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GEOLOGY OF WAGONER COUNTY, OKLAHOMA

CHAPTER I

INTRODUCTION

Scope and Purpose

This paper is a report on a detailed study of the rocks that crop out in Wagoner County, Oklahoma. Prior to this time a detailed geologic map of the County was not available. It is the purpose of this report to furnish such a map along with descriptions of the formations and descriptions of mineral deposits of possible economic value.

Location

Wagoner County is an area of approximately 620 square miles in northeastern Oklahoma, on the southwestern flank of the Ozark uplift and on the eastern edge of the Central Oklahoma Platform.

Cherokee County is located on the eastern boundary, Mayes and Rogers Counties on the northern boundary, Tulsa

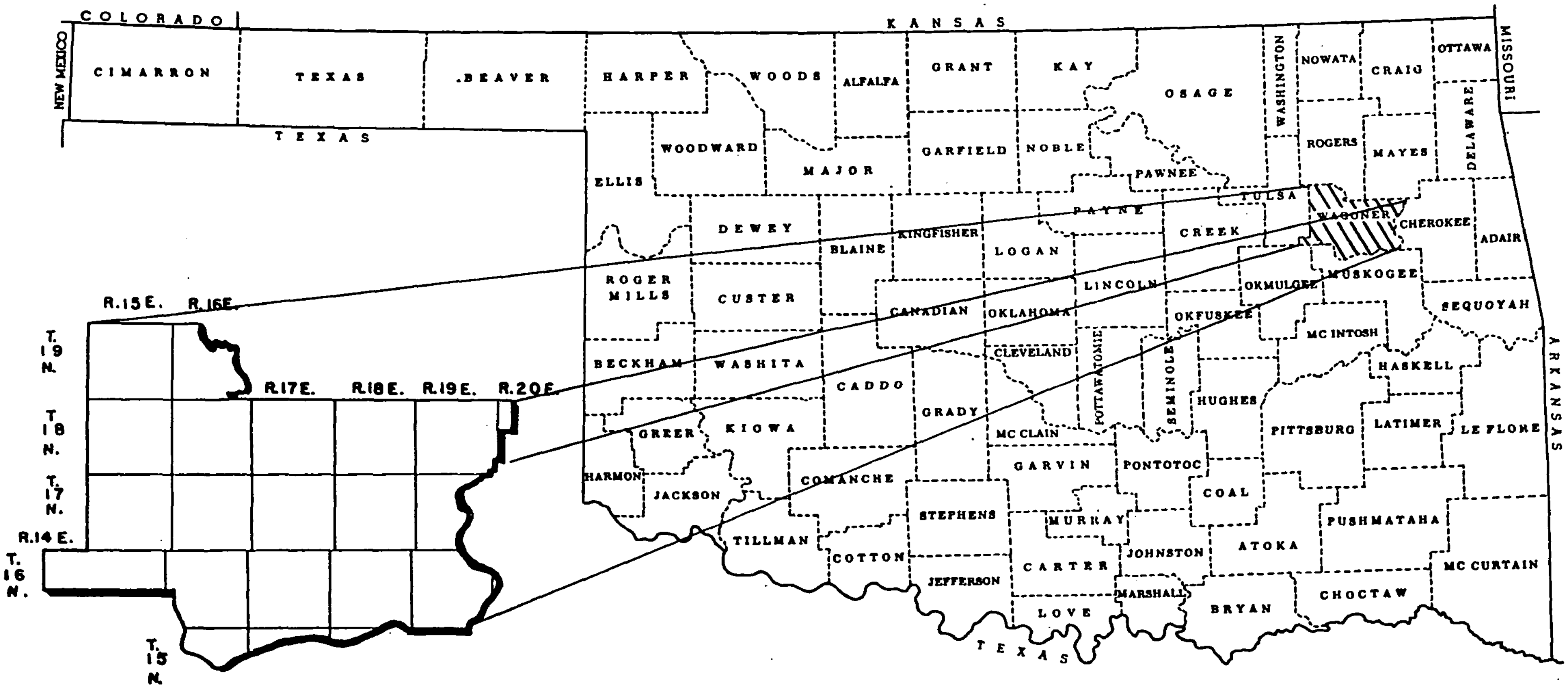

FIGURE 1. LOCATION MAP OF WAGONER COUNTY, OKLAHOMA

County on the west and Muskogee County on most of the southern boundary. Okmulgee County is located at the southern boundary of the westernmost part of Wagoner County.

Part of the eastern boundary between Cherokee and Wagoner Counties is within Fort Gibson Reservoir and Grand River, which is dammed to form the reservoir. The Arkansas River is part of the southern boundary between Wagoner and Muskogee Counties. The Verdigris River and Oklahoma State Highway 33 are along most of the boundary between Wagoner and Rogers Counties. Old U. S. Highway 66 and County Line Road lie along part of the boundary between Tulsa and Wagoner Counties. One portion of Wagoner County lies east of Fort Gibson Reservoir and has no natural boundaries. Another portion lies south and west of the Arkansas River and also has no natural boundaries.

Accessibility

Wagoner County is easily accessible by main paved roads. U. S. Highway 69 crosses the eastern part of the County from north to south, passing through the city of Wagoner. State Highway 16 connects the city of Muskogee, the town of Okay and Fort Gibson Dam, where the highway ends. A paved road joins State Highway 16 at Okay and runs through

Gibson to Wagoner. State Highway 51 crosses the County from east to west, passing through Coweta and Wagoner. State Highway 33 passes through approximately two miles of the northwestern corner of the County, and then runs along the northernmost boundary of the County for about six miles. State Highway 51B is paved from where it joins U. S. Highway 69, seven miles south of Wagoner, to the community of Porter. The remainder of State Highway 51B, from Coweta to Porter is under construction and will be paved. State Highway 104 is paved from Haskell, Muskogee County, to where it joins State Highway 51B, 4.5 miles west of Porter. State Highway 67 is a gravelled road from Coweta west to Tulsa County.

In addition to the State and Federal highways, Wagoner County has a good network of well-improved section line roads that criss-cross most of the County. More than half the number of these roads are well-graded all-weather roads. The exceptions to this network of roads are the part of the County east of Fort Gibson Reservoir and the part of the County south and west of the Arkansas River. In the part of the County east of Fort Gibson Reservoir, one road enters from Mayes County to the north and exits in Cherokee County to the east. One fork of this road leads southward to the reservoir. The westernmost nine sections of the

County located south and west of the Arkansas River lack roads entirely. One road enters these nine sections from the east, but stops on their eastern limit. A few trails lead to scattered oil wells on top of Concharty Mountain.

Four railroads serve Wagoner County, three of them passing through the city of Wagoner. The Kansas, Oklahoma and Gulf, and the Missouri Pacific railroads run through the eastern part of the County in a general north-south direction. The Missouri, Kansas and Texas railroad has a mainline running north-south through the eastern part of the County and a branch line running northwest from the main line. The Midland Valley railroad stays south of the Arkansas River and passes through that part of the County, but does not run through any towns in Wagoner County. The northwest-southeast feeder line of the Missouri, Kansas and Texas railroad passes through Tullahassee, Porter, Red Bird, Coweta and Oneta. The main line of the Missouri, Kansas and Texas railroad passes through Gibson and the city of Wagoner. The Missouri Pacific and the Kansas, Oklahoma and Gulf railroads both pass through Okay and the city of Wagoner.

In addition to this land transportation system, Fort Gibson Reservoir is used by boats of varying sizes. Many good docks are available on both sides of the reservoir.

The Verdigris and Arkansas Rivers are both undeveloped waterways, although small boats are used for recreation.

Previous Investigations

The earliest geologic work done in Wagoner County was that of Drake (1897). His work was of a reconnaissance nature and is of little value now. He carried units from the basin northward.

Taff (1906) mapped the southeastern corner of Wagoner County in the Muscogee Folio. This work contains the earliest mention of the Winslow formation in the County. The Winslow of Taff included all units between the Morrow and the Boggy. Taff recognized the faulting in the part of the County where he worked, but he did not try to map it.

A variety of names have been applied to the rocks between the Fort Scott limestone and the Mississippian limestones. Adams (1901) referred to these rocks as the Cherokee formation. In his work he traced some beds across the County without giving any detail. Hutchison (1907) made a sketch map of northern Oklahoma, including Wagoner County. He called Adam's Cherokee, the Vinita formation. Siebenthal (1907) mapped the Fort Scott limestone, Croweburg coal, Chelsea sandstone and a few coal outcrops in Wagoner County;

although only the name Fort Scott was used, and it did not include the same units that it does today. Gould, Ohern and Hutchison (1910) summarized the work that had been done to 1910, but added nothing to the geology of the County. Ohern (1910) measured a few Pennsylvanian sections in Wagoner County. Snider (1915) worked in the Mississippian rocks on the east side of the County, but made no significant changes in the earlier work. Miser (1926) compiled a geologic map of Oklahoma from published and unpublished maps of the State. A few major faults are shown on this map and this appears to be the first published map of the Bluejacket sandstone across Wagoner County.

Boyle (1927) studied the part of Wagoner County within the Arkansas and Grand Rivers. He recognized the unconformity between the Mississippian limestones and the Morrowan limestones. Boyle used the name Winslow formation for all rocks between the Morrow and the Fort Scott. No geologic map was included in his report.

Cooper (1927) traced some of the coals into Wagoner County, although no map is included in his report. He wrote that the Bluejacket sandstone is traceable to the Arkansas River and also mentioned the presence of a few coals in the area.

Oakes (1944) published a report on the Croweburg coal and associated strata that included the stratigraphy between the Chelsea sandstone and the Verdigris limestone. The report contains several measured sections and several analyses of the Broken Arrow coal in Wagoner County.

"The Morrow series of northeastern Oklahoma" was written by Moore (1947). Most of this report deals with areas to the east, but there are two measured sections in Wagoner County.

During 1950 and 1951, students (Chandler, 1950; Douglas, 1951; Dobervich, 1951) working under Dr. Huffman (1953 and 1958) mapped the eastern part of Wagoner County. Part of the areas studied by these students is now under the water of Fort Gibson Reservoir. Huffman (1958) compiled the work of these and other students, and his report was published. Huffman's work in Wagoner County is used in this report.

Lontos (1952) mapped and described the geology of the southwestern part of Wagoner County.

From about 1950 until the present time, Dr. Carl C. Branson, director of the Oklahoma Geological Survey, has done a considerable amount of field work in Wagoner County. He (Branson, 1954, 1, 1954, 2, 1956) has published articles on the stratigraphy of the area. In addition to the published material, Dr. Branson has additional material on the geology of the County in his personal files. Branson's work in that area started in conjunction with the compiling of a new geologic map of the State (Miser, 1954).

Three theses at Oklahoma University are concerned with part of the geology of Wagoner County. Ware (1954) wrote on the Senora formation in the western part of the County. Morgan (1955) analyzed two Rowe coal samples from this area, giving their location. Dillé (1956) prepared a Precambrian surface paleotopographic map that includes Wagoner County.

Blythe (1957, 1959) mapped and described the Atoka formation across Wagoner County.

In addition to the above mentioned studies within the County, most of the area surrounding the County has been studied. Tillman (1952) mapped and described the geology of part of T. 20 N. that joins wagoner County on the north. Oakes (1952) mapped and described the geology of Tulsa County, Oklahoma. This area borders Wagoner County on the west. Wilson (1937), Stewart (1949) and Campbell (1957) have mapped most of the area that borders Wagoner County south of the Arkansas River. Bell (1959) has remapped a portion of the area mapped by Wilson and Stewart south of the Arkansas River. Stringer (1959) mapped T. 19 N. east of the Verdigris River and north of Wagoner County.

Present Investigation

Vertical stereoscopic aerial photographs of the County were obtained from the Oklahoma Geological Survey. These were covered with acetate sheets and drainage traced thereon. Township plats showing the drainage and cultural features were constructed from the aerial photographs. The township plats were made to the same scale as the photographs, 3.1 inches to the mile. A county highway map was obtained and differences between the map and what was shown on the photographs were noted. The photographs were studied stereoscopically before going to the field in order to get a conception of the topography of the County.

Field work was started in the summer of 1958 and completed in the summer of 1959. Outcrops were indicated on the acetate overlays along with notes of any additional information the outcrop yielded. The geologic information was transferred from the acetate sheets to the township plats. Where possible outcrops were traced on the acetate overlays under the stereoscope. Farmers and ranchers in the area assisted in locating outcrops of coal and limestone marker beds. Most of the exposed geology is in creek beds and as a result much walking was required. Most of the creeks crossing strata below the Chelsea sandstone were walked out, as were many of those on rocks above the Chelsea, in an attempt to locate marker beds. Most of the strip pits have been abandoned and finding them was a matter of traversing the hillsides when a local resident could not be found who would talk about them. Road cuts exposed marker beds and all roads were checked for possible exposures.

Fossils were identified in the laboratory. The geologic data were transferred from the township plats to a map of the County with a scale of 1.5 inches to the mile. Drainage and cultural features were also shown on the County map.

CHAPTER II

GEOGRAPHY

Topographic Features

Maximum relief in Wagoner County is about 400 feet. The highest point is over 900 feet above sea level, on Concharty Mountain, in section 1, T. 16 N., R. 14 E. The lowest point is about 480 feet above sea level, where Grand River leaves the area in the southeast corner of the County.

The topography is characterized by sandstone cuestas separated by shale valleys, and alluvial plains of the river and stream valleys. Most of the cuestas face the east due to the westward dip of the sandstones that cap them. A few sandstone-capped mounds remain standing above the shale valleys and are isolated from the cuestas. Several of these are the result of faulting and others are simply sandstone outliers.

The topography of the eastern part of the County is different from that in the remainder of the County due to the predominance of limestone in the section. Here the nearly flat-lying limestones are deeply eroded with as much as 300 feet of relief. The streams in this area are almost all in a youthful stage of development with steep sided valleys.

The Arkansas River across the southern part of the County has a wide belt of terrace material. These terraces are cut by erosion into rolling hills. In places where erosion has not been checked, the streams have steep banks due to the nature of the terrace material. Terrace material along the Verdigris River is expressed in almost flat deposits. Alluvial deposits cover much of the valley floor along all of the rivers and many of the larger streams.

Drainage

Three principal rivers are present in Wagoner County. The Arkansas River enters the County from the west at sections 30 and 31, T. 17 N., R. 15 E., and flows southeastward. Between the point of entry and the south side of section 18, T. 16 N., R. 16 E., the river lies within the County. From the south side of section 36, T. 16 N., R. 18 E., the river forms the southern boundary of the County. The Arkansas River has a sand-filled channel about one-third to one-half mile wide. During normal flow the water does not cover the entire channel.

The Verdigris River forms the eastern boundary between Wagoner and Rogers Counties in T. 19 N. From the north side of section 2, T. 18 N., R. 16 E., to where it leaves the County at the south side of section 32, T. 16 N., R. 19 E., the Verdigris River is within the County. The Verdigris has many meanders in this area and has left a few ox-bow lakes where it has changed its course. Several of the sharp turns in the river are associated with faulting. The channel of the Verdigris is generally about 100 feet wide.

Fort Gibson Reservoir was formed by artificial damming of Grand River. The dam is in the northwest corner of section 18, T. 16 N., R. 20 E. Grand River flows southward between Cherokee and Wagoner Counties below the dam. Fort Gibson Reservoir covers several square miles of eastern Wagoner County.

Flat Rock Creek, entering from the west, is the only large tributary to Fort Gibson Reservoir and Grand River in Wagoner County. Verdigris River has numerous tributaries. The larger ones entering from the east are: Bull Creek, Billy Creek and Coal Creek. The more important tributaries flowing from the west are: Spunky Creek, Salt Creek, Adams

Creek, another Coal Creek, Gar Creek and Strawberry Creek. Spunky Creek flows into the Verdigris north of this area. The more important tributaries to the Arkansas River within the County are: Concharty Creek, west of the river, and Cedar and Yellow Water Creeks east of the river. In addition to these named tributaries many others flow directly into the larger rivers and into the named tributaries.

Verdigris River flows into the Arkansas River about one mile south of the County and Grand River flows into the Arkansas about 1.2 miles south of the County.

Climate

Wagoner County has an intermediate, humid, continental climate (Blair, 1942, p. 219-220) with a mean annual temperature of 61 degrees. The winters are short and mild with the average temperature for the coldest month 37 degrees, and the coldest recorded temperature minus 6 degrees. The summers are long and hot with July and August having an average temperature of 82.5 degrees and an average humidity of 60 to 70 per cent. The highest recorded temperature is 117 degrees. Table I, with data from the U. S. Weather Bureau in Oklahoma City, shows the mean temperature for each month from 1938 to 1952.

TABLE I

AVERAGE MEAN TEMPERATURE
IN THE CITY OF WAGONER

January	37.4
February	42.9
March	50.7
April	61.7
May	69.5
June	78.3
July	82.5
August	82.6
September	74.4
October	63.8
November	48.6
December	40.6
Annual	61.1

Rainfall

The average annual precipitation measured at the Wagoner sub-station of the U. S. Weather Bureau between 1936 and 1952 was 43.76 inches. As shown by Table II, May is the month of maximum rainfall with April and June also above the monthly average.

TABLE II

AVERAGE MONTHLY RAINFALL

January	2.32
February	3.37
March	2.79
April	4.71
May	6.57
June	5.81
July	2.90
August	3.25
September	3.97
October	3.50
November	2.54
December	2.03
Annual	43.76

Soils

Reference is made to United States Department of Agriculture Miscellaneous Publication MP-42, February, 1955, entitled, "Soils of Wagoner County, Oklahoma" for a soil map and a detailed report on the soils of Wagoner County. The above-mentioned publication mentions 29 soil series and 65 soil types within the County. In all cases the soil cover is related to the underlying bedrock. All of the soils listed are sand, silt or clay loam, depending on the parent material.

The floodplain soils of the Arkansas and Verdigris Rivers are perhaps the most productive. At the time of the above-mentioned publication, 90 per cent of the Arkansas floodplain and approximately 40 per cent of the Verdigris floodplain in Wagoner County were under cultivation.

Many of the soils on the terrace deposits are cultivated where they are level and not subject to rapid erosion. Most of the large peach orchards in the County are located on the terrace deposits associated with the Arkansas River.

Soils overlying the sandstones, shales and limestones are cultivated in some areas and are not in others, depending on the land owners, the topography and the soil fertility. All soils suitable for cultivation are not cultivated. During the time research was done for the above mentioned report, approximately one-half of the income of Wagoner County farmers was from the sale of crops and one-half from the sale of livestock and livestock products. The livestock farmers generally cultivate only enough land to serve their own needs, leaving the rest in pasture or hay.

Some of the crops grown include corn, small grains, cotton, soybeans, melons, sorghums, spinach, beans and cowpeas. In addition to these crops, many farmers grow small amounts of produce for their own needs. Pastures and hay meadows are of alfalfa, Johnson grass, bluestem grass, bermuda grass, clover, lespedeza and prairie cordgrass. Most of the orchards are peach orchards, but there are a few plum and apple orchards. Elm, ash, hickory, pecan, willow, pin oak, red oak, post oak, black oak, blackjack oak and persimmon are the predominant varieties of indigenous trees.

Economic Development

According to the 1950 census, Wagoner County has a population of 16,741, with Wagoner, the county seat, the largest city. The incorporated towns of the County and their populations are: Wagoner (4,395), Coweta (1,601), Porter (562), Okay (427), Red Bird (411), Tullahassee (209) and Oneta (15). Unincorporated communities with unknown populations are Stonebluff, Kadashan, Choska, Clarksville and Gibson. Neodesha, Leliaetta, Payne, Ben Martin and Wybark are named switches on the various railroads, although no centralization of population occurs.

The County has two principal sources of income: farming and the Fort Gibson tourist trade. Okay is almost entirely dependent on the lake resort trade for its subsistence and Wagoner likewise profits from this trade. In addition to the recreational aspects of the lake, the power plant furnishes electricity for northeastern Oklahoma and the lake provides water for the cities of Wagoner and Muskogee. All of the communities profit from agriculture in the County.

Oil is produced in Wagoner County but production is now much less than it was earlier. However, new wells are still being drilled and the County is still an oil producer. Coal played an important role in the early development of the County. The Croweburg coal was mined throughout the length of its outcrop in the western part of the County. The Rowe coal has been mined at several places. At present coal is still mined on a small scale near Porter, and used locally for heating. Other coal beds are, and have been, intermittently mined by hand. In the past, volcanic ash was quarried for building stone. Many of the gravel deposits are used locally in road building and in the past limestone has been used for the same purpose. No manufacturing industries are located in the County at this time.

CHAPTER III

SURFACE STRATIGRAPHY

General Statement

Rocks that crop out in Wagoner County are Mississippian, Pennsylvanian and Quaternary in age. Quaternary deposits are associated with present or former levels of the major streams and rivers in the area. They were deposited during times of high water when the rivers were moving more material than they could hold in suspension. They consist of clay, silt, sand and gravel, and are unconsolidated. The rivers and streams control their outcrops.

Mississippian rocks are exposed where Grand River and its major tributaries have eroded through the Pennsylvanian rocks. Their outcrop patterns are dependent upon the erosion pattern.

Pennsylvanian rocks crop out in a general north-south belt except where interrupted by folding and faulting. They have a gentle southwest dip as a result of tilting by uplift in the Ozark Uplift area. Later erosion has left the north-south outcrop pattern. Pennsylvanian rocks are present over the entire County except where erosion has exposed the Mississippian rocks or where the Quaternary deposits have covered them.

Mississippian System

Mississippian rocks of Wagoner County, Oklahoma, are part of the Osage, Meramec and Chester series. A maximum total of 257 feet of Mississippian rocks is exposed. The Osage series is represented by the Reeds Spring and Keokuk formations, the Meramec by the Moorefield formation, and the Chester by the Hindsville, Fayetteville and Pitkin formations.

The Osage and Meramec rocks are limited to the Cherokee district of the County, east of Fort Gibson Reservoir. The Chester rocks are also found in this district, and along the west side of Fort Gibson Reservoir and Grand River.

The base of the Mississippian in Wagoner County is not exposed. The top of the Mississippian is marked by an unconformity.

Dr. George G. Huffman, of the Geology Department at the University of Oklahoma, and students working under him, have mapped and described the Mississippian geology of the

County as part of a larger report on the geology of the flanks of the Ozark Uplift. The results of this work have been published in Oklahoma Geological Survey Bulletin 77, 1958. The work of Huffman is used in this report and the writer gives full credit to his work, while accepting full responsibility for any errors.

Osage Series

Reeds Spring Formation

History of nomenclature. The Reeds Spring member of the Boone formation was named by Moore (1928, p. 190) for exposures near Reeds Spring, Missouri. Cline (1934, p. 1141) assigned formational rank to the Reeds Spring.

Distribution. The only exposure of the Reeds Spring within the County is in the Big Hollow Creek area, section 2, T. 18 N., R. 19 E.

Character and thickness. At this exposure the Reeds Spring consists of alternating beds of fine-grained, dense, thin-bedded limestone and dark gray chert. A total of 20 feet is exposed along the creek.

Stratigraphic relations. The contact between the Reeds Spring and the underlying St. Joe group is not exposed in Wagoner County, but Huffman (1958, p. 44) reports that the contact is unconformable in northeastern Oklahoma. The Keokuk appears to overlie the Reeds Spring unconformably in the Big Hollow Creek area.

Age and correlation. According to Moore (1928, p. 190) the Reeds Spring is younger than strata of the Fern Glen and older than strata of the Burlington, making the Reeds Spring possibly early Burlington. Cline (1934, p. 1146) came to the conclusion that the Reeds Spring is pre-Burlington and post-Fern Glen in age. This age places it in the Osage series.

Keokuk Formation

History of nomenclature. Owen (1852, p. 92) named the Keokuk from exposures near the town of Keokuk, Iowa. Snider (1914, p. 617) recognized a Keokuk fossil zone within the Boone of northeastern Oklahoma and Girty (1915, p. 5) recognized the Keokuk fossils in the Boone and stated that the Boone extends from Fern Glen to Keokuk in age. Laudon (1939, p. 329) recognized the Keokuk above the Reeds Spring in northeastern Oklahoma.

Distribution. Two exposures of Keokuk are present in Wagoner County. Both along the east shore of Fort Gibson Reservoir, one in sections 2, 3 and 10, T. 18 N., R. 19 E., and the other in sections 25 and 36, T. 18 N., R. 19 E. These exposures result from downcutting of the Grand River through the strata.

Character and thickness. A maximum of 38 feet of Keokuk is exposed in this area, but the base is exposed at only one locality. The Keokuk consists of massive, white to buff chert.

Stratigraphic relations. An unconformity is at the contact of the Keokuk with the underlying Reeds Spring. The top of the Keokuk is marked by an erosional surface of considerable relief with various facies of the Moorefield formation deposited upon it.

Age and correlation. Laudon (1939, p. 329) correlated the Keokuk of northeastern Oklahoma with the Montrose cherts of Iowa. He stated these beds lie in the transition zone between the Burlington and Keokuk of the type section at Keokuk, Iowa. This places the Keokuk of northeastern Oklahoma in the lower Keokuk of the type section and in the Osage series.

Meramec Series

Mayes Group

History of nomenclature. The name Mayes was introduced by Snider (1915, p. 27) for beds between the Boone and

Fayetteville formations in northeastern Oklahoma. The name is from Mayes County, Oklahoma, where the formation shows its maximum development.

Aurin, Clark and Trager (1921, p. 152) introduced the term Mayes into the subsurface as the probable equivalent of the black limestone member of the Mississippi lime. Buchanan (1927, p. 1316) made no change in the use of the term Mayes and agreed with the correlations of Snider (1915, p. 34). Cram (1930, p. 35-39) questioned the correlations that had been made previously and the age and correlation of the Mayes became debatable.

Huffman (1958, p. 48) proposed that the term Mayes be raised to group rank and cited a type locality along the north bank of Grand River in southern Mayes County. According to Huffman, the Mayes Group of northeastern Oklahoma contains the Moorefield formation of Meramecian age and the Hindsville formation of Chesterian age. His terminology is used in this report.

Moorefield Formation

History of nomenclature. The Moorefield was named by Adams, Purdue, Burchard and Ulrich (1904, p. 26) from exposures near Moorefield, Independence County, Arkansas.

Originally it included beds between the Boone chert and the Batesville sandstone. Gordon (1944, p. 1626) restricted the term Moorefield to the lower member and proposed that the term Ruddell be applied to the upper shale member. Huffman (1958, p. 49) proposed that the Moorefield of Oklahoma be divided into four members, three of which are present in Wagoner County, and the term Ruddell shale not be used although its equivalent is probably present. The terminology proposed by Huffman is used in this report.

Stratigraphic relations. In Wagoner County the Moorefield formation is unconformable on the Keokuk chert and is overlain unconformably by the Hindsville limestone.

Age and correlation. Gordon (1944, p. 1631) assigned the Moorefield a St. Louis age. Elias (1956, p. 62) correlated the Ahloso member of the lower part of the Caney shale of the northern Arbuckle Mountains with the Moorefield. The lower part of the Barnett shale of Texas is correlated with the Moorefield by Cloud and Barnes (1946, p. 53). The Ruddell shale of Arkansas was assigned a Ste. Genevieve age by Gordon (1944, p. 1626). The Ruddell shale is probably represented in the Moorefield of northeastern Oklahoma (Huffman, 1958, p. 61). This would make the Moorefield of northeastern Oklahoma equivalent to all or part of the St. Louis-Ste. Genevieve of the type section in Missouri.

Figure 2. Contrast in bedding characteristics of the Reeds Spring, below, and the Keokuk, above. Big Hollow Creek, sec. 2, T. 18 N., R. 19 E.

Figure 3. Bayou Manard member of the Moorefield formation. Cut on an abandoned railroad, center of the north side of sec. 2, T. 18 N., R. 19 E.

Subdivisions. Huffman (1958), p. 49) has divided the Moorefield into four members. From oldest to youngest the members are: the Tahlequah limestone member, the argillaceous Bayou Manard member, the Lindsey Bridge member and the Ordnance Plant shale and siltstone member. The Tahlequah member is not present in Wagoner County.

Bayou Manard Member

History of nomenclature. The name Bayou Manard was proposed by Huffman (1958, p. 51) for exposures along Bayou Manard, a tributary to the Arkansas River southeast of Muskogee and Fort Gibson, in Muskogee County, Oklahoma.

Distribution. Exposures of the Bayou Manard member are found along Big Hollow Creek in section 2, T. 18 N., R. 19 E., and in the Clear Creek area in the south part of the Cherokee district of Wagoner County.

Character and thickness. In Wagoner County the Bayou Manard member consists of gray, dense limestone interbedded with brown to gray siltstones. Fourteen feet are present in the Big Hollow Creek area and nineteen feet in the Clear Creek area.

Age and correlation. Huffman (1958, p. 54) considers the Bayou Manard member to be equivalent to the Moorefield of Gordon (1944) in Arkansas.

Lindsey Bridge Member

History of nomenclature. The Lindsey Bridge member was named by Huffman (1958, p. 55) for exposures near Lindsey Bridge across the Grand River in southern Mayes County, Oklahoma.

Distribution. The Lindsey Bridge member is present throughout the Moorefield exposures in Wagoner County.

Character and thickness. In Wagoner County the Lindsey Bridge member is between four and five feet thick. It consists of gray to brown finely crystalline limestone with abundant chert fragments. Parts of the limestone are fossiliferous.

Ordnance Plant Member

History of nomenclature. Huffman (1958, p. 57) named the Ordnance Plant member for exposures along Pryor Creek, within the Oklahoma Ordnance Plant area, and for exposures along Grand River, near the Low Water Dam just east of the Oklahoma Ordnance Plant area.

Distribution. The Ordnance Plant member is best exposed in the Big Hollow Creek area, on the west side of Hadley Mountain, and in the Clear Creek area in the south part of the Cherokee district of the County.

Character and thickness. Thickness of the Ordnance Plant member varies from 17 feet in the southern exposures to 30 feet in the Big Hollow Creek area to the north. In the south the Ordnance Plant member consists largely of gray silty limestone interbedded with siltstones and in the north it consists largely of gray to brown siltstones.

Age and correlation. Huffman (1958, p. 61) considers the Ordnance Plant member to be at least partially equivalent to the Ruddell shale of Gordon (1944) in Arkansas.

Chester Series

Hindsville Formation

History of nomenclature. The Hindsville limestone was named by Purdue and Miser (1916, p. 12) for exposures near Hindsville, Madison County, Arkansas. Originally the Hindsville was considered the basal limestone member of the Batesville formation. Brant applied the name Hindsville to the Lindsey Bridge member of the Moorefield, believing it to be equivalent to the Hindsville of Arkansas, and gave the name Grand River to what is now considered to be the Hindsville (Huffman, 1958, p. 61). The Hindsville of northeastern Oklahoma consists of the limestone strata between the

Moorefield and Fayetteville formations.

Distribution. The Hindsville limestone crops out on the east side of Fort Gibson Reservoir and is the oldest formation cropping out west of Fort Gibson Reservoir and Grand River. It is present in sections 3, 4, 5 and 9, T. 18 N., R. 19 E., and the top is exposed at low water below Fort Gibson Dam in section 18, T. 16 N., R. 20 E.

Character and thickness. The Hindsville is a bedded, gray, medium- to fine-crystalline, fossiliferous limestone. Thickness of the Hindsville varies from 12 feet on the east side of Hadley Mountain to 36 feet on the west side of the mountain.

Stratigraphic relations. The Hindsville is unconformable on the Moorefield, but the unconformity is not apparent. The Fayetteville is conformable on the Hindsville.

Age and correlation. An early Chesterian age is indicated by the fauna of the Hindsville (Huffman, 1958, p. 63). As yet it has not been possible to correlate the Hindsville out of the Ozark Uplift area. It has been traced eastward into Arkansas and Missouri where the upper part of the Hindsville limestone passes into the Batesville sandstone (Huffman, 1958, p. 63).

Fayetteville Formation

History of nomenclature. The Fayetteville shale was named by Simonds (1888, p. 42) for exposures in valleys in and around Fayetteville, Arkansas. Simonds (1888, p. 26) placed the Fayetteville in the approximate stratigraphic position of the Moorefield. Adams and Ulrich (1904, p. 27) retained the name Fayetteville for exposures around the town of Fayetteville, but placed it and the Wedington sandstone below the Pitkin limestone. The Wedington sandstone member is not present in Wagoner County. The Fayetteville here lies above the Hindsville formation and below the Pitkin formation.

Distribution. The Fayetteville is well exposed in the northeast part of the County on the east side of Fort Gibson Reservoir. It is exposed in sections 3, 4, 5, 8 and 9, T. 18 N., R. 19 E., west of Fort Gibson Reservoir. An exposure is below Fort Gibson Dam in section 13, T. 16 N., R. 19 E.

Character and thickness. The Fayetteville is composed of black shale with dark, finely crystalline limestone concretions, and blue-gray, finely crystalline, fossiliferous limestone beds.

Thickness of the Fayetteville formation varies from 35 feet on the east side of Hadley Mountain, sections 6 and

7, T. 18 N., R. 20 E., to 70 feet in the Big Hollow Creek area on the west side of Hadley Mountain.

Stratigraphic relations. The Fayetteville formation is conformable on the Hindsville formation and conformable beneath the Pitkin formation in Wagoner County.

Age and correlation. A Chesterian age is assigned to the Fayetteville formation by Huffman (1958, p. 71) and Weller (1948, chart 5, p. 188). It is correlated with the Sand Branch member of the Caney (Elias, 1956, p. 65) in the Arbuckle Mountains by Huffman (1958, p. 71).

Pitkin Formation

History of nomenclature. The Pitkin formation was named by Adams and Ulrich (1904, p. 27-28). It had been called the "Archimedes" limestone by previous workers. The Pitkin was named for exposures near Pitkin Post Office, 14 miles south of Fayetteville, Washington County, Arkansas. Beds between the Fayetteville formation and the unconformity at the top are included in the Pitkin formation.

Distribution. The Pitkin formation underlies the Pennsylvanian Morrowan along much of Fort Gibson Reservoir and Grand River. It has apparently been removed by pre-Morrowan erosion near the road between sections 6 and 7, T.

18 N., R. 20 E., but it is present north and south of the road. According to Huffman (1958, p. 71) the exposures along the Wagoner-Mayes County line represent the present northern limit of the Pitkin.

Character and thickness. The Pitkin is a gray, fine- to medium-crystalline, fossiliferous limestone. Locally it is sandy near the top. Shale partings are present throughout the formation.

The thickness of the Pitkin varies considerably due to the unconformity at the top. It is missing in places along the east side of Hadley Mountain and is missing north of the Mayes-Wagoner County line. In exposures in the Yonkers area, and across the lake from the Yonkers area, it is about 20 feet thick. Near Fort Gibson Dam, 29.5 feet of Pitkin is exposed.

Stratigraphic relations. The Fayetteville formation grades upward into the Pitkin, giving a conformable contact below. The unconformity at the top of the Pitkin is marked by a distinct zone of conglomerate in the exposure on the west end of Fort Gibson Dam, section 13, T. 16 N., R. 19 E., and by complete removal of the Pitkin in sections 6 and 7, T. 18 N., R. 20 E.

Age and correlation. Easton (1942, p. 22) was the first to place the Pitkin in the Chester, although Snider (1924, p. 43) suggested that it probably is Chester. Weller (1948, p. 149) correlated the Pitkin of Arkansas and Oklahoma with the Clore, Degonia and Kinkaid of the type section in the Mississippi Valley. Where the upper part of the Pitkin of northeastern Oklahoma has been removed by erosion the Kinkaid equivalents of the Pitkin are probably missing, giving the Clore and Degonia correlation shown by Weller (1948, p. 188). Bennison (1956, p. 112) correlated the Goddard of the Arbuckle Mountain area with the Pitkin of northeastern Oklahoma, but Laudon (1958, p. 14) placed the Pitkin below the Goddard and above the Caney.

Pennsylvanian System

Pennsylvanian rocks crop out over a large part of Wagoner County. Most of the Pennsylvanian rocks consist of sandstone and shale. A few thin limestone marker beds and several thin, lenticular limestones are present.

