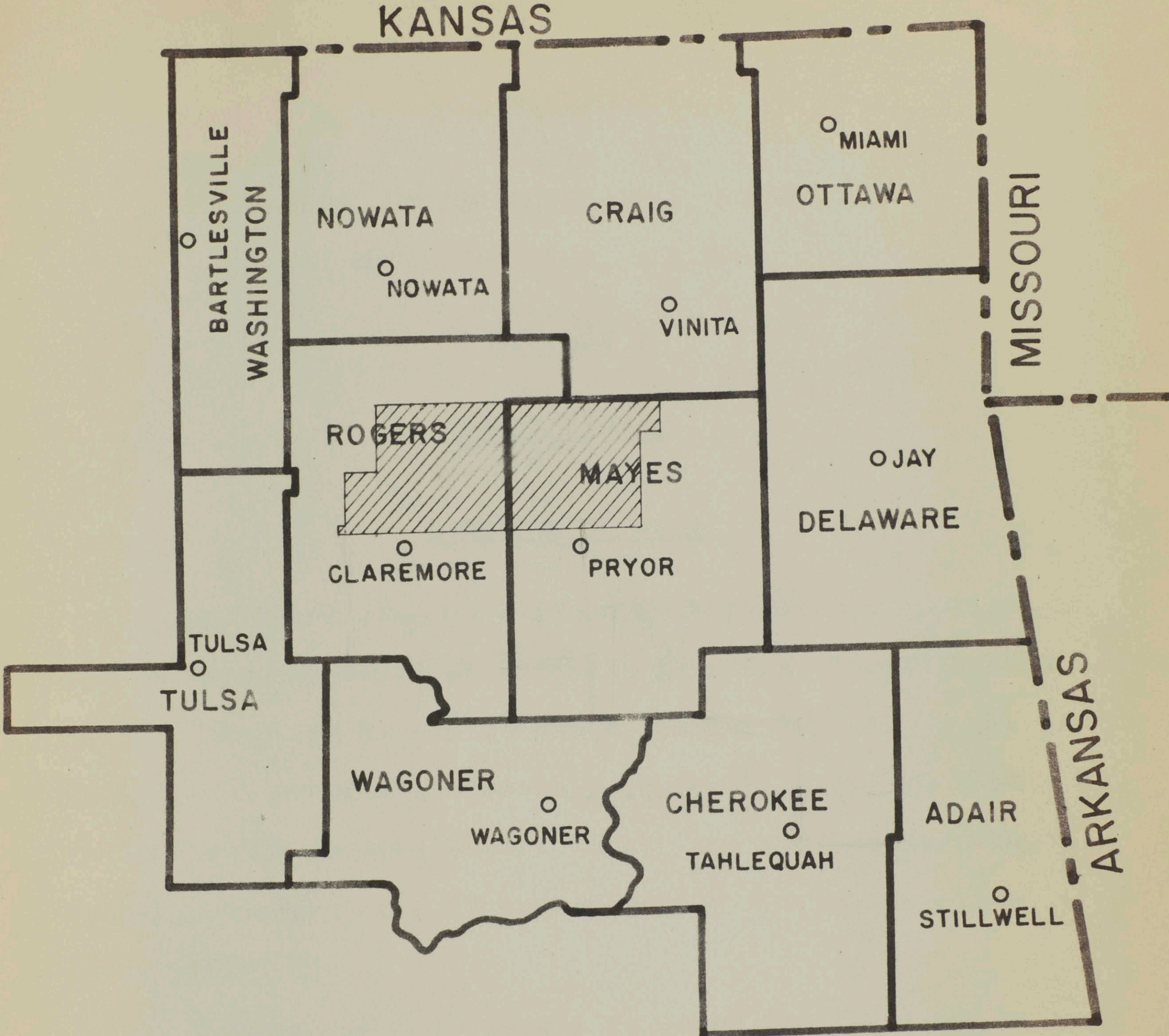
TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

PLATES

FIGURES

Figure | Page



LOCATION MAP
OF
FOYIL AREA

FIGURE 1

GEOLOGY OF THE FOYIL AREA, ROGERS AND

MAYES COUNTIES, OKLAHOMA

CHAPTER I

INTRODUCTION

Location of Area

The Foyil area as defined in this thesis consists of the eastern one-third of Township 22 North, Range 15 East, all of Townships 22 and 23 North, Ranges 16, 17, 18 and 19 East, and a portion of Township 23 North, Range 20 East. It is located in central Rogers County and northwestern Mayes County, Oklahoma, and is approximately 300 square miles in area. (Fig. 1)

The area of this thesis is named for the town of Foyil which is on U. S. Highway 66 and the St. Louis and San Francisco Railroad and is the approximate geographic center of the area. Other towns in the area are Bushyhead, Adair, Dawes, Sageeyah, and Sequoyah.

The border of the Foyil area lies about 23 miles northeast of Tulsa, about 2 miles north of Claremore, the county seat of Rogers County, and about 2 miles north of

Pryor, the county seat of Mayes County.

U. S. Highways 66 and 69 and Oklahoma State Highways 88, 28, and 2 serve the area, as do the St. Louis and San Francisco, Missouri Pacific, and Missouri Kansas and Texas Railroads.

Scope and Purpose of Report

This report is a result of a surface study of the Krebs and Cabaniss groups of Lower Desmoinesian (Upper Middle Pennsylvanian) age as they crop out in the Foyil area. The primary purpose of this investigation was to study the characteristics and measure the thicknesses of these rocks and to make a detailed map of their areal distribution.

The stratigraphic studies made in the Foyil area tie up with similar studies to the north, south, and east. These studies are part of a basic mapping program being conducted by the Oklahoma Geological Survey.

Previous Investigation

Prior to this study, there had been little detailed work done in the Foyil area. In March, 1910, Gould, Ohern, and Hutchison[1] published a bulletin that dealt with grouping of Pennsylvanian rocks in eastern Oklahoma and contained a

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[1] Gould, Charles N., Ohern, D. W., and Hutchison, L. L., "Proposed Groups of Pennsylvanian Rocks of Eastern Oklahoma," State University of Oklahoma Research Bulletin, No. 43, March 1, 1910.

generalized map of the boundaries of these groups. Later the same year Ohern[1] in another bulletin divided the groups into formations. Smith[2] mapped most of the Claremore Quadrangle and Ohern[3] mapped the Nowata and Vinita Quadrangles in 1914. Neither Smith's nor Ohern's work was published but the results of their work were used in the compilation of the Geologic Map of Oklahoma in 1926.[4] Woodruff and Cooper[5] wrote on the geology of Rogers County in 1926 and Ireland[6] wrote on the geology of Mayes County in 1928. Neither work gives very accurate treatment to the interval covered in this report. Oklahoma Geological Survey, Bulletin No. 4, written by C. W. Shannon and others and revised by C. L.

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[1] Ohern, D. W., "Stratigraphy of the Older Pennsylvanian Rocks of Northeastern Oklahoma," State University of Oklahoma Research Bulletin, No. 4, December 1, 1910.

[2] Smith, C. D., "Geology of the Claremore Quadrangle," Unpublished manuscript map on file at the office of the Oklahoma Geological Survey, 1911. (not seen)

[3] Ohern, D. W., "Geology of the Nowata and Vinita Quadrangles," Unpublished manuscript on file at the office of the Oklahoma Geological Survey, 1914. (not seen)

[4] Miser, Hugh D., "Geologic Map of Oklahoma," United States Geological Survey, 1926.

[5] Woodruff, E. G. and Cooper, C. L., "Geology of Rogers County," Oklahoma Geological Survey, Bulletin No. 40-U, 1928.

[6] Ireland, H. A., "Geology of Mayes, Ottawa, and Delaware Counties," Oklahoma Geological Survey, Bulletin No. 40-NN, 1930.

Cooper in 1926,[1] contains a small scale map which includes the Foyil area. Several coals and the base of the Bluejacket sandstone are shown on this map. In 1944 Oakes[2] mapped most of the units from the top of the Chelsea sandstone to the base of the Fort Scott limestone. The line representing the base of the Fort Scott on his map more accurately delineates the base of the Breezy Hill limestone. The coal he refers to as Fort Scott coal is Iron Post coal. Austin[3] mapped the Tiawah limestone and Chelsea sandstone throughout the Foyil area in 1946. In 1947 Renfro[4] mapped the Little Cabin sandstone throughout the area. He found that tracing the Little Cabin south it becomes the Warner sandstone of the Muskogee-Porum area and therefore the term Little Cabin is being dropped and the term Warner is being extended northward as far as this unit is traceable.[5] The term Warner will be used in this thesis.

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[1] Shannon, C. W. and others, "Coal in Oklahoma," Oklahoma Geological Survey, Bulletin No. 4, Plate 1, 1926.

[2] Oakes, Malcolm C., "Broken Arrow Coal and Associated Strata, Western Rogers, Wagoner, and Southeastern Tulsa Counties, Oklahoma," Oklahoma Geological Survey, Circular No. 24, 1944.

[3] Austin, R. B., "The Chelsea Sandstone and Associated Strata, East and Northeast of Claremore, Oklahoma," Unpublished Master of Science Thesis, University of Oklahoma, 1946.

[4] Renfro, H. B., "Geologic Map of the Vinita-Wagoner District, Northeast Oklahoma," Unpublished Doctor's Thesis, University of Wisconsin, 1947. (not seen)

[5] Branson, Carl C., personal communication, September, 1953.

Present Investigation

Preliminary study of work previously done in the area and the planning of methods to be used in the field were done in the spring of 1953. The base map to be used was also compiled during this period from aerial photographs supplied by the Oklahoma Geological Survey.

Field work was carried on extensively throughout the summer of 1953. Earlier mapping of certain units in the area was checked and refined where necessary and also a number of units not previously mapped were either traced across the area or until they disappeared or became unrecognizable.

The aerial photographs used in making the base map were also used in conjunction with the field study. The detailed map work was done by tracing the units on a sheet of transparent acetate paper superimposed over the aerial photographs. Geological data were then transferred to the base map. When sketching on the stereoscopic pairs was thought to be erroneous the key locations were checked in the field. Certain units could not be sketched on stereoscopic pairs and the outcrops were walked throughout the area inasmuch as possible.

Reliable outcrops are few, the best being found in road cuts and along streams. A large amount of time was spent in tracing units that changed thicknesses and characteristics abruptly.

Stratigraphic sections were measured with the use of a hand level and a steel tape. These sections were measured with overlapping portions and fitted together to compute a generalized section. Measurements of units were made in as many places as possible so the results would give the writer an over-all picture. At many places key beds are missing and therefore much difficulty was encountered in determining the tops and bases of certain units. This was particularly true in measuring sandstones in the area. The thicknesses of large covered intervals were calculated mathematically.

Regional dip was disregarded in measuring sections because the error introduced in doing this is undoubtedly no more than that introduced in using the hand level.

Topography and Drainage

The topography of the area is that of broad grass covered valley underlain by shale and prominent eastward facing cuestas that are in most cases covered with timber. The cuestas are formed by the many massive sandstone and limestone units in the area. The relief of most of these cuestas averages about 100 feet. The most prominent cuesta is supported by massive Bluejacket sandstone and rises at many places over 200 feet above the shale valley to the east. Total relief in the area is about 370 feet. The lowest point is in the southwestern corner of the area along the Verdigris River and the highest point is in the central part of the area.

The area has been surveyed by the township and range system and about 75 per cent of the sections are bounded by maintained and traversable roads.

The general strike is nearly northeast-southwest and the general dip is gentle, varying from about 34 feet per mile to about 40 feet per mile to the northwest. As the dip is much too gentle to measure in the field it therefore was calculated by the three point method.

The major drainage in the western half of the area is the Verdigris River with its main tributaries, Blue Creek, Sweetwater Creek, and Dog Creek. The major drainage in the eastern one-half of the region is Pryor Creek with its main tributaries, Little Pryor Creek, Osage Creek, and Seminole Creek. Pryor Creek eventually flows into Grand River south of the Foyil area.

The larger streams are structurally controlled to a large extent. These subsequent streams flow in the shale valleys parallel to the strike of the beds. A few streams follow fault traces for short distances. The smaller streams tend to have a dendritic pattern.

CHAPTER II

STRATIGRAPHY

Introduction

The rocks covered in this study compose the Krebs and Cabaniss groups. The greater part of the interval has previously been called the Cherokee group and was first studied and described in Kansas where it is predominantly shale. The term Cherokee has now been dropped by the Oklahoma Geological Survey and is replaced by the terms Krebs and Cabaniss. This new classification will be used in this report.

In June, 1953, Oakes[1] published a new classification of the Cherokee group interval based on evidence farther south in east-central Oklahoma. He divides the interval into the previously mentioned Krebs and Cabaniss groups. Oakes based his classification of separating this interval into two groups because of abrupt change in character of the sedi-

[1] Oakes, Malcolm C., "Krebs and Cabaniss Groups, of Pennsylvanian Age, in Oklahoma," Bulletin of the American Association of Petroleum Geologists, Vol. 37, No. 6, pp. 1523-1526, June 1, 1953.

ments in the McAlester basin, where coarse chert pebbles mixed with coarse quartz sand in the Thurman sandstone abruptly succeed shale and fine grained sandstone in the underlying Boggy formation; a distinct paleontological break; and discordance in structure between Boggy and older rocks and the structure of post-Boggy rocks. The Boggy is the highest formation in the Krebs group and the Thurman is the lowest formation in the Cabaniss group.

Representatives of five northern Mid-Continent states met at Nevada, Missouri, March 31-April 1, 1953, and reached an agreement on division, classification, and nomenclature of pre-Marmaton Desmoinesian beds in these states. The states represented were Iowa, Kansas, Missouri, Nebraska, and Oklahoma. Representatives from Iowa abstained on a number of items. Older established names were retained with some redefinition and new names were introduced to complete the classification.

This new classification recognizes cyclic sedimentation and coal beds are regarded as the most persistent units in the succession. Divisions of formational rank include beds from the top of a coal bed to the top of the next higher coal bed with four exceptions. Usage of these formational units is restricted to those areas where shelf conditions prevail. The Foyil area is considered to be near the hinge line between the basin to the south and the shelf area to the north.

The basin facies classification will be used in this thesis and correlation with the shelf classification will be made.

Krebs Group

Oakes defines the Krebs group so as to include all rocks between the Atoka formation, below, and the top of the Boggy formation, above, and it contains the following formations listed from older to younger: Hartshorne sandstone, McAlester formation, Savanna formation, and Boggy formation. It extends from the northeast flank of the Arbuckle Mountains northeastward to the Kansas-Oklahoma line, and eastward in the McAlester basin to the Arkansas-Oklahoma line. The Krebs group is named for the town of Krebs, in Township 5 North, Range 15 East, in Pittsburg County, Oklahoma, and is the lowest group of the Des Moines series.

The rocks of this group are for the most part dark to gray shales and some sandstone that is mostly silty and fine to medium grained. It also contains some thin lenticular limestone beds of local occurrence south of the Canadian River, three thin limestones between the Canadian and Arkansas rivers, and at least three thin fairly continuous limestones north of the Arkansas. In addition the Krebs group contains several coal beds.

The Krebs is about 6,000 feet thick west of McAlester, along the axis of the McAlester basin, 8,000 feet thick and partially eroded in the eastern part of the basin, 625 feet thick in the Foyil area, and 340 feet thick along the Kansas-Oklahoma line.

The Krebs group is apparently conformable on the Atoka formation, below, where Atoka is present, but unconformable on older rocks, and is unconformable with the Cabaniss group, above.

In the Foyil area the Krebs group as defined consists of all rocks above the Atoka formation where it is present and the Mississippian Fayetteville shale when the Atoka is absent, below, and below the Senora formation, the lowest formation of the Cabaniss group present, above.