Between 820 and 1,250 feet of Pennsylvanian rocks are exposed in Wagoner County. The Pennsylvanian generally thins northward away from the McAlester Basin. During most of Pennsylvanian time the Wagoner County area was in a shelf environment permitting the formation of thick deposits of black shale and thin, widespread limestone. Shelf sedimentation was cyclic during part of the time. At several intervals during the Pennsylvanian this area came under basinal conditions permitting the influx of thick sequences of sandstone and silty shale.

Although the corresponding Pennsylvanian section in the McAlester Basin is thicker than that on the shelf, the water was usually deeper on the shelf than in the basin. This is shown by the difference in the type of sediments and fossils.

The Pennsylvanian of the Mid-continent has been divided into five series. From oldest to youngest these are the Morrowan, Atokan, Desmoinesian, Missourian and Virgilian. The Morrowan strata are the oldest Pennsylvanian rocks in Wagoner County. They consist largely of limestone, shale and calcareous sandstone which, with their fossils, show marked contrast with the rocks of the remainder of the Pennsylvanian. An unconformity is located above and below the Morrowan. The Atokan contains no coal beds in contrast to the Desmoinesian. There are a few thin, lenticular limestones in the Atokan. The Desmoinesian is cyclic through a large part of the stratigraphic section. The Desmoinesian makes up the thickest part of the section and contains the youngest Pennsylvanian rocks present.

Morrowan Series

The Morrow was originally a formation named by Adams and Ulrich (1904, p. 28). They did not give a type locality in the report, but Adams and Ulrich (1905, p. 4) stated that the unit was named from Morrow Post Office, Washington County, Arkansas. The Morrow was raised to group rank by Purdue (1907, p. 3) and includes the Hale and Bloyd formations. The Morrow was traced into Wagoner County and mapped in part by Taff (1905, 1906). Strata between the Pitkin formation below, and the Atoka formation above, are included in the Morrowan. The Morrowan has been correlated with the early Pottsville of the Appalachian Mountains (Mather, 1915, p. 59).

Hale Formation

History of nomenclature. The Hale was named by Adams and Ulrich (1904, p. 4) for exposures in Hale Mountain, Arkansas (Taff, 1905, p. 4). Simonds (1891, p. 75) had applied the name "Washington" to the strata, but the name was preoccupied and Hale was proposed (Taff, 1905, p. 4). The Hale in northeastern Oklahoma includes strata above the Pitkin formation and below the shale of the Bloyd formation.

Figure 4. Moorefield limestone. SE¼ sec. 6, T. 18 N., R. 20 E.

Figure 5. Pitkin, Hale, Bloyd contact at the west end of Fort Gibson Dam. Northeast corner of sec. 13, T. 16 N., R. 19 E. Pitkin-Hale contact at the break above the white sign. Bloyd-Hale contact at the top of the steep cliff.

Distribution. The Hale is present in the bluffs along the valley of Grand River. The exposures in the southern part of the County are brought to the surface by faulting. None of the exposures west of the river and lake is continuous for any great length. The Hale is also exposed throughout the northeast part of the County.

Character and thickness. In Wagoner County the Hale varies in lithic character from place to place. It is in part a white to gray, fine- to coarse-crystalline limestone. Part of it is a gray to brown sandstone composed of angular to sub-angular quartz grains cemented by a calcareous cement. Shale partings are present throughout the formation. Fossils are abundant in the Hale formation.

Thickness of the Hale varies from 47 feet at the west end of Fort Gibson Dam to 35 feet in the northeast corner of the County.

Stratigraphic relations. The base of the Hale is marked by a profound unconformity with the underlying Pitkin formation. In the area of sections 6 and 7, T. 18 N., R. 20 E., the Hale lies unconformably on the Fayetteville formation, the Pitkin having been removed by erosion. The upper contact of the Hale with the Bloyd is arbitrary and conformable, the shale facies predominating at different levels in the section at different outcrops.

Age and correlation. The Hale represents the oldest Pennsylvanian formation in northeastern Oklahoma, and is Morrowan in age. It has been correlated with the Union Valley formation of the Arbuckles and Ouachitas (Harlton, 1938, p. 854) (Miller and Owen, 1944, p. 417), the Cromwell sandstone of the subsurface (Miller and Owen, 1944, p. 417), and the lower part of the Golf Course formation of the Dornick Hills group in the Ardmore Basin (Ardmore Geological Society, 1956, p. 4).

Bloyd Formation

History of nomenclature. The Bloyd formation was named by Purdue (1907, p. 3) from exposures on Bloyd Mountain, Arkansas (Wilmarth, 1938, p. 216). In Wagoner County the Bloyd consists of shale with thin limestones. It is a facies formation above the Hale and below the Atoka.

Distribution. The Bloyd is present to some degree in every exposure where the Hale is present. In the bluffs along Grand River and Fort Gibson Reservoir it forms a gentle slope above the Hale and Pitkin formations.

Character and thickness. Alternating beds of limestone and shale make up the Bloyd formation. The limestones are normally medium-crystalline, blue-gray and fossiliferous. The shale is generally gray to dark brown and less silty than the overlying Atoka shales. Thickness of the Bloyd ranges from about six feet in the bluffs along Fort Gibson Reservoir in section 27, T. 18 N , R. 19 E., to 40 feet at the west end of Fort Gibson Dam, section 13, T. 16 N., R. 19 E.

Stratigraphic relations. The Hale is gradational and conformable with the overlying Bloyd. The Atoka lies unconformably upon the Bloyd.

Age and correlations. The Bloyd formation is Late Morrowan in age. The Bloyd has been correlated with the upper part of the Golf Course formation (Ardmore Geological Society, 1956, p. 4) of the Ardmore Basin and the Wapanucka formation of the McAlester Basin (Mather, 1915, p. 64, and Harlton, 1938, p. 854).

Atokan Series

Spivey and Roberts (1946, p. 185) proposed that the Atoka be raised to series rank. The Atoka is the only formation in the Atokan series in northeastern Oklahoma.

Atoka Formation

History of nomenclature. The Atoka formation was named by Taff and Adams (1900, p. 273). The name was probably taken from the town of Atoka, Atoka County, Oklahoma, although no type locality was designated. The Atoka formation extends from the top of the Morrowan to the base of the Hartshorne formation.

Distribution. The Atoka formation crops out on both sides of Grand River. East of Grand River it is the youngest formation present and caps the hills in the region. West of the river the Atoka crops out in a belt that extends from the south to the north side of the County.

Character and thickness. The Atoka consists of sandstone and shale with a few thin, lenticular limestones. The sandstones are brown, fine- to medium-grained and micaceous. The shales are black, fissile and normally silty. Conglomerate is present in the base of the Atoka at several outcrops. Some of the sandstones contain invertebrate fossil imprints. The limestones are generally blue-gray, dense, and nonfossiliferous; however, some limestones in the Atoka are fossiliferous.

Thickness of the Atoka decreases from about 375 feet in the southern part of the County to about 130 feet in the northern part of the County.

Stratigraphic relations. An unconformity separates the Morrowan from the Atokan. Limestone and fossil fragments from the Morrowan are found in the basal Atoka conglomerates at a few exposures. The overlying Hartshorne appears to be conformable upon the Atoka, but an unconformity may be present (Blythe, 1959, p. 47).

Age and correlation. The Atokan series lies between the Morrowan and the Desmoinesian series of the Pennsylvanian system of the Mid-continent region. The Atokan is equivalent to part of the Pottsville series of eastern United States.

The Ardmore Geological Society (1956, p. 4-6) has correlated the Atoka with the Golf Course formation in the Dornick Hills group of the Ardmore Basin and with part of the Lampasas group and part of the Bend group of Texas. Northward the Atoka formation is overlapped by the Desmoinesian and loses its identity in Craig County, Oklahoma (Geologic Map of Oklahoma, 1954, and Blythe, 1959, p. 7).

Subdivisions. Wilson (1935, p. 504-507) subdivided the Atoka formation into six named sandstone members and six overlying unnamed shale members. From oldest to youngest these are the Coody sandstone, Pope Chapel sandstone, Georges Fork sandstone, Dirty Creek sandstone, Webbers Falls sandstone and Blackjack School sandstone. The Coody, Georges Fork and Dirty Creek were named from creeks along which they crop out in Muskogee County, Oklahoma. The Pope Chapel and

Blackjack School are named from a church and a school in Muskogee County, and the name Webbers Falls is taken from the town of the same name.

Blythe (1957) has mapped and described the Atoka formation in Wagoner and Mayes Counties, Oklahoma. This writer has accepted the work of Blythe in this report, and gives full credit to him while accepting full responsibility for any errors. The members as proposed by Wilson can not be completely separated and mapped north of the Arkansas River.

Desmoinesian Series

Approximately 725 feet of Desmoinesian strata crop out in Wagoner County. Rocks in the Desmoinesian series have been divided into three groups, the Krebs, Cabaniss and Marmaton. Oakes (1953, p. 1523-1526) established the Krebs and Cabaniss groups. The Krebs was named from the town of Krebs, Pittsburg County, Oklahoma, and the Cabaniss was named from the community of Cabaniss, Pittsburg County, Oklahoma. Moore (1949, p. 47) established the Marmaton group from exposures in Kansas. Included in the Krebs group are the Hartshorne, McAlester, Savanna and Boggy formations. The only formation in the Cabaniss group in northeastern Oklahoma is the Senora. The Thurman and Stuart formations are present with the Senora in the McAlester Basin, but they do not extend as far north as Wagoner County. The Marmaton group includes the Fort Scott and Labette formations north of the Arkansas River, and the Fort Scott and Wetumka formations south of the Arkansas River. Representative strata of the Calvin formation may be present between the Fort Scott and Wetumka formations south of the Arkansas River, but they can not be recognized and are not mapped nor discussed.

Hartshorne Formation

History of nomenclature. The Hartshorne formation was named by Taff (1899, p. 436) from exposures near the city of Hartshorne, Pittsburg County, Oklahoma (Hendricks, 1937, p. 11). Branson (1955, p. 64) proposed that the Hartshorne include rocks from the top of the Atoka to the top of the Upper Hartshorne coal in the type section in the McAlester Basin, and include rocks from the top of the Atoka to the top of the Riverton coal, or in the absence of the Riverton coal, to the base of the Warner sandstone member of the McAlester formation in northeastern Oklahoma. In Wagoner County the Hartshorne formation consists of the rocks from the top of the Atoka formation to the base of the Warner sandstone member of the McAlester formation.

Distribution. The Hartshorne formation is present in a belt trending generally north-south across the eastern part of Wagoner County. In most places it is covered by soil, but a few good exposures are present. Good exposures are in a rock quarry near the northeast corner of section 36, T. 17 N., R. 18 E., and in a quarry in the northeast corner of section 34, T. 18 N., R. 18 E. Good exposures are found along Flat Rock Creek and its tributaries in sections 9, 15 and 16, T. 18 N., R. 18 E.

Character and thickness. The Hartshorne consists of black fissile shale with clay ironstone zones. Two zones of clay ironstone were seen in one exposure and five in another. A one-inch zone of cone-in-cone structure was noted in the Hartshorne shales along Flat Rock Creek in section 16, T. 18 N., R. 18 E. Where measured the thickness of the Hartshorne formation varies from 19.5 feet to 22 feet. A thickness of about 20 feet is common.

Stratigraphic relations. The Atoka appears to be conformable below the Hartshorne. The seas may have withdrawn from the area at the close of the Atokan (Blythe, 1959, p. 47), but no orogenic movement took place. The McAlester formation is conformable above the Hartshorne formation.

Paleontology. The only fossils found in the Hartshorne formation were specimens of *Gonostichus* found in the shale quarry south of State Highway 51, in the northeast quarter of the southeast quarter of section 24, T. 17 N., R. 18 E.

Age and correlation. Branson (1955, p. 65) suggested that the Hartshorne formation of northeastern Oklahoma is equivalent to the Hartshorne of McAlester Basin. The Hartshorne is equivalent in part to the Big Branch formation in the upper part of the Dornick Hills group of the Ardmore Basin and part of the Lampasas group of Texas (Ardmore Geological Society, 1956, p. 4 and 6). The Hartshorne is the oldest formation of the Krebs group and of the Desmoinesian series.

McAlester Formation

History of nomenclature. The McAlester formation was named by Taff (1899, p. 437) from exposures near the town of McAlester, Pittsburg County, Oklahoma, in the McAlester Basin to the south. The McAlester formation has been traced from the basin northward by several workers, as is shown on the Geologic Map of Oklahoma (1954). Branson (1955, p. 64 and p.

67) proposed that the McAlester formation north of the Arkansas River include the beds from the base of the Warner sandstone to the base of the Spaniard limestone. That is the definition of the McAlester used in this report.

Distribution. The McAlester formation crops out throughout the central part of Wagoner County, but at no place in the County is the complete formation exposed. Due to the low dips of the rocks only the more resistant members are exposed.

Character and thickness. The base of the McAlester formation is marked by the Warner sandstone member. The rest of the McAlester formation consists of black, fissile shale with clay-ironstone and some thin beds of micaceous siltstone. A coal of varying thickness is found at places a few inches below the top of the formation. The thickness of the McAlester is variable and difficult to determine because of limited exposures and faulting. The apparent thickness varies between 40 and 100 feet.

Stratigraphic relations. The McAlester is gradational and conformable with the underlying Hartshorne formation; the black shales of the Hartshorne grade into the siltstone and sandstone of the McAlester. The Savanna formation is conformable above the McAlester.

Age and correlation. The McAlester formation of Wagoner County is approximately equivalent to the McAlester formation in the McAlester Basin (Branson, 1955, p. 65). It is a formation of the Krebs group in the Desmoinesian series. It is equivalent to portions of the Pottsville series of the Appalachian Region (Wanless and Sevier, 1956, Correlation Chart).

Subdivisions. The Warner sandstone member marks the base of the McAlester formation and is the only named member.

Warner Sandstone Member

History of nomenclature. The Warner sandstone member of the McAlester formation was named by Wilson (1935, p. 508) from exposures one mile north of Warner, Muskogee County, Oklahoma. At the type locality, the McCurtain shale member is a recognizable unit of the McAlester formation below the Warner. In Wagoner County, the McCurtain shale is not present, or if present, it can not be distinguished from the underlying Hartshorne; therefore the base of the Warner sandstone is considered the base of the McAlester formation.

Distribution. The Warner sandstone is present in a north-south zone through R. 18 E. of Wagoner County. There are several good exposures. Some of them are: at the top of a quarry in the northeast corner of section 36, T. 17 N., R. 18 E.; at the top of a quarry south of State Highway 51 near the center of section 24, T. 17 N., R. 18 E.; in a road-cut on U. S. Highway 69 about 1.5 miles north of Wagoner near the center of the east side of section 34, T. 18 N., R. 18 E.; and near the northwest corner of section 4, T. 18 N., R. 18 E. Other poorer exposures are present along the line of outcrop. The Warner forms a prominent ridge where well developed.

Character and thickness. The Warner consists of tan, fine-grained, cross-bedded sandstone, normally having tan to gray, micaceous, tabular, sandy siltstone in the lower part. At the exposures mentioned above the thickness of the Warner is about 8 feet. The thickness ranges from about 8 feet to an indeterminant, lesser amount in the poorer exposures.

Age and correlation. The Warner sandstone is the basal unit of the McAlester formation in Wagoner County. It has been traced northward into the Little Cabin sandstone of northeastern Oklahoma and of Kansas (Wilson and Newell, 1937, p. 39). The Warner sandstone is the Booch sand of the sub-surface of eastern Oklahoma.

Savanna Formation

History of nomenclature. The Savanna formation was named by Taff (1899, p. 437) from exposures near the town of Savanna, Pittsburg County, Oklahoma, in the McAlester Basin. The Savanna has been traced northward from the type locality as is shown on the Geologic Map of Oklahoma (1954). The Oklahoma Geological Survey has established the base of the Savanna as the base of the Spaniard limestone, and the top of the Savanna as the base of the Bluejacket sandstone (Branson, 1954, 2, p. 2). These limits of the Savanna are used in this report.

Distribution. The Savanna formation is present throughout central Wagoner County.

Character and thickness. The Savanna is cyclic in nature, consisting of sandstone, siltstone, shale, limestone and thin coal. It ranges from 85 to 200 feet in thickness.

Stratigraphic relations. The Savanna formation is conformable with the underlying McAlester and with the overlying Boggy formations.

Age and correlation. The Savanna formation is part of the Krebs group of the Desmoinesian series. It is approximately equivalent to the Savanna formation in the McAlester Basin. Wanless and Siever (1956, Correlation

Chart) have assumed it is equivalent to part of the Tradewater group of Illinois and to part of the Pottsville series of the Appalachian region. The limestones of the Savanna are equivalent to the Brown limes of the subsurface of Oklahoma (Branson, 1954, 2, p. 8).

Subdivisions. Three limestones, one sandstone and two coals within the Savanna have been named. The Drywood coal lies below the Bluejacket sandstone and above the Doneley limestone member of the Savanna. The Rowe coal lies below the Doneley limestone and above the Spiro sandstone member. The Sam Creek limestone member lies between the Spiro and the Spaniard limestone. The base of the Spaniard limestone member marks the base of the Savanna formation.

Spaniard Limestone Member

History of nomenclature. Lowman (1933, p. 31) named the Spaniard from exposures in Spaniard Creek, south of Muskogee, Muskogee County, Oklahoma. This unit can be traced intermittently across Wagoner County.

Distribution. A complete section of the Spaniard limestone lies in the bed of the Verdigris River, in the southeast quarter of section 5, T. 16 N., 18 E. Three other good exposures are found along the river; one near the

Figure 6. Savanna formation exposed below the Bluejacket sandstone in the south bank of the Verdigris River. Center sec. 12, T. 17 N., R. 16 E.

Figure 7. Spaniard limestone. Center SE¼ sec. 5, T. 16 N., R. 18 E.

center of section 4, T. 16 N., R. 18 E., one in the southwest quarter of section 5, T. 16 N., R. 18 E., and the third in the northeast quarter of section 26, T. 16 N., R. 18 E. Other exposures are found: on the west side of the hill in the southeast quarter of section 36, T. 16 N., R. 17 E.; between sections 21 and 22, T. 16 N., R. 18 E.; east of U. S. Highway 69, between sections 3 and 10, T. 16 N., R. 18 E.; at several localities within and north of the city of Wagoner; in an abandoned road near the center of the north side of section 12, T. 17 N., R. 18 E.; near a store south of State Highway 51, at the center of the west side of section 18, T. 17 N., R. 17 E.; at several places along both sides of Billy Creek, sections 1 and 12, T. 17 N., R. 17 E., section 36, T. 18 N., R. 17 E., and section 31, T. 18 N., R. 18 E.; at a few places along a north-south ridge running through section 36, T. 18 N., R. 17 E., and sections 30, 19 and 20, T. 18 N., R. 18 E.; and where it has been excavated and placed on a dam near the center of section 5, T. 18 N., R. 18 E.

Character and thickness. The Spaniard is a medium-crystalline, blue-gray, medium-bedded to massive, fossiliferous limestone. The solitary coral "_Caninia_" is the dominant fossil of the Spaniard. _Composita_ is the most abundant brachiopod. Other brachiopods and pelecypods, gastropods and fusulinids are present.

Thickness of the Spaniard varies from 2.2 feet to 5.5 feet. Two miles north of Wagoner County the Spaniard is only 1.3 feet thick, so it is reasonable to assume that the Spaniard approaches this thickness near the northern boundary of the County, although no exposures are available for measurement. The Spaniard extends southward to the North Canadian River (Wilson and Newell, 1937, p. 46) and northward to central Craig County, Oklahoma (Branson, 1955, p. 67). Neither north nor south do reported thicknesses of the Spaniard approach the 5.5 feet found in Wagoner County.

Paleontology. Fossils are abundant in the Spaniard limestone, but the rocks are as resistant as the fossils and the fossils do not weather out easily. Although the preservation may be good, the fossil specimens are poor.

TABLE III

FAUNA FROM THE SPANIARD LIMESTONE

Anthozoa
- "Caninia" sp.
- "Lophophyllidium" sp.
- Tabulate coral ? A
- Tabulate coral ? B

Brachiopoda

Composita sp.
Chonetes sp.
"Dictyoclostus" sp.
"Marginifera" sp.
Dielasma sp.

Gastropoda

Amphiscapha sp.
Genus A
Genus B
Genus C
Genus D

Crinoidea

Crinoid stem ossicles

Correlation. On the basis of fusulinids, Alexander and Branson (1954, p. 49) have correlated the Spaniard with the Pumpkin Creek limestone of the Big Branch formation, Dornick Hills group in the Ardmore Basin; and with the Stonefort limestone of the Tradewater group of the Illinois Basin.

Beds Between the Spaniard Limestone and the Sam Creek Limestone

Rocks between the Spaniard and Sam Creek limestones consist of black, fissile shale with clay-ironstone concretions, and argillaceous, micaceous siltstone. In section 28, T. 17 N., R. 18 E., a thin coal with an underclay, and a fossiliferous and calcareous clay-ironstone cap occurs near the top in this interval. In the southeast quarter of section 36, T. 16 N., R. 17 E., the unit comprises 35 feet of black, fissile shale, and on the backslope of a ridge in the southwest quarter of section 30, T. 18 N., R. 18 E., the thickness is estimated as 15 feet. Near the center of the north side of section 12, T. 17 N., R. 18 E., the Spaniard and Sam Creek limestones are separated by about six feet of gray silty shale. According to the work of Wilson and Newell (1937, p. 47-49) the concretionary, fossiliferous, ferruginous limestones found in section 28, T. 17 N., R. 18 E., and in section 9, T. 16 N., R. 17 E., are in this unit and not in the Sam Creek member as originally defined.

Sam Creek Limestone Member

History of nomenclature. The Sam Creek limestone was named by Lowman in an unpublished manuscript (Wilson, 1935, p. 510). As originally described it included the calcareous conglomerate and ferruginous limestone zone below the more persistent limestone. Wilson and Newell (1937, p. 49) restricted the Sam Creek to the upper, more persistent limestone. The Sam Creek in Wagoner County includes only the upper unit as defined by Wilson and Newell.

Distribution. Exposures of the Sam Creek are limited. The best exposures are south of the Verdigris

River in sections 9 and 26, T. 16 N., R. 17 E., and near the center of the north side of section 12, T. 17 N., R. 18 E. In section 28, T. 17 N., R. 18 E., the calcareous conglomerate below the Sam Creek is present, and according to Branson (1954, 2, p. 37) a crinoidal shale in the exposure represents the Sam Creek horizon. An exposure is present in the south bank of the Verdigris River, east of the bridge in section 15, T. 16 N., R. 18 E., and in the east bank of the river below the bridge in section 15, T. 17 N., R. 17 E. It crops out in a creek near the southeast corner of section 25, T. 18 N., R. 17 E. The Sam Creek disappears to the south in the vicinity of Warner, Muskogee County, Oklahoma (Wilson and Newell, 1937, p. 50), and to the north near the center of Craig County, Oklahoma (Branson, 1955, p. 67).

Character and thickness. The limestone is blue-gray, dense, ferruginous, silty, argillaceous, fossiliferous and weathers brown or reddish-brown. The Sam Creek varies in thickness from 1.1 to 0.3 feet. This limestone is thickest in sections 9 and 26, T. 16 N., R. 17 E., and thins both north and south. The thickest exposures of the Sam Creek are at about the same latitude as the thickest Spaniard outcrop.

Paleontology. Fossils are found in the Sam Creek

Figure 8. Spaniard limestone in the bed of the Verdigris River. Center SW¼ sec. 5, T. 16 N., R. 18 E.

Figure 9. A long crinoid stem in the Spaniard limestone. Center SE¼ sec. 5, T. 16 N., R. 18 E.

limestone, but few are well preserved. Most specimens are internal molds.

TABLE IV

FOSSILS FROM THE SAM CREEK LIMESTONE

Brachiopoda
- "Dictyoclostus" sp.
- "Marginifera" sp.
- Spirifer sp.
- Composita sp.

Gastropoda

Pelecypoda
- Wilkingia sp.

Plant fossils
- Cordaites sp.

Beds Between the Sam Creek Limestone and the Spiro Sandstone

Zero to about 30 feet of black shale with clay-ironstone concretions and siltstone occur between the Sam Creek limestone and Spiro sandstone.

Spiro Sandstone Member

History of nomenclature. The name Spiro sandstone was first used by Wilson (1935, p. 509) for exposures north and northeast of the town of Spiro, LeFlore County, Oklahoma. According to Wilson (1937, p. 50) the name Spiro is applied to any thick sandstone development between the Bluejacket sandstone and the Sam Creek limestone. This usage has been followed by the author in Wagoner County.

Distribution. The Spiro is an erratic sandstone in Wagoner County. It is found at two localities south of the Verdigris River. It caps an isolated mound and outlines a syncline west of the city of Wagoner. Its greatest areal extent is along the east side of R. 17 E., and the west side of R. 18 E., in T. 18 N.

Character and thickness. The Spiro is a tan, fine-grained, cross-bedded to thin-bedded, micaceous, silty lenticular sandstone. Thickness ranges from zero to about 10 feet.

Age. The Spiro sandstone is a member of the Savanna formation.

Beds Between the Spiro Sandstone and the Rowe Coal

The Rowe coal lies from 20 to 50 feet above the Spiro sandstone in exposures where they are both developed. Black shale with clay-ironstone and tan, micaceous, silty shale are found between the Spiro sandstone and the Rowe coal.

Rowe Coal

The Rowe coal was named by Pierce and Courtier (1937, p. 65) from exposures near Rowe School, Crawford County, Kansas. During 1958 and 1959 the Rowe coal was uncovered at only three locations, although it has been strip-mined at several places. The three exposures found are near old strip-mines. One is on the west side of the hill in section 6, T. 18 N., R. 18 E.; another is on the north side of an isolated mound in section 7, T. 16 N., R. 18 E.; and the third is in a creek flowing west of U. S. Highway 69 near the center of the west one-half of section 33, T. 17 N., R. 18 E. Thickness of the coal at these three exposures is 0.8 feet, 0.7 feet and 1.0 feet respectively, with an underclay about 1.3 feet thick. In addition to these three locations, the Rowe coal has been mined in: section 27, T. 17 N., R. 18 E.; sections 6 and 7, T. 17 N., R. 18 E.; section 26, T. 18 N., R. 17 E.; and section 1, T. 18 N., R. 17 E. A few small one-man mining operations are still carried on during the winter.

Beds Between the Doneley Limestone and the Rowe Coal

About one foot of black shale is exposed between the Rowe coal and the Doneley limestone in the bank of the creek that runs through the abandoned strip pits near the center of the west one-half of section 33, T. 17 N., R. 18 E.

Doneley Limestone Member

History of nomenclature. The Doneley limestone was named by Chrisman (1951, p. 29) from exposures in the northwest quarter of section 16, T. 26 N., R. 20 E., near the Doneley school (now known as the Pheasant Hill School) in Craig County, Oklahoma. Chrisman states that the Doneley overlies a coal that is probably the Rowe coal. Branson (1954, 1, p. 192) first published the name. The Doneley limestone overlies the Rowe coal.

Distribution. The Doneley is limited to one locality. It is found in the bank of a creek that runs through an abandoned Rowe coal strip pit near the center of the west one-half of section 33, T. 17 N., R. 18 E.

Character and thickness. It consists of a dark-gray, dense, nodular limestone. The Doneley limestone is about 0.2 feet thick.

Beds Between the Doneley Limestone and the Drywood Coal

Beds between the Doneley limestone and the Drywood coal are tan, argillaceous siltstone and black to gray, silty shale with clay-ironstone. Thickness of the unit as estimated from a combination of measurements is about 30 feet thick.

Drywood Coal

Exposures of the Drywood coal in Wagoner County are limited to a small area south of the Verdigris River in sections 1, 12 and 13, T. 16 N., R. 17 E. The name Drywood coal was proposed by Searight and others (1953, p. 2448) and described by Searight (1955, p. 35) as being about 10 feet below the base of the Bluejacket sandstone. The Drywood coal varies from 0.1 to 0.4 feet in thickness. In the past it was strip-mined at a locality in the northwest quarter of section 13, T. 16 N., R. 17 E.

Beds Between the Drywood Coal and the Bluejacket Sandstone

Exposed above each of the previously mentioned coal exposures are black, fissile, silty shale with clay-ironstone and some tabular, micaceous siltstone. The exposure at the west side of section 13, T. 16 N., R. 17 E., has a fossiliferous clay-ironstone 0.5 feet above the coal, a bed that was not found at the other exposures. Thickness of the unit varies between 5 and 13.5 feet.

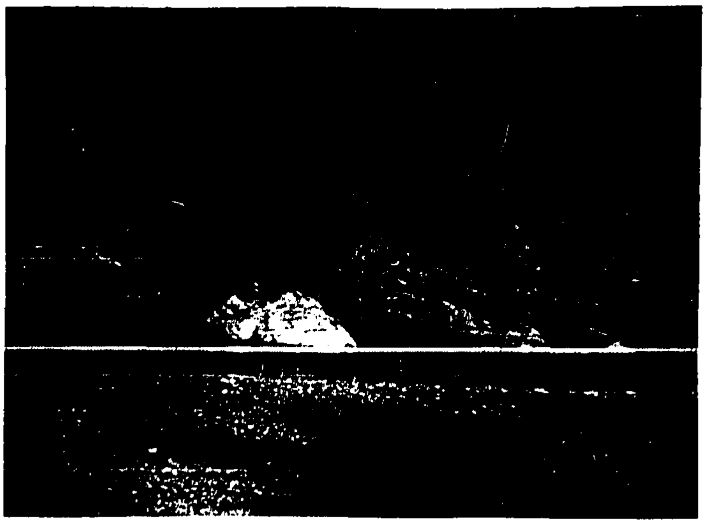

Figure 10. Sam Creek limestone and the conglomeratic zone below it. The zone here contains brown chert pebbles. In the east bank of a creek, near the center of the north side of sec. 9, T. 16 N., R. 17 E.

Figure 11. Base of the Bluejacket sandstone. Near the NW cor. sec. 29, T. 17 N., R. 17 E.

Boggy Formation

History of nomenclature. The Boggy formation was named by Taff (1899, p. 438), probably from exposures near the Boggy creeks in the McAlester Basin of southeastern Oklahoma. As originally defined it included a sequence of sandstones and shales above the Savanna and below the conglomerate at the base of the Thurman formation. Wilson (1935, p. 504) placed the base of the Boggy above the Bluejacket sandstone, making the Bluejacket a sandstone in the Savanna. Dane and Hendricks (1936, p. 312) placed the base of the Boggy somewhere below the Bluejacket sandstone, making the Bluejacket part of the Boggy formation. Branson (1954, 1, p. 192) placed the base of the Boggy at the base of the Bluejacket. This is the base of the Boggy as used in this report. In the McAlester Basin to the south the top of the Boggy can be traced by an easily identifiable chert conglomerate zone at the base of the overlying Thurman formation (Govett, 1957, p. 24). Northward the Thurman and overlying Stuart formations are progressively overlapped by the Senora formation. The time interval represented by the Thurman and Stuart in the basin, is represented by an unconformity northward beyond their limits. The exact location of this unconformity in Wagoner County is in question and it will require work beyond the scope of this report to establish it. It is probably within the shale interval below the Tiawah limestone. Branson (1956, p. 85) stated that the upper limit of the Boggy lies between the Inola limestones of the Boggy and the Tiawah limestone of the Senora formation. He also states that perhaps the top of Weir-Pittsburg coal is the best mappable unit for the boundary. This coal lies below the second Taft sandstone and above the lowest Taft sandstone in this area. One occurrence of the Weir-Pittsburg coal is known in Wagoner County. Taft sandstones are inconsistent and of little value as mapping horizons. For these reasons the upper limit of the Boggy is shown on the map as a line representing the approximate base of the cuesta held up by the Chelsea sandstone. It is above the Weir-Pittsburg coal, above the lower Taft sandstones, below the upper Taft sandstones, and below the Chelsea sandstone, Tiawah limestone and Tebo coal. Strata below this line are affected by the large faults and those above are not.

Distribution. The Boggy formation is present in a north-south zone through the central part of Wagoner County.

Character and thickness. The Boggy formation is cyclic in nature and is about 140 feet thick.

Stratigraphic relations. The Boggy is conformable with the underlying Savanna formation. The top of the Boggy is marked by an unconformity that can not be located in Wagoner County.

Age and correlation. The Boggy formation is the youngest unit in the Krebs group of the Desmoinesian series. The unconformity at the top of the Boggy corresponds to the Pottsville-Allegheny break of eastern North America (Branson, 1956, p. 85). The Boggy north of the McAlester Basin is approximately equivalent to the Boggy in the basin.

Subdivisions. There are three major subdivisions of the Boggy. These are the Bluejacket sandstone member, the Inola limestone member and the Taft sandstone member. In addition to these members there are three named coal beds: the Secor ? coal, the Bluejacket coal and the Weir-Pittsburg ? coal.

Bluejacket Sandstone Member

History of nomenclature. Ohern (1914, p. 28) named the Bluejacket sandstone from exposures near the town of Bluejacket, Craig County, Oklahoma. Howe (1951, p. 2090) restricted the Bluejacket and redefined the type section. The Bluejacket in this report is defined as the sandstone development below the Inola limestones and above the Savanna

Figure 12. Bluejacket sandstone. In a creek near the center of the west half of sec. 36, T. 18 N., R. 16 E.

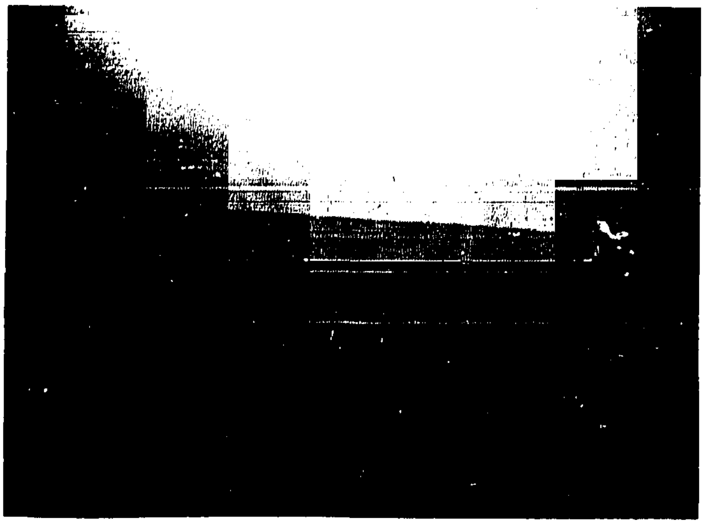

Figure 13. Cross-bedding in the Bluejacket sandstone. Near the center of the west side of sec. 15, T. 16 N., R. 17 E.

formation.

Distribution. The Bluejacket forms an almost continuous series of sandstone ridges west of the Verdigris River in T. 16 N., T. 17 N., and T. 18 N. In most cases the first sandstone ridge west of the river is capped by Bluejacket. East of the Verdigris River the Bluejacket outcrops are limited. Isolated hills capped by Bluejacket sandstone are in sections 5 and 6, T. 18 N., R. 18 E., and section 7, T. 17 N., R. 18 E. These outliers occur on the down-thrown side of faults. Other exposures are in T. 18 N., R. 17 E., where the Bluejacket is present along two different fault scarps. In the southern part of the county the Bluejacket caps isolated mounds rising above the Arkansas and Verdigris River terrace and alluvial deposits. These exposures also are on the down-thrown side of faults.

Character and thickness. The greater part of the Bluejacket sandstone consists of massive to cross-bedded, fine-grained, tan sandstone that weathers brown. In the vicinity of the town of Porter, T. 16 N., R. 17 E., the Bluejacket consists of three sandstones separated by black shale. Northward these sandstones coalesce into one and the section becomes thinner. Shales and siltstones are generally found interbedded with the sandstone in the Bluejacket.

Thickness of the Bluejacket varies from 16.5 to 37.5 feet. The average thickness is about 20 feet.

Age and correlation. The Bartlesville sand of the subsurface of Oklahoma and Kansas is the subsurface equivalent of the Bluejacket (Clark and Cooper, 1927, p. 17). The Bluejacket is the base of the Boggy formation and it has been traced across a large part of eastern Oklahoma, as shown on the "Geologic Map of Oklahoma" (1954). Pierce and Courtier (1937, p. 27) introduced the name Bluejacket into Kansas.

Beds Between the Bluejacket Sandstone and the Secor ? Coal

Beds between the Bluejacket sandstone and the Secor ? coal are restricted to the area near the town of Porter, T. 16 N., R. 17 E., where the coal is found. Here the unit consists of black shale, siltstone and one thin sandstone. Thickness of the unit varies between 10 and 22 feet.

Secor ? Coal

The coal that is strip-mined near the town of Porter is tentatively correlated with the Secor coal of the McAlester Basin on the basis of its position in the stratigraphic section. The most recent Oklahoma coal report (Trumbull, 1957,

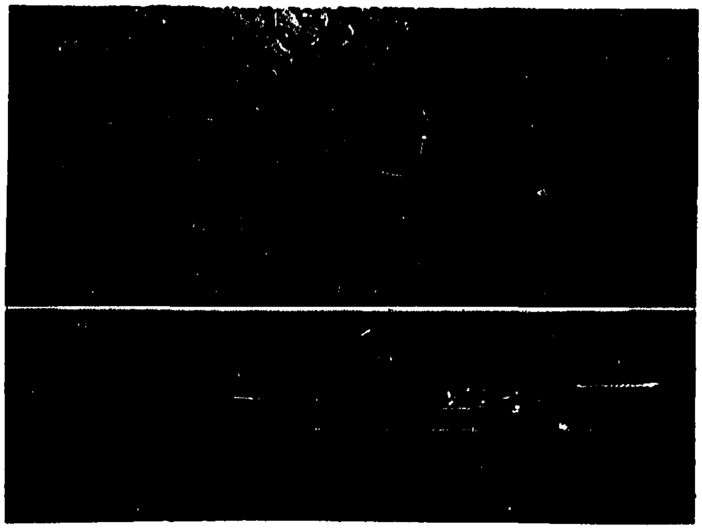

Figure 14. Ripple marks on top of the Bluejacket sandstone. SE¼ sec. 26, T. 18 N., R. 16 E.

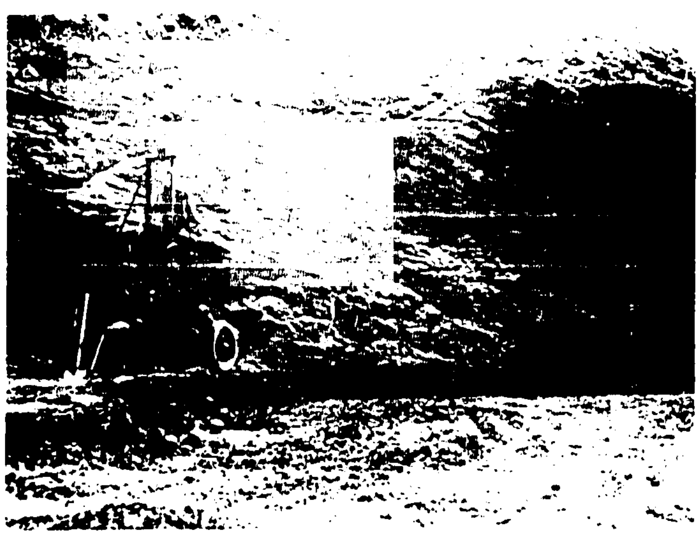

Figure 15. Secor ? coal. Center of sec. 6, T. 16 N., R. 17 E.

p. 350-351) states that the Secor coal lies a short distance above the Bluejacket sandstone, as does this coal. The coal can not be traced beyond the limits of the mined area. It has also been mined near the town of Clarksville, about three miles south of the strip-pits near Porter. Dr. L. R. Wilson, of the Oklahoma Geological Survey, Maurice Higgins, a graduate student working under Dr. Wilson, and others are currently investigating the coals of Wagoner County using spores and pollen for correlation criteria.

The Secor ? coal in the Porter area is between 1.4 and 1.8 feet thick with an underclay about 1.9 feet thick.

Beds Between the Secor ? Coal and the Bluejacket Coal

The only area where strata between the Secor ? coal and the Bluejacket coal are exposed is near the town of Porter. The most conspicuous feature of the Secor ? coal is the abundance of plant fossils in the shale above the coal. These plant fossils are found in a zone extending about 12 feet above the coal. The flora can be described as a "*Neuropteris*" flora. An article on this flora has been prepared by G. R. Biggs, Jr. and is on file in Dr. L. R. Wilson's office at the Oklahoma Geological Survey. It may be published later.

The remainder of this unit consists of argillaceous siltstones and sandy, silty shale. The entire unit is about 35 feet thick.

Bluejacket Coal

The name Bluejacket coal was introduced by Searight and others (1953, p. 2748) and later used by Branson (1954, p. 2748). It was defined by Searight (1955, p. 30) as the top bed of the Bluejacket formation and as lying immediately below the Seville limestone. This terminology is not used in Oklahoma. The Seville limestone is equivalent to the uppermost Inola limestone (Branson, 2, 1954, p. 6). There are at least three Inola limestones in Wagoner County and evidence indicates a coal is found below each of them. It is here proposed that the term Bluejacket coal be applied to the coal immediately below the lowermost Inola limestone (Inola restricted) and coals below the other Inola limestones remain unnamed. This follows the usage of Branson (1954, 2, p. 6), and the coal below the Inola (restricted) is the most widespread.

Thickness of the coal varies from 0.5 to 0.8 feet. It has an underclay about 1.5 feet thick.

Beds Between the Bluejacket Coal and the Inola Limestone

About 0.5 feet of fossiliferous, calcareous, carbonaceous, gray to black, iron-stained shale occurs between the Bluejacket coal and the Inola limestone (restricted).

Inola Limestone Member

History of nomenclature. Lowman (1932, unnumbered page) named the Inola limestone from exposures on Inola Mound, east of Inola, Rogers County, Oklahoma. Wilson (1935, p. 504) raised the Inola limestone to member rank. Branson (1954, 1, p. 192) placed the type section of the Inola in the south road cut on Oklahoma State Highway 20, on the west face of the hill just east of the Rogers County-Mayes County line, near the northwest corner of section 18, T. 20 N., R. 18 E. He also restricted the term Inola to the lowest limestone of the four exposed at that outcrop. The Inola limestones change in character over the area and it is usually not possible to tell which Inola limestone crops out. For this reason, the term Inola is applied to all of the limestones between the Taft sandstones and the Bluejacket sandstone.

Distribution. Sporadic occurrences of the Inola limestones are known from the northern edge of Mayes County, Oklahoma, to northern McIntosh County, Oklahoma (Branson, 1954, 1, p. 192), a distance of about 65 miles. At least three of the limestones are exposed in section 36, T. 17 N., R. 16 E., and in section 26, T. 18 N., R. 17 E., but at most exposures only one limestone crops out, and its exact stratigraphic position can not be determined.

Character and thickness. Due to the nature of the outcrops of the Inola limestones in the County, no attempt is made to distinguish which of the limestones crops out, unless more than one crops out in the same general area. The limestones generally have the same characteristics. The Inola is mapped as a zone of Inola limestones rather than trying to use the lower bed as restricted by Branson (1954, 1, p. 192). In section 12, T. 17 N., R. 16 E., there are 10.5 feet of strata between two of the Inola limestones, and in section 36, T. 17 N., R. 16 E., there are 3.8 feet of black shale between the top and the middle limestone bed and 6 feet of black shale with clay-ironstone and *Stigmaria* between the middle and the lower limestone beds. In section 26, T. 18 N., R. 17 E., 14 feet of strata occurs between the upper and the middle Inola and 32 feet between the middle and lower Inola limestones. They are blue-gray, fine- to medium-crystalline, bedded to massive, fossiliferous limestones. Individual limestone beds vary between 0.4 and 1.8 feet in thickness. In sections 2, 10, 11, 24 and 25, T. 18 N., R. 16 E., a nodular chert zone is found in the Inola limestone zone. The chert is probably secondary.

Paleontology. The Inola limestones are not fossiliferous throughout. Fossils, or the lack of fossils can not be used to distinguish between the various Inola limestones. Fossils are poorly preserved and usually do not weather out of the limestone.

TABLE V

FAUNA FROM THE INOLA LIMESTONE

Anthozoa
- "Lophophyllidium" sp.
- "Caninia" sp.

Brachiopoda
- Chonetes sp.
- Composita sp.
- Dielasma sp.
- "Marginifera" sp.
- Mesolobus sp.
- Neospirifer sp.

Crinoidea
- Crinoid stems

Gastropoda

Correlations. Inola limestones are recognized in the subsurface of northeastern Oklahoma and they are probably correlative (Branson, 1954, 2, p. 8). The Inola is correlated with the Seville limestone of Missouri and Illinois (Searight, 1955, p. 40). Branson (1954, 2, p. 6) restricts the Seville correlation to the upper Inola limestone.

Beds Between the Inola Limestone and the Taft Sandstone

Siltstones and black shales with clay-ironstone comprise the unit between the Inola limestone and the Taft sandstone. At one locality the thickness is 55 feet. At other localities the thickness can not be determined accurately.

Taft Sandstone Member

History of nomenclature. Wilson (1935, p. 510-511) named the Taft sandstone from exposures near the town of Taft, Muskogee County, Oklahoma. He stated that it was in the lower part of the Boggy formation 80 to 150 feet above the Inola limestone. The Taft sandstone north of the Arkansas River is here defined as any sandstone between the Inola limestone below and the Tiawah limestone above. Since these sandstones are lenticular and discontinuous, and the upper sandstone may be in the Senora formation, they have no time-stratigraphic significance.

Figure 16. Siliceous nodules in black Boggy shale a few feet above the Bluejacket sandstone. NW¼ sec. 3, T. 17 N., R. 16 E.

Figure 17. Nodular chert zone in the Boggy formation. This zone is in about the same position as one of the Inola limestones. NE cor. sec. 10, T. 18 N., R. 16 E.

Distribution. The Taft sandstone is present through much of the western part of Wagoner County. It occurs west of the Arkansas River in T. 16 N., R. 15 E. North of the Arkansas River the lower Taft sandstones are involved in the faulting in the area. In T. 17 N., the Taft forms the cap rock for the hills and ridges east of the town of Coweta. In most of T. 18 N., and T. 19 N., the Taft sandstones form benches in the east-facing cuestas formed by the Chelsea sandstone. A few isolated Taft outliers cap some of the hills associated with faulting; the more conspicuous of these are in section 9, T. 17 N., R. 16 E., and in section 26, T. 18 N., R. 17 E.

Character and thickness. The sandstones are irregularly bedded, at many places having siltstones and shale interbedded with the sandstone. They are tan, fine-grained, micaceous sandstone.

Thickness of the individual beds of the Taft sandstones varies between 6.5 and 33 feet. In the area east of Coweta, where three Taft sandstones occur, about 30 feet of micaceous siltstone and unexposed strata separate the sandstones. The middle sandstone of these three is about 12 feet thick and the other two are about six to eight feet thick.

Correlation. The Red Fork sand of the subsurface is the approximate equivalent of the Taft sandstone (Branson, 1954, 2, p. 8). The Red Fork is also a lenticular sandstone.

Weir-Pittsburg ? Coal

No exposures of the Weir-Pittsburg ? coal were found, only an abandoned strip pit. This location is above the lowest Taft sandstone and about 90 feet below the base of the Taft sandstone that caps the hill. The strip pit is located on the north side of a mound in section 9, T. 17 N., R. 16 E.

Senora Formation

History of nomenclature. The Senora formation was named by Taff (1901, p. 4). Taff gave no type locality for the Senora. Gould (1925, p. 44) lists the old post office of Senora, Okmulgee County, Oklahoma, as the type locality. As originally defined the Senora included a series of sandstone and shale between the Stuart shale below, and the Calvin sandstone above. The Senora formation of this report includes all of the strata between the top of the Boggy formation and the base of the Fort Scott formation. The base of the Senora has been previously discussed.

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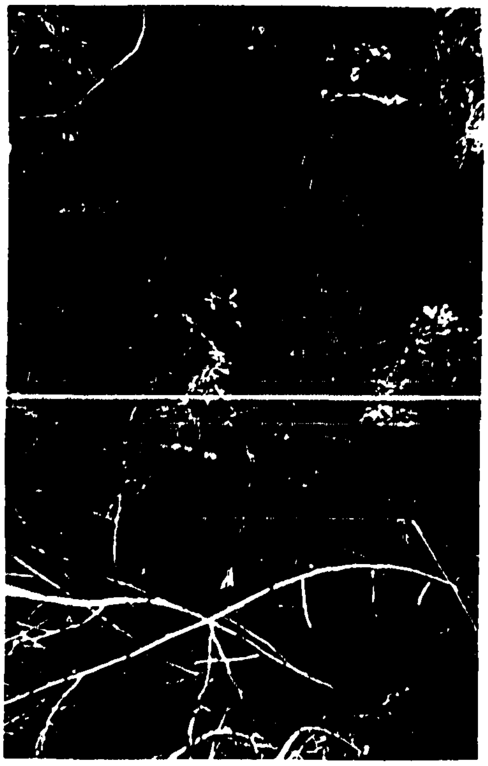

Figure 18. Inola limestone (restricted). Near the NW cor. sec. 5, T. 18 N., R. 16 E.

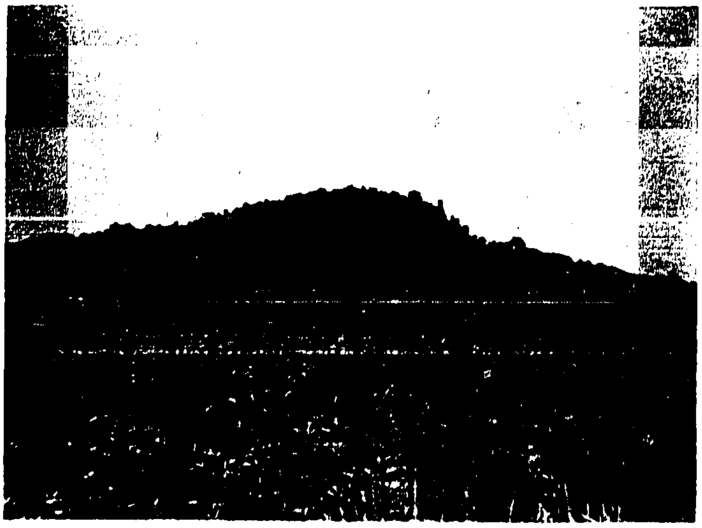

Figure 19. A mound capped by Taft sandstone. Weir-Pittsburg ? coal is on the north side of this mound. Sec. 9, T. 17 N., R. 16 E.

Distribution. Outcrops of the Senora formation are known in a north-south zone through most of R. 15 E. In T. 17 N., and T. 18 N., the top of the Senora lies to the west in Tulsa County. The lower sandstone member of the Senora forms an escarpment, the base of which at places indicates the approximate lower limit of the formation. This escarpment is not everywhere reliable, but it helps in locating the base.

Character and thickness. Parts of seven cyclothems are found in the Senora of Wagoner County, indicating its cyclic nature. Thickness of the Senora varies from about 245 feet to about 470 feet.

Stratigraphic relations. An unconformity separates the Senora formation from the underlying Boggy. The Blackjack Creek limestone member of the Fort Scott formation overlies the Senora conformably.

Age and correlation. The Senora is the only formation of the Cabaniss group in northeastern Oklahoma. The Senora is Desmoinesian in age. The Senora in Wagoner County is approximately the same age as the Senora in the McAlester Basin. It is correlated with the lower part of the Allegheny series of eastern United States (Branson, 1956, p. 85), and with the upper part of the Tradewater group of the Illinois

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Basin (Wanless and Siever, 1956, Correlation Chart). Members of the Senora formation have been traced northward into southeastern Kansas and southwestern Missouri.

Subdivisions. Four limestone, and four sandstone and shale members are recognized in the Senora of Wagoner County. The limestones are: the Tiawah, near the base of the Senora; the McNabb, under the Croweburg coal and near the middle of the Senora; the Verdigris, above the Croweburg coal; and the Breezy Hill, near the top of the Senora. The sandstone and shale members are: the Chelsea, above the Tiawah; the Lagonda, above the Verdigris; the Kinnison, below the Breezy Hill; and the Excello above the Breezy Hill. Three identifiable coals are found in the area, and two of questionable identity. These are: the Tebo coal, below the Tiawah limestone; the Croweburg coal; the Iron Post coal, below the Kinnison shale; and two coals between the Chelsea sandstone and the Croweburg coal.

Tebo Coal

The Tebo coal is the lowest named unit of the Senora. It is found in the east side of section 2, T. 16 N., R. 15 E., and near the center of the southwest quarter of section 31, T. 18 N., R. 16 E. Its development is not continuous throughout the County. Thickness of the Tebo is 0.3 feet at one of the above locations and 0.5 feet at the other. The underclay at each outcrop is about 0.5 feet thick.

Beds Between the Tebo Coal and the Tiawah Limestone Member

The beds between the Tebo coal and the Tiawah limestone are exposed at the above-mentioned Tebo coal outcrops. At the exposure in section 2, the unit is about 15 feet thick and at the other exposure it is about 3 feet. Black fissile shale with phosphate nodules is exposed in the interval.

Tiawah Limestone Member

History of nomenclature. Lowman (1932, unnumbered page) named the Tiawah from exposures near the town of Tiawah, Rogers County, Oklahoma. The Tiawah is below the Chelsea sandstone and above the Tebo coal.

Distribution. Outcrops of the Tiawah are found in the western part of the County below the Chelsea sandstone ridges. An exposure of the Tiawah near the center of the south side of section 2, T. 16 N., R. 15 E., is the southernmost Tiawah outcrop that has been reported. Through most of T. 18 N., the Tiawah has apparently been removed by channeling of the overlying Chelsea sandstone. Good exposures of the Tiawah are in the center of the south side and near the northeast corner of section 2, T. 16 N., R. 15 E.; in a creek bed near the center of the southwest quarter of section 31, T. 18 N., R. 16 E.; near the center of the south side of section 1, T. 18 N., R. 15 E.; on a north-south section road near the southeast corner of section 25, T. 19 N., R. 15 E.; near the southwest corner of section 24, T. 19 N., R. 15 E.; and near the center of the south side of section 7, T. 19 N., R. 16 E.

Character and thickness. The limestone changes in character from north to south. In the north it is a blue-gray, finely crystalline, massive, fossiliferous limestone, with fusulinids and brachiopods being the predominant fossils. In the southern part of the County it is a dark gray, thin bedded, ferruginous, silty, fossiliferous limestone, with *Myalina* as the only fossil. The change in character is noticeable between the two exposures in T. 18 N. The zone of transition has been removed by the Chelsea channeling.

The Tiawah thins southward to extinction. A maximum thickness of 5.5 feet is found in section 7, T. 19 N., R. 16 E., and a minimum of 0.3 feet at the south side of section 2,

T. 16 N., R. 15 E.

Stratigraphic relations. The Chelsea sandstones have channelled down into the Tiawah limestone, removing it at several places.

Paleontology. The Tiawah limestone contains Myalina in the southern part of the County and Composita and fusulinids in the northern part of the County. In the northern part there are few macrofossils in the Tiawah.

Age and correlation. The Tiawah is in the lower part of the Senora formation. It is known as the "Pink" lime in the subsurface of northeastern Oklahoma and southeastern Kansas (Lowman, 1932, unnumbered page). Branson and Alexander (1954, p. 49-50) have correlated the Tiawah with the Seahorne limestone of the Illinois Basin.

Beds Between the Tiawah Limestone Member and the Chelsea Sandstone Member

Black shale occurs between the Tiawah limestone and the Chelsea sandstone. Where the Chelsea sandstone has channelled through the Tiawah limestone this unit is absent. The average thickness of the unit is about four feet.

Chelsea Sandstone Member

History of nomenclature. Ohern (1914, p. 29) named the Chelsea sandstone for exposures near the town of Chelsea, Rogers County, Oklahoma. Branson (1954, 1, p. 193) raised the Chelsea sandstone to member rank. The base of the Chelsea is the first sandstone above the Tiawah limestone, or in the absence of the Tiawah, the first sandstone above the base of the Senora. The top of the Chelsea is difficult to determine. It is the highest sandstone in the series of sandstones and shales that make up the Chelsea.

Distribution. The Chelsea forms a prominent escarpment across the western part of Wagoner County. The base of the Chelsea is near the base of the escarpment at places because of shale development in the member.

Character and thickness. The Chelsea consists of tan, fine-grained, cross-bedded to massive, micaceous sandstone; black to gray, silty shale; and sandy siltstone. At the south side of section 1, T. 18 N., R. 15 E., the base of the Chelsea is a fossiliferous, sandy limestone. A calcareous clay-ironstone is above this. Thickness of the member varies from about 100 feet to about 180 feet.

Correlation. The Skinner sand of the subsurface of northeastern Oklahoma is the approximate equivalent of the Chelsea at the surface (Branson, 1954, 2, p. 8).

Beds Between the Chelsea Sandstone Member and the Croweburg Coal

Rocks between the Chelsea sandstone and the Croweburg coal are cyclic in nature. Coal crops out in section 2, T. 19 N., R. 15 E., and in section 6, T. 16 N., R. 15 E., between the Chelsea and the Croweburg. The rest of the unit consists of gray to black shale, siltstone, fine-grained, silty sandstone and thin, lenticular limestones. Thickness is between 80 and 114 feet.

The coal exposed in this unit is not correlated with any of the named coals to the north because there is no basis for correlation. The coal in section 2 is about 0.5 feet thick, with a poorly developed underclay. It is located east of the road in the west bank of a creek that crosses under the road, near the center of the west side of section 2, T. 19 N., R. 15 E. Another exposure of coal is in the east bank of the road, in front of a house almost on the half section line of the same section. Coal about 1.1 feet thick crops out west of U. S. Highway 64 in the northeast quarter of section 6, T. 16 N., R. 15 E.

McNabb Limestone Member

History of nomenclature. The name McNabb limestone was first used in print in 1951 by Gatchell and Fitts (1951,

p. 23). They applied the name to the underlime of the Croweburg coal. The name next appears in print in 1954 (Branson, 1954, 2, p. 3 and 5). The McNabb limestone is here defined as the underlime below the Croweburg coal.

Distribution. One exposure of the McNabb limestone is known in Wagoner County. It crops out about 8 feet below the Croweburg coal on the south side of a creek that drains the strip pits, west of the road, near the northwest corner of the southeast quarter of the northeast quarter of section 20, T. 19 N., R. 15 E. Limestones below the Croweburg coal in section 6, T. 16 N., R. 15 E., are not underlimes.

Character and thickness. The McNabb is gray-brown, medium-crystalline, fossiliferous limestone about 1.2 feet thick.

Beds Between the Croweburg Coal and the McNabb Limestone Member

Black fissile shale is exposed between the Croweburg coal and the McNabb limestone at the outcrop of the McNabb limestone listed above. The lower part is covered. The interval is 8 feet.

Croweburg Coal

Pierce and Courtier (1937, p. 74) established the name Croweburg in the literature. Prior to that time the Croweburg had been known by a variety of local names. Oakes (1944, p. 12) correlated the Broken Arrow coal of Wagoner County with the Croweburg coal of Kansas, and Branson (1954, 2, p. 2) adopted the name Croweburg for the Broken Arrow.

The Croweburg has been strip-mined continuously from a point on the Tulsa-Wagoner County line to the Wagoner-Rogers County line to the north. South of the Arkansas River there are four strip pits in the Croweburg. None of these strip pits has been active during the past year.

Exposed Croweburg coal varies in thickness from 1.4 to 1.8 feet. The underclay is about 1.5 feet thick. The Croweburg is exposed in the road above the McNabb limestone outcrop mentioned above and north of the northernmost strip pit, near the base of Concharty Mountain, in section 6, T. 16 N., R. 15 E.

Beds from the Croweburg Coal to the Verdigris Limestone Member

Black fissile shale with phosphate nodules occurs between the Croweburg coal and the Verdigris limestone. The unit thins from about 34 feet in an abandoned strip pit north of State Highway 33, at the south side of section 33, T. 20 N., R. 15 E., to about 15 feet in section 19, T. 18 N., R. 15 E., where the line of outcrop leaves the County. South of the Arkansas River the Verdigris limestone is about 4 feet above the coal and forms the cap rock.

Verdigris Limestone Member

History of nomenclature. The name Verdigris limestone first appeared in print in 1928 on a map included in a report by Woodruff and Cooper (1928, map, in pocket). This map was taken from maps prepared by D. W. Ohern and C. D. Smith. It is probable that Smith originated the name in his work on the Claremore Quadrangle, although his work was never completed and is not available. Woodruff and Cooper used the name on the map, but not in the text of the report. A limestone described by Cooper (1927, p. 161) as being 35 to 50 feet below the Fort Scott limestone in northeastern Oklahoma is probably the Verdigris, but he did not use the name. A type section has been established by Branson (1954, 3, p. 53) at a former bridge site of old U. S. Highway 66, near the center of the east side of the southeast quarter of section 17, T. 20 N., R. 15 E. At this locality the

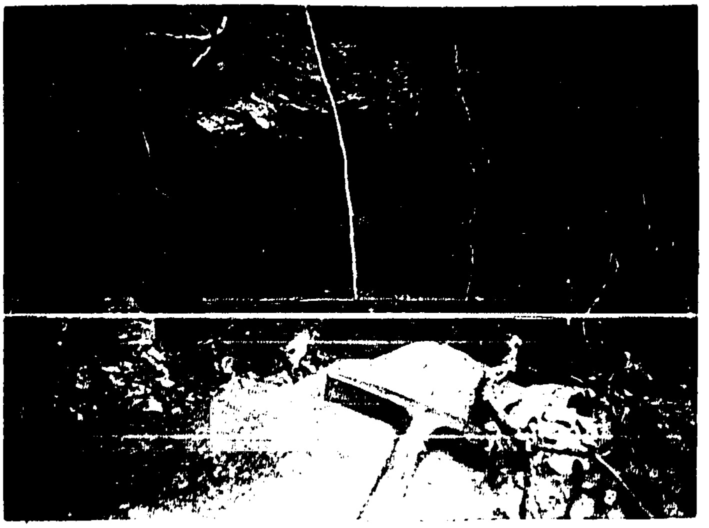

Figure 20. Croweburg coal. North of the northernmost abandoned strip-pit. SE¼ sec. 6, T. 16 N., R. 15 E.

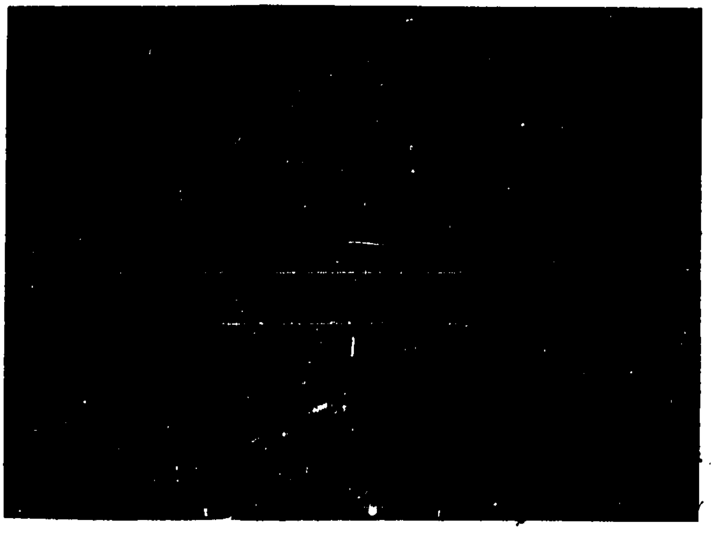

Figure 21. Verdigris limestone exposed below Lagonda shale in an abandoned strip-pit. Center strip-pit. SE¼ sec. 6, T. 16 N., R. 15 E.

Verdigris limestone is on the south bank of the Verdigris River, from which it received its name. Tillman (1952, p. 14) has a measured section at this locality.

Distribution. The Verdigris limestone crops out along the west edge of the Croweburg coal strip pits. South of the Arkansas River the Verdigris is present in the abandoned Croweburg strip pits on the east side of Concharty Mountain.

Character and thickness. South of the river it is a silty, fossiliferous, ferruginous limestone. North of the Arkansas it is a blue-gray, finely-crystalline, fossiliferous, bedded limestone with shale partings. At the northern border of Wagoner County the Verdigris is 7 feet thick. South of the Arkansas River in Wagoner County it is about 2.2 feet thick.

Paleontology. Fossils are abundant in the Verdigris limestone, but they are poorly preserved and do not weather out.

TABLE VI

FAUNA FROM THE VERDIGRIS LIMESTONE MEMBER

Anthozoa
"Lophophyllidium" sp.

Brachiopoda
Chonetes sp.
Composita sp.
Derbyia ? sp.
Hustedia sp.
"Marginifera" sp.
Mesolobus sp.

Bryozoa
"Fenestrellina" sp.

Crinoidea
Crinoid stems, arms and plates

Gastropoda

Pelecypoda
"Myalina" sp.

Correlation. The Ardmore limestone of Missouri and Kansas has in part been traced into the Verdigris limestone but the name Verdigris is retained (Branson, 1954, 2, p. 2).

Lagonda Member

History of nomenclature. The Lagonda was named by Gordon (1893, p. 19) from exposures in an old quarry near the Lagonda Post Office, Chariton County, Missouri. He described the Lagonda as constituting the uppermost division

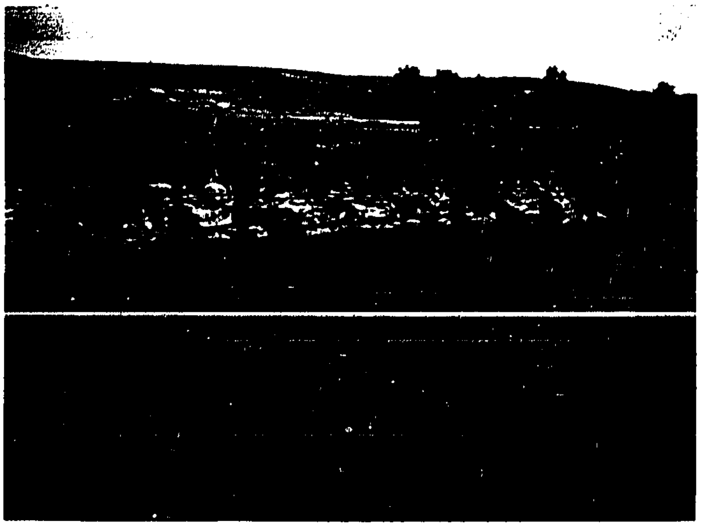

Figure 22. Verdigris limestone exposed in a water-filled strip-pit. South side SW¼ sec. 16, T. 19 N., R. 15 E.

Figure 23. Verdigris limestone exposed in an abandoned strip-pit. Southernmost strip-pit. SE¼ sec. 6, T. 16 N., R. 15 E.

of the lower coal measures and overlying the Bevier coal. Searight (1955, p. 37) states that the Lagonda lies between the Bevier and Mulky formations, terms not used in Oklahoma. Ware (1954, p. 22-25) restricted the Lagonda to the erratic, lenticular sandstone beds that are found in the member. The Lagonda as used in this report includes all strata between the base of the Iron Post coal and the top of the Verdigris limestone.

Distribution. The Lagonda member crops out in a north-south zone along the western part of R. 15 E., to the point where it leaves the County on the west. The Lagonda forms a narrow belt near the base of Concharty Mountain south of the Arkansas River.

Character and thickness. North of the Arkansas the Lagonda consists of sandstone and shale. The sandstone is fine-grained, tan, thin-bedded to massive and micaceous. The shales are gray to tan and silty. The sandstone is lenticular and may occur at any vertical position in the member. South of the river it is a gray to tan, silty shale.

The Lagonda is about 106 feet thick south of the river and between 78 and 150 feet thick north of the river.

Correlation. The Squirrel sand of the subsurface of northeastern Oklahoma and southeastern Kansas is the approximate equivalent of the sandstones in the Lagonda member.

Iron Post Coal

Overlying the Lagonda member is the Iron Post coal. Three exposures of the Iron Post are present in Wagoner County. The best exposure is in the south bank of a road cut on a road under construction on the north side of the northwest quarter of section 6, T. 19 N., R. 15 E. This road will replace the present State Highway 33 when it is completed. The second exposure is on the north bank of the road cut on State Highway 33, west of Spunky Creek, in the northwest quarter of section 6, T. 19 N., R. 15 E. Another exposure is located in the west bank of a tributary to Spunky Creek near the southwest corner of section 8, T. 19 N., R. 15 E. The Iron Post coal is 1.1 feet thick at the northernmost exposure and 0.5 feet thick at the southernmost exposure. The underclay is about 1.2 feet thick.

Howe (1951, p. 2092) named the Iron Post coal from exposures near the old settlement of Iron Post, in the southeast quarter of section 36, T. 28 N., R. 19 E., Craig County, Oklahoma.

Kinnison Shale Member

History of nomenclature. The rocks between the Iron Post coal and the Breezy Hill limestone were named the Kinnison by Howe (1951, p. 2092-2093). No changes have been made in the usage of the term Kinnison.

Distribution. Outcrops of the Kinnison shale are present below the base of the Breezy Hill limestone in sections 6, 7, 8, 18, 19 and 30, T. 19 N., R. 15 E. Good exposures are found at the Iron Post coal localities mentioned above.

Character and thickness. The Kinnison is a black fissile shale between one and two feet thick.

Breezy Hill Limestone Member

History of nomenclature. The Breezy Hill limestone was named by Pierce and Courtier (1937, p. 33) from exposures on Breezy Hill, near Mulberry, Crawford County, Kansas. In southeastern Kansas Pierce and Courtier described the Breezy Hill as being 4 to 8 feet below the top of the Cherokee shale, the top being the base of the Fort Scott limestone. In Wagoner County the Breezy Hill is between 3 and 6 feet below the Fort Scott limestone.

Distribution. Outcrops of the Breezy Hill in Wagoner

Figure 24. Iron Post coal. South side of a road under construction. North side NW¼ sec. 6, T. 19 N., R. 15 E.

Figure 25. Contact between the Breezy Hill limestone and the Excello shale. In the north road cut on State Highway 33. NW¼ sec. 6, T. 19 N., R. 15 E.

County are limited to the westernmost tier of sections in R. 15 E. One outlier extends into sections 8 and 17, T. 19 N., R. 15 E. South of the Arkansas River the Breezy Hill is exposed near the base of the sandstones on Concharty Mountain.

Character and thickness. South of the Arkansas River the Breezy Hill is a dark brown, ferruginous, silty, fossiliferous limestone about 2.5 feet thick. North of the river it is a blue-gray, fine-crystalline, bedded to massive, fossiliferous limestone between 3 and 7 feet thick.

Paleontology. The Breezy Hill limestone is fossiliferous, but the fossils normally do not weather out of the limestone.

TABLE VII

FAUNA FROM THE BREEZY HILL LIMESTONE

Anthozoa
- "Lophophyllidium" sp.

Brachiopoda
- Chonetes sp.
- Composita sp.
- Hustedia sp.
- "Marginifera" sp.
- Mesolobus sp.
- Neospirifer sp.

Bryozoa

Crinoidea
- Crinoid stems

Excello Shale Member

History of nomenclature. The Excello shale was named by Searight and others (1953, p. 2748). It is described by Searight (1955, p. 35) as a fissile, black shale at the top of the Venteran, which is also the top of the Cabaniss group. He gave it formation rank. This usage is not followed in Oklahoma. The Excello member includes the strata between the top of the Breezy Hill limestone and the base of the Fort Scott limestone. It is here proposed that it be given member rank in Oklahoma.

Distribution. The Excello shale is between the Breezy Hill limestone and the Fort Scott limestone in sections 6, 7, 18, 19 and 30, T. 19 N., R. 15 E., and in sections 6, 7 and probably 18, T. 16 N., R. 15 E.