Cabaniss Group

Oakes defines the Cabaniss group as including all rocks above the Krebs group and below the base of the Marmaton group. Between the Arbuckle Mountains and the Arkansas River, the base of the Marmaton is in the Calvin sandstone and in northeast Oklahoma it is the base of the Fort Scott limestone. The Marmaton is the highest group in the Des Moines series. The Cabaniss group is named for the village of Cabaniss in Township 6 North, Range 12 East, Pittsburg County, Oklahoma, and comprises the following formations listed older to younger in age: Thurman sandstone, Stuart shale, and Senora formation.

The rocks of the Cabaniss group are much coarser than those of the underlying Krebs group in the McAlester basin but grade southwestward and northeast ward into finer grained sediments. The Senora formation contains several thin persistent limestones as well as a number of coal beds, several of economic importance.

The Cabaniss group is thickest near the village of Cabaniss where it is 1,000 feet thick but thins southwestward and northeastward because of overlap of lower units as well as thinning within units. It is 350 feet thick at the Arkansas River, 215 feet thick at the Foyil area, and 160 feet thick at the Kansas-Oklahoma line.

The Cabaniss is unconformable on the Krebs group, below, and conformable with the overlying Marmaton group. The Thurman sandstone is thought to be overlapped by the Stuart shale beneath the broad, surficial deposits associated with the South Canadian River, and the Stuart is overlapped by the Senora formation in Township 13 North, Range 16 East. Northeastward to the Kansas-Oklahoma line the lower beds in the Senora are progressively overlapped northward by higher Senora beds. The Senora is the only formation of the Cabaniss group present in the Foyil area. In earlier reports by Lowman[1,2] the Thurman sandstone and Stuart shale were erroneously

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[1]Lowman, S. W., "Lower and Middle Pennsylvanian Stratigraphy of Oklahoma East of the Meridian and North of the Arbuckle Mountains," Tulsa Geological Society Digest, Vol. 1, unnumbered p. 35, 1932.

[2]Lowman, S. W., "Cherokee Structural History in Oklahoma," Tulsa Geological Society Digest, Vol. 2, p. 31, 1933.

correlated with beds in northeast Oklahoma.

The Cabaniss group as defined in the Foyil area consists of all rocks above the Boggy formation, the highest formation in the underlying Krebs group, below, and below the base of the Fort Scott limestone, above.

General Features

During Krebs and Cabaniss time the Foyil area was part of a relatively stable shelf or platform area on which thin but extensive, cyclic sedimentary units were deposited. This shelf area was raised and lowered by crustal unrest during Pennsylvanian time with resulting repeated alternating transgression and regression of the sea. As a result the sediments and their lithologic character were repeated with each transgression and regression of the sea. This type of sedimentation is called cyclic sedimentation and the resulting sequence of rocks in one cycle is called a cyclothem. However, farther south into the McAlester Basin the cyclothems are not as well developed as those on the platform area. The slight rise or fall of the sea causing the variation of sediments on the platform area did not affect the deeper part of the basin and sedimentation went on uninterrupted thereby resulting in fewer and thicker sedimentary units.

In Kansas the interval under discussion is predominantly shale. However, southward towards the McAlester Basin, sandstones and limestones are both introduced and become thicker. In the Foyil area, the exposed rocks of the Krebs and Cabaniss groups consist of approximately 26 per cent sandstone. Many of the shale intervals are arenaceous and the limestones in the upper part of the interval have a high silt content.

Rocks of the same class but of different ages in the Foyil area are difficult to distinguish one from the other. In the field the best method of distinguishing certain units is to observe the units immediately overlying or underlying any designated unit. In order to recognize a sequence in some cases both those above and below were necessarily used. The different limestone members usually have a high silt content and are in almost every case abundantly fossiliferous. The sandstones contain mica and iron compounds in varying amounts and contain plant fragments and impressions but lack invertebrate fossils.

In the Foyil area under the present scheme of classification, the Krebs and Cabaniss groups contain 5 formations and numerous members.

The rock units will be described in descending order, from youngest to oldest, which is the order in which they were mapped in the field.

Fort Scott Limestone

The Fort Scott limestone, the basal member of the

Marmaton group, was named by Swallow[1] after the town of Fort Scott, Kansas. Southward this unit consists of two limestone members, the upper and the lower. The lower member is identified as the Blackjack Creek limestone of Kansas. Only the base of the Lower Fort Scott was mapped, no thicknesses were measured and only a brief description is given. This limestone is dense, highly fossiliferous, dark-gray to blue-gray on fresh exposure, and contains considerable silt. It is apparently conformable with the underlying shale.

Excello Shale

The Excello is hard, black, fissile shale, buff to tan at the top at some localities and containing abundant phosphatic nodules which range in size up to about an inch in diameter. This shale is of great assistance in distinguishing the Lower Fort Scott limestone from the underlying Breezy Hill limestone. It is uniform in thickness at about 5 feet.

The nucleus of the phosphatic nodules present in the Excello shale is in many cases a fossil. Glaphyrites angulatus (Miller and Furnish) was found to be the nucleus of one of these nodules at the center of the SE 1/4 sec. 3, T. 23 N., R. 17 E. On the north side of the section line

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

road near the northeast corner of sec. 1, T. 23 N., R. 16 E., the following fossils were found to be present in the nodules:

Edestus sp.
Orbiculoidea missouriensis (Shumard)
Glaphyrites angulatus (Miller and Furnish)

Breezy Hill Limestone

The Breezy Hill limestone was named and described by Pierce and Courtier[1] in 1937 from a type locality near Mulberry, Kansas. The Breezy Hill of Oklahoma is identified with the Breezy Hill of Kansas. This finely crystalline, compact limestone is gray on fresh exposure but weathers light brown to buff and has a high silt content. At several places pieces of this limestone were weathered to a light, porous, iron-stained residue. The Breezy Hill limestone is fairly uniform in thickness throughout the area, with an average thickness of about 7 feet. The Breezy Hill is abundantly fossiliferous, especially in its upper half. The following fossils were collected from the Breezy Hill limestone about 50 yards northwest of the southeast section corner of section 20, T. 22 N., R. 16 E.:

Crinoid stem ossicles
Ramose bryozoans
Fenestrate bryozoans
Phricodothyris perplexa (McChesney)
Marginifera muricatina Dunbar and Condra
Chonetinella flemingi (Norwood and Pratten)
Dictyoclostus americanus Dunbar and Condra
Lophophyllidium girtyi Jeffords

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[1]Pierce, W. G. and Courtier, W. H., "Geology and Coal Resources of the Southeastern Kansas Coal Field in Crawford, Cherokee, and Labette Counties," *Kansas Geological Survey, Bulletin* No. 24, 1934.

Faunule collected from the Breezy Hill limestone in the NW 1/4, SW 1/4, of sec. 18, T. 22 N., R. 16 E., includes:

Neospirifer dunbari R. H. King
Dictyoclostus americanus Dunbar and Condra
Echinoconchus semipunctatus (Shepard)

Fusulina plena Alexander is present in the Breezy Hill limestone in the SE 1/4 of sec. 3, T. 23 N., R. 17 E.[1]

About two feet below the top of the Breezy Hill there is a zone that contains considerably more silt than the rest of the unit and it therefore weathers exceptionally fast. This was also noted by Lohman[2] north of the Foyil area and by Tillman[3] to the south. Tillman found a one foot shale bed introduced in this part of the Breezy Hill in the NW 1/4 of sec. 5, T. 19 N., R. 15 E., and in the SW 1/4 of sec. 18, T. 20 N., R. 15 E.

Kinnison Shale

The name Kinnison shale was first proposed for the interval between the Breezy Hill limestone, above, and the Iron Post coal, below, by Howe[4] in 1951. Howe also proposed

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[1] Alexander, R. D., "The Desmoinesian Fusulinids of Northeastern Oklahoma," Unpublished Master of Science Thesis, University of Oklahoma, p. 52, 1953.

[2] Lohman, C., Jr., "Geology of the Whiteoak Area, Craig and Rogers Counties, Oklahoma," Unpublished Master of Science Thesis, University of Oklahoma, p. 47, 1952.

[3] Tillman, J. L., "Geology of the Tiawah Area, Rogers and Mayes Counties, Oklahoma," Unpublished Master of Science Thesis, University of Oklahoma, p. 10, 1952.

[4] Howe, W. B., "Bluejacket Sandstone of Kansas and Oklahoma," Bulletin of the American Association of Petroleum Geologists, Vol. 35, No. 8, pp. 2092-93, 1951.

the name Iron Post for the coal immediately underlying the Kinnison shale. This shale is dark gray in its lower part and buff to yellow near the top at most places. It varies in thickness from a minimum of about 0.5 feet to a maximum of 2 feet and thins from north to south. In the northwest corner of sec. 36, T. 22 N., R. 15 E., this shale is both calcareous and fossiliferous. This is the only locality in the Foyil area where this condition was noted.

Interval From the Kinnison Shale to the Lagonda Sandstone

The name Lagonda has been approved for the rocks between the Iron Post coal, above, and the base of the shale interval below the Lagonda sandstone, below, by representatives of five northern Mid-Continent states at a conference held at Nevada, Missouri, March 31-April 1, 1953. All units are termed Lagonda, i.e. Lagonda shale, except the Iron Post coal, which is at the top of the Lagonda interval. North of the Foyil area the base of this interval is the top of the Bevier coal. There is also another coal below the Bevier coal and above the Verdigris limestone, the Wheeler coal. Neither of these coals is present in the Foyil area; therefore, the Lagonda interval is defined in the Foyil area as those rocks below the Kinnison shale, above, and above the base of the Lagonda sandstone, below.

The Iron Post coal varies in thickness from 8 to 18 inches but maintains a fairly constant thickness of 17 inches. It is of fairly good quality and persists throughout the area. This coal has been strip mined commercially at one locality, in sections 3 and 4, T. 23 N., R. 17 E. Elsewhere stripping has been done on a small scale by individual farmers to provide coal for their own use. Underlying the Iron Post coal is a limonitic underclay at most places about 0.3 feet.

The Lagonda shale is primarily gray to buff, iron-stained, and varies in thickness from about 2 to 20 feet. This interval thickens from north to south but the variable thickness is due primarily to the behavior of the underlying Lagonda sandstone which grades laterally and vertically into silty shale. This shale and many of the other shales in the area contain a peculiar dike-like structure. However, no stratigraphic significance is attached to this characteristic.

In the southeastern part of the Foyil area this interval contains a 0.5 foot, fossiliferous, dirty gray, sandy limestone. This bed is here called the Lagonda limestone and it divides the Lagonda shale into upper and lower units. The sandy limestone is present at outcrops in the NW 1/4 of sec. 36 and in the NE 1/4 of sec. 34, T. 22 N., R. 15 E., and at the E 1/4 corner of sec. 8, T. 22 N., R. 16 E. Also present at the outcrop in the NW 1/4 of sec. 36, T. 22 N., R. 15 E., is a 0.17 foot, compact, fine, nodular, buff to dark brown, micaceous, fossiliferous, impure limestone.

This is the only locality at which this limestone was found. Lohman[1] found the Lagonda sandstone to be brown, calcareous, and fossiliferous in the northern part of T. 25 N., R. 18 E. From evidence in the Foyil area, the writer believes this calcareous sandstone to be the Lagonda limestone, with the Lagonda sandstone probably present in a shale facies. Tillman[2] found a tan micaceous sandstone in this interval farther south. It is believed that the Lagonda limestone changes facies from a limestone to a sandstone from north to south.

Lagonda Sandstone

As previously stated the use of the name Lagonda was approved by representatives of five Mid-Continent states at a conference in Nevada, Missouri, on March 31-April 1, 1953. This sandstone in subsurface is called the "Squirrel" or "Prue." It is called the "Squirrel" by drillers because of its habit of "jumping around" in well logs. In the Foyil area the sand and sandy zone between the Breezy Hill limestone and the Verdigris limestone is correlated with and called the Lagonda sandstone.

The Lagonda sandstone varies greatly in both thickness and characteristics. It varies from an indistinct shale interval, to an interbedded zone of thin sandstones and sandy

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[1]Lohman, C., Jr., Unpublished Master of Science Thesis, University of Oklahoma, pp. 43-44, 1952.

[2]Tillman, J. L., Unpublished Master of Science Thesis, University of Oklahoma, p. 11, 1952.

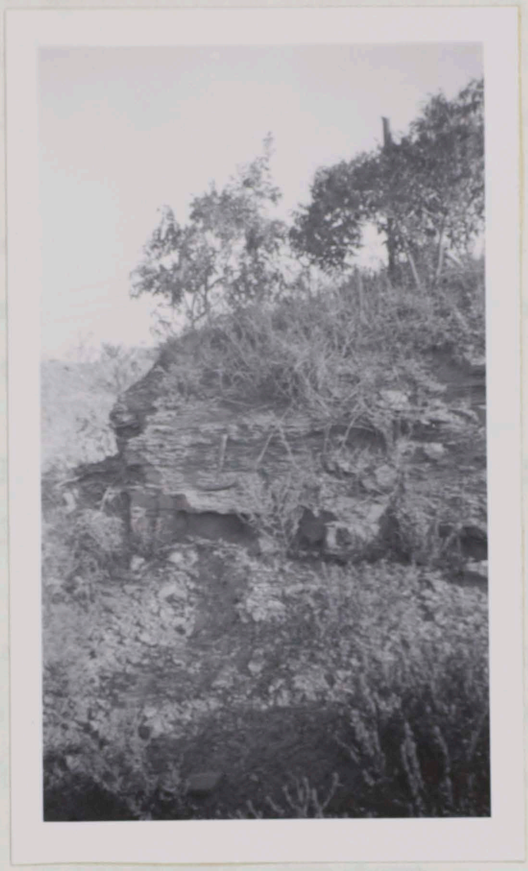

Fig. 2. Thin bedded shaley
Lagonda sandstone. South 1/4
corner of sec. 19, T. 22 N.,
R. 16 E.

shales, to a massive sandstone 9 feet thick. The writer regards the Lagonda sandstone as a sandy zone grading both laterally and vertically into sandy shale. In general this unit thickens from north to south. At the N 1/4 corner of sec. 6, T. 23 N., R. 17 E., the Lagonda is massive and 2 feet thick, in the NE 1/4 of sec. 18, T. 22 N., R. 16 E., it is indistinctly exposed shale interval, and at the E 1/4 corner of sec. 22, T. 22 N., R. 16 E., it is 9.5 feet thick and consists of three massive beds separated by thin sandy shale zones. The Lagonda is a medium to fine-grained, moderate brown to buff, micaceous, cross-bedded, somewhat indurated sandstone.

The Lagonda forms broad rolling hills that blend with and make spurs from those supported by the Breezy Hill and Fort Scott limestones.

Interval From the Lagonda Sandstone to the Verdigris Limestone

The rocks of this interval consist of gray to buff shales that are silty at places and generally are poorly exposed. The interval varies from 2 feet to about 18 feet, although it is at most places well over 10 feet in thickness.

Verdigris Limestone

This unit was originally named by C. D. Smith[1] from exposures at the Verdigris River. The name first appeared in print in 1928 on Smith's[2] geologic map of the Claremore Quadrangle which accompanied Oklahoma Geological Survey Bulletin Number 40-U. The Verdigris was first described by Cooper[3]

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[1] Smith, C. D., "Geology of the Claremore Quadrangle," Unpublished manuscript map on file at the office of the Oklahoma Geological Survey, 1914. (not seen)

[2] Woodruff, E. G., and Cooper, C. L., Oklahoma Geological Survey, Bulletin No. 40-U, 1928.

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

in 1928. This unit extends northward into Missouri where it previously had been named the Ardmore limestone. However, at the conference at Nevada, Missouri, the name Ardmore was dropped and the name Verdigris was approved for this limestone.

The Verdigris limestone persists throughout the area with one notable exception and is 5 to 7 feet thick. The limestone is missing as a lithologic unit in the SE 1/4 of sec. 6 and the NE 1/4 of sec. 7, T. 23 N., R. 17 E., because it has been removed by solution. It deviates from its normal thickness in the central one-third of T. 22 N., R. 16 E., where it attains a thickness of 14 feet. This consistent single massive limestone is easily recognized both in the field and on areal photographs.

The Verdigris is finely crystalline, compact, highly fossiliferous, and contains silty and argillaceous impurities. On fresh exposure it is medium to dark gray but upon weathering it becomes rusty brown to yellowish orange with the more resistant fossils etched in relief.

Faunule collected from the Verdigris limestone in the NE 1/4 of sec. 20, T. 22 N., R. 16 E., includes:

Crinoid stem ossicles
Phricodothyris perplexa (McChesney)
Dictyoclostus americanus Dunbar and Condra
Chonetes granulifer Owen
Cancrinella boonensis (Swallow)
Marginifera muricatina Dunbar and Condra
Caninia torquia (Owen)

Fusulina equilaqueata Alexander is present in the Verdigris limestone in the SE 1/4 of sec. 3, T. 23 N., R. 17 E.[1]

Interval From the Verdigris Limestone to the Chelsea Sandstone

By field measurements at three equally spaced localities along the outcrop belt this rock interval was found to be about 80 to 90 feet. North of the Foyil area Lohman[2] found this interval to be about 108 feet, while Tillman[3] found the interval thickens from south to north mainly in the upper part.

The only bed of stratigraphic importance within this interval is the Broken Arrow coal. The coal varies in thickness within the Foyil area from 16 to 21 inches and lies 50 to 60 feet below the base of the Verdigris limestone. The Broken Arrow is a coal of commercial quality and is strip mined extensively in T. 22 N., R. 16 E., and has been strip mined less extensively in T. 23 N., R. 17 E. The Broken Arrow coal is the equivalent of the Croweburg coal of Kansas.

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[1] Alexander, R. D., Unpublished Master of Science Thesis, University of Oklahoma, p. 29, 1953.

[2] Lohman, C., Jr., Unpublished Master of Science Thesis, University of Oklahoma, p. 40, 1952.

[3] Tillman, J. L., Unpublished Master of Science Thesis, University of Oklahoma, pp. 16-18, 1952.

The name Croweburg was retained by the conference at Nevada, Missouri, but the name Broken Arrow will still be used in Oklahoma. For detailed information on this coal the reader is referred to the work of Oakes.[1]

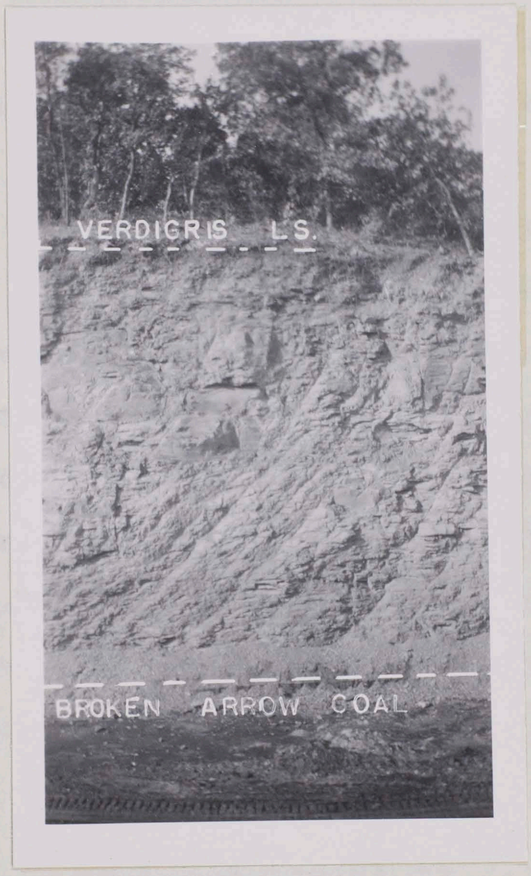

Fig. 3. Rock interval between the Verdigris limestone and the Broken Arrow coal exposed in the strip pit in sec. 16, T. 22 N., R. 16 E.

Immediately underlying the Verdigris limestone is a 2 foot, black, fissile shale containing phosphatic nodules.

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[1]Oakes, Malcolm C., Oklahoma Geological Survey, Circular No. 24, 1944.

This black shale is of considerable value in identifying the overlying Verdigris. The rocks of the remainder of the interval down to the Broken Arrow coal are variable. The rocks are composed of gray shale and gray to buff silty shale. The shale immediately above the Broken Arrow contains large calcareous siliceous concretions that have the shape of flattened spheres. A very unusual sedimentary feature is present in the silty shale interval overlying the Broken Arrow in sec. 16, T. 22 N., R. 16 E. Current bedding is shown very plainly here by thin alternating gray and black beds. The black color is due to the carbonaceous matter present. The unusual feature exhibited is the high ripple mark index of 15. The index is determined by dividing the length between successive crests (15 inches) by the amplitude of the ripples (1 inch). This index is considered extremely high for water laid sediments. Throughout most of T. 22 N., R. 16 E., and the southeast part of T. 23 N., R. 16 E., there is a local sandstone that varies in thickness from 0 to 10 feet and lies about 5.5 feet below the Verdigris limestone. This silty, fine grained sandstone is tan to grayish yellow and grades laterally and vertically into silty shale of the same color.

The shale underlying the Broken Arrow coal is highly variable in thickness due to its contact with the underlying Chelsea sandstone. The contact of the shale with the underlying Chelsea is highly graditional so that it is difficult to pick a definite boundary. At no place is this interval completely exposed. Where exposed in part it is gray shale that becomes silty at many places. In the NE 1/4 of sec. 16, T. 22 N., R. 16 E., about 100 yards west of the east section line road a 2 inch coal underlain by black shale is exposed in the creek bed. This is probably the Sequoyah coal. However, because the beds above and below are covered, no attempt at correlation is here made. An outcrop of coal which is probably Sequoyah coal was found at the N 1/4 corner on the north side of the section line road of sec. 5, T. 23 N., R. 17 E. No attempt at correlation is here made. East of this locality about 600 yards on the north side of the road in the "bar" ditch a buff silty shale contains plant leaf impressions and plant fragment impressions in abundance. Those identified are:

Calamites stem
Lepidodendron *sp.*
Lepidodendron *scutatum* Lesquereux
Lepidodendron *latifolium* Lesquereux
Pecopteris *dentata* Brongniart
Pecopteris *vestida* Lesquereux
Pecopteris *unita* Brongniart
Pecopteris *arborescens* (Brongniart)
Pecopteris *pseudovestita* White
Pecopteris *miltoni* Artis
Neuropteris *ovata* Hoffman
Cordaites *grandifolius* Lesquereux

Chelsea Sandstone

The Chelsea sandstone was named and described by Ohern[1]

[1] Ohern, D. W., "Geology of the Nowata and Vinita Quadrangles," Unpublished manuscript on file at the office of the Oklahoma Geological Survey, p. 41, 1914. (not seen)

in 1914, but the name did not appear in print until 1927 when it was included in the generalized stratigraphic column for Kay, Grant, Garfield, and Noble counties by Clark and Cooper.[1]

The Chelsea is composed of two lithologic zones, a lower massive, coarse, highly ferruginous, strongly cross-bedded zone and a sandy shale zone that grades laterally and vertically into shale, so the top of the Chelsea is exceptionally difficult to distinguish from the overlying shale. The lower massive zone commonly supports a dense growth of oak trees while the upper zone forms a gentle sloping grass covered prairie.

The lithology of the Chelsea sandstone is variable where it is well developed. It is medium to fine grained, fairly well sorted, light red to yellow, highly ferruginous, micaceous, and crossbedded. Towards the top the amount of sand decreases and the amount of silt and shale increases. The upper unit is micaceous and buff to tan. About a mile northeast of Foyil the Chelsea is massive and well developed throughout its entire thickness.

Due to the nature of the topography and to the lithology of the upper part of the Chelsea, the total thickness of this unit was difficult to obtain. In the SE 1/4 of sec. 28 and the NW 1/4 of sec. 33, T. 23 N., R. 17 E., 70 feet of

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[1]Clark, G. C. and Cooper, G. L., "Oil and Gas Geology of Kay, Grant, Garfield, and Noble Counties," Oklahoma Geological Survey, Bulletin No. 40-H, fig. 5, p. 77, 1927.

tan, massive, crossbedded sandstone was measured. This is believed to be the maximum thickness of the Chelsea in the Foyil area. In the SW 1/4 of sec. 18, T. 22 N., R. 17 E., on the south section line the Chelsea consists of 44 feet of massive, crossbedded sandstone, and 13.5 feet of silty, fine grained sandstone.

The Chelsea sandstone is continuous throughout most of the Foyil area with an outcrop belt attaining a width of 5 miles, except in the NE 1/4 of T. 23 N., R. 17 E., where the outcrop belt changes to a width of only about a half mile because the characteristic Chelsea is absent. Here it is a silty sandstone facies that is indistinctly set off from the rocks above and below. This silty sandstone facies extends into the area north of the Foyil area where it again regains its characteristic lithology in the northern part of T. 24 N., R. 18 E.[1] Up dip to the east in the northern part of sections 5 and 6, T. 23 N., R. 19 E., the Chelsea sandstone is again present in its characteristic lithology. Along the eastern edge of the outcrop, the Chelsea sandstone contains relatively little shale, but down dip, towards the west, the amount of shale and siltstone in the Chelsea increases so that as previously mentioned the top of the Chelsea is an indistinct boundary.

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[1]Lohman, C., Jr., Unpublished Master of Science Thesis, University of Oklahoma, p. 37, 1952.

Regionally, as well as locally, the base of the Chelsea sandstone is recognized as an irregular surface.

Fig. 4. Massive Chelsea sandstone exposed in a road cut near the southwest corner of sec. 28, T. 23 N., R. 17 E.

Interval From the Chelsea Sandstone to the Tiawah Limestone

The rocks of this interval consist of gray, silty shale underlain by black, fissile shale that contains abundant pea-sized phosphatic nodules at some localities. The chief characteristic of this interval is its variable thickness, ranging from 0 to 10 feet. At the northeast corner of sec. 36, T. 23 N., R. 17 E., this sequence as well as the underlying Tiawah limestone is absent. Here the base of the Chelsea sandstone lies on the black fissile shale below the Tiawah. This shale above the Tiawah as well as the Tiawah limestone is absent about 300 yards north of the southeast corner of sec. 27, T. 22 N., R. 17 E. Here the base of the Chelsea also lies on the black fissile shale below the Tiawah limestone; the shale interval and the underlying Tiawah limestone having been removed by pre-Chelsea erosion. The absence of the shale and its variable thickness where present elsewhere in the Foyil area is certainly indicative of the reality of the previously mentioned irregular surface on which the base of the Chelsea was deposited.

Tiawah Limestone

The Tiawah limestone was named by S. W. Lowman[1] in 1932 from exposures about the town of Tiawah, a short distance southeast of Claremore. This limestone is referred to in the subsurface as the "Pink"[2] limestone because of the pink calcite that is present.

The limestone is compact and fossiliferous and has a high silt content like most of the other limestones in the area. On fresh exposure the Tiawah is gray and upon weathering becomes light gray to buff. Where the Tiawah is present it varies in thickness from about 2 to 4 feet. On continued exposure, it weathers rapidly to a gray ironstained clay which represents the insoluble impurities remaining. Due to

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[1]Lowman, S. W., Tulsa Geological Society Digest, Vol. 1, Unnumbered p. 34, 1932.

[2]Fitts, L. E., Jr., and Brant, R. A., "Pennsylvanian and Mississippian Rocks of Eastern Oklahoma," Tulsa Geological Society, Field Trip Guide, 1946.

this rapid and complete weathering, the Tiawah limestone could not be continuously mapped. Also, as previously mentioned, the Tiawah is absent due to pre-Chelsea erosion.

Wellerella sp. was collected from the Tiawah limestone in the NE 1/4 of sec. 15, T. 22 N., R. 17 E.

Interval From the Tiawah Limestone to the Taft Sandstones

In the southern one-half of the Foyil area the rocks of the interval from the Tiawah limestone to the upper Taft sandstone are fairly distinctive. However, north of the Diver Creek fault the upper and middle Taft sandstones are represented by a shale facies so that the total interval from the Tiawah limestone to the lower Taft sandstone is indistinctly exposed.

This interval is variable, ranging from 22.5 feet to 41 feet, and contains two distinctive units: the Tebo coal and the "White" sandstone.

Immediately underlying the Tiawah limestone is a black fissile shale which contains small pea-sized phosphatic nodules. This shale at some localities grades into gray shale near the top. At one locality the black fissile shale is abnormally thin and the overlying gray shale attains a thickness of about 1.5 feet. The thickness of this interval is variable, at least partially due to the pre-Chelsea erosion that removed part of the rocks at certain previously named localities. It ranges from about 1.5 feet to about 5 feet in thickness.

Immediately underlying the black fissile shale is the Tebo coal. This coal is thin and poorly developed so that possibly it is present at localities not found by the writer. A 2 to 3 foot gray underclay underlies the coal. Immediately underlying this underclay at some localities is a light buff, somewhat ferruginous, fine grained, fairly massive, micaceous, sandstone varying in thickness from a minimum of 0.5 feet to a maximum of 5.5 feet. This sandstone was first described and referred to as the "White" sandstone by Austin[1] because of its white appearance on a fresh exposure. The writer believes this sandstone to be local in nature and not as extensive as Austin believed it to be. Because of its characteristics and its relationship to the underlying sandstones it may actually belong to the Taft sandstone series. It was not found to be as continuous as the lower sandstones and therefore it was not mapped as a lithologic unit.

The rocks of the remainder of the interval to the upper Taft sandstone consists of 9 to 17 feet of gray to tan, somewhat carbonaceous, silty shales.

<u>Taft Sandstones</u>

The rocks which make up the Taft sandstones and inter-

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[1]Austin, R. B., Unpublished Master of Science Thesis, University of Oklahoma, p. 5, 1946.

bedded shales in the Foyil area are equivalent, at least in part, to the Taft sandstone described and named by Wilson.[1] The Taft is named for exposures south of Taft, Oklahoma, in sec. 19, T. 15 N., R. 17 E. At the type locality, this unit is 50 feet thick.

In the Foyil area the Taft interval contains approximately 146 feet of interbedded sandstones and shales and at least two coal beds. This sand and shale sequence, like all of the other similar sequences in the Krebs and Cabaniss groups, grades both laterally and vertically from sandstone to sandy shale to shale so that no single phase represents the same stratigraphic position throughout the area. The interval contains many local sandstone lenses and three fairly consistent mappable sandstone members. For mapping and descriptive purposes, these three members are called upper, middle, and lower in this report and their bases are shown on the geologic map which accompanies this report.

The shales in this interval are somewhat variable. They range in color from tan to gray to gray-black and their lithology varies from soft fissile to ferruginous, silty shale. Interbedded with the shales, especially in the shale intervals below the upper and middle mapped sandstone members, are thin

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[1] Wilson, C. W., 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. 13, No. 4, p. 511, 1935.

clay ironstone beds, one of which may be the cap rock of the coal that is being sporadically strip mined in the NW 1/4 of sec. 15, T. 22 N., R. 17 E.

Of the three sandstones mapped, the lower one is the only unit that persists completely across the area. The upper Taft is continuous as a mappable unit as far north as the Diver Creek fault. North of the fault this unit is unrecognizable due to a facies change into shale so it cannot be distinguished from the shales above and below. This member is about 5 to 5.5 feet thick. The middle Taft is the least developed of the three mapped sandstone members and much difficulty was encountered in tracing this sandstone northward. It is continuous, or nearly so, throughout T. 22 N., but north of sec. 6, T. 22 N., R. 18 E., it is not present due to a facies change to shale northward. When present as a distinct unit it varies from less than a foot to about 4 feet in thickness.