Character and thickness. In Wagoner County the Excello is a fissile, black shale with phosphate nodules, and is about 3 to 6 feet thick.

The top of the Excello shale member marks the top of the Senor formation and the top of the Cabaniss group.

Fort Scott Formation

History of nomenclature. The Fort Scott formation was named by Swallow in 1866, from exposures near the city of Fort Scott, Kansas (Wilmarth, 1938, p. 758). According to Pierce and Courtier (1937, p. 42) Swallow applied the name to the upper one of two Fort Scott limestones. Adams (1903, p. 29) established the Fort Scott formation as it is used at present. Cline (1941, p. 36) named the lower limestone of the Fort Scott the Blackjack Creek and the upper limestone the Higginsville. Howe (1951, p. 2092) stated that only the Blackjack Creek member of the Fort Scott formation extends into Oklahoma.

Distribution. The Blackjack Creek member of the Fort Scott formation is present along the west side of T. 19 N. Near the base of the sandstones on Concharty Mountain, south of the Arkansas River, it is exposed at places.

Character and thickness. Along the west side of T. 19 N., the Blackjack Creek is a blue-gray, fine-crystalline, bedded, slightly fossiliferous limestone about 6 to 9 feet thick. South of the Arkansas River it is a silty, ferruginous, gray-brown, fossiliferous limestone about 0.8 feet thick.

Stratigraphic relations. A noticeable change in lithic character occurs at the base of the Blackjack Creek limestone, but there is no evidence of an unconformity. The Labette shale overlies the Fort Scott conformably.

Age and correlation. The base of the Fort Scott limestone marks the base of the Marmaton group of the Desmoinesian series. The base of the Calvin sandstone in the McAlester Basin marks the base of the Marmaton group in that area. Southward the Fort Scott loses its identity and passes beneath a thick sequence of sandstones and shales of the Wetumka formation.

The Blackjack Creek limestone is correlated with the Hanover limestone of the Illinois Basin by Alexander and Branson (1954, p. 50) and corresponds to part of the Allegheny of eastern United States (Wanless and Siever, 1956, Correlation Chart).

Labette Formation

History of nomenclature. Haworth (1898, p. 36) named the Labette shales. Since he mentioned that the maximum thickness of the Labette occurs at Labette City, Labette County, Kansas, it is possible that this location was intended to be the type locality, but he does not mention a type locality. The use of the term Labette in northeastern Oklahoma conforms with the usage in Kansas. It includes strata between the Fort Scott limestone and the Oologah limestone in this region. Only the bottom few feet are exposed in Wagoner County. South of the Arkansas River part of the Labette is present below the Wetumka sandstone and shale.

Distribution. A small amount of Labette is present in the northwest corner of section 6, T. 19 N., R. 15 E. South of the Arkansas River the term Labette is applied to the shale between the Fort Scott limestone and the base of the sandstone.

Character and thickness. Five feet of Labette shale is exposed in an excavation near the southwest corner of section 31, T. 20 N., R. 15 E. Here the Labette is a black fissile shale. South of this exposure, within Wagoner County, there is less Labette exposed. The character here should be the same, although it is covered with soil. On Concharty Mountain the Labette is represented by about 6 feet of phosphatic black shale.

Stratigraphic relations. The Labette is conformable upon the underlying Blackjack Creek member of the Fort Scott formation and appears to be conformable under the Wetumka formation.

Age and correlation. The sandstone and shale sequence that makes up the greater part of the strata in Concharty Mountain has been traced southward into the Wetumka formation (Oakes, 1959, personal communication). This would place the basinal equivalents of the Labette in part of the Wetumka or in part of the Calvin. The Labette has been traced northward into Kansas and Missouri.

Calvin Formation

History of nomenclature. The Calvin was named by Taff (1901, p. 4). He did not give a type locality, but the name was probably taken from the town of Calvin, Hughes County, Oklahoma where the Calvin sandstones are well developed. Present usage follows that of Taff.

Distribution. The Fort Scott limestone and the Calvin formation interfinger near the base of Concharty Mountain. The Calvin thins as it approaches the mountain from the south. The Calvin formation can not be positively identified at this locality and for that reason it is discussed no further.

Wetumka Formation

History of nomenclature. Taff (1901, p. 4) named the Wetumka formation. He gave no type locality, but he probably took the name from the town of Wetumka, Hughes County, Oklahoma. Present usage of the term follows that of Taff.

Distribution. The thick sandstone and shale sequence above the Fort Scott limestone on Concharty Mountain is the

Wetumka.

Character and thickness. The Wetumka consists of tan, medium-grained, massive to bedded sandstones interbedded with gray to tan, silty, sandy shale. About 120 feet of Wetumka is present.

Stratigraphic relations. The Wetumka appears to be conformable with the underlying shales referred to as the Labette on Concharty Mountain. The top of the Wetumka is not exposed.

Age and correlation. The sandstone and shale on top of Concharty Mountain are shown on the State Geologic Map (1954) as Wewoka. Malcolm C. Oakes, of the Oklahoma Geological Survey is currently tracing these beds southward toward the type sections as part of the work on Okmulgee County. He now believes these beds to be Wetumka rather than Wewoka (personal communication, 1959).

Quaternary System

Sedimentary deposits of Quaternary age consist of unconsolidated clay, silt, sand, and gravel. Quaternary deposits of Wagoner County can be classed as terrace or alluvial deposits. They lie unconformably upon the older Paleozoic rocks of the area. All are associated with the rivers and streams of the County.

Terrace Deposits

Terrace material covers a wide area on each side of the Verdigris River. The Verdigris River has three types of terrace material associated with it. At a few isolated exposures there are gravel deposits containing dark brown chert pebbles and light brown silt and clay-sized particles. One of these deposits is in sections 18 and 19, T. 16 N., R. 18 E. Another is in sections 4 and 5, T. 18 N , R. 17 E. These are small, thin deposits and may represent a more widespread occurrence that has been reduced by erosion. Other terrace deposits along the Verdigris River contain brown chert pebbles in a dark brown, sandy, silty clay. These are more widespread in Wagoner County where several of them are quarried for road surfacing material. Many of the terrace deposits along the Verdigris River do not contain gravel in sufficient quantity to make them useful for road surfacing material. These consist of a gray-brown, fine sand, and silt with little or no clay. They weather into peculiar patterns similar to weathering in loess. Volcanic ash is at places found in these deposits. Although these are located close to the Verdigris River and appear to be associated with it, they may be wind-blown, or in part wind-blown. At least 20 feet of terrace material is present in one of the gravel quarries. Most deposits that are quarried are thinner than 20 feet, but others that are not quarried may be thicker. An exact thickness of the terrace can not be obtained due to the nature of their occurrence.

Little or no gravel is associated with the terrace deposits along the Arkansas River in Wagoner County. Some of those along the Arkansas River resemble the gray-brown, fine sand, and silt deposits along the Verdigris River. These also have a peculiar erosion pattern similar to that in loess and may also be wind-blown, or in part wind-blown. Other terrace deposits along the Arkansas River are red sand, silt, and clay. This type is much more widespread. Streams cut through these leaving high steep cliffs. These deposits are associated with an earlier period in the history of the Arkansas River when it flowed at a higher level than it now does. They may also be in part wind-blown.

In sections 34 and 35, T. 18 N., R. 19 E., a terrace deposit along Grand River contains a large amount of gravel with sand, silt, and clay. Other terrace deposits are exposed east of Grand River when the lake is at its normal level. These deposits appear to be similar to the deposit mentioned above west of the river. About 15 feet of terrace material is exposed in the above mentioned quarry.

Alluvial Deposits

Alluvial deposits are present along the Grand, Verdigris and Arkansas Rivers and their larger tributaries. These consist of sand, silt and clay in varying ratios.

Most of the alluvial deposits consist of light-brown silt and clay. Along the banks of the Verdigris River up to 25 feet of alluvium is exposed. It weathers easily leaving relatively steep banks along the river. At least two levels of alluvium are present east of the Verdigris River in section 23, T. 17 N., R. 17 E. This condition is indicated at other places along the river, particularly on the east side.

Alluvial deposits along the Arkansas River consist of light-brown sand, silt and clay. In the Choska area, T. 16 N., R. 16 E., three levels of alluvium are present. Prior to the time this area was drained a large part of it was under swamp and marsh. The levels of alluvium are such that their origin could not have resulted from draining of the land, but would have been related to the swampy conditions that existed.

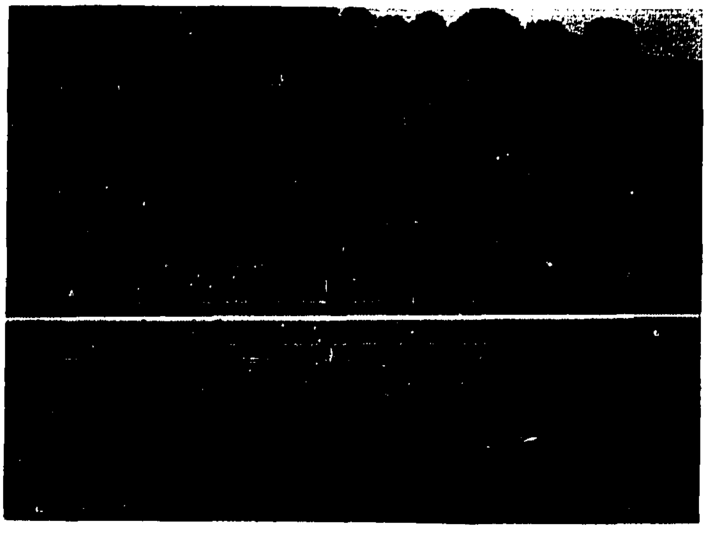

Figure 26. Weathering in a terrace deposit north of the Verdigris River. SW¼ sec. 34, T. 17 N., R. 18 E.

Figure 27. Weathering in a terrace deposit north of the Arkansas River. South side of sec. 8, T. 17 N., R. 15 E.

The larger streams in Wagoner County at places have alluvial deposits along them. These are normally extensions of the deposits of the larger rivers and have the same character.

CHAPTER IV

STRUCTURAL GEOLOGY

Rocks in Wagoner County generally dip to the west or southwest at the rate of 50 to 60 feet to the mile. This homoclinal structure is locally interrupted by faults and folds.

Wagoner County lies in an area between the Ozark Uplift to the northeast and the McAlester Basin to the south. Near the end of Boggy time the rocks in the McAlester Basin were faulted and folded (Govett, 1957, p. 38). This time corresponds with the period of faulting and folding in Wagoner County. These faults are probably associated with movement in the McAlester Basin and in the Ozark Uplift.

Faults

All of the faults are normal faults and all have a general northeast-southwest trend. The faults are probably a result of movement of the basement rocks in adjusting to the pressure and release of pressure caused by movements in the previously mentioned areas.

Only the major faults in the County are mapped. Numerous small faults are present, but they are not important to the geology of the area.

A fault is in section 13, T. 18 N., R. 19 E., and section 18, T. 18 N., R. 20 E. Beds of the Fayetteville formation are brought into contact with beds of the Atoka formation, indicating a displacement of about 60 feet. The fault can be traced across the two sections.

Another fault of about the same magnitude is located in sections 5 and 8, T. 18 N., R. 19 E. This fault also has brought Fayetteville beds into contact with Atoka beds, indicating about 60 feet of vertical movement, and it can be traced about two miles. This fault has smaller faults associated with it which are of lesser magnitude and have different directions of strike.

North Flower Creek fault enters Wagoner County from the east in section 24, T. 16 N., R. 19 E., and can be traced southwestward about three miles to the point where it passes beneath Quaternary gravel deposits. At its maximum displacement, it brings the Pitkin formation into contact with the Atoka formation, indicating about 85 feet of throw.

Centered in section 30, T. 18 N., R. 18 E., is a structurally high area exposing Atokan rocks within Desmoinesian rocks. This high is bounded by faults on the northwest and the southeast. Smaller northeast-southwest trending faults are within the high area. Displacement along these faults can not be accurately determined.

A graben is centered in section 36, T. 17 N., R. 17 E. This graben has dropped beds as young as the Spaniard limestone into contact with the Atoka formation. Displacement along the southern fault is greater than that along the northern fault as shown by the position of the Spaniard limestone. The actual displacement is questionable because of the variable thickness of the McAlester formation. This graben is associated with a northeast-southwest trending fault that has the down-thrown side on the west.

A small graben is in section 34, T. 18 N., R. 19 E., and in sections 3 and 4, T. 17 N., R 19 E. Displacement of the faults on each side of the graben can not be determined.

A fault with the down-thrown side on the west crosses sections 30 and 31, T. 18 N , R. 19 E., and sections 12 and 13, T. 17 N., R. 18 E. This fault has a maximum throw in section 12. The displacement decreases slowly northward and rapidly southward. Branching from this fault is a smaller fault with a maximum displacement of about 60 feet in sections 11 and 12, T. 17 N., R. 18 E. Reverse drag is apparent in the Warner sandstone west of this fault. The down-thrown side is on the east.

Webbers Falls sandstone and shale dips into the Verdigris River bed below the bridge in section 19, T. 16 N., R. 19 E. The dip on these rocks is the drag on the down-thrown side of a fault that passes south and east of them. The fault can not be traced for any great distance because of Quaternary cover.

A mound in sections 5 and 6, T. 19 N., R. 18 E., is on the down-thrown side of a fault that passes about 0.7 miles east. The fault can be traced intermittently about 7 miles to a point where it is lost under terrace deposits.

A fault with the down-thrown side on the west enters the County in section 1, T. 18 N., R. 17 E., and extends about 6 miles southwestward where it becomes indistinct. A mound capped by thin Taft sandstone in section 26, T. 18 N., R. 17 E., is on the down-thrown side of the fault.

A graben containing the Savanna formation is in sections 2, 3, and 10, T. 18 N., R. 17 E. The amount of throw on these faults can not be determined. The faults can only be traced a short distance before going under the Quaternary cover.

Two faults are located north of the city of Wagoner. They intersect in section 4, T. 17 N., R. 18 E. Both faults have the down-thrown side on the north and both have small vertical displacement.

The Rowe coal has been down-faulted on the east side of a fault that passes through the west side of section 27, T. 17 N., R. 18 E. This fault passes southward beneath the Quaternary deposits and is indicated south of the Verdigris River by a mound that rises above the alluvial deposit.

A shale mound is west of U. S. Highway 69, in section 16, T. 17 N., R. 18 E. The Verdigris River has been diverted to a new channel by the Spaniard limestone in section 5, T. 16 N., R. 18 E. This limestone has relatively steep southwestward dip that is the drag on the down-thrown side of a fault. The fault passes east of the limestone and the mound.

Atoka sandstone and shale is exposed in section 25, T. 16 N., R. 18 E. This outcrop is on the down-thrown side of a fault that passes to the east. The fault can not be traced beyond the exposure because of the Quaternary cover.

About one mile west of the Atoka outcrop, the Spaniard limestone crops out on the south bank of the Verdigris River and dips steeply southwestward into the river. A

Figure 28. Steeply dipping Boggy sandstone and shale on the down-thrown side of a fault. NW cor. sec. 24, T. 18 N., R. 16 E.

Figure 29. Drag on a small unmapped fault. NE¼ sec. 2, T. 16 N., R. 16 E.

fault runs east of the limestone outcrop and the dips are the result of drag on the down-thrown side.

The Spaniard crops out again west of this exposure in sections 21, 22 and 23, T. 16 N., R. 18 E., as a result of a fault that runs through sections 22 and 27, T. 16 N., R. 18 E. The up-thrown side of this fault is on the west.

Isolated mounds capped by Bluejacket sandstone are in sections 25, 26, 35 and 36, T. 16 N., R. 17 E., and section 1, T. 15 N., R. 17 E. These mounds are on the down-thrown side of a fault that passes east of the easternmost mound. Erosion has divided them into five separate mounds surrounded by Quaternary deposits.

Spaniard limestone crops out in the bed of the Verdigris River in the southwest quarter of section 5, T. 16 N., R. 18 E., and a mound capped by Bluejacket sandstone is in section 7, T. 16 N., R. 18 E. The limestone and mound are both on the down-thrown side of a fault located east of them. This fault probably intersects another fault with the down-thrown side on the west, located west of this one, and extends southwestward beneath the Quaternary cover.

Two ridges of Bluejacket sandstone are separated by a fault that runs from section 1 to section 15, T. 16 N., R. 17 E. Reverse drag is along this fault. The fault has about 50 feet of throw with the down-thrown side on the east.

Another fault with about 50 feet of vertical displacement runs northeast through the town of Porter. The throw decreases to the northeast. The down-thrown side is on the east.

About 2.5 miles north of this fault is another fault with the down-thrown side on the east. It has a vertical displacement of about 40 feet.

A fault with about 30 feet of throw runs across sections 19, 30 and 31, T. 17 N., R. 17 E., section 36, T. 17 N., R. 16 E., and section 1, T. 16 N., R. 16 E. This fault has the down-thrown side on the east.

A fault with unknown displacement runs through sections 12, 13, 24 and 26, T. 17 N., R. 16 E. Normal drag is on this fault in section 1, and reverse drag in section 14. The down-thrown side is on the east.

A relatively long and straight fault emerges from beneath the Quaternary in section 21, T. 17 N., R. 16 E., and passes northeastward, leaving the County in section 1, T. 18 N., R. 16 E. Displacement on this fault can not be determined. The down-thrown side is on the west. A Taft outlier is on the down-thrown side on the fault in section 9, T. 17 N., R. 16 E. In section 27, T. 18 N., R. 16 E., a fault branches eastward. Rocks along the down-thrown side of this fault dip steeply. The down-thrown side is on the east. Displacement can not be determined.

A small local fault crosses sections 3, 4 and 9, T. 18 N., R. 16 E., and section 34, T. 19 N., R. 16 E. Throw on this fault is estimated to be about 15 feet. The down-thrown side is on the west. Reverse drag is present in the sandstone in section 34.

A fault emerges from beneath the Quaternary in section 33, T. 19 N., R. 16 E., and can be traced southwestward to section 17, T. 18 N., R. 16 E. This fault has about 100 feet of vertical displacement and the down-thrown side is on the east.

Folds

Three small synclines and three small anticlines are detectable in Wagoner County. These structures are associated with faulting and may be caused by it.

A small syncline is in sections 7 and 18, T. 18 N., R. 18 E., and sections 12 and 13, T. 18 N., R. 17 E. This syncline is outlined by the Spiro sandstone member of the Savanna formation. The axis of the structure curves from northeast to east. Another small syncline is outlined by the Spiro sandstone in sections 32 and 33, T. 18 N., R. 18 E., and sections 4 and 5, T. 17 N., R. 18 E. The axis of this syncline trends northeast. This structure is probably the result of the large fault that parallels the western limb of the syncline. A mound capped by Bluejacket sandstone, in section 7, T. 17 N , R. 18 E., is probably the result of the combination of being located on the down-thrown side of the fault and being in the syncline. The third syncline is outlined by the Warner sandstone member of the McAlester formation in section 34, T. 18 N., R. 18 E., and section 3, T. 17 N., R. 18 E. The axis curves from northeast to east.

The city of Wagoner is located on a small anticline outlined by exposures of the Spaniard limestone member of the Savanna formation. The structure covers about 2 square miles. An anticline is centered in section 12, T. 16 N., R. 17 E. This structure is outlined by the Bluejacket sandstone. Faults are on both sides of it. The Bluejacket sandstone outlines another anticline in sections 3, 4, 5 and 9, T. 16 N., R. 17 E., and sections 32 and 33, T. 17 N., R. 17 E. Faults are on both sides of this structure. The axes of these three folds have a northeast trend.

the Spiro sandstone in sections 32 and 33, T. 18 N., R. 18 E., and sections 4 and 5, T. 17 N., R. 18 E. The axis of this syncline trends northeast. This structure is probably the result of the large fault that parallels the western limb of the syncline. A mound capped by Bluejacket sandstone, in section 7, T. 17 N , R. 18 E., is probably the result of the combination of being located on the down-thrown side of the fault and being in the syncline. The third syncline is outlined by the Warner sandstone member of the McAlester formation in section 34, T. 18 N., R. 18 E., and section 3, T. 17 N., R. 18 E. The axis curves from northeast to east.

The city of Wagoner is located on a small anticline outlined by exposures of the Spaniard limestone member of the Savanna formation. The structure covers about 2 square miles. An anticline is centered in section 12, T. 16 N., R. 17 E. This structure is outlined by the Bluejacket sandstone. Faults are on both sides of it. The Bluejacket sandstone outlines another anticline in sections 3, 4, 5 and 9, T. 16 N., R. 17 E., and sections 32 and 33, T. 17 N., R. 17 E. Faults are on both sides of this structure. The axes of these three folds have a northeast trend.

Figure 30. Tilted Senor sandstone strata. Small pool of water in the foreground. Near the center of the W side sec. 2, T. 19 N., R. 15 E.

Figure 31. Jointing in the Boggy shale. Strike of the large joints is roughly northeast-southwest. A fault passes a short distance west of these rocks. NW¼ sec. 3, T. 17 N., R. 16 E.

Joints

Joints are found in some of the shales, sandstones and limestones. The major joints generally parallel the faults and the minor joints are generally perpendicular to them.

Pimple Mounds

Pimple mounds are on some of the terrace deposits. They vary in size from one to twenty feet across and from one to two feet in height. Composition of the mounds is the same as that of the terrace deposit.

The mounds in this area are probably the result of erosion of the deposit by surface water (Melton, 1954, p. 109-110).

CHAPTER V

HISTORICAL GEOLOGY

The oldest rocks exposed at the surface in Wagoner County are part of the Reeds Spring formation. Huffman (1958, p. 107) thinks the chert in the Reeds Spring is primary because of its intricate interbedding with limestone. It is thought that the Keokuk chert was originally deposited as a thick-bedded, cross-laminated, crinoidal limestone and was replaced by silica at a later time (Huffman, 1958, p. 107).

Following deposition of the Keokuk formation the area was uplifted and eroded, producing an uneven surface on the Osagean cherts. The limestones and shales of the overlying Moorefield filled the valleys and covered the hills. The fine particles in the Moorefield shales were derived from the Ozark Uplift to the northeast. At the end of Moorefield time the seas withdrew without orogenic movement in this area. After a short interval of emergence, the sea returned and the Hindsville limestone was deposited.

The environment changed with deposition of the Fayetteville black shales. Decreased circulation and an influx of fine material resulted in the formation of thick, black shales. At least one lenticular limestone is in the Fayetteville. Following deposition of the Fayetteville black shale, conditions changed and limestones of the Pitkin formation were deposited.

Prior to deposition of the Morrowan rocks the area was uplifted and tilted to the south. Erosion removed the Pitkin formation north of the northern border of Wagoner County. At several exposures of the Morrowan, the base is marked by a zone of conglomerate containing pebbles of Mississippian rocks. The Hale formation of the Morrowan series contains a thick section of massive, calcareous sandstone in the northeastern part of the area. This sand was derived from the Ozark Uplift to the northeast and deposited under conditions that permitted good sorting and deposition of calcareous cement. Fossils are present in this sandstone. The limestone and shale in the Hale are beyond the limit of the sandstone deposition. The Bloyd consists of limestone and shale. At the close of Morrowan time the sea withdrew and the area was uplifted and tilted to the south, permitting erosion to remove part of the Morrowan rocks.

During Atokan time the sea began to encroach upon the area from the south. The older units of the Atoka are progressively overlapped northward by younger units. Part of the sandstone and shale of the Atoka was derived from the south and part of it was derived from the northeast. Limestone and chert fragments from the Mississippian and Morrowan rocks to the northeast are found at the base of the Atoka in some outcrops. Black shales were deposited at several intervals in the Atoka and lenticular limestones were deposited during middle and late Atoka time. Blythe (1959, p. 47) has suggested that the sea withdrew from this area at the close of the Atokan. No orogenic movement accompanied the withdrawal.

Desmoinesian time began with the deposition of the Hartshorne black shale. Although coal is not found in the Hartshorne formation within the County, it is found to the north and south, indicating the beginning of cyclic conditions in northeastern Oklahoma.

The Desmoinesian was cyclic through the time that Krebs and Cabaniss rocks were deposited with six exceptions. These exceptions are shown by the Warner, Spiro, Bluejacket, Taft, Chelsea and Lagonda members. During Desmoinesian time the McAlester Basin, to the south, was being filled with sediment. At the time of deposition of the previously mentioned members, the basinal environment extended northward onto the platform.

During the remainder of Lower and Middle Desmoinesian time the platform was under cyclic conditions and coal limestone, black shale, sandstone, siltstone and clay-ironstone were deposited.

Some kind of local movement occurred shortly before deposition of the Sam Creek limestone member of the Savanna formation. This is shown by the conglomerate below the Sam Creek limestone.

The sea withdrew from the area and erosion removed part of the sediment near the end of the time of Krebs deposition. This unconformity is masked in Wagoner County. The area was subjected to forces that faulted and folded the rocks about this same time.

Sedimentation in Upper Desmoinesian time continued to be cyclic in the area north of the Arkansas River. The Fort Scott formation, at the base of the Marmaton, pinches out southward and passes into the basinal facies of the Marmaton exposed on Concharty Mountain. Thick Wetumka sandstones and sandy shales were deposited above the Fort Scott formation.

These are the youngest Pennsylvanian rocks in the County.

The history of the area between the time of deposition of the Wetumka and the deposition of the Quaternary sand and gravel is unknown.

During Quaternary time at least two levels of terrace material were deposited along the major rivers. The rivers obtained approximately their present courses during this time.

In recent time the rivers have changed courses and deposited at least two levels of alluvium, indicating that the area is continually undergoing change.

CHAPTER VI

ECONOMIC GEOLOGY

Wagoner County has a moderate amount of mineral resources. Except for oil and gas, these resources have been little used because no industry has been established to make use of them. The 1957 "Minerals Yearbook" (p. 21) places a value of $1,596,165.00 on the minerals produced in Wagoner County for that year. Petroleum, natural gas, and sand and gravel were the most important minerals produced.

The most recent Oklahoma coal report (Trumbull, 1956, p. 312 and p. 379) estimates that Wagoner County has a coal reserve of 27.91 million tons in the Croweburg coal. The Croweburg has been strip-mined to a depth of about 35 feet in T. 18 N., and T. 19 N., R. 15 E. In T. 16 N., R. 15 E., the Croweburg is not situated in a suitable position for strip-mining. In Wagoner County the Croweburg is between 1.4 and 1.8 feet thick. With the exceptions of parts of T. 16 N., R. 15 E., the Croweburg has been strip-mined along its entire outcrop.

The Iron Post coal has not been mined in this area. It is between 0.5 and 1.1 feet thick. The Breezy Hill and Fort Scott limestones above the Iron Post make strip-mining of the coal impracticable under present economic conditions. The Iron Post crops out along the west side of T. 19 N., R. 15 E.

The coals above the Chelsea sandstone are not mined in this area.

The Tebo coal has been dug in section 31, T. 18 N., R. 16 E. Because of the usual occurrence of the Tebo coal below the Tiawah limestone and the Chelsea sandstone, conditions for strip-mining it are not favorable. The Tebo coal in this area is also too thin to be extensively mined at a profit. It is between 0.3 and 0.5 feet thick.

Only one occurrence of the Weir-Pittsburg coal is known in the area. It is on the north side of a mound in section 9, T. 17 N., R. 16 E. An abandoned strip-pit marks the location of the coal, but nothing is known about the operation.

In section 26, T. 18 N., R. 17 E., coal is found under the upper two Inola limestones. These coals have been separately mined at this locality. An abandoned strip-pit in section 18, T. 18 N., R. 16 E., is probably in one of these coals. The coal in section 18 is about 0.8 feet thick.

The Bluejacket coal has not been mined in Wagoner County. In sections 25 and 36, T. 17 N., R. 16 E., less than 10 feet of overburden is above about 0.5 feet of coal. The Bluejacket coal also crops out at the section line between sections 12 and 13, T. 17 N., R. 16 E.

Below the Bluejacket coal is a coal tentatively correlated with the Secor coal of the McAlester Basin. This coal is between 1.6 and 1.8 feet thick. It has an easily removed overburden and is strip-mined near the town of Porter for local consumption during the winter. It is stripped to a depth of about 15 feet. During 1956, a total of 1,234 tons of coal was mined in the Porter area (Young, and others, 1956, p. 681) by the Porter Coal Company. These are the latest figures available on the production.

The Drywood coal has been strip-mined in the northwest quarter of section 13, T. 16 N., R. 17 E., but it is too thin for any large operations.

The Rowe coal has been strip-mined in section 6, T. 18 N., R. 18 E.; near the center of section 1, T. 18 N., R. 17 E.; in the southeast quarter of section 6, T. 17 N., R. 18 E.; near the center of the west side of section 7, T. 17

N., R. 18 E.; near the center of section 27, T. 17 N., R. 18 E.; near the center of the west one-half of section 33, T. 17 N., R. 18 E.; and in the north side of a hill in section 7, T. 16 N., R. 18 E. It is between 0.7 and 1.0 foot thick where exposed.

Coal smut is below the Spaniard limestone at several outcrops, and a one-foot coal has been reported beneath the Spaniard in section 5, T. 18 N., R. 18 E. In the southeast quarter of section 36, T. 16 N., R. 17 E., this coal is locally developed and it has been mined in one small area. This is the oldest coal found in Wagoner County.

An abandoned volcanic ash quarry is near the south side of section 34, T. 17 N., R. 18 E., and Branson (1954, 2, p. 37) reports an abandoned quarry in the vicinity of the center of the west side of section 28, T. 17 N., R. 18 E. Volcanic ash can be seen in several of the terrace deposits.

Sandstone has been quarried at several localities in Wagoner County for use in building construction in the communities and rural areas of the County. Sandstone has been used in bank stabilization at Fort Gibson Reservoir and in fills on railroads and highways.

The Spaniard limestone has been quarried and crushed for use in highway construction. Unlimited supplies of limestone for this purpose remain in the Spaniard and other limestones that crop out in the County.

Gravel is quarried from terrace deposits for County road surfacing material as the need arises. These deposits have sufficient sand, silt and clay mixed with the gravel to make a good road surface.

Where the sandstone members are well developed, the soil is not good for farming, but it supports timber and grass. The Mississippian rocks along Grand River and Fort Gibson Reservoir have only a thin soil cover. The large terrace and alluvial deposits are covered with a rich soil. The phosphate in the shales and the carbonate in the limestone, along with other minerals in the rocks, contribute to the richness of the soil. An untapped supply of timber covers many acres of good soil.

A sand dredging operation is at the north end of the U. S. Highway 69 bridge over the Arkansas River. The amount of sand available in the Arkansas River is unlimited. Sand and gravel together are ranked behind oil and gas in value of mineral resources produced.

Water is abundant both in the subsurface and at the surface in the County. Most of the better farms have their own water wells and the towns of Porter and Coweta obtain their water supplies from wells. Sandstones, and terrace and alluvial deposits are the best aquifers.

Surface water is stored in many ponds and small lakes for livestock. Grand River has been artificially dammed, forming Fort Gibson Reservoir, which is one of Oklahoma's leading recreation areas. The lake serves as a water supply for the cities of Wagoner and Muskogee, and hydroelectric power is generated and distributed throughout eastern Oklahoma.

Oil formerly was much more important in the County than it now is. Oil and natural gas are still the leading mineral industries in the area (Grandone, and others, 1957, p. 21). In 1958, 421 oil and gas wells were active (Vance-Rowe Reports, East-Central Oklahoma). Available figures indicate that 2,942 wells have been drilled in search of oil and gas, and 1,336 of these produced in some quantity. Present production averages 743 barrels per day. Oil was first discovered in the County in 1914 (Boyle, 1927, p. 6) and drilling is still going on.

As of 1958, producing wells are located in 19 different fields. Few wells have been developed east of the line between R. 18 E., and R. 19 E., and most of the wells are west of R. 18 E. The oil industry in the County began in the Stone Bluff area, T. 16 N., R. 15 E., and this area continues to lead the rest of the County in production. This area contains 184 of the active wells. At least two of these wells have produced more than one million barrels of oil and are still producing (Vance-Rowe Reports), and two others have produced more than 100,000 barrels. The Coweta field is the second largest producer in the County with 62 active wells and a daily production of 109 barrels. Most of these wells are located east of the town of Coweta in T. 17 N., R. 16 E. The Oneta field, located south of the community of Oneta in T. 18 N., R. 15 E., is the third largest field with 39 active wells and a daily average of 67 barrels.

Oil is, or was produced from the Dutcher sands, the Mounds ("Wilcox") sands, and the Burgen sandstone. The Dutcher sands have been the largest producer. The Bartlesville, Red Fork and Skinner sands of northeastern Oklahoma crop out in the County, and are too shallow to be oil producers here.

CHAPTER VII

SUMMARY

Six Mississippian formations crop out in Wagoner County. These include part of the Osage series, and all of the Meramec and Chester series. The Osage series consists predominantly of chert and the Meramec and Chester series consists predominantly of limestone and shale. The Osage series contains the Reeds Spring and the Keokuk formations, the Meramec series contains the Moorefield formation, and the Chester series contains the Hindsville, Fayetteville and Pitkin formations. A total of 257 feet of Mississippian rocks is exposed.

Pennsylvanian strata include rocks of the Morrowan, Atokan and Desmoinesian series. A maximum of 1,250 feet of Pennsylvanian sediments crop out. Morrowan rocks consist predominantly of sandstone, limestone and shale of the Hale and Bloyd formations. The Atokan consists of Atoka sandstone and shale with a few thin, lenticular limestones.

Cyclic sedimentation began in the area during Desmoinesian time. The Krebs, Cabaniss and Marmaton groups make up the Desmoinesian series. Rocks of these groups are sandstone, shale, thin limestone and thin coal. The Krebs group has the Hartshorne, McAlester, Savanna and Boggy formations. The Senora formation is the only representative of the Cabaniss group in the County. South of the Arkansas River, the Calvin and Wetumka formations are the approximate equivalents of the Fort Scott, Labette and younger formations of the Marmaton group north of the Arkansas Rover. The McAlester formation contains the Warner sandstone member; the Savanna formation the Spaniard, Sam Creek and Doneley limestone members, the Spiro sandstone member, and the Rowe and Drywood coals; the Boggy formation has the Bluejacket and Taft sandstone member, the Inola limestone member, and the Secor ?, Bluejacket and Weir-Pittsburg ? coals; and the Senora formation has the Tiawah, McNabb, Verdigris and Breezy Hill limestone members, the Taft and Chelsea sandstone members, the Tebo, Croweburg, Iron Post and other coals, the Lagonda sandstone and shale member, and the Kinnison and Excello shale members. The Fort Scott formation in this area has the Blackjack Creek limestone member.

Fossils are found in most of the limestones and in some of the shales. The Mississippian and the Morrowan formations have characteristic fossils. Those in the Atokan and Desmoinesian are long ranging forms and are poorly preserved.

Near the end of Boggy time the area was subjected to forces that caused extensive faulting and some folding. Most of the faults have a northeast-southwest trend caused by movement in the Ozark Uplift and in the McAlester Basin. Folding appears to be associated with the faulting, as are the joint patterns.

During a large part of Mississippian time the area was under quiet marine conditions permitting limestones to be deposited. The condition was interrupted when the area became restricted in Fayetteville time. The sea withdrew at the end of Reeds Spring, Keokuk, Moorefield and Pitkin time. The sea was still relatively calm and clean during Morrowan time. The sea withdrew at the end of the Morrowan. During Atokan time the sea advanced from the south depositing shale, sandstone, and thin, lenticular limestones. At the beginning of the Desmoinesian, the area became cyclic, and continued that way into the Marmaton. The area was under a platform type of environment during most of the Desmoinesian, but occasionally the basinal environment advanced into the area and sandstone and shale were deposited.

Wagoner County is rich in mineral resources, but they have been relatively unexploited because of a lack of need for the minerals. Oil and gas in the County have been extensively developed, but oil is still to be found. Except for the Croweburg, coal has been relatively untouched, and the Croweburg still has ample reserves. Sand and gravel are plentiful in the area, as are limestone and sandstone. The soils of the County are rich and they support a large agricultural industry. Water is plentiful in the subsurface as well as on the surface.