The upper and middle Taft sandstones are very similar in lithology, being buff to tan, fine grained, thinly bedded, and silty. Topographically, the upper and middle Taft sandstones have subdued expression. The upper unit is contained in most places in the lower part of the escarpment formed by the Chelsea sandstone and underlying Tiawah limestone. The middle Taft forms a small, poorly defined escarpment in the shale valley to the east of the Chelsea sandstone escarpment.

The lower Taft sandstone is the best developed of the sandstones in this interval. Lithologically this sandstone is tan to buff, fairly massive, micaceous, fairly well sorted, medium to fine grained, highly ferruginous, and contains abundant Stigmaria. At a number of localities, especially in the north central part of sec. 10, T. 22 N., R. 18 E., the sandstone is made up in part of brick red, highly ferrugineous, rectangular, concentrically layered structures. These structures are attributed to secondary weathering and no stratigraphic significance is attached to them. The base of this unit is well developed but towards the top the amount of silt and fine grained sandstone increases so that the contact between the top of this sandstone unit and the base of the overlying shale unit is not distinct, as is the case with nearly all of the sandstones in the area. The lower Taft varies in thickness from over 5 feet to about 41 feet and caps many of the Bluejacket escarpments, extending their heights another 50 or 60 feet.

In the area adjoining the Foyil area to the south, three mappable sandstone units were found to be continuous, and to extend into the Foyil area. As previously mentioned the upper and middle units grade into shale in the northern part of the Foyil area. The lower unit extends into the Whiteoak area adjoining the Foyil area on the north as the Taft sandstone.

An impure but continuous coal bed is present 14 to 18 feet below the upper Taft sandstone. About 200 yards north of the southeast corner of sec. 27, T. 22 N., R. 17 E., this coal is 6 inches thick, is impure, and is underlain by a gray-black underclay. At the northeast corner of sec. 1, T. 22 N., R. 17 E., this coal bed is represented by 5.5 feet of interbedded thin coals and shaley clay. In the south central part of sec. 12, T. 22 N., R. 17 E., the coal has been strip mined in past years. Now these strip pits are abandoned and covered so that no coal bed was actually observed. Elsewhere, at several localities along the outcrop of this interval, the presence of this coal was noted.

Another coal, which is well developed and of commercial quality, is located between the lower and middle Taft sandstones. Its exact stratigraphic position in the section is questionable. The localities at which it crops out are such that little can be seen of the interval above or below. In the southern part of sec. 7 and the northern part of sec. 18, T. 23 N., R. 18 E., this coal is overlain by platy, black shale and the interval below it contains a silty sandstone that is probably lower Taft. The coal at this locality has been strip mined but at present no work is being done.

In the NW 1/4 of sec. 15, T. 22 N., R. 17 E., a 12-inch coal overlain by 4.5 feet of black platy shale is present and is believed to be the same coal as that described

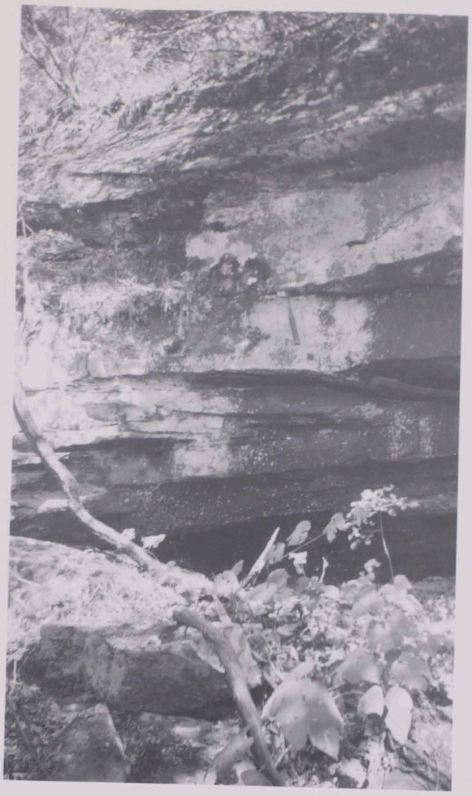

Fig. 5. Massive lower Taft sandstone in NE 1/4 of sec. 11, T. 23 N., R. 18 E. Notice cross-bedding near the top of picture.

above. The interval above the black shale contains several thin calcareous, fossiliferous, clay ironstone beds. At this locality the coal lies 32 feet below a 3.5 foot sandstone bed which the writer believes to be middle Taft. It is believed that the coal described at these two localities is the correlative of the Weir-Pittsburg coal of Kansas, but no attempt at correlation is here made. At the present time, James L. Morgan, a graduate student at the University of Oklahoma, is conducting a spore analysis study on this and several other coals. With information obtained from his study a more definite correlation will undoubtedly be made.

Mesolobus mesolobus (Norwood and Pratten) was collected from the clay ironstone caprock above the Wier-Pittsburg (?) coal in the NW 1/4 of sec. 15, T. 22 N., R. 17 E.

Interval From the Taft Sandstones to the Inola Limestone

Because of the covered nature of the slopes below the lower Taft sandstone, this interval at the few localities it occurs is poorly exposed. In the NE 1/4 of sec. 11, T. 23 N., R. 18 E., it consists of 0.6 feet of clay ironstone underlain by 11 feet of black to gray shale. In the NE 1/4 of sec. 16, T. 22 N., R. 18 E., the base of the lower Taft sandstone is poorly exposed, but the interval from the highest Inola limestone to the probable base of the lower Taft is here about 1.5 feet of poorly exposed gray shale. In the center of this section the lower Taft is separated from the upper Inola limestone by 0.3 feet of gray to buff shale. Tillman[1] noted a 3 to 4 inch coal in this interval from evidence obtained in a recently dug water well. The writer found no coal that could definitely be placed in this interval.

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[1]Tillman, J. L., Unpublished Master of Science Thesis, University of Oklahoma, p. 30, 1952.

Inola Limestone

The Inola limestone was first named and described by Lowman[1] in 1932 from its presence in Inola Mound, near Inola, Oklahoma. As described by Lowman, it is a single 0.8 foot bed of gray fossiliferous limestone. In the adjoining area south of the area under discussion, along Oklahoma Highway 20 in sec. 18, T. 21 N., R. 18 E., 4 limestones occur. At four localities in the Foyil area, two Inola limestones were found and at three localities one limestone, which is believed to be the lower Inola, was found.

The Inola limestones apparently weather even more rapidly than any other limestones in the area, because exposures are rare. This is unfortunate because this limestone horizon is important in distinguishing the underlying Bluejacket sandstone from the overlying lower Taft sandstone. This limestone horizon could not be mapped as a continuous unit. The isolated outcrops located by the writer are shown on the geologic map accompanying this report.

The northernmost known outcrop of Inola is in the NE 1/4 of sec. 6, T. 23 N., R. 19 E. This is believed to be the lower Inola because it contains fusulinids, which are known only in the lower limestone unit elsewhere. At this locality this limestone is gray on fresh exposure and splotchy

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[1] Lowman, S. W., Tulsa Geological Society Digest, Vol. 1, Unnumbered p. 34, 1932.

gray-white on continued exposure. It is compact and fossiliferous. In the center of sec. 16, T. 22 N., R. 18 E., at the mouth of an old abandoned drift mine two Inola limestones and the interval separating them is well exposed. Here the upper limestone consists of 1.7 feet of dark gray unweathered, light gray weathered, fossiliferous, silty limestone. The lower limestone is 0.8 feet thick and has the same appearance as the upper limestone. It is separated from the upper limestone by 5 feet of gray shale which contains large clay ironstones. The lower limestone at this locality is assumed to be the cap rock of a coal, but because the mine was filled with water no direct evidence could be found. Two Inola limestones are in the NE 1/4 of sec. 16, T. 22 N., R. 18 E., and are separated by a 3.9 foot covered interval. Here the lower limestone is the cap rock of an underlying coal. Elsewhere the outcrops of Inola and their associated intervals are covered to the extent that they could not be placed in their stratigraphic sequence with any accuracy.

A faunule from the upper Inola limestone near the center of sec. 16, T. 22 N., R. 18 E., includes:

<u>Neospirifer</u> <u>dunbari</u> R. H. King
<u>Marginifera</u> <u>haydenensis</u> Girty
<u>Phricodothyris</u> <u>perplexa</u> (McChesney)

A faunule from the lower Inola limestone in the NE 1/4 of sec. 6, T. 23 N., R. 19 E., includes:

Crinoid stem ossicles
<u>Wedekindellina</u> <u>sp</u>.

Chonetinella flemingi (Norwood and Pratten)
Phricodothyris perplexa (McChesney)
Marginifera haydenensis Girty

A faunule from the lower Inola limestone in the NE 1/4 of sec. 11, T. 23 N., R. 18 E., includes:

Fusulina sp.
Wedekindellina sp.
Ramose bryozoans

The following fusulinids are present in the lower Inola limestone in the NW 1/4 of sec. 32, T. 23 N., R. 18 E.[1,2]:

Wedekindellina henbesti (Skinner)
Fusulina leei Skinner

Interval From the Inola Limestone to the Bluejacket Sandstone

The rocks of this interval consist of a gray to buff shale, a thin poorly developed coal, an underclay, and a gray to buff shale underlying the underclay. This interval was observed in its entirety at only one locality, in the NE 1/4 of sec. 16, T. 22 N., R. 18 E. Here it consists of 4 feet of gray to buff shale, a coal zone consisting of 1 inch of coal, 0.5 inches of light gray clay, and 1.5 inches of coal, 0.33 feet of underclay, and about 12 feet of gray to buff silty shale. Elsewhere rocks of parts of this interval were observed. In the NE 1/4 of sec. 11, T. 23 N., R. 18 E., the Inola limestone is underlain by 3 feet of gray shale which is in turn underlain by 7 inches of impure coal. In the SW 1/4

[1]Alexander, R. D., Unpublished Master of Science Thesis, University of Oklahoma, p. 23, 1953.

[2]Ibid., Alexander, R. D., p. 40, 1953.

sec. 17, T. 23 N., R. 18 E., at the Diver Creek fault, massive Bluejacket sandstone which is standing nearly vertical is overlain by about 1 foot of gray shale, a well developed coal with an underclay, and above the coal, a black, platy shale. The coal at the localities mentioned above is the Bluejacket coal of the shelf facies classification. At the center of sec. 16, T. 22 N., R. 18 E., this coal is undoubtedly well developed, although no direct evidence was observed. At this locality a coal has been mined quite extensively. The lower Inola limestone forms the roof of one of the drift mines, which seems to indicate the coal below the lower Inola is the one being mined. No work is being carried on now, and the mines are filled with water.

Bluejacket Sandstone

The Bluejacket sandstone is by far the most prominent sandstone in the Krebs and Cabaniss groups. In subsurface this sandstone is called the "Bartlesville" sandstone. A considerable portion of the oil production of northeast Oklahoma is from the "Bartlesville". The Bluejacket was originally described by Ohern[1] in 1914 for exposures 2 miles west of Bluejacket, Oklahoma. The name first appeared in print in

[1] Ohern, D. W., "Geology of the Nowata and Vinita Quadrangles," Unpublished manuscript on file at the office of the Oklahoma Geological Survey, 1914. (not seen)

1921 in a paper by McCoy[1] who erroneously correlated it with the Warner sandstone. Gould[2] established the use of the term Bluejacket as a member of the Cherokee group in 1925. He mentioned that it was named by Ohern and that the base was shown on Miser's Geologic Map of Oklahoma (then unpublished). As originally defined by Ohern, the type section of the Bluejacket includes several other members. Howe[3], in 1951, specifically designated the exposure in NE 1/4, NE 1/4 of sec. 25, T. 27 N., R. 20 E., as the type section for the Bluejacket sandstone and differentiated it from the underlying finer grained "Twelve-Foot" sandstone named and described by Lohman.[4]

Along the eastern edge of the outcrop of the Bluejacket in the Foyil area it is generally massive. However, downdip it becomes silty and less resistant. This is particularly true in the central part of T. 23 N., R. 18 E. It is also the case in the southwestern part of T. 22 N., R. 18 E. However in the southern one-half of sec. 31, T. 22 N.,

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[1] McCoy, A. W., "A Short Sketch of the Paleogeography and Historical Geology of the Mid-Continent Oil District and Its Importance to Petroleum Geology," Bulletin of the American Association of Petroleum Geologists, Vol. 5, No. 5, p. 548, 1921.

[2] Gould, C. N., "Index to the Stratigraphy of Oklahoma," Oklahoma Geological Survey, Bulletin No. 35, p. 64, 1925.

[3] Howe, W. B., Bulletin of the American Association of Geologists, Vol. 35, No. 8, p. 2090, 1951.

[4] Lohman, C., Jr., Unpublished Master of Science Thesis, University of Oklahoma, pp. 16-17, 1952.

R. 18 E., this sandstone again becomes massive and continues southward into the adjoining area as a massive resistant sandstone. The depositional environment of the Bluejacket sandstone has been the subject of a number of studies. Weirich[1] considers it a sheet sand of varying thickness with lensing characteristics along its eastern margin. Many geologists writing about it assume it to be a series of off shore bars. Some writers explain the thickening of the Bluejacket by channeling at the base. In order for this to be true, the strike of the thickened Bluejacket would have to be approximately perpendicular to the general strike of all the other sediments in the area. The evidence found in the Foyil area shows that the strike of the thickened Bluejacket is parallel to the strike of the other sediments. The writer believes the origin of the thickening of the Bluejacket is off shore bars.

Evidence found in the Foyil area shows that prior to deposition of the Bluejacket sandstone, an irregular surface existed.

Lithologically, the Bluejacket is massive and medium grained at its base, but becomes progressively finer grained and less resistant towards the top, so that in many cases it is hard to distinguish the contact between it and overlying

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[1]Weirich, T. E., "Petroleum Geology of Nowata and Washington Counties, Oklahoma," Kansas Geological Society, Eleventh Annual Field Conference, p. 90, 1937.

sediments. The lower part is composed of massive, medium grained, crossbedded, ferruginous sandstone. In the NW 1/4 of sec. 36, T. 23 N., R. 18 E., the lower 15 feet of the massive Bluejacket is conglomeratic, with an irregular base which rests on silty sandstone. The slope below this outcrop is covered with talus to the extent that the underlying rocks could not be seen.

Due to lithologic variation, it was difficult to measure the total thickness of the Bluejacket sandstone. Also because of this variation much difficulty was encountered in mapping this unit. Its total thickness was found to be variable from about 33 feet to over 56 feet. The best exposure of the Bluejacket sandstone in the Foyil area was measured along the south section line of sec. 12, T. 23 N., R. 18 E., where it is 56.5 feet thick. The lower 37 feet is massive tan, medium grained sandstone. Overlying this massive sandstone is 8.5 feet of buff silty sandstone, which is in turn overlain by 11 feet of massive, medium to fine grained, tan, micaceous sandstone. At the northeast corner of sec. 16, T. 22 N., R. 18 E., the lower Bluejacket is composed of 21 feet of crossbedded, tan, medium grained, micaceous sandstone grading upward into 12 feet of thin bedded, fine grained, tan, micaceous, silty sandstone.

The massive Bluejacket is resistant and forms the most prominent escarpment in the Foyil area. This escarpment

Fig. 6. Talus and slump fill near the Bluejacket sandstone escarpment in sec. 1, T. 22 N., R. 18 E.

Fig. 7. Typical Bluejacket sandstone escarpment.

is extended higher in parts of the Foyil area by the presence of the lower, well developed, Taft sandstone as mentioned previously. The massive Bluejacket typically supports a growth of scrub oak trees.

The upper Bluejacket is weak and weathers back from the face of the escarpment and generally blends with the topography formed by the overlying sediments. A covering of grass is supported by this part of the Bluejacket over most of its outcrop.

As is the case with most of the sandstones in the area, no fossils were found except for plant fragments. Stigmaria was noted in the Bluejacket.

Regionally, the Bluejacket sandstone is one of the more extensive and more important members of the Krebs and Cabaniss groups. The Bluejacket, because of its prominent escarpment and fairly persistent lithologic character, can be easily traced across a considerable expanse of territory. North of the Foyil area it has been traced into Kansas where it is the equivalent of the Columbus sandstone of older reports. The term Columbus was preoccupied at the time of its proposal and since has been suppressed in favor of Bluejacket. The Bluejacket extends southward beyond the Muskogee-Porum district into the McAlester Basin. As previously defined, the Bluejacket was 200-250 feet above the base of the Boggy formation in the Muskogee-Porum district.[1] However, the Oklahoma Geological Survey has revised the classification and now considers the Bluejacket to be the basal member of the Boggy formation.[2]

Interval From the Bluejacket Sandstone to the Warner Sandstone

The exposures of rocks of this interval are the poorest of any in the Krebs or Cabaniss groups. Most of the slopes below the Bluejacket escarpment are covered with talus so that little of this part of the rock interval can be seen. The remainder of the interval underlies a broad featureless plain to the east. There are no resistant units of any appreciable thickness. However, there are occasional sandstone lenses. One such lense was found in the SE 1/4 of the NE 1/4, sec. 35, T. 22 N., R. 18 E., near the east section line. Most of the exposures are located in stream beds where the streams have exposed bed rock. Exposures of the important stratigraphic units in this interval are few and where seen are of such a nature that they cannot be placed correctly in the section with relation to other units.

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[1]Newell, N. D. and Wilson, C. W., Jr., "Geology of the Muskogee-Porum District, Muskogee and McIntosh Counties, Oklahoma," Oklahoma Geological Survey, Bulletin No. 57, p. 54, 1937.

[2]Branson, Carl C., Personal Communication, October, 1953.

The thickness of this sequence varies somewhat because of the irregular surface on which the Bluejacket sandstone was deposited. The interval is given in the generalized stratigraphic column accompanying this report as 265 feet. However it varies from about 230 feet to 275 feet.

The interval contains three units of stratigraphic importance insofar as is known. These are, in descending order: the Doneley limestone, the Sam Creek limestone, and the Spaniard limestone.

The interval from the base of the Bluejacket to the Doneley limestone is highly variable due to the irregular surface present at the time of deposition of the Bluejacket sandstone. The interval varies from 5.5 feet at the NE 1/4 corner of sec. 16, T. 22 N., R. 18 E., to about 50 feet near the N 1/4 corner of sec. 5, T. 23 N., R. 19 E., and contains the Drywood coal of the shelf classification which is persistant throughout the Foyil area. At the N 1/4 corner of sec. 5, T. 23 N., R. 19 E., a coal which the writer believes to be the Drywood is overlain by 0.5 feet of black fissile shale, which is in turn overlain by an 8 inch silty, dark gray, impure limestone which is the local cap rock of the Drywood. Lohman[1] mapped this limestone as the Doneley and called the underlying coal the Rowe. Twenty-eight feet below this coal is a thin, dark, fossiliferous, impure limestone,

[1]Lohman, C., Jr., Unpublished Master of Science Thesis, University of Oklahoma, 1952.

which Lohman mapped and called Sam Creek. Because of the similarity of the lithology to other occurrences and the interval from this unit to the overlying Bluejacket, the writer believes this limestone to be the Doneley. At this locality the limestone is a cap rock for a 3-inch coal believed to be the Rowe coal. About 6.5 feet below this coal is another coal 1 inch in thickness.

The Bluejacket-Doneley interval is at most places covered to such an extent that little can be seen. Lithologically the rocks of interval consist of gray to gray-black to black fissile shale and tan silty shale and contain some clay ironstone beds. At the northeast corner of sec. 16, T. 22 N., R. 18 E., this interval is 5.5 feet of gray shale. The Drywood coal and associated sediments are gone because of pre-Bluejacket erosion. The Drywood coal is fairly persistant throughout the area and at most places is capped by black fissile shale. This coal varies greatly in thickness and development. At some localities it is a series of interbedded coal and shale beds and at others it attains a thickness of 14 inches or more of well developed coal. It has been strip mined to a small extent locally for private use. At some localities the coal Lohman thought to be the Rowe coal is probably the Drywood coal. Since the work done by Lohman, more information about this interval has become available.

The Doneley limestone is a new stratigraphic name. It was named and described by Louie P. Chrisman[1] in 1951 for its exposure in the NW 1/4 of sec. 16, T. 26 N., R. 20 E., and the name appears in print in the *Proceedings of the Oklahoma Academy of Science* for 1952. It is named for the Doneley School (subsequently renamed the Pheasant Hill School) in sec. 16, T. 26 N., R. 20 E. At the type locality this limestone is black on fresh exposure and weathers red, compact, finely crystalline, and 0.3 feet thick. In the Foyil area, the Doneley is variable in color from dark red to gray to black, fossiliferous, and silty. It occurs in characteristic association with a coal and intervening shale.

The Doneley limestone extends across the entire width of the Foyil area and is known to extend farther to the north and to the south.

A faunule from the Doneley limestone in the SW 1/4 of sec. 14, T. 23 N., R. 18 E., includes:

Crinoid stem ossicles
Composita sp.
Chonetes granulifer Owen
Mesolobus mesolobus (Norwood and Pratten)
Marginifera missouriensis (Girty)
Lophophyllidium magnificum (Morgan)

Astartella vera Hall was found in the Doneley limestone near the S 1/4 corner of sec. 1, T. 22 N., R. 18 E.

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[1]Chrisman, Louie P., "Geology of the Big Cabin Creek Area, Craig County, Oklahoma," Unpublished Master of Science Thesis, University of Oklahoma, sec. 32, p. 64, 1952.

The coal of which the Doneley limestone is the cap rock is persistant throughout the Foyil area and extends both north and south. This coal is identified with the Rowe coal of Kansas. In the Foyil area, it is poorly developed at most localities. It is 2 to 4 inches thick and has an underclay associated with it. In the NW 1/4 of sec. 8, T. 23 N., R. 19 E., it attains a thickness of over 12 inches and is strip mined for local use. Here the coal is overlain by 0.06 feet of black limestone and the intervening shale interval is absent. Elsewhere the intervening shale interval is gray to tan, fossiliferous, and varies from 0.3 to 2.3 feet in thickness.

The rocks of the interval from the Rowe coal to the Sam Creek limestone are at no place seen in entirety. Near the N 1/4 corner of sec. 16, T. 23 N., R. 19 E., a 1-inch coal and associated underclay is separated from the Rowe coal by 3.5 feet of gray and gray-black fissile shale and 3 feet of Rowe underclay. In an outlier capped by Bluejacket sandstone in the NW 1/4 of sec. 20, T. 23 N., R. 19 E., a 3-inch coal is present about 38 feet below a coal believed to be the Rowe. Northwest of this locality at the southeast corner of sec. 18, T. 23 N., R. 19 E., the exposed interval below the Rowe coal contains alternating gray to tan shale and clay ironstone beds.

This interval was calculated mathematically to be about 120 feet thick.

The Sam Creek or upper "brown" limestone was named by Lowman[1] in 1932. He designated the type section and the type locality at an exposure about one-eighth mile east of the center of sec. 15, T. 14 N., R. 18 E., along the south bank of Sam Creek in Muskogee County. The Sam Creek consists of 8.5 feet of alternating limestone and fossiliferous shale beds at Lowman's type locality. Newell[2] emended the original definition to restrict the name Sam Creek to the uppermost limestone at the type locality because it is the only one which is at all persistant.

In the Foyil area the Sam Creek was found at only two localities. At both localities it has approximately the same thickness and lithology. In the SE 1/4 of sec. 30, T. 23 N., R. 19 E., the Sam Creek limestone is dark gray on fresh exposure, dark red weathered, fossiliferous, silty, and 1.1 feet thick. A Sam Creek outcrop with these same characteristics was found in the center of sec. 4, T. 23 N., R. 19 E. In the SW 1/4 of sec. 4, T. 21 N., R. 18 E., along the south bank of Seminole Creek, a limestone outcrop similar to the above was found by Tillman.[3] Lohman, in the area

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[1]Lowman, S. W., Tulsa Geological Society Digest, Vol. 1, Unnumbered p. 34, 1932.

[2]Newell, N. D. and Wilson, C. W., Jr., Oklahoma Geological Survey, Bulletin No. 57, p. 49, 1937.

[3]Tillman, J. L., Unpublished Master of Science Thesis, University of Oklahoma, p. 40, 1952.

to the north found what he thought to be the Sam Creek with an entirely different lithology. He also found a persistant coal underlying this limestone. The writer believes that where this limestone was found associated with coal it is actually the Doneley limestone and underlying Rowe coal. No coal was found underlying the Sam Creek in the Foyil area.

Dictyoclostus americanus Dunbar and Condra was collected from the Sam Creek limestone in the SE 1/4 of sec. 30, T. 23 N., R. 19 E.

Fig. 8. Sam Creek limestone 1.1 feet thick near the east 1/4 corner of sec. 30, T. 23 N., R. 19 E.

At the locality of sec. 30, T. 23 N., R. 19 E., the lower "brown" limestone or Spaniard and the intervening interval between the two "brown" limestones is fairly well exposed. Here this interval consists of 2.3 feet, very fine, buff, thin bedded sandstone, about 3.3 feet of gray, silty shale, 1.5 feet of black fissile shale, about 0.2 feet of slightly fossiliferous clay ironstone, and about 1 foot of fossiliferous, black, fissile shale.

The Spaniard limestone was named and first described by Lowman[1] in 1933 from outcrops along Spaniard Creek in the SW 1/4, NE 1/4 of sec. 11, T. 13 N., R. 18 E., south of Muskogee. Three outcrops believed to be the Spaniard limestone were found in the Foyil area. In the Foyil area the Spaniard is a zone of interbedded clay ironstones, impure limestones, and calcareous shales. In the NE 1/4 of sec. 10, T. 23 N., R. 19 E., in the bed of Rock Creek, cone-in-cone structure is present in the interbedded black, fissile, calcareous shale interval. In the SE 1/4 of sec. 30, T. 23 N., R. 19 E., the Spaniard consists of 0.33 feet of dark red, impure, highly fossiliferous limestone, 0.1 feet of highly fossiliferous black fissile shale, and 0.13 feet of dark red, highly fossiliferous, compact, limestone.

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[1] Lowman, S. W., Tulsa Geological Society Digest, Vol. 2, p. 31, 1933.

The following fossils were found at the above locality:

Crinoid stem ossicles
Proetid trilobite
Delocrinus sp.
Aviculopecten sp.
Juresania ovalis Dunbar and Condra
Derbyia crassa (Meek and Hayden)
Composita subtilita (Hall)
Neospirifer cameratus (Morton)

Underlying the Spaniard limestone is 5 feet of lavender to black fissile shale. Below this shale is a 4-inch impure coal. In the west central part of sec. 32, T. 23 N., R. 19 E., a thin coal whose stratigraphic position is below that of the previously mentioned coal was found. However, because of the covered nature of the interval between these two coals no field measurement was possible.

The remaining interval to the Warner sandstone is completely covered so that no part of this interval was observed. It certainly does not contain any resistant units of any appreciable thickness. This interval was calculated mathematically to be about 102 feet.

Warner Sandstone

The Warner sandstone of this report is the Little Cabin sandstone of older reports. Ohern[1] named the Little Cabin sandstone for exposures on Little Cabin Creek in Craig

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[1]Ohern, D. W., "Geology of the Nowata and Vinita Quadrangles," Unpublished manuscript on file at the office of the Oklahoma Geological Survey, 1914. (not seen)

County, Oklahoma. The first description of the Little Cabin in print was by Cooper in 1928.[1] This sandstone unit since has been traced south into the Warner sandstone member of the McAlester formation south of the Arkansas River. Because these two names refer to the same sandstone, the Oklahoma Geological Survey has dropped the term Little Cabin in favor of the term Warner.[2] This sandstone extends northward into Kansas.

The Warner sandstone is the first conspicuous stratum below the Bluejacket and forms a low subdued escarpment which gives relief to the otherwise featureless plain in the area. The characteristics of the Warner are typical of the other sandstones in the Krebs and Cabaniss groups. It varies from well developed sandstone to sandy shale. At some localities the Warner was mapped as best the outcrop could be inferred from the gentle rolling topography and sandy soil.

The Warner varies in thickness from 3 feet to about 31 feet. Its maximum thickness was measured near the E 1/4 corner of sec. 31, T. 22 N., R. 19 E., along the section line south of Pryor Creek. Here it is 31 feet of tan, fine grained, well indurated sandstone. Northward, the Warner becomes thinner but near the northern boundary of the Foyil

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[1] Cooper, G. L., Proceedings of the Oklahoma Academy of Science, Vol. 7, pp. 160-161, 1920.

[2] Branson, Carl C., Personal Communication.

Fig. 9. About 3 feet of massive well developed Warner sandstone in sec. 8, T. 22 N., R. 19 E.

area it is again much thicker and has the same lithology as mentioned above. In the center of sec. 8, T. 22 N., R. 19 E., the Warner is about 3 feet thick, massive, tan, medium grained, and fairly well indurated.

Interval From the Warner Sandstone to the Base of the Krebs Group

Within the Foyil area the basal beds of the Krebs group rest unconformably on the Fayetteville shale of Chester

(Upper Mississippian) age and apparently conformably on the Atoka formation. The Mississippian-Pennsylvanian contact is a wide spread regional unconformity and represents a considerable hiatus. However, in the Foyil area there is no noticeable topographic relief on the pre-Krebs surface and beds succeed each other across the boundary in apparent conformity.

In the Foyil area the interval from the Warner sandstone to the base of the Krebs group is somewhat variable. Near the E 1/4 of sec. 31, T. 22 N., R. 19 E., in the south bank of Pryor Creek where the base of the Krebs group rests with apparent conformity on Atoka limestone, this interval is about 33 feet. Where the base of the Krebs group rests unconformably on the Fayetteville shale, this interval is about 50 feet. Pre-Warner sediments consist of black, fissile shale near the base, grading vertically into gray to gray-yellowish silty shale. Throughout most of the Foyil area there is a yellowish tan, silty, fine grained sandstone containing abundant Taonurus. No attempt was made to map this unit but it is fairly persistant. It is best seen near the northwest corner of sec. 11, T. 23 N., R. 19 E., in the "bar" ditch on the east side of U. S. Highway 69. Here it is underlain and overlain by black fissile shale. Newell[1]

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[1]Newell, N. D. and Wilson, C. W., Oklahoma Geological Survey, Bulletin 57, pp. 33-34, 1937.

questionably identified this sandstone as the Blackjack School sandstone member of the Atoka formation on the basis of the presence of _Taonurus_ in it and in Atoka sandstones farther south. The writer believes this sandstone may actually be Hartshorne sandstone in age. However no conclusive evidence can be here offered. _Taonurus_ has a long range so that its presence cannot necessarily be used as definite evidence for correlation. If this _Taonurus_ bearing fine grained sandstone is Hartshorne in age, then the Krebs group in the Foyil area contains four formations.

CHAPTER III

STRUCTURE

The prevailing feature of the structure of the Foyil area is the regional dip of about 34-40 feet per mile in a west-northwest direction. Local variations in dip are present and most are due to fault drag. Because the dip is much too gentle to measure by clinometer, it was obtained by the three point method using known outcrop points, the elevations of which were estimated by reference to the U. S. Geological Survey topographic maps of Claremore and Pryor Quadrangles. The general strike of the beds is north-northeast.

The regional structure of northeast Oklahoma, of which the Foyil area is a part, consists of the gentle Prairie Plains Homocline, accentuated on the west flank of the Ozark uplift, with several northeast-southwest trending en echelon faults. The uplift of the central Ozark region carried upward with it the strata on all sides with decreasing dip away from the mountains.