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APPENDIX A

MEASURED SECTIONS

1.

SE cor. sec. 10, T. 18 N., R. 19 E. Measured in the road cut on the east side of the road.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Atoka formation			
	Sandstone, tan, fine grained, bedded	5.0	37.8
	Covered	3.5	32.8
	Sandstone, tan, fine grained, bedded	6.0	29.3
	Siltstone, tan, thin bedded, micaceous	12.0	23.3
	Sandstone, white, weathers brown, medium grained, bedded, angular grains	1.3	11.3
	Covered	10.3	10.0
Bloyd formation			
	Limestone, blue gray, medium crystalline, fossiliferous	2.7	8.6
	Limestone, tan, argillaceous, fossiliferous	1.2	5.9
	Limestone, gray to tan, medium crystalline, bedded, fossiliferous	1.4	4.7
	Limestone, gray, weathers yellow brown, coarse crystalline, fossiliferous, friable	1.0	3.3
	Shale, black to gray	1.5	2.3
	Limestone, blue gray, medium crystalline, fossiliferous	0.3	0.8
	Covered, probably shale	0.5	0.5

Hale formation		
Limestone, blue gray, coarse crystalline, fossiliferous	0.5	75.6
Covered, probably shale	4.0	75.1
Limestone, blue gray, coarse crystalline, fossiliferous	2.1	71.1
Covered	3.0	69.0
Limestone, blue gray, coarse crystalline, fossiliferous	4.1	66.0
Covered	0.7	61.9
Limestone, blue gray, coarse crystalline, fossiliferous	0.8	61.2
Covered	3.0	60.4
Limestone, blue gray, coarse crystalline, fossiliferous, bedded	6.0	57.4
Covered	1.3	51.4
Limestone, light gray, coarse crystalline, bedded, fossiliferous	1.0	50.1
Limestone, light gray, coarse crystalline, bedded, fossiliferous	5.3	49.1
Sandstone, tan, weathers brown, medium grained, bedded to massive, calcareous, fossiliferous	3.6	43.8
Shale, gray	0.5	40.2
Sandstone, tan to white, medium grained, bedded to massive, calcareous, fossiliferous	2.6	39.7
Sandstone, white, weathers brown, medium grained, massive, calcareous, fossiliferous	7.5	37.1
Shale, gray, silty	0.6	29.6
Sandstone, tan, medium grained, bedded to massive, calcareous, fossiliferous	3.3	29.0
Sandstone, tan, medium grained, bedded, calcareous, fossiliferous	1.3	25.7
Covered	5.5	24.4
Limestone, blue gray, medium crystalline, thick bedded, fossiliferous, oolitic in part	3.9	18.9

Shale, black, fissile	0.7	15.0
Limestone, blue gray, medium crystalline, massive, fossiliferous	3.5	14.3
Shale, black, fissile	0.1	10.8
Limestone, blue gray, dense, siliceous	0.2	10.7
Shale, black, fissile	0.1	10.5
Limestone, dark gray, dense, fossiliferous	0.9	10.4
Covered	9.5	9.5
Pitkin formation		
Limestone, light brown, weathers brown, medium crystalline, thin bedded	3.3	6.9
Covered	0.8	3.6
Limestone, dark gray, dense, fossiliferous	2.8	2.8
Fayetteville formation	not measured	

2\.

SW cor. sec. 34, T. 19 N., R. 18 E. Measured in a field north of the east-west road.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
McAlester formation			
	Warner sandstone member		
	Sandstone, tan medium grained, thin bedded, silty, micaceous	8.0	8.0
Hartshorne formation			
	Shale, black, silty, with clay-ironstone	5.5	22.0
	Covered, probably black shale	16.5	16.5
Atoka shale		not measured	

3.

NE¼ sec. 36, T. 17 N., R. 18 E. Measured in an old shale quarry.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
McAlester formation			
	Warner sandstone member		
	Sandstone, tan, medium grained, thin to medium bedded, micaceous, silty	3.1	8.6
	Siltstone, tan, bedded, sandy	1.0	5.5
	Siltstone, tan, argillaceous, tabular	4.5	4.5
Hartshorne formation			
	Shale, black, fissile	4.0	20.5
	Clay-ironstone zone	0.1	16.5
	Shale, black, fissile	1.0	16.4
	Clay-ironstone zone	0.1	15.4
	Shale, black, fissile	6.0	15.3
	Clay-ironstone zone	0.1	9.3
	Shale, black, fissile	1.0	9.2
	Clay-ironstone zone	0.1	8.2
	Shale, black, fissile	1.0	8.1
	Clay-ironstone zone	0.1	7.1
	Shale, black, fissile	6.0	7.0
	Covered	1.0	1.0
Atoka formation			
	Shale, tan, silty	Only the top exposed	

4.

SW¼ sec. 5, T. 16 N., R. 18 E. Measured in an island in the river and in the south bank.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Savanna formation			
	Covered		
	Shale, black, fissile	5.0	16.7
	Clay-ironstone zone	0.2	11.7
	Shale, black, fissile, with clay-ironstone	6.0	11.5
	Spaniard limestone member		
	Limestone, blue gray, medium crystalline, fossiliferous	5.5	5.5
McAlester formation			
	Covered		
	Sandstone, tan, medium grained, thick bedded	1.9	3.7
	Shale, black, silty, micaceous	1.8	1.8

5.

Center of the west side of sec. 22, T. 16 N., R. 18 E. Measured in a road between the house and barn on the face of an escarpment.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Savanna formation			
	Spaniard limestone member		
	Limestone, blue gray, medium crystalline, bedded, fossiliferous	2.2	2.2

McAlester formation			
	Clay, yellow brown, silty	2.0	4.8
	Sandstone, tan, medium-grained, thin-bedded	1.0	2.8
	Shale, black, fissile	1.8	1.8

6.

SW¼ sec. 24 and NW¼ sec. 25, T. 16 N., R. 18 E. Measured between the river and a tributary to the river south of the section corner.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Savanna formation			
	Shale, black, fissile, with clay-ironstone	7.0	40.0
	Clay-ironstone, calcareous, fossiliferous	0.3	32.7
	Coal, thins from 0.4 feet to coal smut	0.4	32.4
	Underclay	0.3	32.0
	Shale, black, fissile	1.1	31.7
	Limestone, bluish red, argillaceous, silty, ferruginous	0.4	30.6
	Shale, black, fissile, with clay-ironstone	About 25.0	30.2
	Spaniard limestone member		
	Limestone, blue gray, medium crystalline, fossiliferous	5.2	5.2
McAlester formation			
	Shale, gray, calcareous	0.1	35.1
	Coal smut		
	Shale, black, fissile, with clay-ironstone and calcareous siltstone	35.0	35.0

7\.

Center of the west side of sec. 27, T. 17 N., R. 18 E. Measured in a creek bank east of the road.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Savanna formation			
	Shale, black, fissile, with clay-ironstone	3.0	6.4
	Limestone, dark gray, dense, nodular, argillaceous, ferruginous, weathers to a clay-ironstone	0.2	3.4
	Coal	0.1	3.2
	Underclay	1.5	3.1
	Shale, tan, silty	1.6	1.6
	Sandstone, tan, fine grained, silty, only the top exposed		

8\.

NW¼ sec. 7, T. 17 N., R. 18 E. Measured on the west side of a small mound on an east-west road.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Savanna formation			
	Covered		
	Shale, black, fissile	1.0	11.8
	Clay-ironstone, fossiliferous	0.3	10.8
	Shale, black, fissile	0.5	10.5
	Coal smut		
	Shale, black, fissile, with clay-ironstone	10.0	10.0

9.

Center of sec. 28, T. 17 N., R. 18 E. Measured in a road cut in a north-facing escarpment.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Savanna formation			
Spiro sandstone member			
	Sandstone, tan, fine grained, thin bedded, cross bedded, silty, argillaceous	8.0	28.9
	Shale, black, fissile	2.0	20.9
Zone of the Sam Creek limestone member			
	Calcareous conglomerate, matrix of dense, reddish brown, ferruginous, fossiliferous limestone		
	Pebbles of gray silty clay	0.2	18.9
	Shale, black, fissile, with clay-ironstone	5.0	18.7
	Clay-ironstone, fossiliferous, slightly calcareous	0.3	13.7
	Coal smut		
	Underclay	0.4	13.4
	Shale, black, fissile	8.0	13.0
	Siltstone, gray, tubular, micaceous	5.0	5.0

10.

Sections 5 and 6, T. 18 N., R. 18 E. Measured on the hill in these two sections.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Boggy formation			
Bluejacket sandstone member			
	Sandstone, tan, medium grained, cross bedded	3.5	3.5

Savanna formation			
	Shale, black, fissile, with clay-ironstone and siltstone	57.0	114.8
	Rowe coal	0.8	57.8
	Covered	57.0	57.0
	Spaniard limestone member		
	Limestone, blue gray, medium crystalline, bedded, fossiliferous	Not found in place	

11.

SE¼ sec. 6 and NW¼ sec. 7, T. 17 N., R. 18 E. Measured between the strip-pits north of the road and the hill south of the road.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Boggy formation			
	Bluejacket sandstone member		
	Sandstone, tan, medium grained, massive	22.0	22.0
Savanna formation			
	Covered, 4.5 feet of tan, silty, shale exposed above and near one of the strip-pits	148.0	148.0
	Rowe coal strip-pits, coal not exposed		

12.

NE¼ sec. 7, T. 16 N., R. 18 E. Measured on the northeast part of the hill, and in the river north of the hill.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Boggy formation			
	Bluejacket sandstone member		
	Sandstone, tan, medium grained, cross bedded	20.0	20.0

Savanna formation		
Covered, some black, fissile shale and some tan, tabular, micaceous siltstone exposed	55.0	97.0
Rowe coal	0.7	42.0
Underclay	1.3	41.3
Shale, black, fissile, micaceous siltstone and covered	40.0	40.0
Spaniard limestone member		
Limestone, blue gray, medium crystalline, fossiliferous	Top exposed	

13\.

East side SE¼ sec. 2, T. 16 N., R. 17 E. Measured in the road on the face of the escarpment.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Boggy formation			
	Bluejacket sandstone member		
	Sandstone, tan, fine grained, cross bedded, silty micaceous	16.5	16.5
Savanna formation			
	Shale, black, fissile, silty, micaceous, with clay-ironstone	5.0	5.5
	Drywood coal	0.1	0.5
	Underclay	0.4	0.4
	Covered		

14.

Center of the west side of sec. 13, T. 16 N., R. 17 E. Measured in the road on the north face of the escarpment.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Savanna formation			
	Shale, black, fissile, silty, micaceous	6.5	14.6
	Clay-ironstone, fossiliferous	0.2	8.1
	Shale, black, fissile	0.5	7.9
	Drywood coal	0.1	7.4
	Underclay	1.3	7.3
	Shale, black, fissile, with clay-ironstone	6.0	6.0

15.

North side, NE¼ sec. 13, T. 16 N., R. 17 E. Measured in the south side of the road on the west face of the escarpment.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Boggy formation			
	Bluejacket sandstone member		
	Sandstone, tan, fine grained, bedded	1.5	1.5
Savanna formation			
	Siltstone, tan, thin bedded, micaceous	2.5	19.4
	Shale, black, fissile	11.0	16.9
	Drywood coal	0.4	5.9
	Underclay	1.0	5.5
	Shale, black, fissile, with tabular, gray siltstone	4.5	4.5
	Covered		

16.

Center, W½ sec. 6, T. 16 N., R. 18 E. Measured in the south bank of the Verdigris River.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Savanna formation			
	Shale, black, fissile, clay-ironstone, micaceous	10.2	14.5
	Sam Creek limestone member		
	Limestone, dark gray, dense, siliceous, fossiliferous	0.3	4.3
	Shale, black, fissile	4.0	4.0
	Covered by water		

17.

South side of sec. 26 and north side of sec. 35, T. 16 N., R. 17 E. Measured on the hill south of the road and in the road ditch.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Boggy formation			
	Bluejacket sandstone member		
	Sandstone, tan, medium grained, cross bedded	10.0	10.0
Savanna formation			
	Covered, probably shale	70.0	79.1
	Sam Creek limestone member		
	Limestone, blue gray, medium crystalline, massive, thin bedded in the top, silty, ferruginous	1.1	9.1
	Shale, gray	8.0	8.0

18.

NE¼ sec. 8 and NW¼ sec. 9, T. 16 N., R. 17 E. Measured in a creek that drains the strip pits in section 8.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Boggy formation			
Secor ? coal		1.4	49.2
Underclay		2.3	47.8
Covered		8.0	45.5
Bluejacket sandstone member			
	Sandstone, tan, fine grained, cross bedded	3.0	37.5
	Covered	8.0	34.5
	Sandstone, tan, fine grained, cross bedded	4.0	26.5
	Shale, black, fissile, with tan, micaceous siltstone and covered	15.0	22.5
	Sandstone, tan, medium grained, cross bedded	4.0	7.5
	Sandstone, tan, medium grained cross bedded, clay-ironstone and blue shale interbedded	3.5	3.5
Savanna formation			
Shale, black, fissile, with clay-ironstone and covered		12.0	19.3
Sam Creek limestone member			
	Limestone, blue, weathers brown, fine crystalline, sandy, fossiliferous	1.0	7.3
Shale, black, fissile		5.2	6.3
Siltstone, calcareous, dark gray, fossiliferous, ferruginous		1.1	1.1
Shale, black, fissile		Not measured	

19.

North side of sec. 9, T. 16 N., R. 17 E. Measured in the creek bank south of the road.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Boggy formation			
	Bluejacket sandstone member		
	Sandstone, tan, fine grained, cross bedded	2.5	7.0
	Siltstone, tan, thin bedded, micaceous	4.5	4.5
Savanna formation			
	Shale, black, fissile, with clay-ironstone	24.5	36.3
	Siliceous nodules, dark gray	0.3	11.8
	Shale, black, fissile	8.0	11.5
	Sam Creek limestone member		
	Limestone, gray, weathers brown, ferruginous, silty, fossiliferous	2.5	3.5
	Calcareous conglomerate, matrix of reddish brown, ferruginous, silty limestone, pebbles of brown and gray chert	1.0	1.0
	Shale, gray	Not measured	

20.

SE¼ sec. 36, T. 16 N., R. 17 E., and NE¼ sec. 1, T. 15 N., R. 17 E. Measured on the north side of the hill.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Boggy formation			
	Bluejacket sandstone member		
	Sandstone, tan, fine grained, cross bedded	5.0	5.0

Savanna formation			
Shale, black, fissile, and covered		50.0	86.1
Sam Creek limestone member			
Limestone, brown, argillaceous, ferruginous, fossiliferous		0.3	36.1
Shale, black, fissile, with clay-ironstone		35.0	35.8
Spaniard limestone member			
Limestone, blue gray, medium crystalline, fossiliferous	At least	0.8	0.8
McAlester formation			
Coal	At least	0.4	4.2
Underclay		1.3	3.8
Siltstone, tan, thin bedded, micaceous, with clay-ironstone and some black shale		2.5	2.5
Alluvium from the Arkansas River			

21.

Sec. 9, T. 16 N., R. 17 E. Measured in the north-south creek running through the section, in the west fork in the creek, in the strip-pits, and in the east-west road on the south side of the SW¼ of the section.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Boggy formation			
	Covered		
	Bluejacket coal	0.8	66.5
	Underclay	0.4	65.7
	Siltstone, tan, thin bedded, micaceous, with clay-ironstone	23.0	65.3
	Siltstone, tan, argillaceous, with clay-ironstone and plant fossils	12.0	42.3
	Secor ? coal	1.6	30.3
	Underclay	1.8	28.7
	Shale, black, fissile, with tan, tubular, siltstone	7.0	26.9

Sandstone, tan, fine grained, thin bedded	0.4	19.9
Siltstone, tan, thin bedded, micaceous	1.0	19.5
Sandstone, tan, fine grained, cross bedded, micaceous	1.5	18.5
Shale, black, fissile, with clay-ironstone and siltstone	12.0	17.0
Bluejacket sandstone member		
Sandstone, tan, medium grained, cross bedded	5.0	5.0

22.

Center of sec. 6, T. 16 N., R. 17 E. Measured in an active strip-pit. (active during part of January, 1959).

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Boggy formation			
	Siltstone, tan, argillaceous, with clay-ironstone concretions and plant fossils	8.5	11.7
	Shale, gray, fissile, with clay-ironstone concretions and plant fossils	1.7	3.2
	Clay, gray, with coal streaks	0.1	1.5
	Secor ? coal	1.4	1.4
	Underclay exposed in the bottom of the strip pit		

23.

SE¼ sec. 26, T. 18 N., R. 16 E. Measured in a north-south road and in an east-west.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Boggy formation			
Inola limestone member			
	Limestone, blue gray, fine crystalline, fossiliferous	0.5	12.5
	Covered		
	Shale, black, fissile, micaceous siltstone in the lower part	3.5	4.5
Bluejacket sandstone member			
	Sandstone, tan, fine grained, thin bedded, ripple marked	Top exposed	

24.

SE¼ sec. 35, T. 18 N., R. 16 E. Measured in a creek north of the road and in the road.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Boggy formation			
Inola limestone member			
	Only fragments found		
	Shale, black, fissile, with phosphate nodules	14.0	24.3
	Chert, blue gray, nodular	0.3	10.3
	Shale, black, fissile	3.5	10.0
	Siltstone, tan, micaceous, tabular	2.5	6.5
Bluejacket sandstone member			
	Sandstone, tan, fine grained, massive	4.0	4.0

25.

South side of sec. 12, T. 17 N., R. 16 E. Measured in an east-west road and north of the road.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Boggy formation			
Inola limestone member			
	Limestone, blue gray, fine crystalline, fossiliferous	0.5	15.0
	Covered	3.0	14.5
	Sandstone, tan, fine grained, thin bedded, silty	0.8	11.5
	Covered, some black shale exposed	6.0	10.7
	Shale, black, fissile, fossiliferous	0.7	4.7
Inola limestone member			
	Limestone, blue gray, medium crystalline, fossiliferous	0.3	4.0
	Shale, black, carbonaceous, iron stained	0.3	3.7
	Bluejacket coal	0.5	3.4
	Underclay	1.2	2.9
	Shale, gray, iron stained	1.7	1.7

26.

NW¼ sec. 36, T. 17 N., R. 16 E. Measured in the south side of the road and in the east bank of the creek north of the bridge.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Boggy formation			
Inola limestone member			
	Limestone, blue gray, dense, fossiliferous	0.5	14.6
	Shale, black, fissile, with phosphate nodules	3.8	14.1

Inola limestone member		
Limestone, dark gray, coarse crystalline, carbonaceous, fossiliferous	1.1	10.3
Shale, black, fissile, with clay-ironstone and Stigmaria	5.0	9.2
Shale, black to tan, silty, fossiliferous	1.0	4.2
Inola limestone member		
Limestone, blue gray, fine crystalline, silty, fossiliferous	0.4	3.2
Shale, black, fissile	0.6	2.8
Bluejacket coal	0.8	2.2
Underclay	1.4	1.4

27.

NE¼ sec. 26, T. 18 N., R. 17 E. Measured in the road-side ditch at the northeast point of the hill and on the hill.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Boggy formation			
	Taft sandstone member		
	Sandstone, tan, fine grained, cross bedded, argillaceous	4.0	113.8
	Shale, black, fissile, with clay-ironstone	55.0	109.8
	Inola limestone member		
	Limestone, blue gray, medium crystalline, massive, fossiliferous	1.0	54.8
	Shale, black, fissile, and covered to the coal	5.0	53.8
	Coal, reported thickness	1.3	48.8
	Covered	8.0	47.5
	Inola limestone member		
	Limestone, dark gray, dense, nodular, fossiliferous, pyritiferous	0.3	39.5

Covered to coal	1.0	39.2
Coal, reported thickness	1.3	38.2
Covered, black shale, clay-ironstone and indications of coal about 10 feet from the bottom	30.0	36.9
Inola limestone member		
Limestone, blue gray, medium crystalline, massive, fossiliferous, weathers to a knobby surface	1.3	6.9
Shale, black, fissile, with clay-ironstone	5.0	5.6
Clay-ironstone zone, fossiliferous	0.1	0.6
Shale, black, fissile	0.5	0.5

28.

Center of the north side of sec. 10, T. 18 N., R. 16 E. Measured in the road.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Boggy formation			
	Taft sandstone member		
	Sandstone, tan, fine grained, bedded, micaceous	3.0	33.8
	Shale, black, fissile, with clay-ironstone and micaceous siltstone	30.0	30.8
	Inola limestone member		
	Limestone, blue gray, fine crystalline, bedded, fossiliferous	0.8	0.8
	Covered		

29.

Center of the north side of sec. 26, T. 18 N., R. 16 E. Measured in the road in front of a house.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Boggy formation			
Taft sandstone member			
	Sandstone, tan, fine grained, bedded, micaceous	6.5	30.0
	Siltstone, tan, tabular, micaceous	8.5	23.5
	Shale, black, fissile, with clay-ironstone	9.2	15.0
	Clay-ironstone	0.3	5.8
	Shale, black, fissile	4.6	5.5
Inola limestone member			
	Limestone, blue gray, fine crystalline, fossiliferous	0.9	0.9

30.

Center of sec. 9, T. 17 N., R. 16 E. Measured on the northwest slope of the hill.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Boggy formation			
Taft sandstone member			
	Sandstone, brown, medium grained, cross bedded	5.5	109.5
	Covered, with a few outcrops of black shale	71.0	104.0
	Sandstone, brown, medium grained	1.0	33.0
	Covered, with some black shale exposed	22.0	32.0
	Zone of Weir-Pittsburg ? coal, thickness of coal and underclay unknown, location marked by abandoned strip-pits		

	Covered, with some black shale exposed	10.0	10.0

31.

South side of the SW¼ sec. 26, T. 17 N., R. 16 E. Measured in an east-west road on the east face of the escarpment.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Boggy formation			
Taft sandstone member			
	Sandstone, tan, fine grained, cross bedded	4.0	57.4
	Shale, black, with clay-ironstone and tan, tabular siltstone	12.5	53.4
	Sandstone, tan, fine grained, cross bedded	1.4	40.9
	Shale, black, with clay-ironstone and tan, tabular siltstone	11.0	39.5
	Sandstone, tan, fine grained, thin bedded	4.5	28.5
	Siltstone, tan, sandy, micaceous	16.5	24.0
	Covered	5.5	7.5
	Siltstone, tan, thin bedded, micaceous	2.0	2.0

32.

Center of the south side of sec. 7, T. 19 N., R. 16 E. Measured in the road on the east face of the escarpment.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Senora formation			
Chelsea sandstone member			
	Sandstone, light brown, medium grained, massive	9.0	102.0

	Shale, black, fissile	4.5	93.0
	Tiawah limestone member		
	Limestone, dark gray, fine crystalline, massive, fossiliferous	5.5	88.5
	Shale, black, fissile, siltstone, tan, micaceous, and sandstone, tan, fine grained, thin bedded	83.0	83.0
Alluvium from the Verdigris River			

33.

SE¼ sec. 1, T. 18 N., R. 15 E. Measured in the east-west section-line road.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Senora formation			
	Chelsea sandstone member		
	Sandstone, brown, fine grained, cross bedded, micaceous	11.0	149.0
	Shale, black, with clay-ironstone and thin bedded siltstone	38.0	138.0
	Clay-ironstone, reddish brown, fossiliferous, calcareous	0.3	100.0
	Sandstone, gray brown, fine grained, bedded, micaceous calcareous	1.5	99.7
	Shale, black, and covered	4.0	98.2
	Limestone, brown, sandy, micaceous, fossiliferous	1.0	94.2
	Clay, gray, and shale, gray	0.5	93.2
	Tiawah limestone member		
	Limestone, gray, dense, massive, fossiliferous, weathers brown	2.7	92.7
	Shale, black, with clay-ironstone, micaceous siltstone and covered	26.5	90.0
	Taft sandstone member		
	Sandstone, tan, medium grained, bedded, micaceous	1.5	63.5
	Siltstone, tan, micaceous, bedded, with some black shale and fine grained sandstone	10.0	62.0

	Shale, black to tan, with tan siltstone and covered	52.0	52.0
	Approximate position of the Inola limestone		

34.

SW¼ sec. 31, T. 18 N., R. 16 E. Measured in a creek running through the quarter section, and including the Chelsea outlier east of the creek.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Senora formation			
Chelsea sandstone member			
	Sandstone, tan, fine grained, cross bedded	8.0	107.9
	Covered	88.0	98.9
	Sandstone, tan, fine grained, bedded	1.5	10.9
Tiawah limestone member			
	Limestone, dark gray, ferruginous, silty, abundant myalinas	1.2	6.4
	Shale, black, fissile, and covered	3.0	5.2
	Tebo coal	0.9	2.2
	Underclay	1.3	1.3
	Shale, black, fissile, and siltstone	Not measured	

35.

Center of the west side of sec. 2, T. 19 N., R. 15 E. Measured in a creek that flows eastward from the road.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Senora formation			
	Covered		
	Coal	0.4	24.4

Underclay	0.5	24.0
Sandstone, tan, fine grained, silty, bedded, micaceous	4.5	23.5
Covered, and black, fissile shale	12.0	19.0
Shale, black, fissile, with clay-ironstone and thin bedded, micaceous siltstone	7.0	7.0

36.

Sections 19, 20, 21 and 22, T. 18 N., R. 15 E. Top of the massive sandstone at the SE corner of section 22 to Broken Arrow Coal in a strip-pit 1/8 mile east of the SW corner of section 19, westward component of dip ranges from 40 to 60 feet per mile. From Oakes, 1944, modified by the writer.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Senora formation			
	Shale in pit above coal	Not measured	
	Croweburg coal	1.8	111.8
	Covered, shale, probably about	10.0	110.0
	Sandstone, thin-bedded, silty, about	10.0	110.0
	Covered, probably shale, clay to silty, about	60.0	90.0
	Chelsea sandstone member		
	Sandstone, silty, about	10.0	30.0
	Covered, probably silty shale, about	20.0	20.0
	Sandstone, massive, not tree-bearing in this vicinity	Not measured	

37.

Near the center of the east side of sec. 20, T. 19 N., R. 15 E. Measured between the limestone exposure in a creek west of the road and the coal exposure in the road south of the creek.

Name of Formation	Description	Thickness in Feet Of Unit	Thickness in Feet To Base of section
Senora formation			
	Croweburg coal	1.4	12.0
	Underclay	1.5	10.6
	Cover and black, fissile shale	8.0	9.1
	McNabb limestone member		
	Limestone, dark gray, dense, fossiliferous, weathers reddish gray	1.1	1.1

38.

SE¼ sec. 29, T. 19 N., R. 15 E. Measured in the strip-pit 0.1 mile west of the SE corner of the section. From Oakes, 1944, modified by the writer.

Name of Formation	Description	Thickness in Feet Of Unit	Thickness in Feet To Base of section
Senora formation			
	Shale, weathered	10.0	38.3
	Verdigris limestone member		
	Limestone, dark, weathers yellow, massive, fossiliferous	2.0	28.3
	Shale, gray, weathers yellow, about	2.5	26.3
	Shale, black, fissile	5.7	23.8
	Shale, dark, contains discoidal concretions	5.7	18.1
	Shale, clay, dark	11.0	12.4
	Croweburg coal	1.4	1.4
	Underclay, bottom of pit		

39.

Sec. 30, T. 18 N., R. 15 E. Measured in an abandoned but fresh strip-pit near the NW corner of section 30. From Oakes, 1944, modified by the writer.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Senora formation			
	Shale, weathers yellow	10.0	30.0
	Verdigris limestone member		
	Limestone, dark, weathers yellow, fossiliferous	2.5	20.0
	Shale, black, fissile, contains phosphatic nodules	5.7	17.5
	Shale, dark	10.0	11.8
	Croweburg coal, about	1.8	1.8
	Underclay, bottom of pit		

40.

Sec. 29, T. 19 N., R. 15 E. Measured in a pit 0.1 mile west and 150 feet north of SE corner. This is a fresh exposure and shows details of the Verdigris limestone. From Oakes, 1944, modified by the writer.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Senora formation			
	Shale, weathered to clay	Not measured	
	Verdigris limestone member		
	Limestone, dark, fossiliferous	0.3	4.65
	Shale seam	0.03	4.35
	Limestone, dark, fossiliferous	1.5	4.3
	Shale seam	0.1	2.8
	Limestone, dark, fossiliferous	2.0	2.7
	Clay seam	0.2	0.7
	Limestone, dark, fossiliferous	0.5	0.5
	Shale, black, fissile to blocky	Not measured	

41.

South side of sec. 33, T. 20 N., R. 15 E. Measured between the bottom of the strip-pit north of State Highway 33 and the top of the hill west of the strip-pit.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Senora formation			
Lagonda member			
	Siltstone, tan, thin bedded	0.5	93.1
	Covered, black, fissile shale, clay-ironstone, and tan, thin bedded, micaceous siltstone	50.0	92.6
Verdigris limestone member			
	Limestone, gray, medium crystalline, bedded, fossiliferous, with shale partings	7.0	42.6
	Shale, black, fissile, with phosphatic nodules	34.0	35.6
	Croweburg coal	1.6	1.6
	Underclay exposed in the bottom of the pit		

42.

NE¼ sec. 6, T. 19 N., R. 15 E. Composite section.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Labette formation			
	Shale, black, fissile	5.0	5.0
Ft. Scott formation			
Blackjack Creek limestone member			
	Limestone, gray, medium crystalline, fossiliferous, with shale partings	7.1	7.1

Senora formation			
Excello shale member			
	Shale, black, fissile in the upper part, blocky in the lower part, phosphatic	3.9	17.7
Breezy Hill limestone member			
	Limestone, gray, medium crystalline, massive, with some shale partings, fossiliferous	7.5	13.8
Kinnison shale member			
	Shale, gray, fissile, calcareous, fossiliferous	1.0	6.3
Iron Post coal		1.1	5.3
Underclay		1.2	4.2
Lagonda member			
	Shale, black, fissile, with thin siltstone and thin fine grained sandstone beds	3.0	3.0

43.

Sec. 7, T. 19 N., R 15 E. Log of a water well, near the SW corner of the section, supplied by Luther White. From Oakes, 1944, modified by the writer.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Soil			
Fort Scott formation			
Blackjack Creek limestone member			
	Limestone	9.0	9.0
Senora formation			
Excello shale member			
	Shale, black, fissile, with phosphatic nodules	6.0	97.0
Breezy Hill limestone member			
	Limestone	6.0	91.0
Kinnison shale member			
	Shale, white	2.0	85.0

	Iron Post coal	0.5	83.0
	Lagonda member		
	Shale, gray	4.5	82.5
	Sand, gray, fine grained, micaceous	20.0	78.0
	Shale, gray, sandy	20.0	58.0
	Shale, gray	33.0	38.0
	Verdigris limestone member		
	Limestone, gray	5.0	5.0

44.

South side of sections 5 and 6, T. 18 N., R. 15 E. Measured in the section line road between the top of the strip-pits and the limestone outcrop on the ridge west of the strip-pits near the center of section 6.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Senora formation			
	Breezy Hill limestone member		
	Limestone, gray, dense, bedded, fossiliferous	1.5	136.7
	Kinnison shale and Iron Post coal not recognizable		
	Lagonda member		
	Covered, black, fissile shale and clay-ironstone; tan, micaceous, thin bedded, siltstone; tan, thin bedded, fine grained sandstone	130.0	135.2
	Verdigris limestone member		
	Limestone, gray, medium crystalline, fossiliferous, with shale partings	2.0	5.2
	Limestone, gray, medium crystalline, fossiliferous, massive	1.7	3.2
	Shale, black	1.5	1.5
	Covered by water		

45.

Composite section south of the Arkansas River from below the Tiawah limestone at the south side of section 2, T. 16 N., R. 15 E., to the top of Concharty Mountain in section 7, T. 16 N., R. 13 E. Taken in part from Branson, 1954, page 39.

Name of Formation	Description	Thickness in Feet Of Unit	To Base of section
Wetumka formation			
	Sandstone, tan, medium grained, massive to bedded, interbedded with sandy shale	120.0	120.0
Labette formation			
	Shale, gray, fissile, phosphatic nodules	6.0	6.0
Fort Scott formation			
	Blackjack Creek limestone member		
	Limestone, gray, massive, ferruginous, fossiliferous	0.8	0.8
Senora formation			
	Excello shale member		
	Shale, black, fissile with phosphatic concretions	6.0	469.8
	Breezy Hill limestone member		
	Limestone, gray, fine crystalline, massive, fossiliferous	2.5	463.8
	Lagonda member		
	Shale, gray fissile with clay-ironstones in lower part and some covered	106.0	461.3
	Verdigris limestone member		
	Limestone, dark gray, thin bedded, silty, ferruginous, fossiliferous	0.9	355.3
	Shale, brown, calcareous, silty, with thin limestone stringers	0.7	354.4

Limestone, blue gray, dense, massive, fossiliferous	0.3	353.7
Shale, gray, calcareous, fossiliferous, with thin limestone stringers	0.3	353.4
Shale, black fissile with phosphatic concretions	4.2	353.1
Croweburg coal	1.6	348.9
Underclay	0.8	347.3
Siltstone, tan, thin bedded	3.5	346.5
Shale, brown, silty and covered	37.0	343.0
Limestone, dark gray, thin bedded, ferruginous, silty, fossiliferous	0.3	306.0
Shale, black, fissile	3.5	305.7
Siltstone, gray, calcareous, fossiliferous, weathers brown, and non-calcareous	1.5	302.2
Shale, brown, silty	3.0	300.7
Covered and gray shale	65.0	297.7
Coal	1.1	232.7
Underclay	0.3	231.6
Shale, gray, fissile and sandstone, tan, fine grained	35.0	231.3
Chelsea sandstone member		
Sandstone, tan, medium grained, massive to cross bedded, lenses and is interbedded with gray fissile shale	180.0	196.3
Shale, black fissile	4.0	16.3
Tiawah limestone member		
Limestone, dark gray, dense, massive, contains Myalina	0.3	12.3
Shale, gray, silty, with clay-ironstone	12.0	12.0
Covered		

EXPLANATION

QUATERNARY — PLEISTOCENE AND RECENT

Qal

ALLUVIUM

(Sand, silt and clay on floodplains of present streams.)

Qt

TERRACE DEPOSITS

(Gravel, sand, silt and clay.)

PENNSYLVANIAN — DESMOINESIAN — Marmaton Group

Pwt

WETUMKA FORMATION

(Tan, medium-grained sandstone interbedded with sandy shale. About 120 feet thick.)

Plb

LABETTE FORMATION

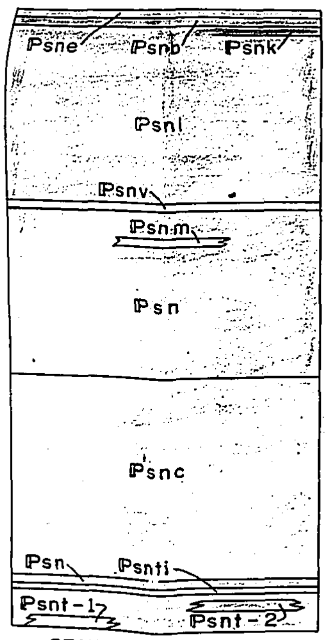
(Black shale. 6 feet exposed.)

Pfs

FORT SCOTT FORMATION

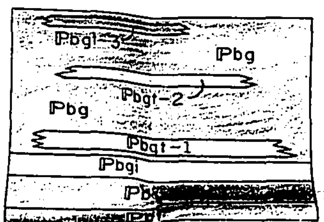
(Gray, fossiliferous limestone, grades southward into a silty, ferruginous, fossiliferous limestone. Between 0.8 and 9 feet thick.)

PENNSYLVANIAN — DESMOINESIAN — Krebbs Group



SENORA FORMATION

(Cyclic, consisting of sandstone, shale limestone and coal. 245 to 470 feet thick. Divided into the following members: Excello shale [Psne], Breezy Hill limestone [Psnb], Kinnison shale [Psnk], not mappable over most of the county, Lagonda sandstone and shale [Psnl], Verdigris limestone [Psnv], McNabb limestone [Psnm], Chelsea sandstone [Psnc], Tiawah limestone [Psnti], Taft sandstones [Psnt-1 the youngest] and the Iron Post, Croweburg, Tebo and other coals.)