The local structure in the Foyil area is complicated by several faults, varying from 1 to 3 miles in length. A fault zone with several small faults trending both northeast-southwest and northwest-southeast in secs. 15 and 22, T. 23 N., R. 16 E. was mapped as accurately as possible. It is impossible to map all of the small displacements which are present in the area, so only those large enough to show on areal photographs were mapped. Little is known of the detailed nature of the faults in the Foyil area. Their stratigraphic throw can be estimated but their exact throw, dip, and direction of movement cannot be accurately determined. All are presumed to be normal faults. Evidence for these faults was one or more of the following: visible displacement, fault drag, or interruption of the outcrop pattern.

The Big Cabin fault trends northeast-southwest and is a southward extension of the Big Cabin fault of the Whiteoak area.[1] Its downthrown side is to the northwest and it extends about 2 miles southwest into the Foyil area. Its throw is best estimated from exposures in the bed of Rock Creek in the NW 1/4 of sec. 10, T. 23 N., R. 19 E. The Fayetteville limestone is present immediately under the U. S. Highway 69 bridge over Rock Creek. Upstream to the northwest a short distance is an exposure that is probably Spaniard limestone. No accurate stratigraphic throw could be measured, but it is estimated to be near 125 feet here.

The Pryor Creek fault trends northeast-southwest from

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[1]Lohman, C., Jr., Unpublished Master of Science Thesis, University of Oklahoma, p. 52, 1952.

the SW 1/4 of sec. 28, T. 22 N., R. 19 E., to the southeast corner of sec. 36, T. 22 N., R. 18 E. It probably extends southward into the adjoining area. Fault drag in the Warner sandstone associated with this fault can be seen near the S 1/4 corner of sec. 29, T. 22 N., R. 19 E. The course of Pryor Creek in sec. 31, T. 22 N., R. 19 E., is controlled by this fault. Near the creek bottom on the south bank in this section an Atokan limestone as well as the underlying Fayetteville limestone is exposed due to this faulting. The southeast side of this fault is upthrown and the throw is estimated to be about 20 feet.

The Diver Creek fault trends northeast-southwest from the SW 1/4 of sec. 17, T. 23 N., R. 18 E., to the W 1/4 corner of sec. 30, T. 23 N., R. 18 E., and is downthrown to the northwest. In the SW 1/4 of sec. 17 in the floor of Diver Creek, fault drag in the Bluejacket can be seen. At the southwest corner of sec. 17, and about 400 yards east of the northwest corner of sec. 30, T. 23 N., R. 18 E., fault drag in the lower Taft is associated with this fault. North of this fault no well developed Taft sandstone is present so that there is no way to determine the throw of the fault, which is probably no more than 25 feet.

The Spencer Creek fault trends northeast-southwest and extends from about the N 1/4 corner of sec. 11, T. 23 N., R. 16 E., northward through sec. 2 and into the adjoining area. The downthrown side of this fault is to the west. Here the Lagonda sandstone on the upthrown side is at the same level as the Fort Scott limestone on the downthrown side. The throw therefore is approximately 25 feet.

The Verdigris River fault is en echelon with and probably directly associated with the Spencer Creek fault. It lies approximately one-half mile west of the Spencer Creek fault and extends from about the N 1/4 corner of sec. 10, T. 23 N., R. 16 E., northeastward through the northeast corner of sec. 3, T. 23 N., R. 16 E., and northward into the adjoining area. The downthrown side is covered with alluvium so the amount of throw of this fault cannot be determined. The downthrown side is to the northwest.

A fault zone consisting of several small faults trending both northeast-southwest and northwest-southeast is present in secs. 15 and 22, T. 23 N., R. 16 E. Because of the nature of the area no detailed information could be obtained. The approximate throw of these faults is thought to be about 15 feet.

The course of the Verdigris River is believed to be at least partially controlled by faulting, although no direct evidence was found. If the Verdigris were a consequent stream it would flow south-southeast. Instead it flows in a south-southwest direction. At many places it is a subsequent stream controlled by the regional structure. If it

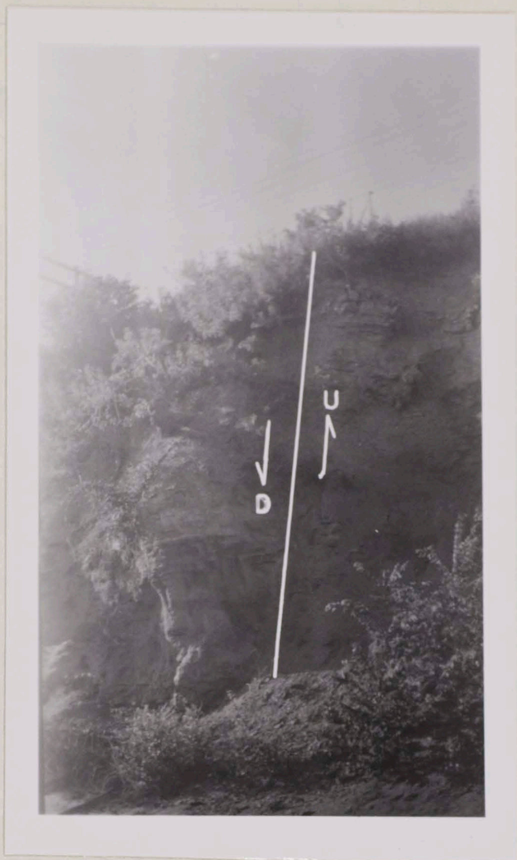

Fig. 10. Faulted Lagonda sandstone upthrown to the right with a throw of about 18 feet. Located in sec. 29, T. 22 N., R. 16 E., in railroad cut.

were not in part controlled by faulting, it would flow parallel to the regional strike and then pass through water gaps in the direction of its ultimate drainage. Instead of doing this, the Verdigris River flows parallel to the regional strike and at several places it turns and flows almost due west (see fig. 11). This condition can be seen about one mile north of Sageeyah in sec. 13, T. 22 N., R. 15 E., and in the northeast part of T. 23 N., R. 16 E. At the latter

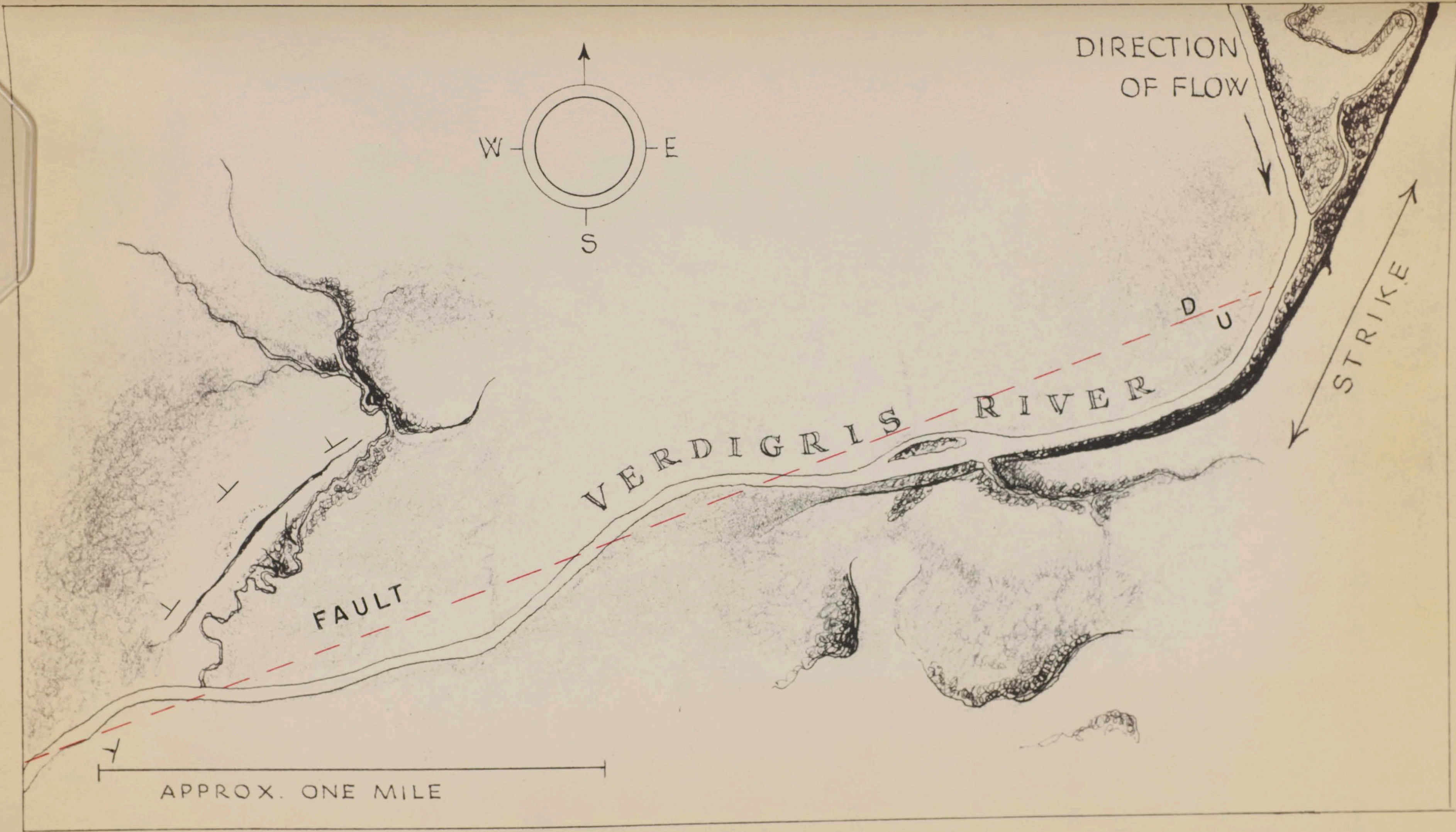

Fig. 11. Diagram Showing the Course of the Verdigris River Being Controlled by Possible Faulting in the Northeast Part of T. 23 N., R. 16 E.

locality the river flows due west and cuts into a surface expressed dome.

The Spencer Creek fault, the Verdigris River fault, the fault zone in secs. 15 and 22, T. 23 N., R. 16 E., and the faults partially controlling the course of the Verdigris River are post-Cabaniss in age. They are believed to be related to the well known belts of en echelon faults in north central Oklahoma, having been formed at the same time and by the same forces. The en echelon faults of north central Oklahoma are known to cut beds as young as upper Virgilian and perhaps are Pontotoc in age.

The Diver Creek fault is pre-Tiawah -- post-Taft in age.

The Big Cabin fault and the Pryor Creek fault have the same trend as the Diver Creek fault and may be of the same age.

Other faults in northeast Oklahoma are known to be pre-Tiawah -- post-Taft and follow the same northeast-southwest trend. The Diver Creek fault, the Big Cabin fault, and the Pryor Creek fault are probably genetically related to these faults.

CHAPTER IV

INTER-REGIONAL CORRELATIONS

Kansas - Oklahoma

The Krebs and Cabaniss groups of northeast Oklahoma are similar lithologically to the Cherokee group of Kansas and Missouri. Exact equivalence of several beds of the Oklahoma and Kansas sections and the approximate correlation between other members of the groups between the two states have been recognized for several decades. The greatest differences between the Oklahoma and Kansas sections are the thinning of the interval, the lesser percentage of sandstone in Kansas, and the better developed cyclothems of Kansas.

In the past there has been some confusion in Oklahoma as to exactly which limestone of the section was the lower Fort Scott or Blackjack Creek limestone of Kansas. The older reports covering Rogers County and their accompanying maps seem to indicate that their writers regarded what is now known to be the Breezy Hill of Oklahoma as the lower Fort Scott of Kansas. Recent work by Howe and mapping by Warren of the Oklahoma Geological Survey has shown the relationships between the Breezy Hill and the upper and lower Fort Scott limestones of Oklahoma. On the basis of this work, the Fort Scott coal of older Oklahoma reports is known to be the Iron Post coal and the Mulky coal of Kansas is known to be absent in northeast Oklahoma.

The Lagonda sandstone and Verdigris limestone are both traceable from Oklahoma into similar beds in Kansas. The Chelsea sandstone plays out northward and is not present in Kansas. The correlation between the Tiawah limestone and the cap rock of the Tebo coal of Kansas and Missouri was established during a field conference in August, 1951, participated in by Searight and Howe of Missouri, and Dott, Branson, and Oakes of Oklahoma. In Kansas the Tebo coal is known as the "Pilot" coal because it is the first coal overlying the economically important Wier-Pittsburg coal. The Taft sandstone dies out northward and is not present in Kansas. The Bluejacket sandstone of Oklahoma is equivalent to the Bluejacket sandstone of Kansas and is traceable across the state line.

The northernmost outcrop of the Inola limestone is in the NE 1/4 of sec. 6, T. 23 N., R. 19 E., of the Foyil area. The Doneley limestone and Rowe coal have been traced northward. Work done by Branson and Howe has established the equivalence between the Doneley of Oklahoma and the cap rock of the Rowe coal of Kansas. The Little Cabin sandstone of Kansas is the lithologic equivalent of the Warner sandstone and is traceable across the state line.

The Krebs and Cabaniss rocks together are nearly, but not quite the same, stratigraphically, as the Cherokee rocks of southeastern Kansas. The lower part of the Krebs group is older than any Cherokee rocks of Kansas and the Thurman sandstone, the Stuart shale, and the lower part of the Senora formation are probably not represented in Kansas because of the progressive northward overlap in the post-Boggy rocks.[1]

Northeast Oklahoma - McAlester Basin

The relationship between the Krebs-Cabaniss rocks of Oklahoma north of the Arkansas River and the rest of the mid-continent region is generally clear because of lithologic similarity. However, this is not the case basinward. The relationship of the Krebs-Cabaniss rocks to the lower Desmoinesian rocks of the McAlester Basin is obscured by dissimilar lithology and greatly increased thicknesses. Newell and Wilson[2] in their work on the Muskogee-Porum district made an important contribution toward establishing correlation between the two areas.

Under the new scheme of basin classification by Oakes[3]

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[1]Oakes, M. C., Bulletin of the American Association of Petroleum Geologists, Vol. 37, No. 6, pp. 1525-1526, 1953.

[2]Newell, N. D. and Wilson, C. W., Oklahoma Geological Survey, Bulletin 57, 1937.

[3]Ibid., Oakes, M. C.

the Cabaniss group contains the following formations in descending order: the Senora formation, the Stuart shale, and the Thurman sandstone.

The horizon of the base of the lower Fort Scott limestone, which is the boundary between the Cabaniss and Marmaton groups in the Foyil area, cannot be traced into the McAlester Basin except to say that it lies somewhere within the lower Calvin sandstone. Oakes in his recent work on this part of the section considered the Breezy Hill as a part of the Fort Scott limestone. Therefore the Breezy Hill limestone also is equivalent to the Calvin sandstone of the McAlester Basin. The top of the Calvin in northeast Oklahoma is now placed above the top of the upper Fort Scott limestone.

The Verdigris limestone becomes thinner southward and has not been found south of sec. 26, T. 16 N., R. 14 E., in Wagoner County.[1]

In the Foyil area the Senora formation of the Cabaniss group is underlain by the Boggy formation of the Krebs group. The boundary between the Boggy and the Senora is indistinct north of the Arkansas River and is placed within the shale interval between the upper Taft sandstone and the Tiawah limestone at a structural break within the interval discovered by Oakes and confirmed by Branson. A structural

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[1]Lontos, J. T., "The Geology of the Coweta Area, Wagoner, Muskogee, and Okmulgee Counties, Oklahoma," Unpublished Master of Science Thesis, University of Oklahoma, p. 15, 1952.

break found by the writer in the Foyil area also confirms this to a certain degree. The Diver Creek fault cuts Taft and older sediments but does not cut Tiawah and younger sediments in the east central part of T. 23 N., R. 18 E. The Tiawah limestone is then the lowest named member in the Senora formation, but not the exact base.

The Krebs group of the basin classification of Oakes is the oldest group of Desmoinesian age and contains four formations listed in descending order: the Boggy formation, the Savanna formation, the McAlester shale, and the Hartshorne sandstone.

The top of the Boggy formation as previously mentioned lies in the shale interval between the Tiawah limestone and the Taft sandstone. The base of the Boggy is now placed at the base of the Bluejacket sandstone and the formation includes the Taft sandstones, the Inola limestones, and the Bluejacket sandstone. The base of the Boggy was previously placed lower in the section. The strata affected in the reclassification include the Doneley limestone and the Rowe coal. These units are probably the equivalent of the "Lower Boggy" coal and the persistent limestone above mentioned by Newell.[1]

The Savanna formation as defined in the Foyil area includes all strata from the base of the Bluejacket sandstone

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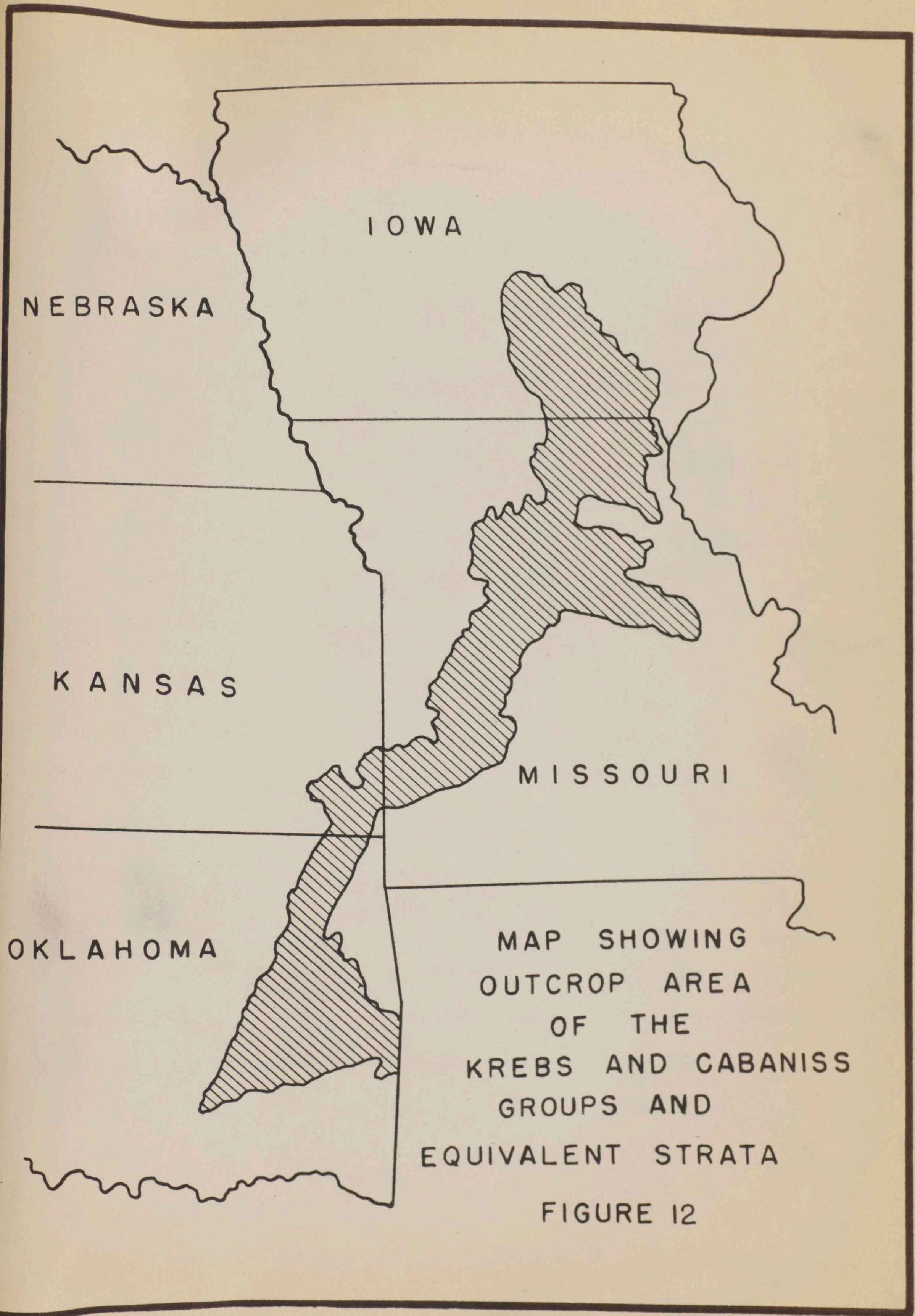
[1]Newell, N. D. and Wilson, C. W., Oklahoma Geological Survey, Bulletin 57, p. 53, 1937.

to the base of the Spaniard limestone and contains the Doneley limestone, the Sam Creek limestone, and the Spaniard limestone.

The McAlester formation underlies the Savanna formation and includes all the strata from the base of the Spaniard limestone to the shale interval below the Warner sandstone in the Foyil area.

The presence of any Hartshorne sandstone in the Foyil area is questionable. As previously mentioned the fine grained Taonurus-bearing sandstone that was questionably identified as the Blackjack School sandstone of the Atoka formation by Newell may actually be the Hartshorne equivalent in the Foyil area.



MAP SHOWING OUTCROP AREA OF THE KREBS AND CABANISS GROUPS AND EQUIVALENT STRATA

FIGURE 12

CHAPTER V

HISTORICAL GEOLOGY

During middle Pennsylvanian time, the Foyil area was situated near the southern margin of a vast moderately stable shelf. The area to the north, Kansas, Nebraska, Missouri, and Iowa was a part of the stable interior of the continent. A sedimentary trough, the Ouachita geosyncline, existed in southern Oklahoma and Arkansas, with its axis, or line of greatest subsidence, believed to be south of McAlester. The name given the area between the shelf margin and the Ouachita geosyncline is the McAlester Basin. Between the axis of the geosyncline and the shelf margin, the rate of thinning of sediments diminishes shelfward to the shelf margin where their thickness is constant, or nearly so.

At the beginning of Pennsylvanian time, the seas were restricted to the center of the basin, but by Morrowan time the sea had advanced northward to about the latitude of T. 23 N., with accompanying deposition of Morrowan sediments. Regional uplift brought Morrow time to a close and the seas withdrew into the basin.

Atoka time was chiefly a period of infilling of the

McAlester Basin. Great thicknesses of sediments accumulated because of the rapid subsidence of that area. These deposits thin rapidly northward by overlap and convergence.

Beginning in Desmoinesian time there was a rapid advance of the seas northward over the shelf area. The lower Desmoinesian rocks of eastern Oklahoma is in overall aspect a single sedimentary sequence formed by a single major advance of the sea. There is, however, a break in sedimentation at the top of the Boggy in the eastern and northeastern part of the state. The Thurman and Stuart pinch out northward between the Boggy and Senora south of the Foyil area, indicating a hiatus between the Taft sandstone and the Tiawah limestone. Post Taft -- pre-Tiawah faulting and an important paleontological break between the Inola limestone and the Tiawah limestone is the basis on which the top of the Boggy is placed within the Taft - Tiawah interval. The post-Taft -- pre-Tiawah faulting probably accompanied a slight uplift which resulted in nondeposition of, or truncation of, the Thurman and Stuart.

Lower Desmoinesian sediments, like Atoka sediments, thin rapidly northward both by onlap and convergence. In the McAlester Basin the Krebs-Cabaniss sediments are about 7,000 feet thick and thin to about 838 feet in the Foyil area. Most of the convergence occurs in the McAlester, Savanna, and Boggy formations.

During lower Desmoinesian time, the mid-continent shelf area experienced several minor uplifts or oscillations in sea level which produced cyclothems. These cyclothems are best developed in Kansas where Abernathy, modified by Moore,[1] has described 16 cyclothems. The less well developed and fewer cyclothems in Oklahoma indicates that tectonically the region, including the Foyil area, was intermediate between the mid-continent shelf area and the McAlester Basin.

The McAlester Basin continued to subside rapidly during all of Krebs time and the sediments in that region are many times thicker than those of the shelf area and are not detectibly cyclical in nature. During Cabaniss time the subsidence rate of the basin diminished considerably, so that the deposits of the basin are only about two or three times as thick as those on the shelf.

By upper Desmoinesian time the shelf had become more stable than it was in lower Desmoinesian time and the sediments differ in overall lithologic character.

The depositional environment of the Foyil area was that of a moderately stable shelf passing into a more stable shelf to the north and a subsiding basin to the south. The deposits are mostly marine. The coals and underclays are the only definite non-marine deposits. The water was shallow,

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[1] Moore, R. C., "Divisions of the Pennsylvanian System of Kansas," Kansas Geological Survey, Bulletin No. 83, pp. 43-47, 1949.

turbulent, and muddy. The sandstones show, especially by cross-bedding, evidence of strong current action.

CHAPTER VI

ECONOMIC PRODUCTS

Oil and Gas

There is some oil and gas production within the Foyil area, but none of importance. Gas production is in many cases for private consumption.

There are three main producing horizons within the Foyil area. These are the Bartlesville and Burgess sandstones and the "Mississippi lime" of drillers.

The Bartlesville sandstone is the sub-surface equivalent of the Bluejacket sandstone. Only the western part of the Foyil area produces from the Bartlesville because a large part of the area lies to the east of the Bluejacket outcrop or it is too near the outcrop for possible production. West and southwest of Chelsea, Oklahoma, the Bartlesville has been a prolific producer in the past.

The Burgess is a producing sand lying above, but close to, the "Mississippi lime". The Burgess as here described is probably a conglomeratic zone at the Mississippian-Pennsylvanian contact.

The "Mississippi lime" of drillers includes all of the limestone in the Mississippian system. No further explanation is here attempted.

Oil and gas accumulation in the Bartlesville and Burgess in the Foyil area, and surrounding areas, seems to be controlled principally by variation in the porosity and permeability of the sandstone rather than by structure. Producing areas as a whole seem to be unrelated to structure.

There are three fields in the Foyil area that produce or have produced oil or gas in the past, and all are in the portion of the area located in Rogers County.

The main producing area is the southern extension of the Chelsea field in the northwestern part of T. 23 N., R. 17 E. The Chelsea field contains the oldest oil well in Oklahoma, and produces principally from the Bartlesville sand at about 460 feet. Some oil has been found in the Burgess sand at about 600 feet.

Another producing area was the Sageeyah pool which is located in secs. 24, 25, and 36, T. 22 N., R. 15 E. The oil production was from the Bartlesville sand at about 650 feet and there was some gas from the Burgess sand at 970 feet.

There has been considerable production from the Foyil structure in sec. 6, T. 22 N., R. 17 E., just south of the village of Foyil.

Most of the drilling done in recent years has been mainly to produce gas for farm consumption.

The prospect for future production in the area seems poor. Most of the possible oil structures have been tested and there is at present no exploration for commercial production. The writer believes that the shallow depth at which the producing horizons are found discourages any oil exploration in the future. However, a small dome in parts of secs. 4, 5, 8, and 9, T. 23 N., R. 16 E., may be a possible productive structure.

Coal

A great many beds of coal occur in the Krebs and Cabaniss groups. However, most of them are thin and of no economic importance. At least six of the coals in the Foyil area have been mined in the past, mostly for local use.

The most important coal commercially in the Foyil area is the Broken Arrow coal. The Rogers County Coal Company is actively engaged in stripping this coal in sec. 16, T. 22 N., R. 16 E., at the present time. The Broken Arrow coal is persistent and where it has been commercially strip mined, it is about 17 inches in thickness. This coal is fairly hard, bituminous, and has good burning qualities.

Other coals which have been mined locally are: the Iron Post coal, the coal underlying the upper Taft sandstone, the Wier-Pittsburg (?) coal, the Drywood coal, and the Rowe coal.

The localities where mining has been done are shown on the geologic map which accompanies this report.

The coal industry of northeast Oklahoma has a limited future. The coal resources of the area have by no means been fully developed. However, the coal industry has been on the decline because of a shrinking market. At present most towns-people use natural gas for home heating and many farmers have changed from coal to liquified petroleum gas.

Building Stones

There is an adequate supply of building stone for local use in the area. The sandstones are in places thin-bedded and commonly weather into joint controlled blocks, so as to make good building stone. At some places deposition from ground water has made them quartzitic.

Water Supply

There are many small ponds in the area that have been formed by the damming of creeks. These small ponds serve as an excellent water supply for farm animals. Water for local use is obtained by drilling wells. Because of the westward dip of the sediments, and the character of the sandstones, not too much difficulty is encountered in finding localities for good water wells. Locally, ground water contains a large amount of gas and is unfit for use.

Others

Since the supply of gravel for county road use is limited, shale from abandoned strip pits is used to some extent by the county. The phosphatic shales are a possible source of phosphate for farm use. However, their future development is not likely. The underclays of the numerous coal beds are a possible source of clay for ceramics but are in most cases too thin for economic development.

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APPENDIX

MEASURED STRATIGRAPHIC SECTIONS

Bed		Feet
	1. Sec. 36, T. 22 N., R. 15 E. Measured east up near vertical escarpment 0.13 miles west of the N 1/4 corner of the section.	
12	EXCELLO shale, black, fissile, contains phosphatic nodules, not measured	
11	BREEZY HILL limestone, gray to buff, silty, highly fossiliferous....................	6.8
10	KINNISON shale, gray, fossiliferous, calcareous..................................	1.5
9	IRON POST coal..................................	1.25
8	Underclay..................................	0.66
7	Shale, gray..................................	1.75
6	Limestone, dirty gray, sandy, impure, fossiliferous..................................	0.5
5	Shale, gray-buff, silty, iron-stained...........	8.5
4	Limestone, dark brown, micaceous, impure, fossiliferous, nodular....................	0.2
3	Shale, gray, iron-stained, contains flow structure..................................	3.3
2	LAGONDA sandstone, tan, medium grained, micaceous..................................	2.6
1	Shale, gray, iron-stained, silty, micaceous, carbonaceous, not measured	
	2. Sec. 27, T. 22 N., R. 15 E. Measured west up near vertical escarpment on west bank of the Verdigris River 0.25 miles northwest of the southeast corner of the section.	
10	FORT SCOTT limestone, not measured	
9	EXCELLO shale, black, fissile, contains abundant phosphatic nodules........................	5.3
8	BREEZY HILL limestone, gray, silty, fossiliferous..................................	7.0

Bed		Feet
7	KINNISON shale, gray, silty, carbonaceous........	0.5
6	IRON POST coal..	1.2
5	Underclay..	1.1
4	Shale, gray..	5.0
3	Limestone, dirty gray, sandy, impure..............	0.5
2	Shale, gray, iron-stained..............................	8.2
1	LAGONDA sandstone, tan, micaceous, carbonaceous, shaley, not measured	

3. Sec. 18, T. 22 N., R. 16 E. Measured south up near vertical escarpment on the south bank of the Verdigris River 0.08 miles north of the W 1/4 corner of the section.

7	FORT SCOTT limestone, not measured	
6	EXCELLO shale, black, fissile, contains phosphatic nodules..................................	5.0
5	BREEZY HILL limestone, tan to gray, silty, fossiliferous..................................	9.0
4	Shale, partially covered, black, fissile at top, about..................................	35.0
3	VERDIGRIS limestone, buff, fossiliferous........	5.5
2	Shale, black, fissile, contains phosphatic nodules..................................	2.5
1	Shale, gray, contains clay ironstones, not measured.	

4. Sec. 8, T. 22 N., R. 16 E. Measured south up south bank of creek 0.06 miles south of the E 1/4 corner of the section.

6	BREEZY HILL limestone, not measured	
5	KINNISON shale, gray, silty........................	0.9
4	IRON POST coal..	1.5
3	Underclay, about..	1.0
2	Shale, gray, silty, partly covered................	11.0
1	Limestone, gray to tan, sandy.....................	0.9

5. Sec. 3, T. 23 N., 17 E. Measured northwest along road up hill from a point 0.17 miles northwest of the southeast corner of the section to the top of the hill.