BOGGY FORMATION

PENNSYLVANIAN — DESMOINESIAN — Cabaniss Group

Pma
Pmaw

McALESTER FORMATION

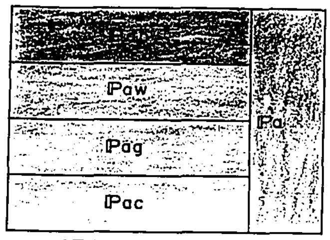
(Black shale, siltstone and Warner sandstone member [Pmaw] at the base of the formation. Warner about 8 feet thick. The McAlester is 40 to 100 feet thick.)

Phs

HARTSHORNE FORMATION

(Black shale with clay-ironstone. About 20 feet thick.)

PENNSYLVANIAN — ATOKAN



ATOKA FORMATION

(Sandstone, shale and lenticular limestone. 130 to 375 feet thick. Atoka undifferentiated [Pa] and the following members: Blackjack Creek [Pab], Webbers Falls [Paw], Georges Fork-Dirty Creek members undifferentiated [Pag] and the Coody-Pope Chapel members undifferentiated [Pac].)

PENNSYLVANIAN — MORROWAN

Pb

BLOYD FORMATION

(Gray fossiliferous limestone interbedded with gray shale. 6 to 40 feet.)

Ph

HALE FORMATION

(Gray, fossiliferous sandstone grading laterally into gray, fossiliferous limestone. 35 to 47 feet thick.)

MISSISSIPPIAN — CHESTERIAN

Mp

PITKIN FORMATION

(Gray, fossiliferous limestone. 20 to 30 feet thick.)

Mf

FAYETTEVILLE FORMATION

(Black shale and gray limestone. 35 to 70 feet thick.)

Mh

HINDSVILLE FORMATION

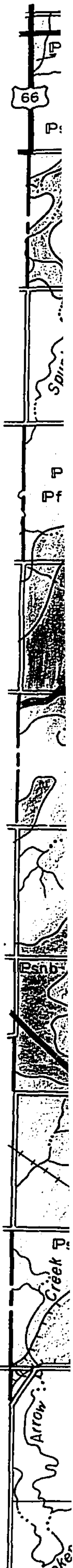
(Gray, medium crystalline, fossiliferous limestone. 12 to 36 feet thick.)

MISSISSIPPIAN — MERAMECIAN — Mayes Group

Mm

MOOREFIELD FORMATION

(Divided into 4 members, 3 of which crop out in the area. They are: the upper brown calcareous siltstone [Ordnance Plant member], gray, cherty calcarenite [Lindsey Bridge member] and lower brown, argillaceous limestone [Bayou Menard member]. Tahlequah member absent. Not separately mapped. Formation is 35 to 45 feet thick.)



TION

DESMOINESIAN

Cabaniss Group

Pmc / Pmaw

McALESTER FORMATION

(Black shale, siltstone and Warner sandstone member [Pmaw] at the base of the formation. Warner about 8 feet thick. The McAlester is 40 to 100 feet thick.)

Phs

HARTSHORNE FORMATION

(Black shale with clay-ironstone. About 20 feet thick.)

Pab / Paw / Pag / Pac / Pa

ATOKA FORMATION

(Sandstone, shale and lenticular limestone. 130 to 375 feet thick. Atoka undifferentiated [Pa] and the following members: Blackjack Creek [Pab], Webbers Falls [Paw], Georges Fork-Dirty Creek members undifferentiated [Pag] and the Coody-Pope Chapel members undifferentiated [Pac].)

Pb

BLOYD FORMATION

(Gray fossiliferous limestone interbedded with gray shale. 6 to 40 feet.)

Ph

HALE FORMATION

(Gray, fossiliferous sandstone grading laterally into gray, fossiliferous limestone. 35 to 47 feet thick.)

Mp

PITKIN FORMATION

(Gray, fossiliferous limestone. 20 to 30 feet thick.)

Mf

FAYETTEVILLE FORMATION

(Black shale and gray limestone. 35 to 70 feet thick.)

Mayes Group

Mh

HINDSVILLE FORMATION

(Gray, medium crystalline, fossiliferous limestone. 12 to 36 feet thick.)

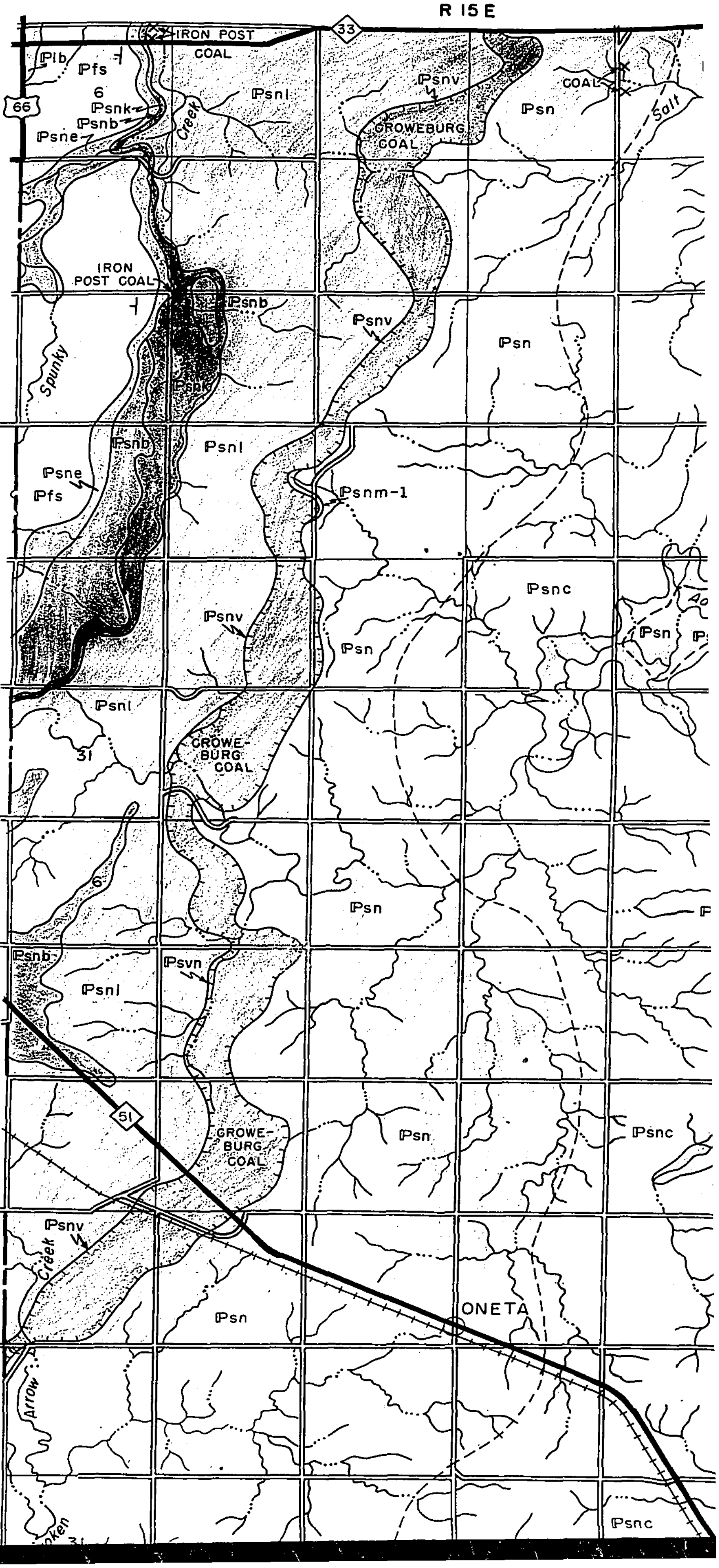
Mm

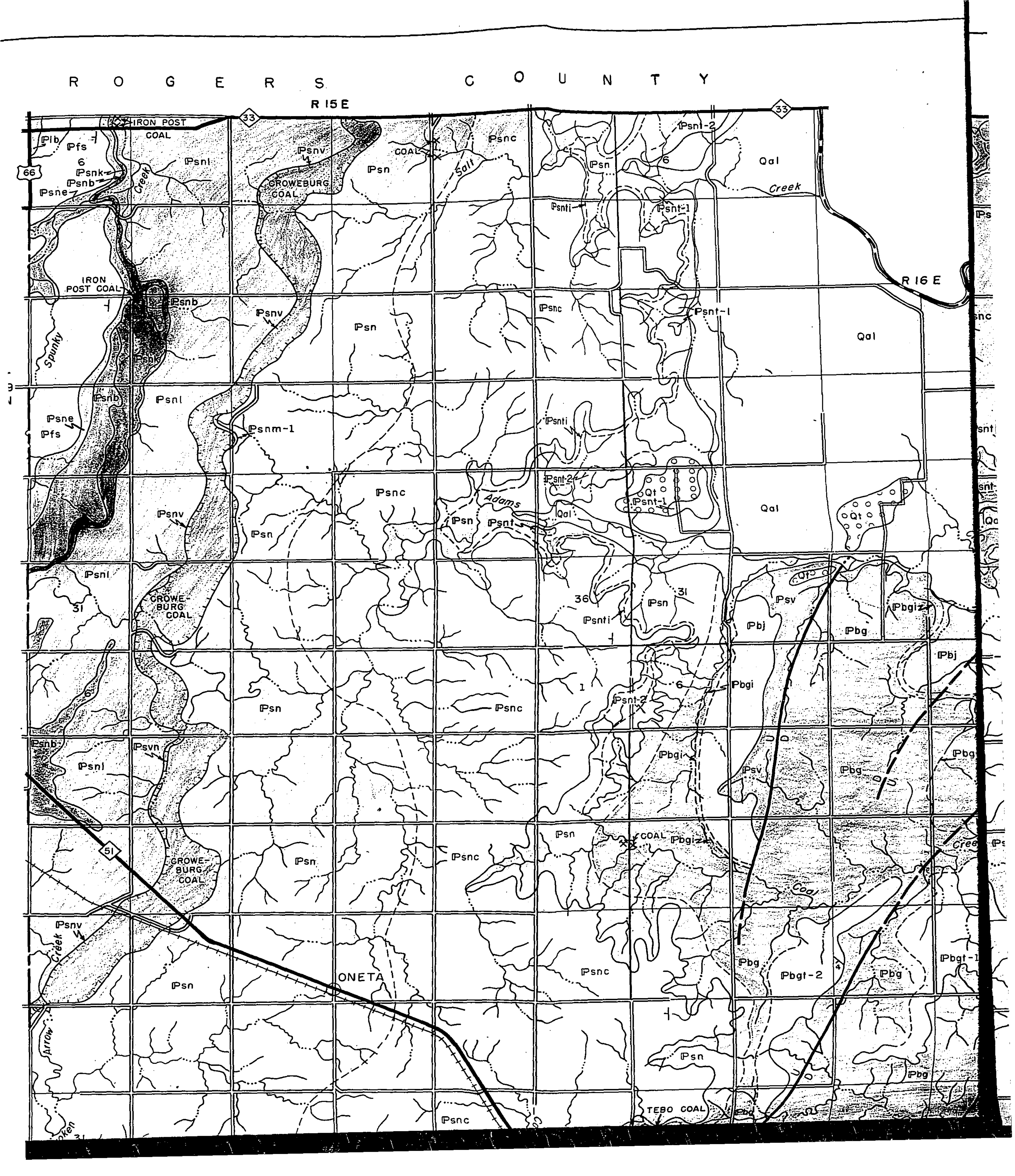
MOOREFIELD FORMATION

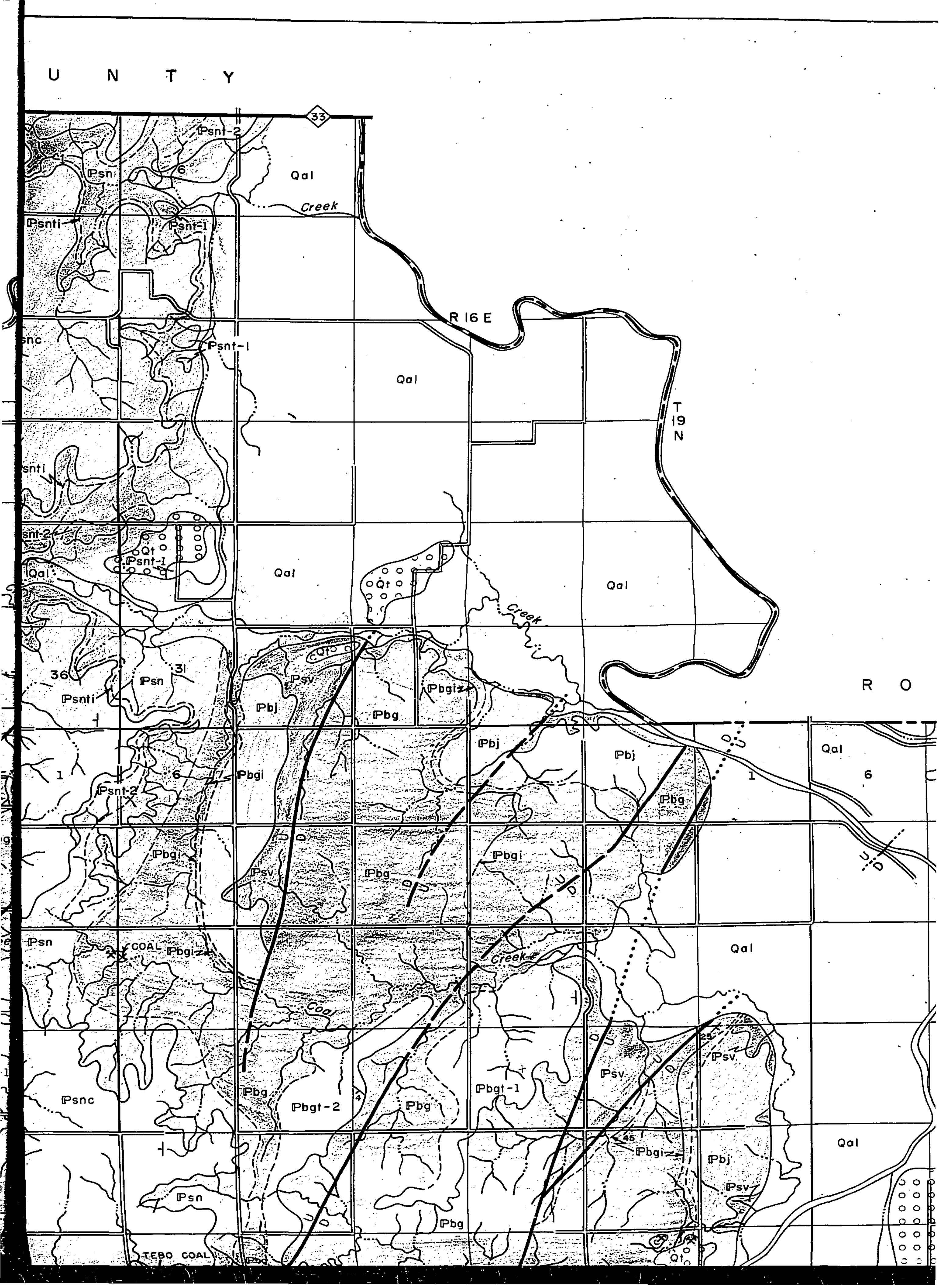
(Divided into 4 members, 3 of which crop out in the area. They are: the upper brown calcareous siltstone [Ordnance Plant member], gray, cherty calcarenite [Lindsey Bridge member] and lower brown, argillaceous limestone [Bayou Menard member]. Tahlequah member absent. Not separately mapped. Formation is 35 to 45 feet thick.)

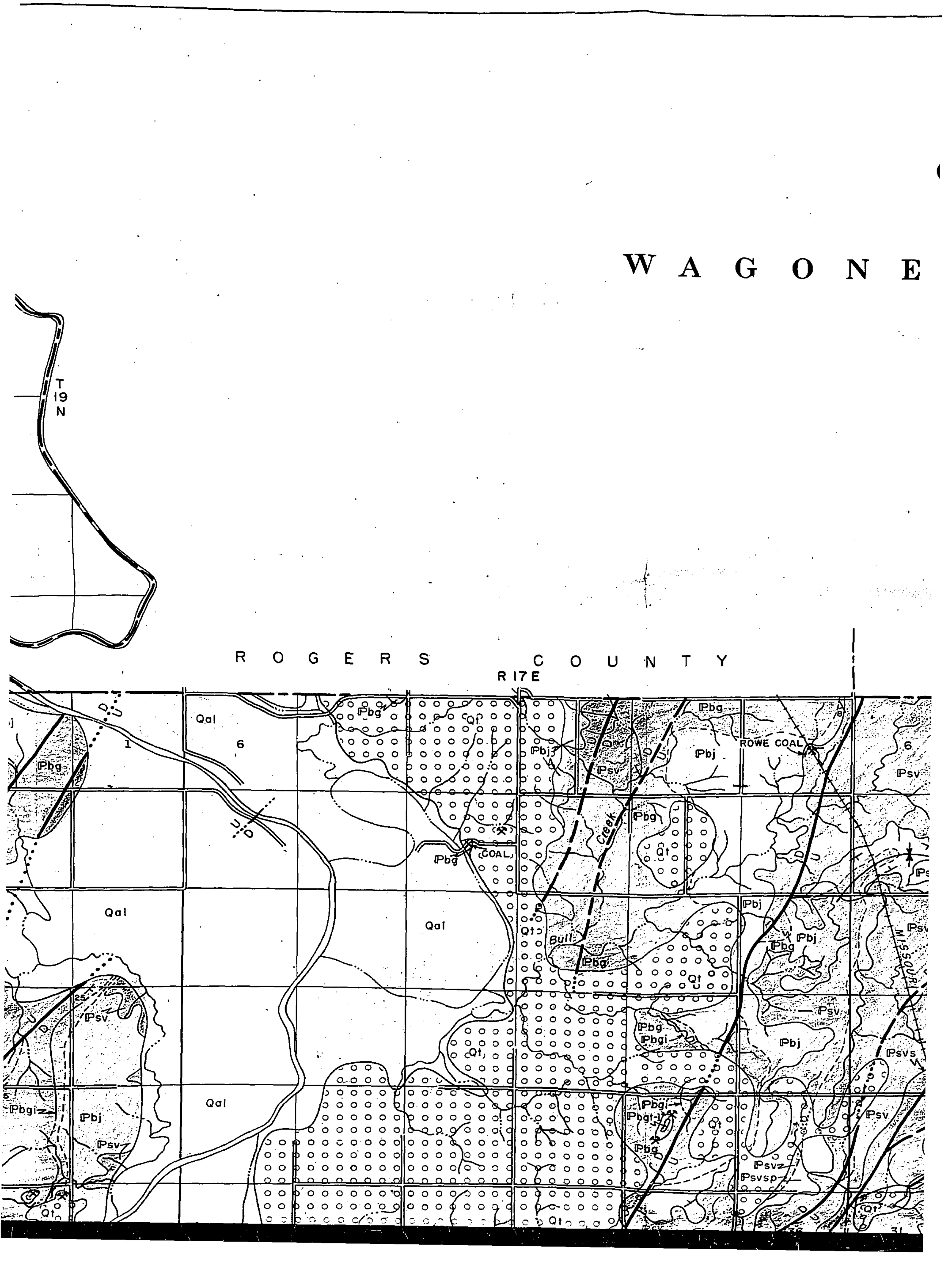
ROGERS C

SAN COUNTY




R O G E R S C O U N T Y
R 15 E
R 16 E
IRON POST COAL
CROWEBURG COAL
IRON POST COAL
CROWE-BURG COAL
CROWE-BURG COAL
COAL
COAL
TEBO COAL
ONETA
Salt Creek
Creek
Spunky Creek
Adams
Coal
Creek
Arrow
33
66
51
Pfs
Plb
Psnk
Psnb
Psne
Psnl
Psnv
Psnc
Psn
Psnt-1
Psnt-2
Psnti
Psnm-1
Psvn
Psv
Pbj
Pbg
Pbgi
Pbgiz
Pbgt-1
Pbgt-2
Qal
Qt


U N T Y
33
Psnt-2
Psn
Qal
Creek
Psnti
Psnt-1
R 16 E
snc
Qal
T
19
N
snti
snt-2
Qt
Qal
Creek
36
31
Psnti
Psn
Psv
Pbj
Pbg
Pbgi
R O
Pbgi
Psnt-2
Pbj
Pbg
Pbgi
Psv
Psn
COAL
Creek
Coal
Psnc
Pbg
Pbgt-2
Pbgt-1
Psv
Pbgi
Pbj
Qal
Psn
Pbg
TEBO COAL
Qt



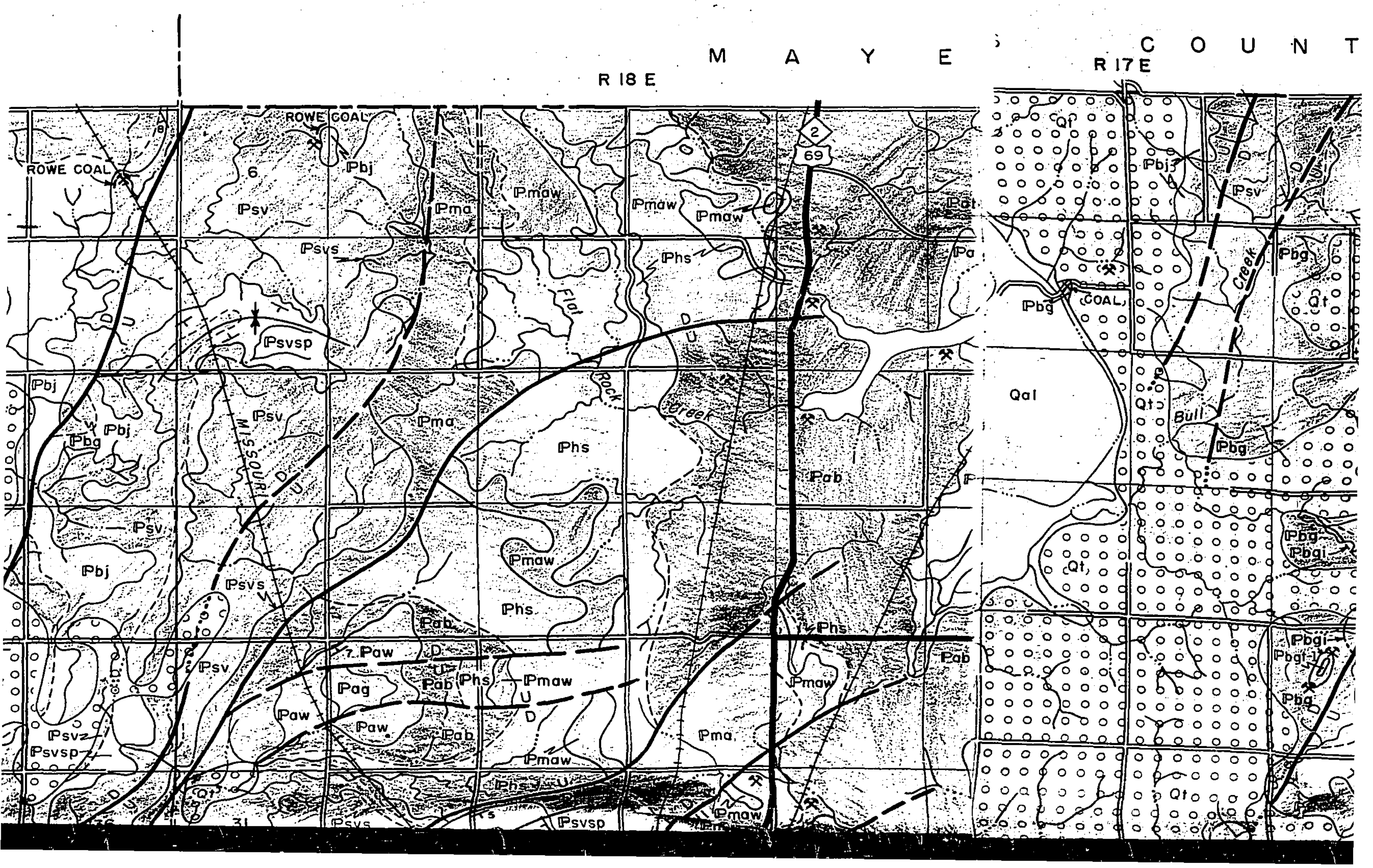
WAGONE
T
19
N
ROGERS COUNTY
R 17 E
Qal
Qt
Pbg
Pbj
Psv
Pbgi
Pbgt-1
Psvs
Psvz
Psvsp
COAL
ROWE COAL
Bull
Creek
MISSOURI
U
D
1
6
25
31
36

G E O L O G I C M
O F
G O N E R C O U N T Y, W

b y

Raymond W. Govett
Ph. D. 1959

0 1/2 1 2 3
Miles



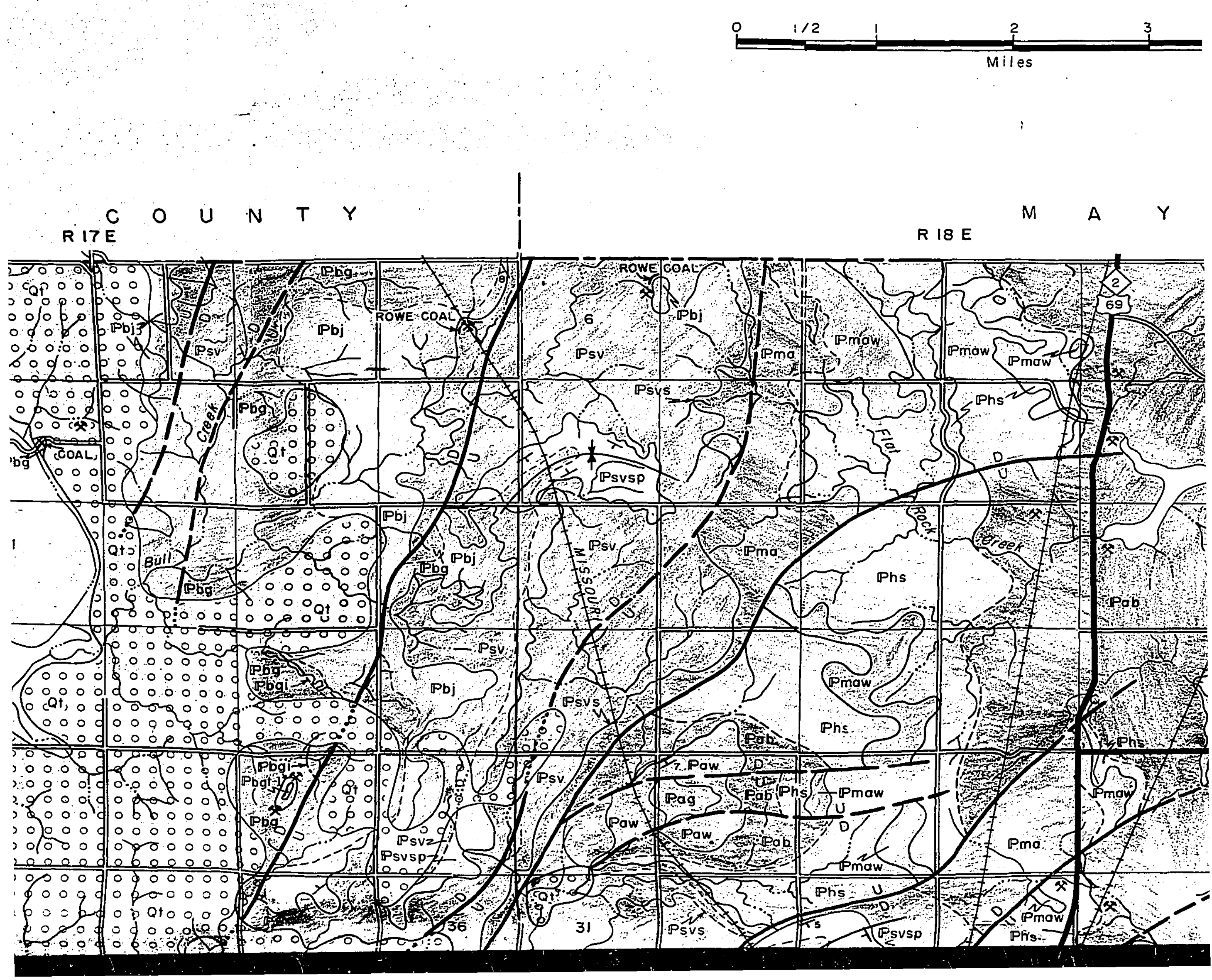
GEOLOGIC

OF

WAGONER COUNTY,

by

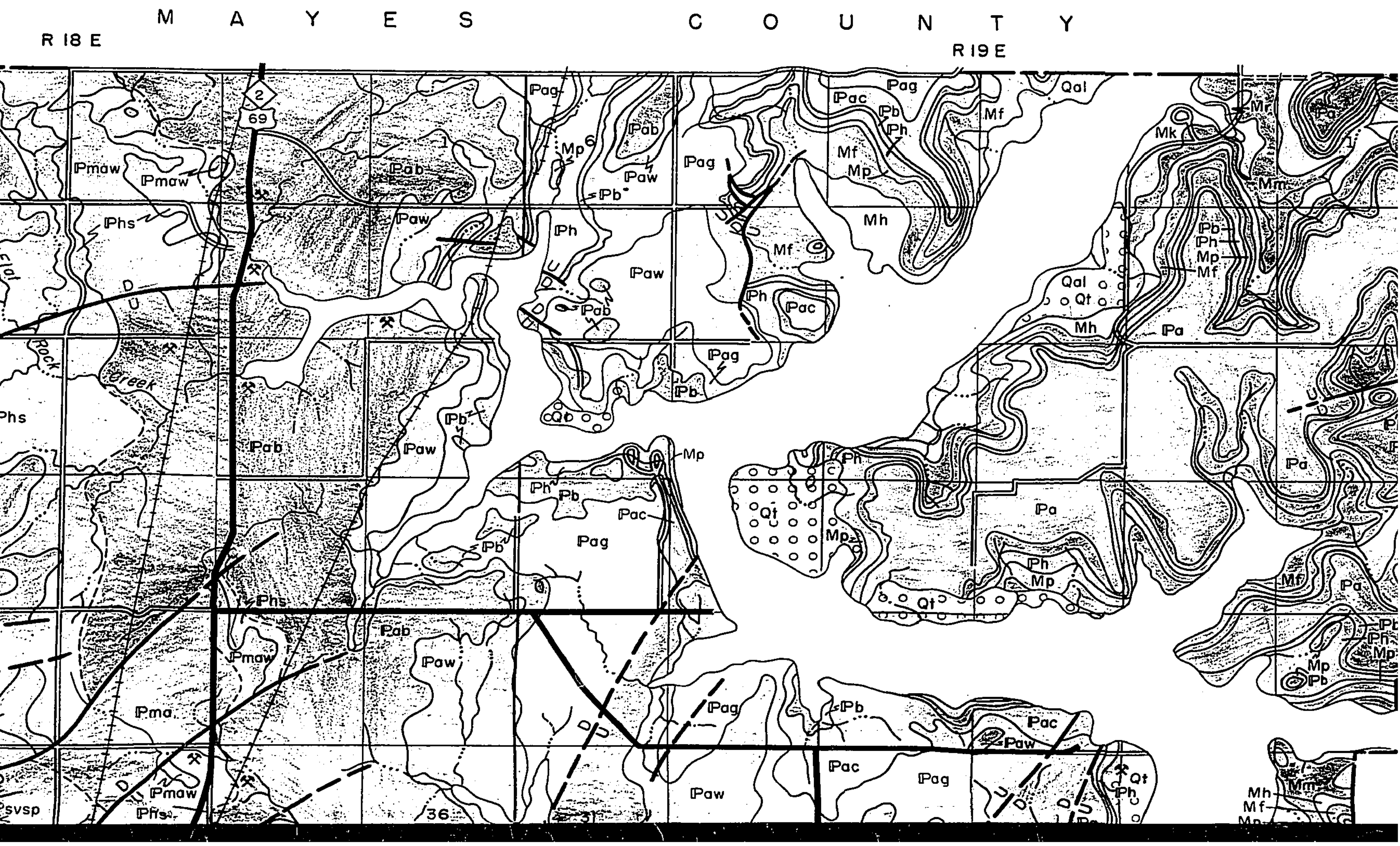
Raymond W. Govett
Ph. D. 1959



OGIC MAP
OF
UNTY, OKLAHOMA

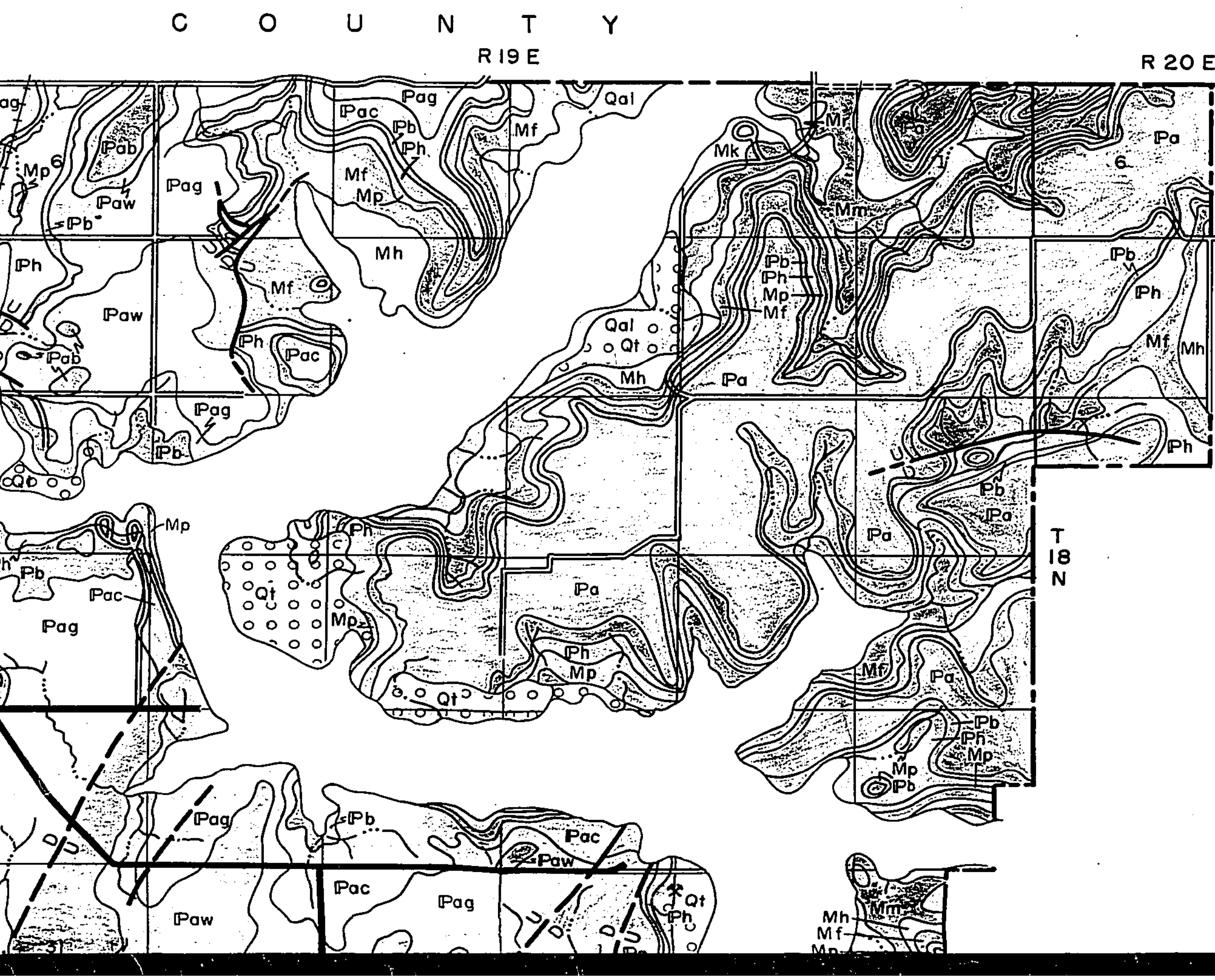
by

ymond W. Govett
Ph. D. 1959



P

L A H O M A



C O U N T Y
R19E
R 20 E
T
18
N
Pag
Pac
Pb
Ph
Mf
Mp
Mh
Qal
Qt
Mk
Mm
Pa
Paw
Pab
Mr

PENNSYLVANIAN

MORROWAN

Pb

BLOYD FORMATION

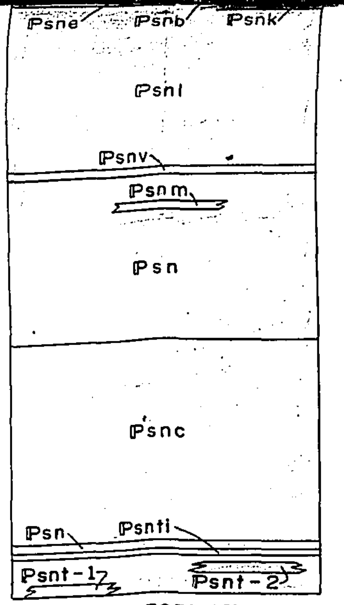
(Gray fossiliferous limestone interbedded with gray shale. 6 to 40 feet.)