13	EXCELLO shale, covered, not measured	
12	BREEZY HILL limestone, light gray to buff, fossiliferous..................................	7.5
11	KINNISON shale, gray to black.....................	1.8
10	IRON POST coal..	1.3

Bed		Feet
9	Underclay, iron-stained..........................	0.3
8	Shale, covered..................................	2.0
7	LAGONDA sandstone, tan, thin bedded, silty......	2.9
6	Shale, gray, silty..............................	12.0
5	VERDIGRIS limestone, compact, light gray, fossiliferous..............................	6.1
4	Shale, black, fissile, contains phosphatic nodules.................................	2.5
3	Shale, gray to tan..............................	10.5
2	Sandstone, tan, silty, crossbedded..............	1.1
1	Shale, gray, not measured	

6. Sec. 6, T. 23 N., R. 17 E. Measured from the base of the hill 0.24 miles west of the N 1/4 corner of the section west to the top of the hill.

Bed		Feet
11	FORT SCOTT limestone, not measured	
10	EXCELLO shale, black, fissile, contains phosphatic nodules.................................	4.0
9	BREEZY HILL limestone, buff, dense, fossiliferous..................................	5.5
8	KINNISON shale, gray to gray-black..............	2.0
7	IRON POST coal..................................	1.5
6	Underclay, iron-stained.........................	0.3
5	Shale, sandy near middle, partially covered.....	6.2
4	LAGONDA sandstone, tan, micaceous, massive......	2.0
3	Shale, gray to buff, sandy......................	18.5
2	VERDIGRIS limestone, buff, dense, fossiliferous.	4.2
1	Shale, black, fissile, not measured	

7. Sec. 18, T. 22 N., R. 17 E., and secs. 23 and 24, T. 22 N., R. 16 E. Measured from base of escarpment 0.4 miles east of the southwest corner of sec. 18 west to the top of the strip pit 0.20 miles southwest of the northeast corner of sec. 23.

Bed		Feet
14	VERDIGRIS limestone, yellowish-brown to orange, silty, not measured	
13	Shale, black, fissile, contains abundant phosphatic nodules..........................	2.0
12	Shale, gray, iron-stained.......................	6.0
11	Shale, gray, silty..............................	16.0
10	Sandstone, buff to tan, fine grained............	3.5
9	Shale, gray, contains brown clay ironstones.....	22.0
8	BROKEN ARROW coal...............................	1.5

Bed		Feet
7	Covered, about....................................	50.0
6	CHELSEA sandstone	
	Sandstone, silty, tan, partially covered, about....................................	13.5
	Sandstone, tan to yellow-brown, medium grained, massive, crossbedded, about......	44.0
5	Covered, about....................................	10.0
4	TIAWAH limestone, dirty gray to tan, silty, fossiliferous, about......................	3.9
3	Covered, probably silty shale..................	3.5
2	"WHITE" sandstone, buff, iron-stained, thin bedded....................................	2.5
1	Shale, silty, not measured	

8. Sec. 16, T. 22 N., R. 16 E. Measured from the bottom to the top of the strip pit about 0.17 miles south of the N 1/4 corner of the section.

Bed		Feet
7	VERDIGRIS limestone, gray on fresh exposure, orange to brown weathered, compact, fossiliferous..............................	11.1
6	Shale, gray-black, iron-stained contains phosphatic nodules, variable thickness........	6.0
5	Shale, gray, sandy, micaceous, contains abundant flattened gray siliceous concretions..	22.8
4	Shale, light gray, silty, micaceous.............	24.8
3	Shale, gray, contains thin clay ironstone beds..	9.7
2	BROKEN ARROW coal..............................	1.6
1	Underclay, not measured	

9. Sec. 27, T. 22 N., R. 16 E. Measured up north side of strip pit in NW 1/4 of the section.

Bed		Feet
8	VERDIGRIS limestone, yellowish-orange, silty, fossiliferous, not measured	
7	Shale, black, fissile..........................	2.0
6	Shale, gray, silty.............................	5.5
5	Sandstone, massive, fine grained, tan...........	10.0
4	Shale, gray, silty, about......................	44.0
3	Shale, gray, silty, contains clay ironstones....	5.0
2	BROKEN ARROW coal..............................	1.8
1	Underclay, not measured	

10. Sec. 13, T. 22 N., R. 16 E. Measured in strip pit 0.2 miles west of Rogers County Coal Company loading dock.

Bed		Feet
8	Shale, black, fissile, contains phosphatic nodules, not measured	
7	Shale, gray-buff, silty, partially covered......	25.3
6	Sandstone, tan, fine grained, massive...........	0.7
5	Sandstone, tan, silty, thin bedded..............	0.3
4	Sandstone, tan-buff, medium grained, massive....	1.9
3	Sandstone, tan, thin bedded, silty..............	2.5
2	Shale, gray, silty, carbonaceous................	25.0
1	BROKEN ARROW coal...............................	1.6

11. Sec. 28, T. 22 N., R. 17 E. Measured south up hill 0.33 miles south of the northeast corner of the section.

5	CHELSEA sandstone, not measured	
4	Shale, gray, lower part black, fissile..........	5.7
3	Clay, gray, ironstained.........................	2.5
2	"WHITE" sandstone, massive, tan, contains ferruginous concretions....................	5.5
1	Shale, gray, not measured	

12. Sec. 27, T. 22 N., R. 17 E. Measured from the base of the hill 0.17 miles north to the top of the hill. (North from Southeast corner) See p. 37

15	CHELSEA sandstone, not measured	
14	Shale, black, fissile, contains pea-sized phosphatic nodules.............................	1.5
13	TEBO (?) coal, smutty...........................	0.1
12	Underclay, gray.................................	3.0
11	"WHITE" sandstone, buff, fine grained, massive, micaceous.......................................	1.5
10	Shale, gray-gray black, fissile, about..........	16.5
9	UPPER TAFT sandstone, buff, silty, contains ferruginous material.........................	5.1
8	Shale, gray to gray-black, fissile..............	13.6
7	Coal, smutty....................................	0.5
6	Underclay, gray-black...........................	0.5
5	Covered, about..................................	85.0
4	MIDDLE TAFT sandstone, tan, thin bedded.........	4.1
3	Covered, about..................................	33.0
2	LOWER TAFT sandstone, buff, iron-stained, thin bedded..	5.3
1	Shale, silty, buff, not measured	

13. Sec. 2, T. 22 N., 17 E. Measured west up hill along the south section line near the southwest corner of the section.

Bed		Feet
6	CHELSEA sandstone, tan, micaceous, massive sandstone, conglomeratic near the base, not measured	
5	Shale, black, fissile	7.5
4	TIAWAH limestone, gray, fossiliferous, compact	1.8
3	Shale, gray to buff, silty	5.5
2	"WHITE" sandstone, gray, micaceous, thin bedded	4.0
1	Shale, sandy, tan, micaceous, not measured	

14. Sec. 36, T. 23 N., R. 17 E. Measured from a point near the base of the hill 0.08 miles west of the northeast corner of the section west up the hill.

5	CHELSEA sandstone, tan, fine grained, micaceous, crossbedded-conglomeratic at the base, not measured	
4	Shale, black, fissile, contains pea-sized phosphatic nodules	2.5
3	TEBO coal	0.06
2	Underclay	2.0
1	Shale, gray, sandy, not measured	

15. Sec. 1, T. 22 N., R. 17 E. Measured from the base of the escarpment at the northeast corner of the section south to the top of the escarpment.

15	CHELSEA sandstone, not measured	
14	Shale, gray to gray-black, fissile, about	0.7
13	Covered, contains gray iron-stained clay	11.0
12	Shale, gray, sandy, partially covered	20.0
11	"WHITE" sandstone, gray to tan, fine grained, micaceous	5.5
10	Covered, probably shale	8.5
9	UPPER TAFT sandstone	
	Buff, micaceous, thin bedded	1.5
	Tan to buff, micaceous, massive	1.5
	Tan, micaceous, thin bedded	2.8
8	Shale, gray, silty	0.5
7	Sandstone, buff, fine grained, micaceous, massive	2.3
6	Shale, gray to gray-black	11.9
5	Coal, interbedded with clay, smutty	5.5
4	Shale, gray	3.5
3	Covered, probably shale	11.0
2	MIDDLE TAFT sandstone, brown to tan, massive	0.8
1	Covered, not measured	

Bed		Feet
	16. Sec. 15, T. 22 N., R. 17 E. Measured from the bottom of the strip pit, southwest to the farm house just east of the W 1/4 corner of the section.	
4	MIDDLE TAFT sandstone, tan, thin bedded, silty..	3.0
3	Shale, gray, fossiliferous clay ironstone beds near bottom of the rock interval..........	27.5
2	Shale, black, fissile............................	4.5
1	WIER-PITTSBURG (?) coal..........................	1.0
	17. Sec. 16, T. 22 N., R. 18 E. Measured from the northeast corner of the section south up hill.	
15	LOWER TAFT sandstone, tan, micaceous, massive, not measured	
14	Covered..	1.3
13	UPPER INOLA limestone, gray to tan, compact, fossiliferous................................	1.5
12	Covered, probably gray shale.....................	3.9
11	LOWER INOLA limestone, gray to tan, fossiliferous......................................	1.5
10	Shale, gray......................................	0.5
9	BLUEJACKET coal, contains clay...................	0.25
8	Underclay..	0.25
7	Shale, gray, silty...............................	12.0
6	BLUEJACKET sandstone	
	Buff, micaceous, thin bedded, silty.......	12.0
	Buff, medium grained, massive, crossbedded..............................	21.0
5	Shale, gray, silty near top......................	5.5
4	DONELEY limestone, brown, impure, fossiliferous.	0.6
3	Shale, gray to buff..............................	0.3
2	ROWE coal..	0.17
1	Underclay, gray-black, not measured	
	18. Sec. 16, T. 22 N., R. 18 E. Measured at the mouth of the abandoned drift mine at the center of the section.	
5	LOWER TAFT sandstone, buff, massive, not measured	
4	Shale, buff, silty...............................	0.3
3	UPPER INOLA limestone, light gray with dark gray spots, fossiliferous....................	1.7
2	Shale, gray, contains large clay ironstones.....	5.0
1	LOWER INOLA limestone, dark gray, compact, fossiliferous...............................	0.8
	Water level in drift mine.	

19. Sec. 12, T. 23 N., R. 18 E. Measured from the base of the hill on the section line south of the Bitter Creek School at the SW 1/4 of the section west 0.5 miles to the top of the hill.

Bed		Feet
7	Shale, gray	4.0
6	Coal, smutty	0.02
5	Underclay, gray	1.0
4	BLUEJACKET sandstone	
	Tan, fine grained, massive	11.0
	Gray to buff, shaley	8.5
	Brownish yellow to tan, medium grained, massive	37.0
3	Shale, black, fissile, gray near top	15.0
2	DRYWOOD coal	1.2
1	Underclay, not measured	

20. Secs. 11 and 12, T. 23 N., R. 18 E. Measured northeast up the stream bed from the center of the northeast 1/4 of sec. ~~12~~ 11, to a point 0.12 miles east of the northwest corner of sec. 12.

Bed		Feet
7	LOWER TAFT sandstone, buff, massive, cross-bedded, contains _Stigmaria_	38.5
6	Clay ironstone, dark red	0.6
5	Shale, black to gray	11.0
4	LOWER INOLA limestone, compact, light gray with dark gray spots, contains fusulinids	1.5
3	Shale, gray	0.3
2	BLUEJACKET coal	0.6
1	Underclay, not measured	

21. Sec. 14, T. 23 N., R. 18 E. Measured east along the south section line from the floor of the creek 0.2 miles east of the southwest corner of the section to the top Bluejacket outlier.

Bed		Feet
9	BLUEJACKET sandstone, tan, medium grained, not measured	
8	Shale, buff, silty	0.5
7	DRYWOOD coal	0.2
6	Underclay	2.0
5	Shale, gray to tan, silty	7.0
4	Covered	33.0
3	Shale, gray	2.0
2	Shale, black, fissile, contains thin clay ironstone beds	3.0

Bed		Feet
1	DONELEY limestone, dark brown, impure, fossiliferous	0.5

22. Sec. 18, T. 23 N., R. 19 E. Measured west up the side of the Bluejacket outlier in the SE 1/4 of the section.

Bed		Feet
15	BLUEJACKET sandstone, massive, contains *Stigmaria*, not measured	
14	Shale, black, fissile, becomes buff near top	13.5
13	DRYWOOD coal	1.0
12	Underclay	0.6
11	Shale, gray, partially covered, about	26.5
10	Clay ironstone	0.1
9	Shale, gray, calcareous, fossiliferous	0.3
8	DONELEY limestone, dark gray, impure, fossiliferous	0.2
7	Shale, gray, calcareous, fossiliferous	1.5
6	ROWE coal	0.33
5	Underclay, about	0.5
4	Shale, gray	3.0
3	Coal, smutty	0.2
2	Underclay, about	0.1
1	Shale, gray, contains numerous clay ironstone beds, not measured	

23. Sec. 5, T. 23 N., R. 19 E. Measured west along the north section line from the N 1/4 corner of the section to the top of the hill.

Bed		Feet	
14	BLUEJACKET sandstone, not measured < Drywood coal 0.2		
13	Shale, gray, partially covered	25.0+	
12	Limestone, dark gray, impure, sparingly fossiliferous	0.7	Doneley LS
11	Shale, black, fissile	0.5	
10	DRYWOOD coal	0.6	Rowe coal
9	Underclay	2.0	
8	Covered, about	26.0	Sam Creek LS
7	DONELEY limestone, dark gray, fossiliferous, impure	0.2	
6	Shale, gray	2.2	Unnamed coal
5	ROWE coal	0.25	
4	Underclay	3.0	
3	Shale, gray-black, fissile	3.5	Unnamed coal
2	Coal	0.08	
1	Underclay, not measured		

24. Sec. 8, T. 23 N., R. 19 E. Measured north-

Bed		Feet
	east up stream bed on the southwest side of the Bluejacket outlier in the NW 1/4 of the section.	
8	BLUEJACKET sandstone, tan, massive, not measured	
7	DRYWOOD coal and interbedded shale..............	2.2
6	Underclay, gray..................................	3.0
5	Shale, black, fissile, contains flattened spheroidal clay ironstones measuring up to 1 foot in diameter..................	14.0
4	DONELEY limestone, black, impure.................	0.1
3	ROWE coal..	1.2
2	Underclay..	0.1
1	Shale, gray-black, fissile.......................	11.0
	25. Sec. 30, T. 23 N., R. 19 E. Measured on the north bank of the stream 0.3 miles northwest of the southeast corner of the section.	
12	Shale, black, fissile, not measured	
11	SAM CREEK limestone, dark red weathered, dark gray on fresh exposure, fossiliferous.....	1.2
10	Sandstone, fine grained, buff, thin bedded, ferruginous..................................	2.3
9	Shale, gray, silty...............................	3.3
8	Shale, black, fissile............................	1.5
7	Clay ironstone, sparingly fossiliferous..........	0.15
6	Shale, black, fissile, fossiliferous, calcareous.....................................	1.0
5	SPANIARD limestone zone	
	Dark red, compact, fossiliferous..........	0.33
	Shale, black, fissile, calcareous, fossiliferous............................	0.2
	Dark red to brown, compact, abundantly fossiliferous............................	0.15
4	Shale, black, fissile, lavender near top........	5.0
3	Coal...	0.33
2	Underclay..	0.8
1	Shale, gray, not measured	
	26. Sec. 31, T. 22 N., R. 20 E. Measured from the water level of the Pryor Creek south to the top of the hill.	
3	WARNER sandstone, very fine grained, tan........	31.2

Bed		Feet
2	Covered, black shale near bottom.................	33.0
1	ATOKA limestone, dark red, impure, fossiliferous, not measured	