Ph

HALE FORMATION

(Gray, fossiliferous sandstone grading laterally into gray, fossiliferous limestone. 35 to 47 feet thick.)

PENNSYLVANIAN — DESMOINESIAN — Krebbs Group



SENORA FORMATION

(Cyclic, consisting of sandstone, shale limestone and coal. 245 to 470 feet thick. Divided into the following members: Excello shale [Psne], Breezy Hill limestone [Psnb], Kinnison shale [Psnk], not mappable over most of the county, Lagonda sandstone and shale [Psnl], Verdigris limestone [Psnv], McNabb limestone [Psnm], Chelsea sandstone [Psnc], Tiawah limestone [Psnti], Taft sandstones [Psnt-1 the youngest] and the Iron Post, Croweburg, Tebo and other coals.)

MISSISSIPPIAN — CHESTERIAN

Mp

PITKIN FORMATION

(Gray, fossiliferous limestone. 20 to 30 feet thick.)

Mf

FAYETTEVILLE FORMATION

(Black shale and gray limestone. 35 to 70 feet thick.)

Mh

HINDSVILLE FORMATION

(Gray, medium crystalline, fossiliferous limestone. 12 to 36 feet thick.)

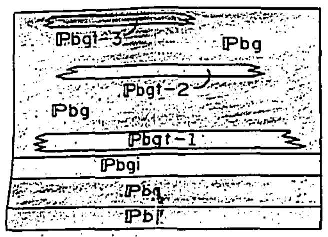
MERAMECIAN — Mayes Group

Mm

MOOREFIELD FORMATION

(Divided into 4 members, 3 of which crop out in the area. They are: the upper brown calcareous siltstone [Ordnance Plant member], gray, cherty calcarenite [Lindsey Bridge member] and lower brown, argillaceous limestone [Bayou Menard member]. Tahlequah member absent. Not separately mapped. Formation is 35 to 45 feet thick.)

PENNSYLVANIAN — DESMOINESIAN — Cabaniss Group



BOGGY FORMATION

(Cyclic, consisting of sandstone, shale, limestone and coal. About 140 feet thick. Divided into the following members: Taft sandstones [Pbgt-3 the youngest and Pbgt-1 the oldest], Inola limestone [Pbgi], Bluejacket sandstone [Pbj] at the base of the formation, and the Weir-Pittsburg?, Bluejacket, Secor? and other coals.)

OSAGEAN

Mk

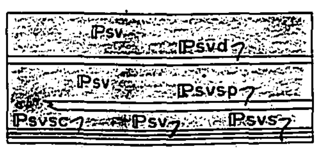
KEOKUK FORMATION

(Massive, white to buff chert. A maximum of 38 feet is exposed.)

Mr

REEDS SPRING FORMATION

(Blue-gray limestone interbedded with dark gray chert. 20 feet exposed.)



SAVANNA FORMATION

(Cyclic, consisting of sandstone, shale, limestone and coal. 85 to 200 feet thick. Divided into the following members: Doneley limestone [Psvd], Spiro sandstone [Psvsp], Sam Creek limestone [Psvsc], Spaniard limestone [Psvs] at the base of the formation, and the Rowe and Drywood coals.)

U / D — Fault: Dashed where inferred; Dotted where concealed; U, Upthrown side; D, Downthrown side

Axis of syncline

Axis of anticline

6 — Strike and dip

Quarry

Strip pit

Railroad

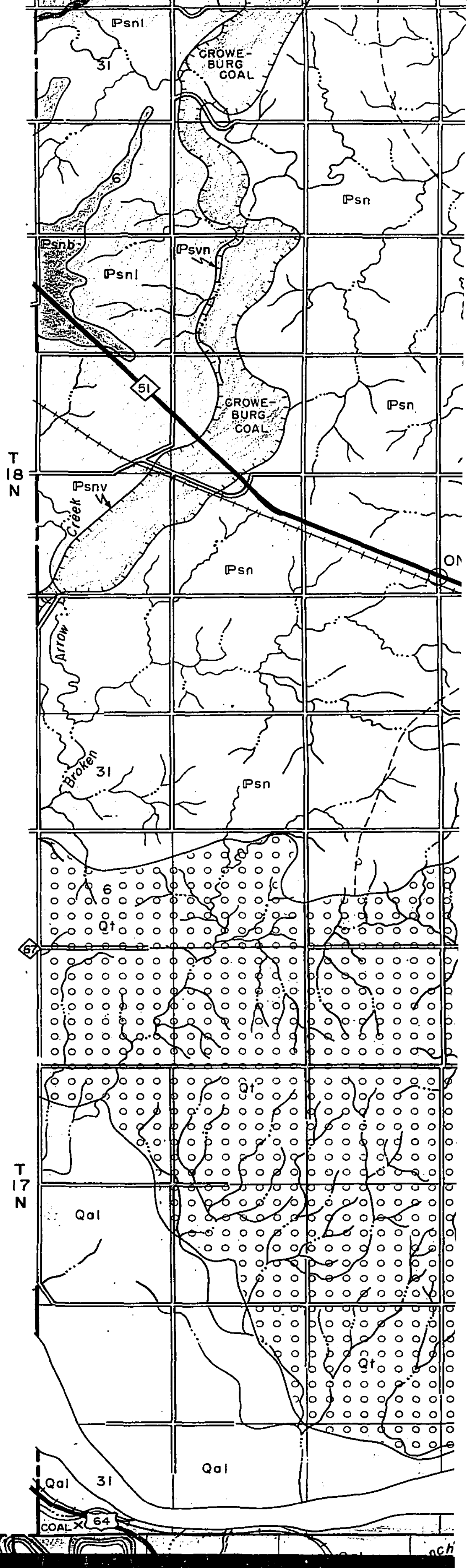
66 — U. S. highway

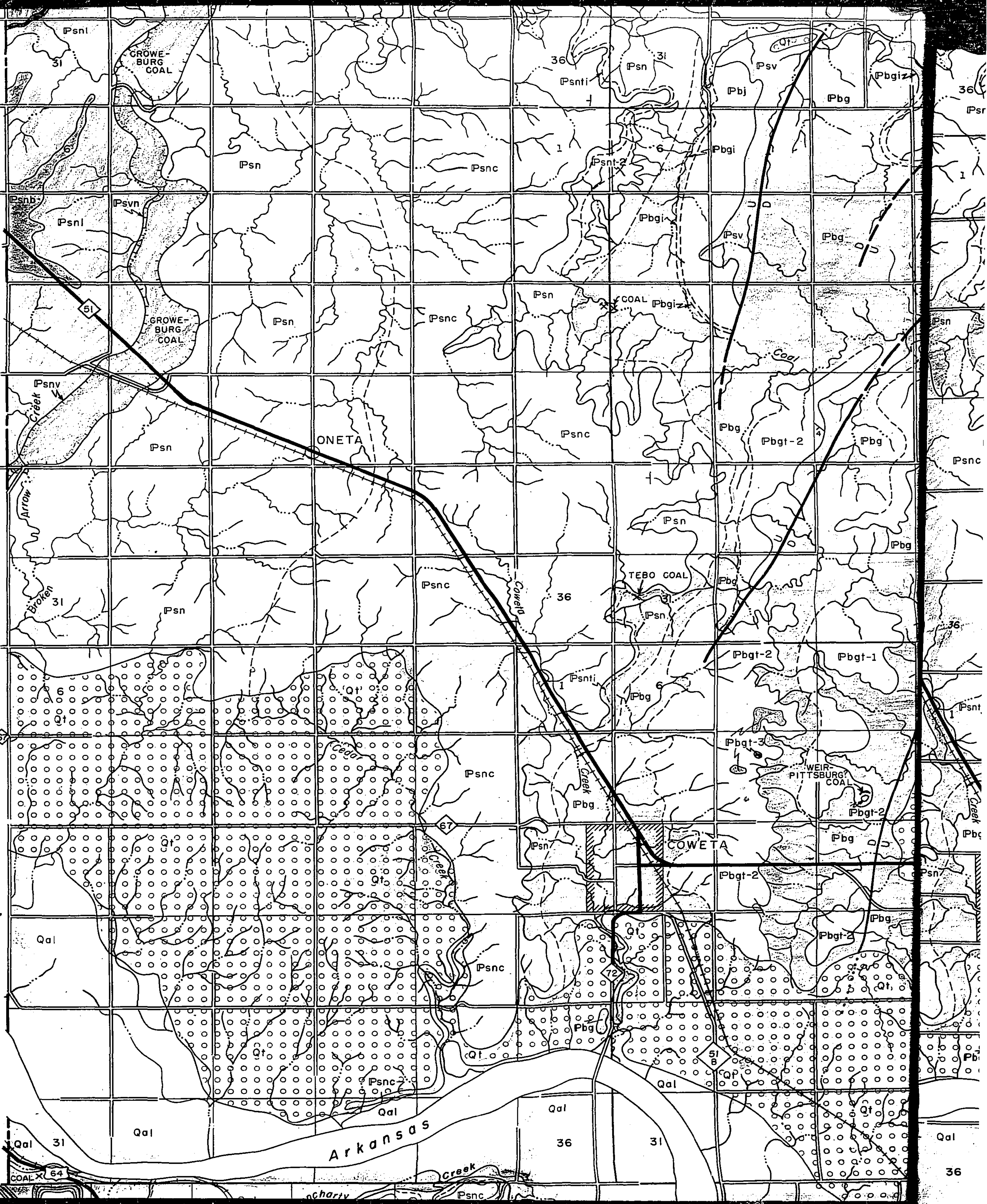
51 — State highway

Paved road

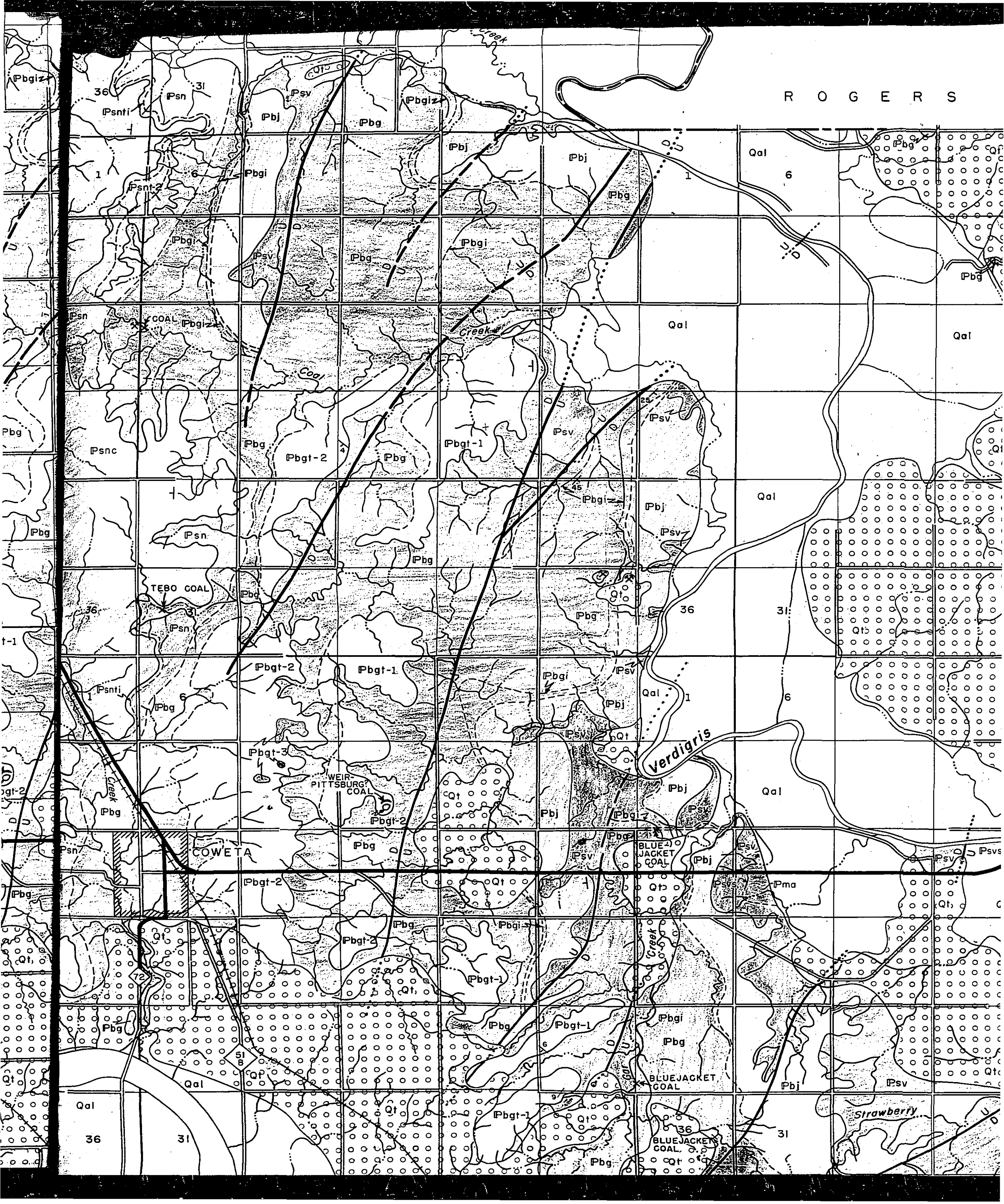
Improved road

Unimproved road



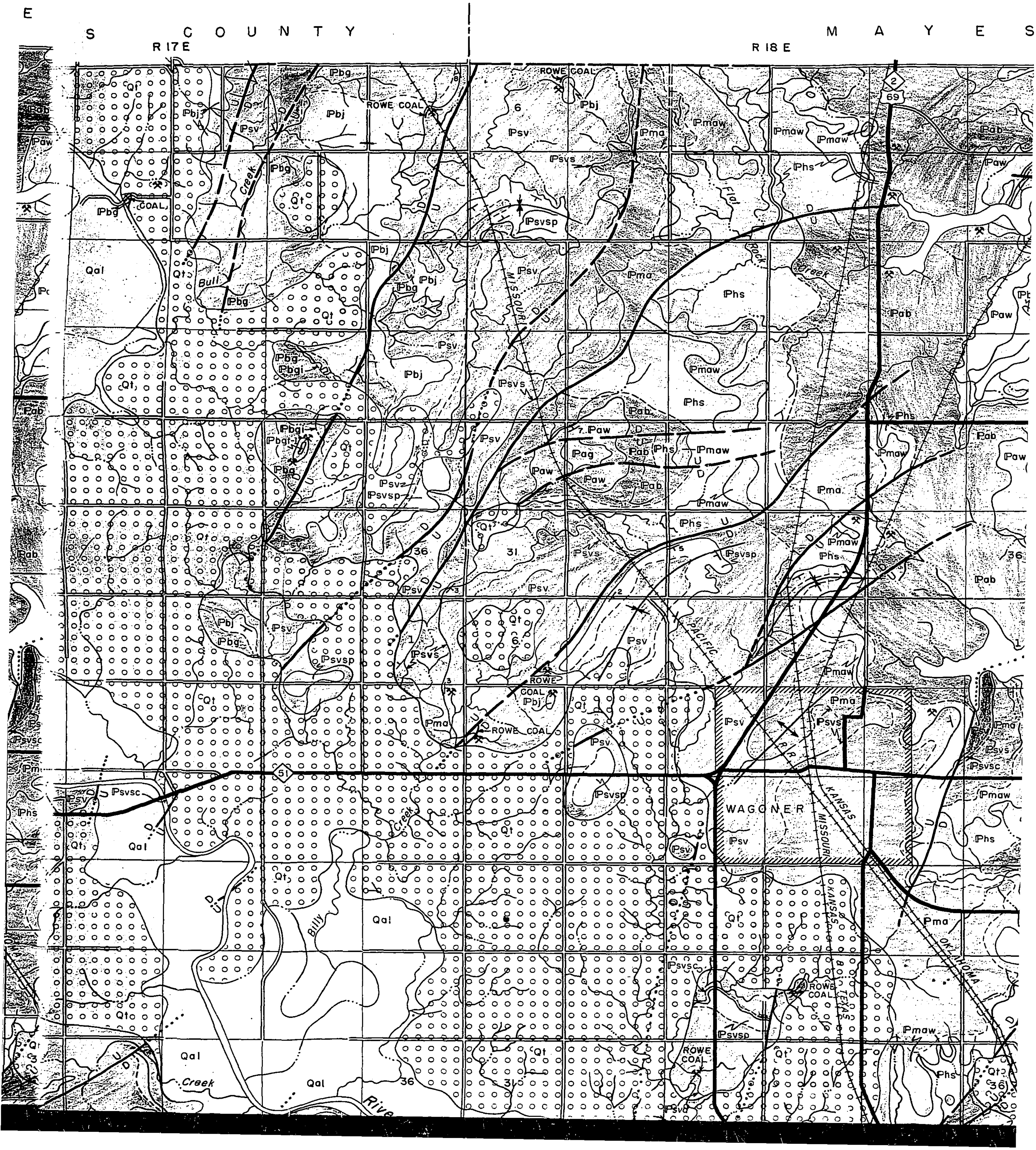


TULSA COUNTY
T 18 N
T 17 N
ONETA
COWETA
GROWEBURG COAL
TEBO COAL
WEIR-PITTSBURG? COAL
COAL
Arkansas
Coweta Creek
Broken Arrow Creek
Cedar Creek
Psn
Psnc
Psnl
Psnb
Psvn
Psnv
Psnti
Psnt-2
Psv
Pbj
Pbg
Pbgi
Pbgiz
Pbgt-1
Pbgt-2
Pbgt-3
Qt
Qal
51
67
72
64

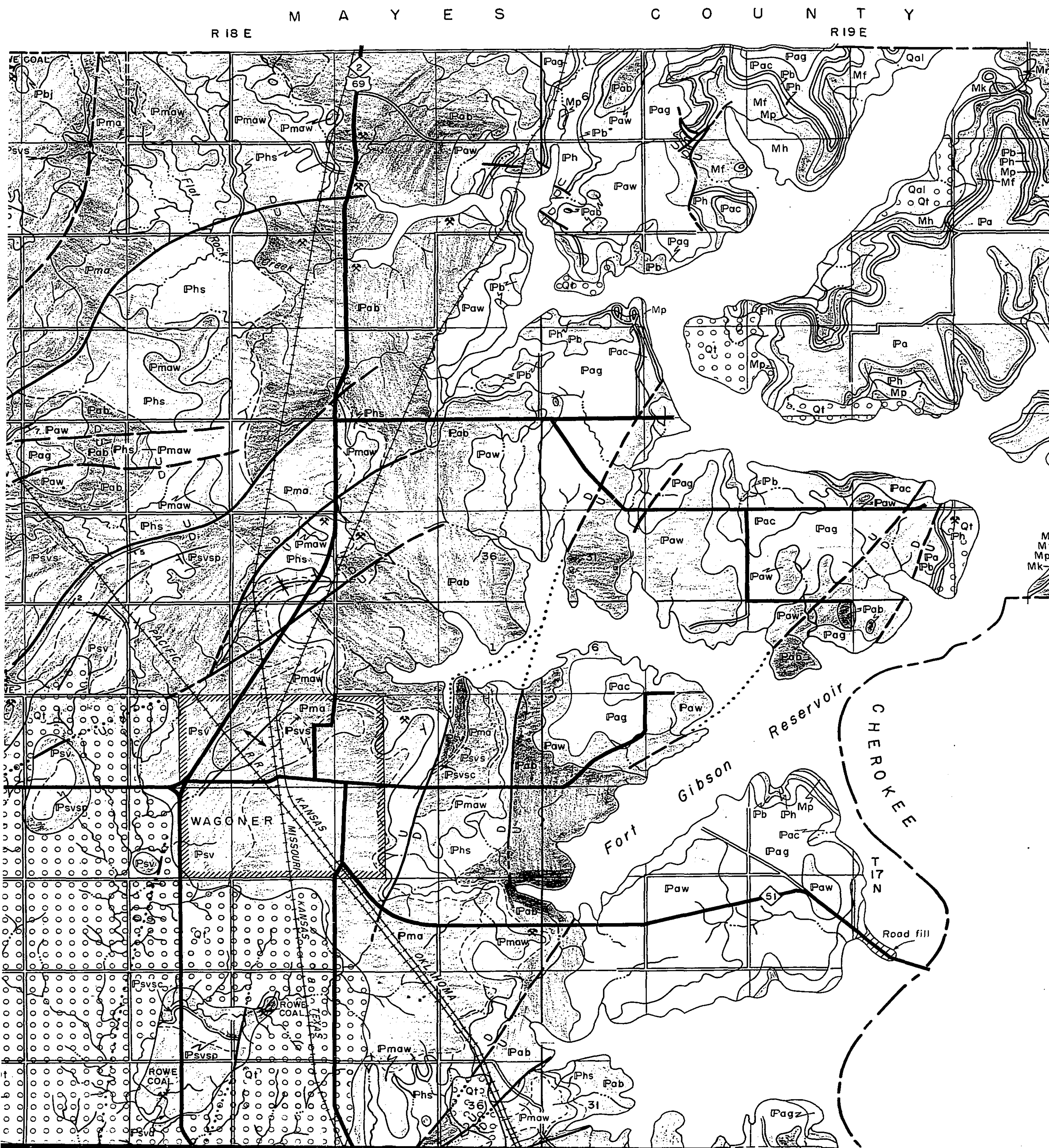


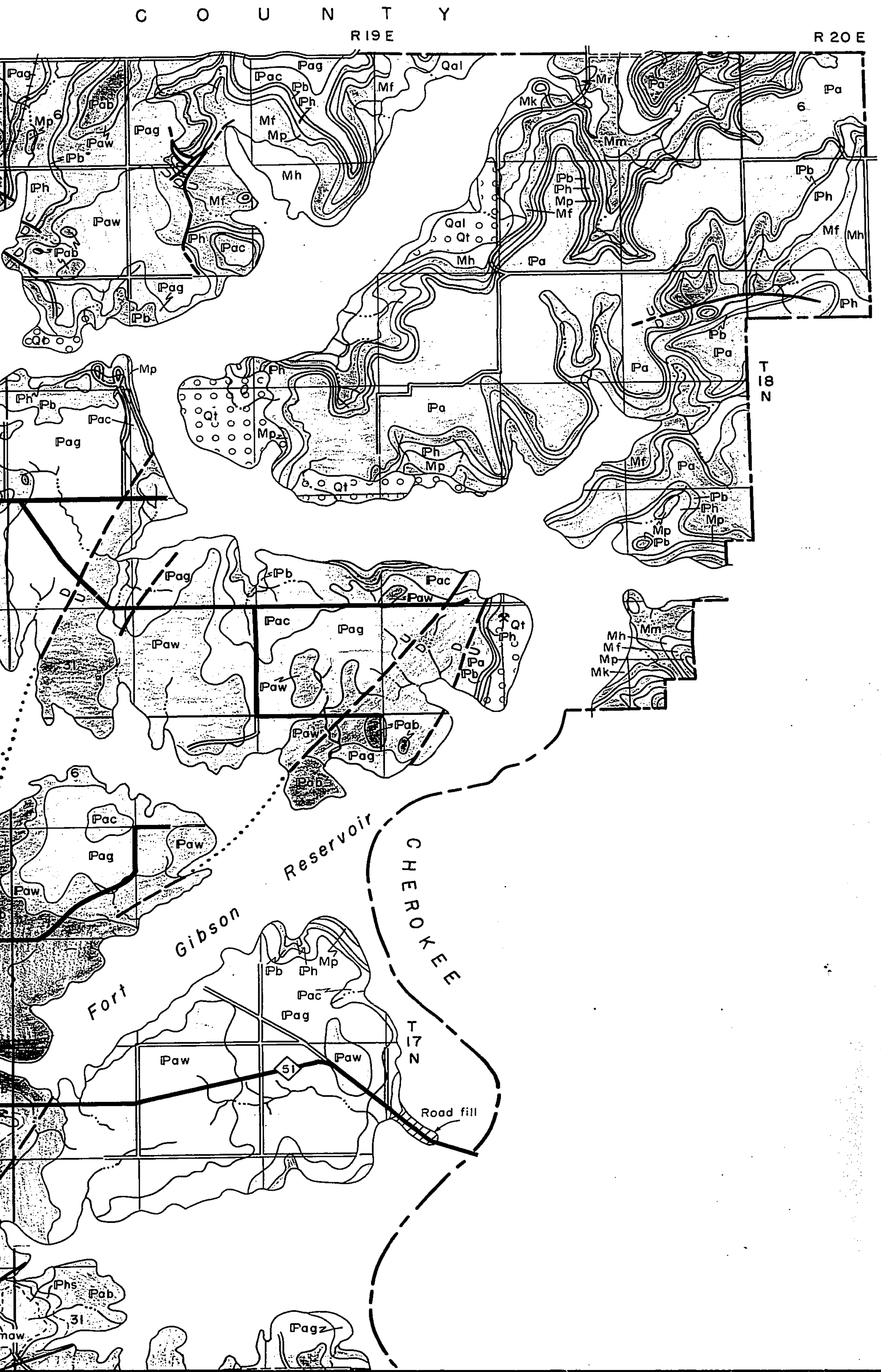
R O G E R S
COWETA
Verdigris
Coal
Creek
Strawberry
COAL
TEBO COAL
WEIR-PITTSBURG? COAL
BLUE JACKET COAL
BLUEJACKET COAL
Pbg
Pbj
Pbgi
Pbgiz
Pbgt-1
Pbgt-2
Pbgt-3
Psv
Psvs
Psn
Psnc
Psnti
Psnt-2
Pma
Qal
Qt


ROGERS COUNTY
MAYES
R 17 E
R 18 E
ROWE COAL
COAL
Bull Creek
Flat Rock Creek
Billy Creek
Strawberry Creek
River
MISSOURI PACIFIC
MISSOURI KANSAS TEXAS
WAGONER
51
69
2
Qal
Qt
Pbg
Pbj
Pbgi
Psv
Psvs
Psvsp
Psvsc
Pma
Pmaw
Phs
Pab
Paw
Pag
36
31
6
1



E
S COUNTY
MAYES
R 17 E
R 18 E
ROWE COAL
WAGONER
KANSAS
MISSOURI
PACIFIC
OKLAHOMA
Creek
Bull
Billy
Rock
Flat
51
69
2
Qal
Qt


M A Y E S C O U N T Y
R 18 E
R 19 E
Flat Rock Creek
Fort Gibson Reservoir
CHEROKEE
WAGONER
T 17 N
Road fill
ROWE COAL
KANSAS
MISSOURI
KANSAS & TEXAS
OKLAHOMA
PACIFIC
2
69
51
36
31
6
1



C O U N T Y
R19E
R20E
T 18 N
T 17 N
Fort Gibson Reservoir
CHEROKEE
Road fill
51

U, Upthrown side
D, Downthrown side

Axis of syncline

Strike and dip

Quarry

Strip pit

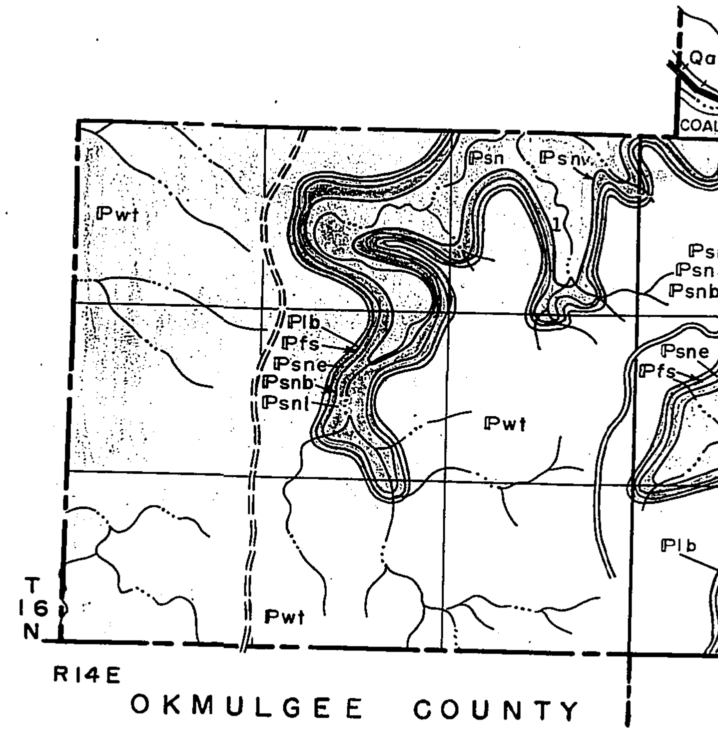
Railroad

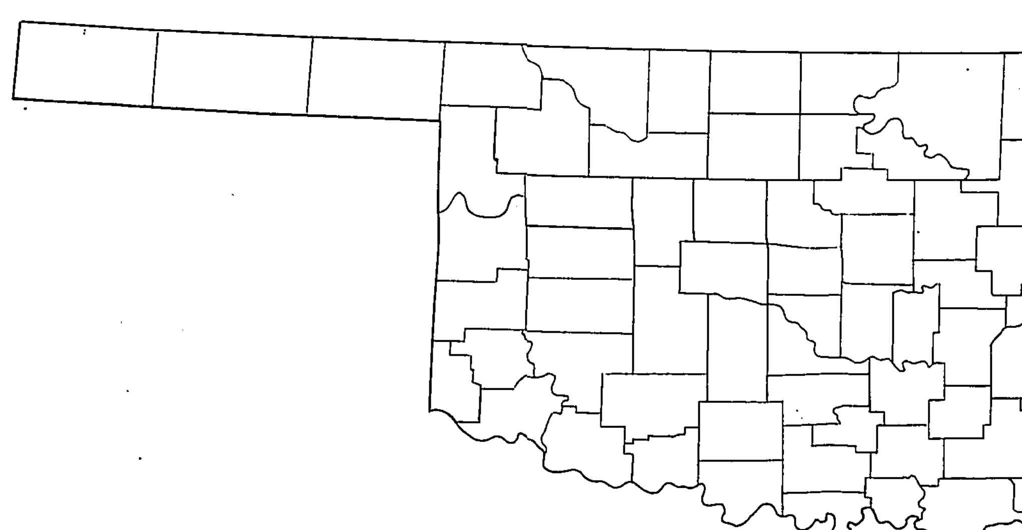
State highway

Paved road

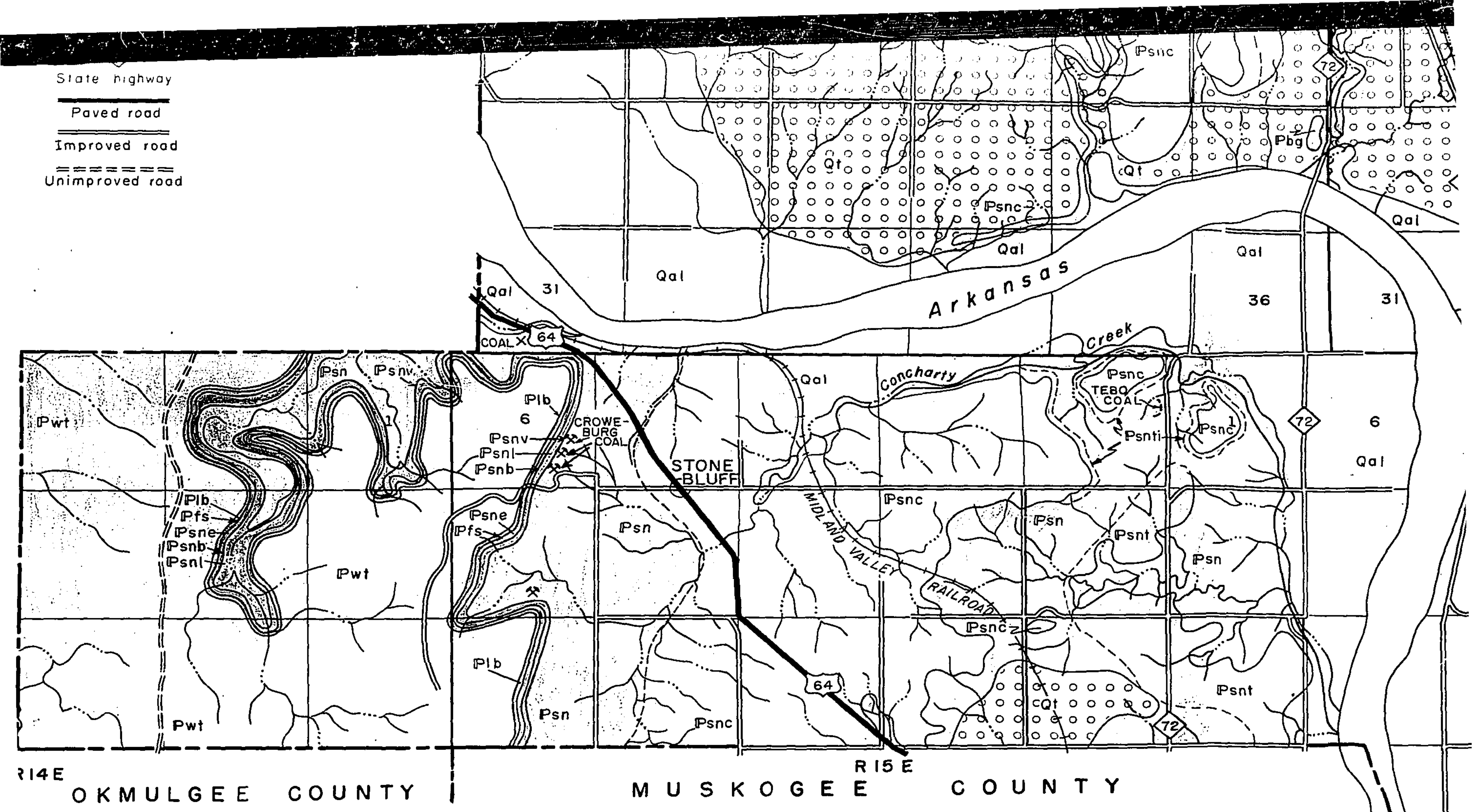
Improved road

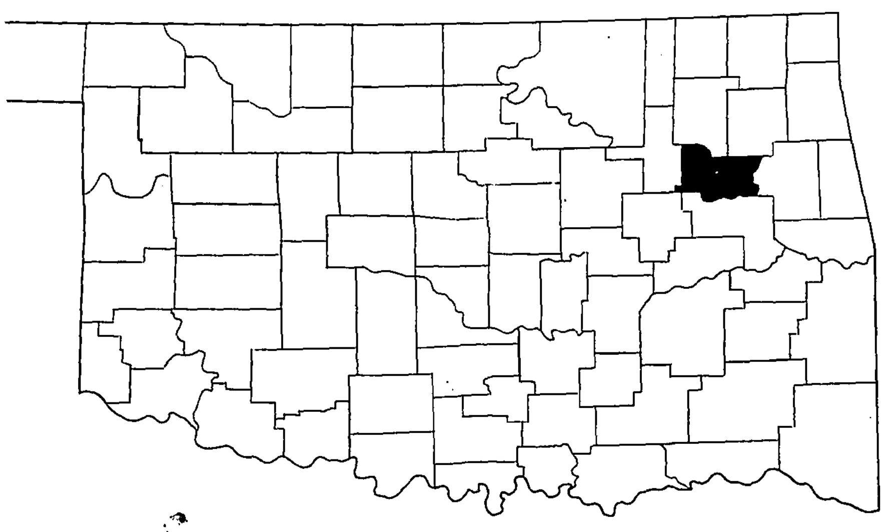
Unimproved road



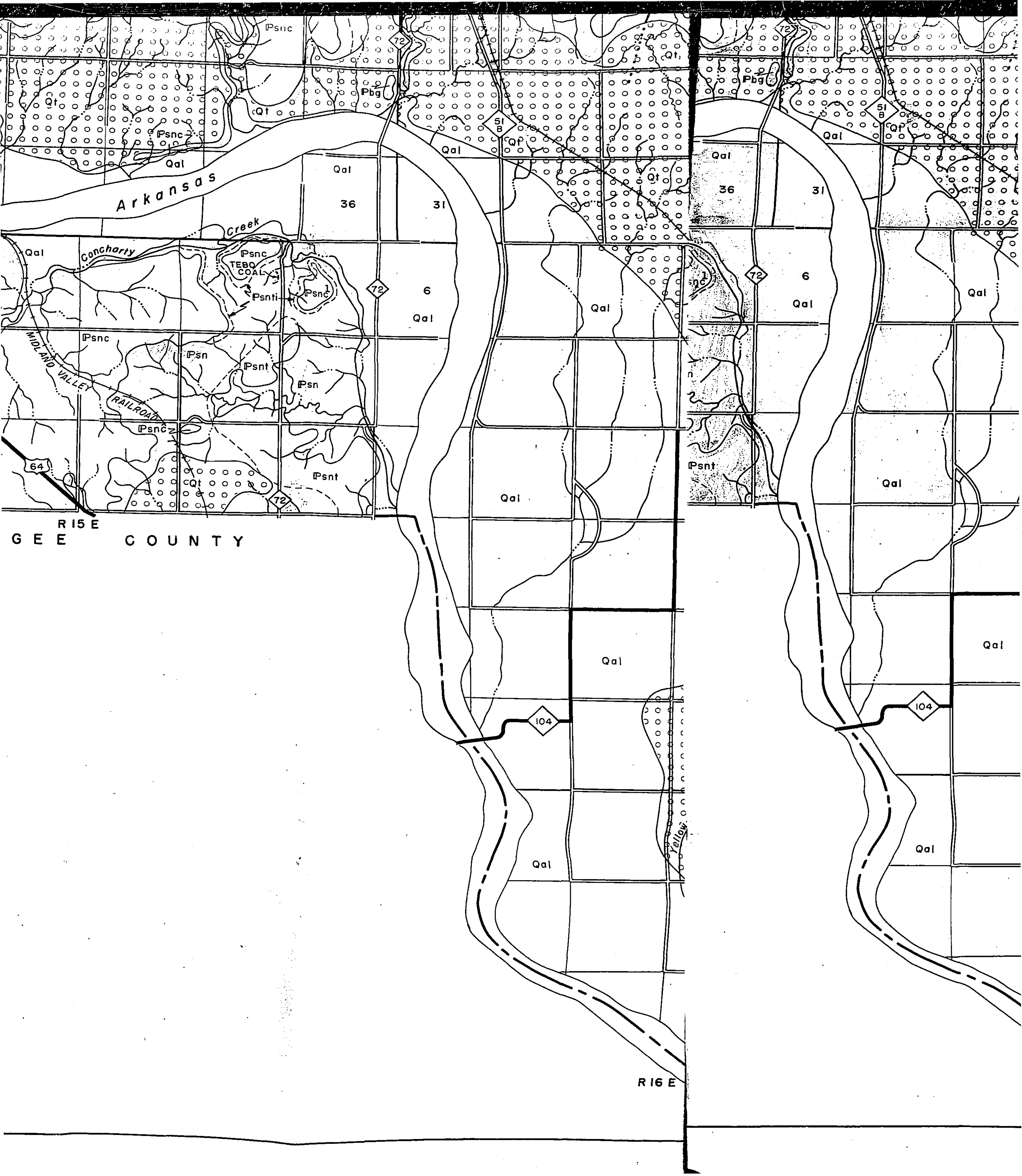


Index map of Oklahoma showing location of Wagoner county



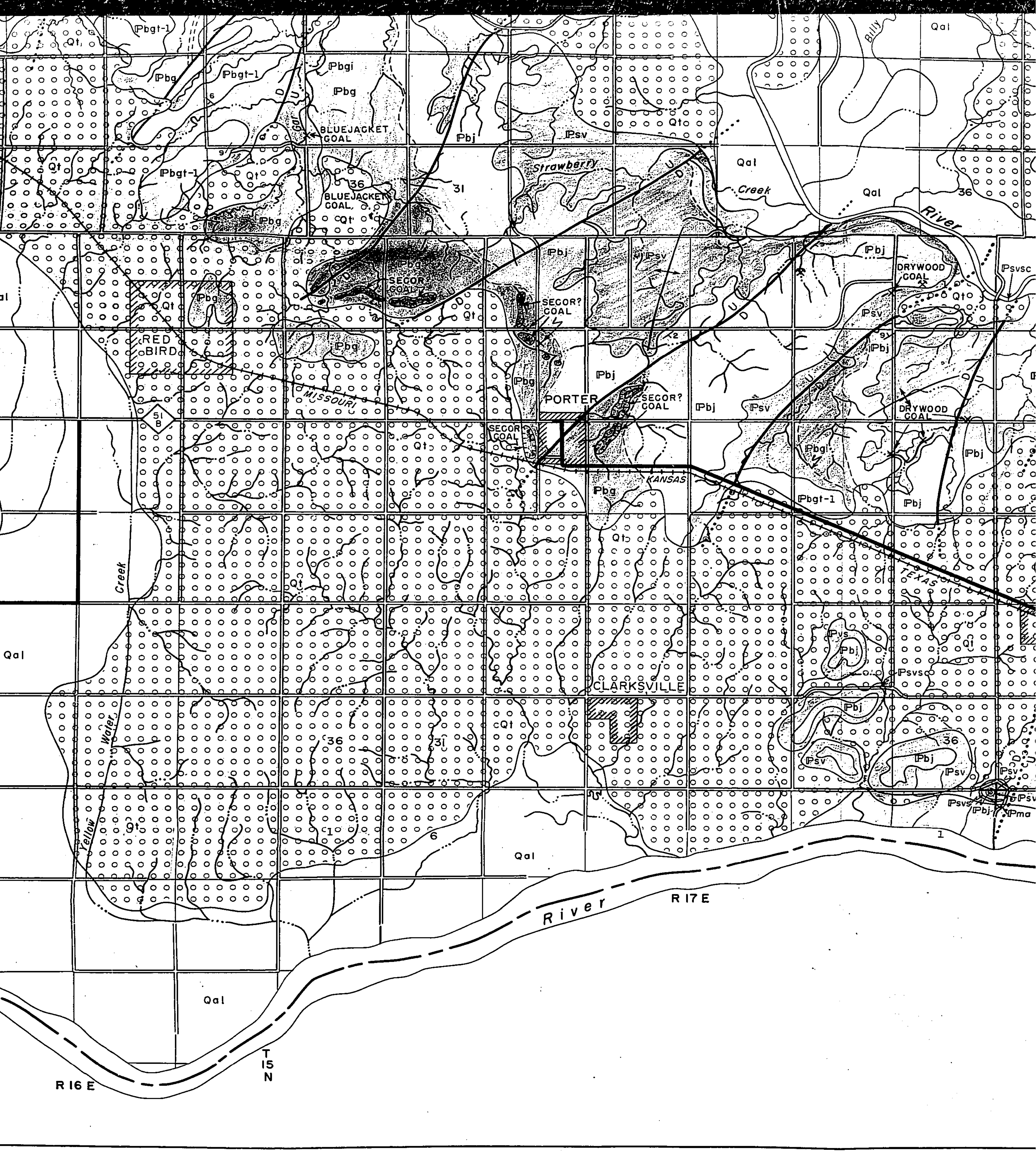


Oklahoma showing location of Wagoner county (black).



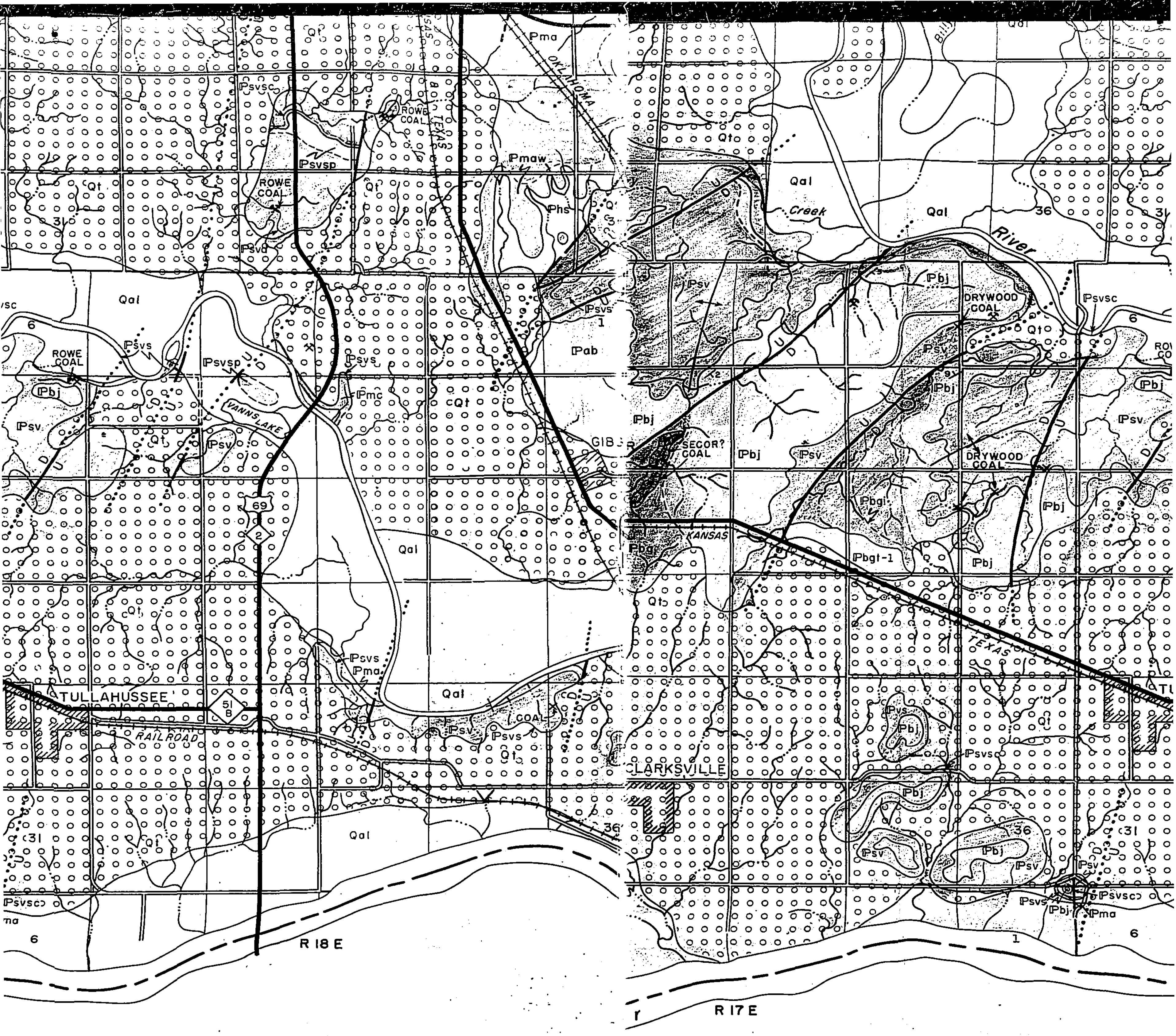
Psnc
Pbg
Qt
Qal
Arkansas
Concharty Creek
TEBO COAL
Psnti
Psn
Psnt
MIDLAND VALLEY RAILROAD
36
31
6
72
51 B
64
104
Yellow
R 15 E
R 16 E
GEE COUNTY

Pbgt-1
Qt
Pbg
Pbgi
BLUEJACKET GOAL
Pbj
Qal
36
31
6
1
Pbgt-1
BLUEJACKET COAL
SECOR COAL
RED BIRD
MISSOURI
Psnt
Creek
Yellow Water
Yellow
104
72
51 B
R16E
T 15 N

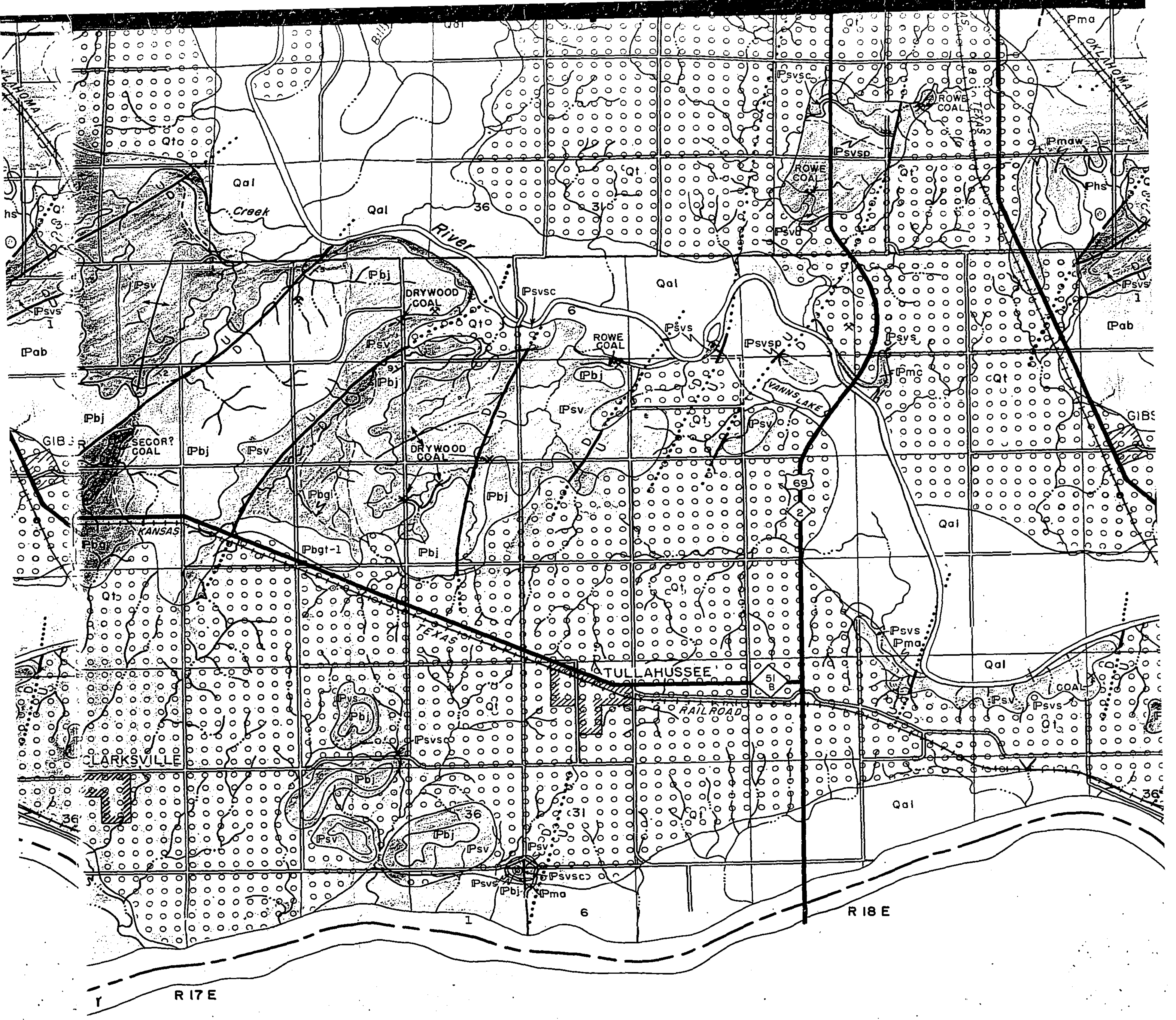


Pbgt-1
Qt
Pbg
Pbgi
BLUEJACKET COAL
Psv
Strawberry
Creek
Qal
River
Billy
36
31
Pbj
SECOR COAL
SECOR? COAL
DRYWOOD COAL
Psvsc
RED BIRD
MISSOURI
PORTER
KANSAS
TEXAS
Pbgl
Creek
Yellow Water
CLARKSVILLE
Pvs
Psvs
Pma
River
R 17 E
R 16 E
T 15 N

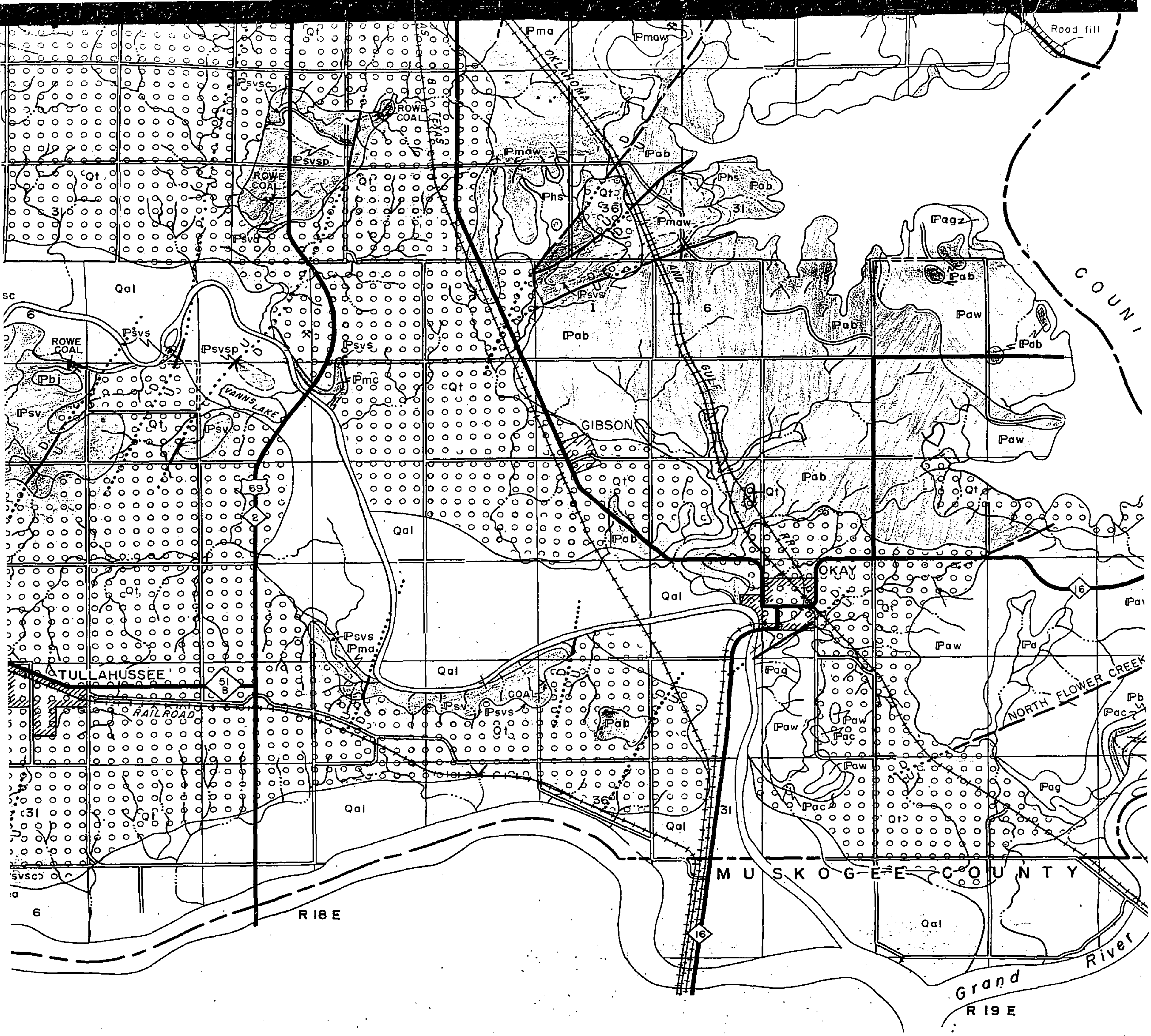

Qal
Billy
Strawberry
Creek
River
Qt
Psv
Pbj
Psvsc
Psvsp
Pma
Pmaw
Phs
ROWE COAL
DRYWOOD COAL
SECOR? COAL
PORTER
Pbg
Pbgl
Pbgt-1
KANSAS
TEXAS
RAILROAD
TULLAHUSSEE
CLARKSVILLE
VANNS LAKE
Psvs
Pmc
Pvs
69
2
51 B
36
31
6
1
R 17 E
R 18 E
River



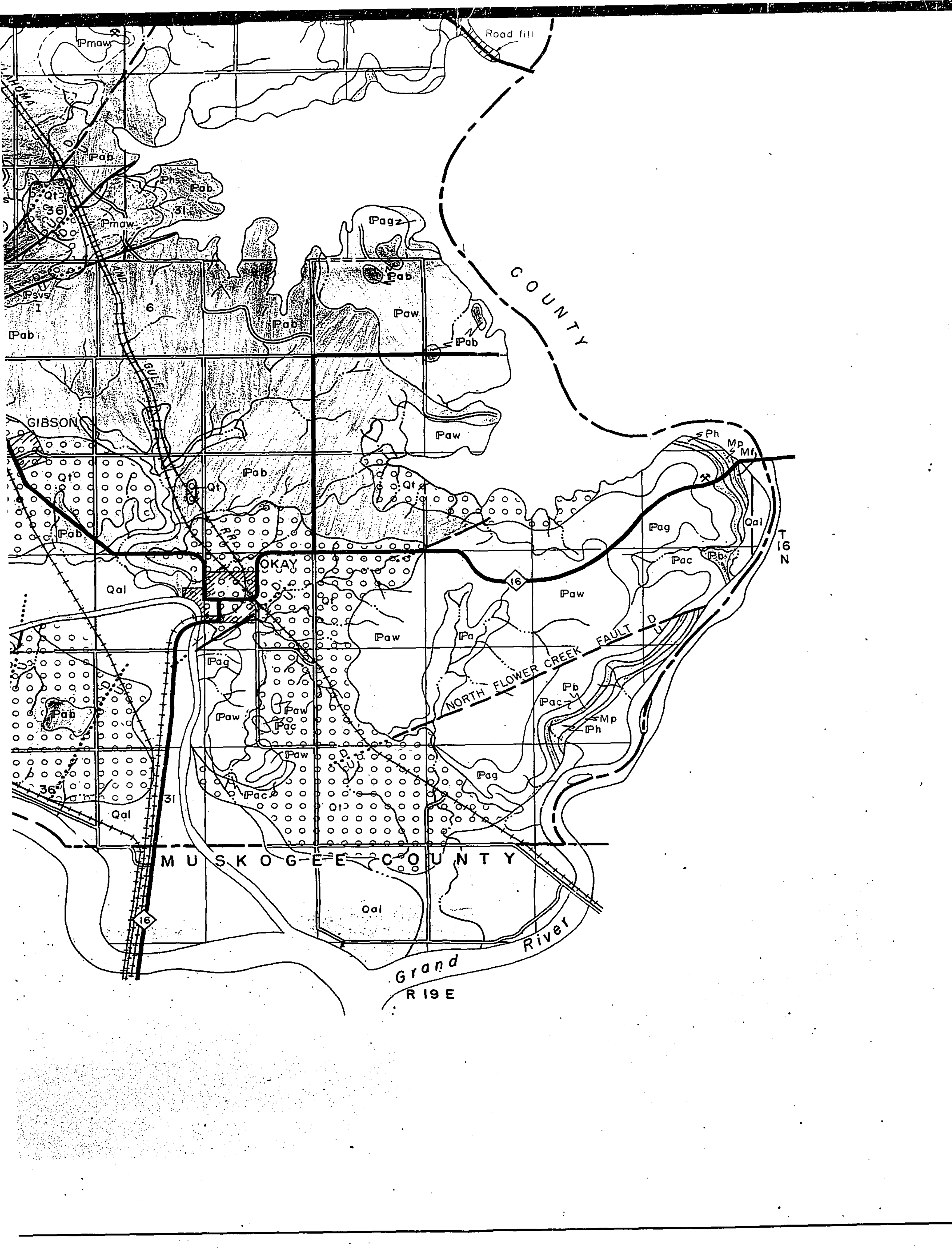
TULLAHUSSEE
RAILROAD
VANNS LAKE
ROWE COAL
Qal
Qt
Psvsc
Psvsp
Psvs
Psv
Pbj
Pma
Pmc
Pmaw
Phs
Pab
OKLAHOMA
TEXAS
KANSAS
69
51 B
2
R 18 E
CLARKSVILLE
SECOR? COAL
DRYWOOD COAL
Pbgl
Pbgl-1
Creek
River
R 17 E



Qal
Creek
River
Qt
36
31
Psvsc
ROWE COAL
Psvsp
Pmaw
Phs
Pma
OKLAHOMA
TEXAS
Pab
Psv
Pbj
DRYWOOD COAL
Psvs
Pmc
VANNS LAKE
GIBS
SECOR? COAL
KANSAS
Pbgl
Pbgt-1
69
2
TULLAHUSSEE
51 B
RAILROAD
Pma
COAL
CLARKSVILLE
R 17 E
R 18 E



TULLAHUSSEE
RAILROAD
GIBSON
OKAY
VANNS LAKE
ROWE COAL
COAL
NORTH FLOWER CREEK
MUSKOGEE COUNTY
Grand River
R 18 E
R 19 E
Road fill
OKLAHOMA
TEXAS
GULF
69
2
51 B
16



Road fill
COUNTY
GIBSON
OKAY
NORTH FLOWER CREEK FAULT
MUSKOGEE COUNTY
Grand River
R 19 E
T 16 N
Qal
Qt
Pab
Paw
Pag
Pac
Pagz
Pmaw
Psvs
Phs
Pb
Ph
Mp
Mf
16
31
36
6
1

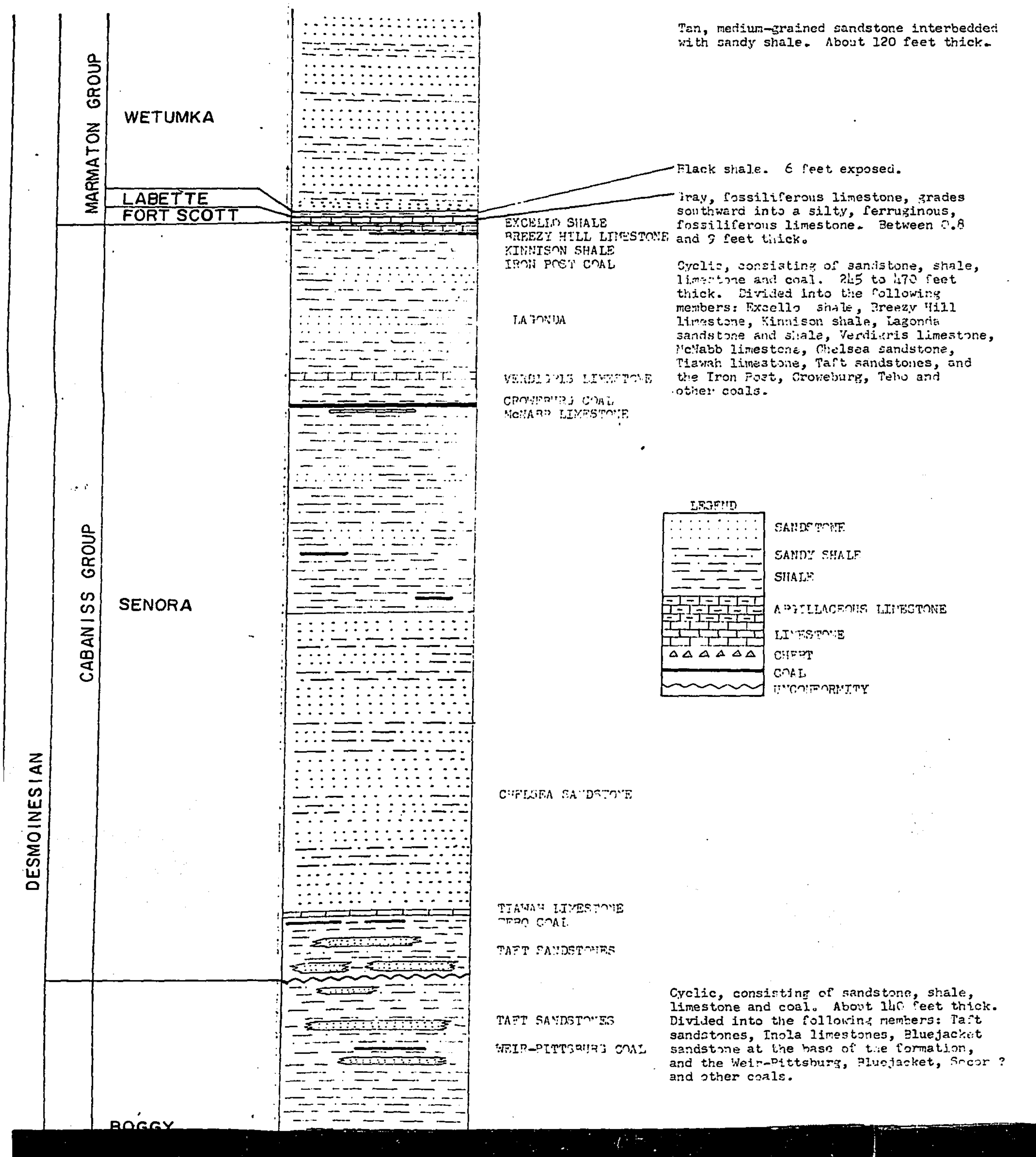
GENERALIZED COLUMNAR SECTION

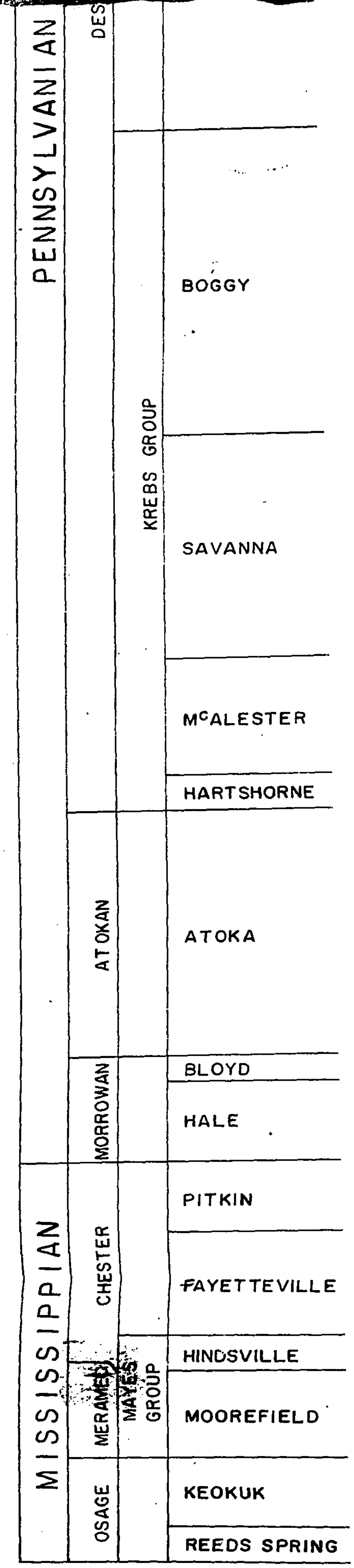
OF

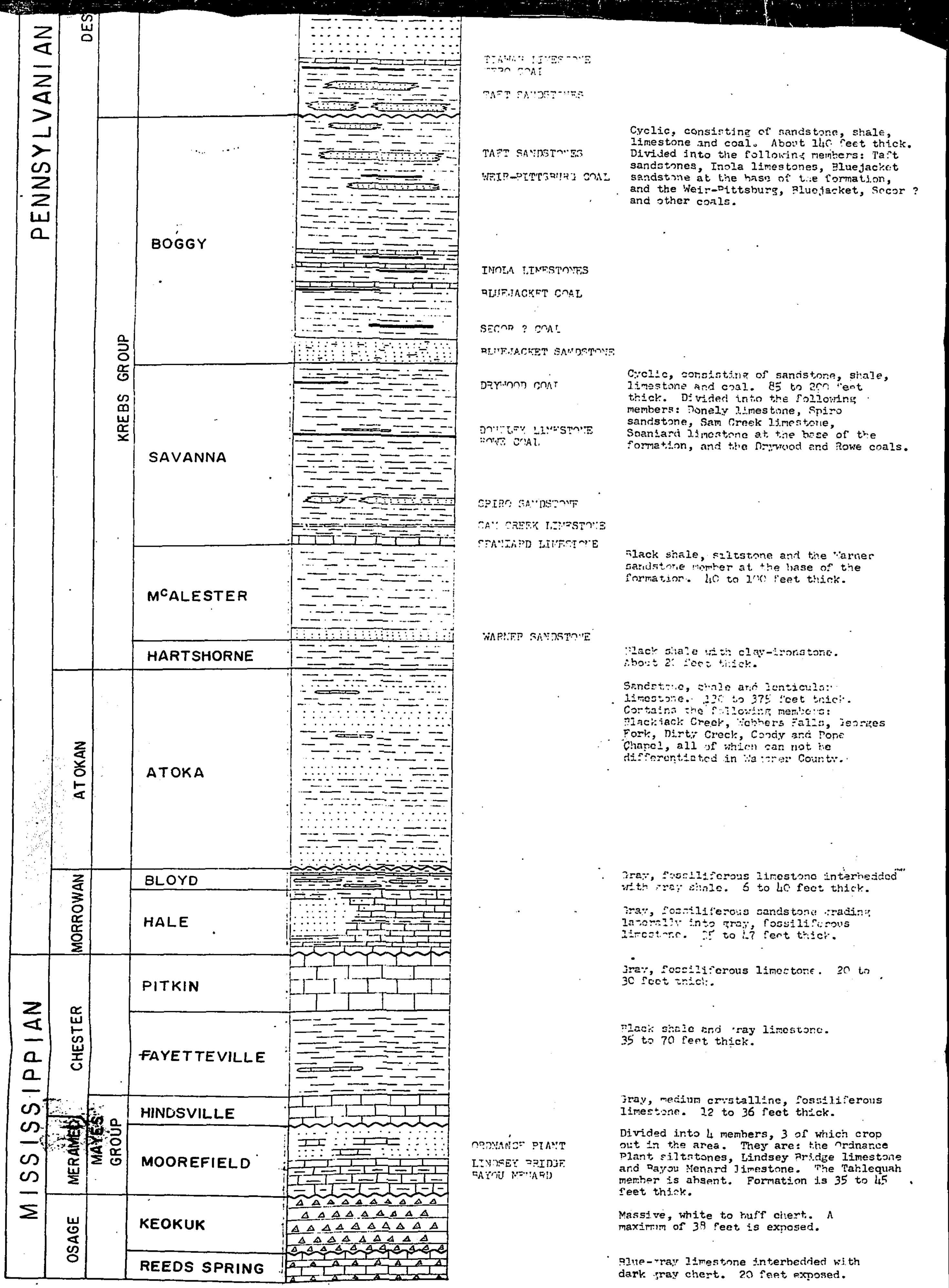
WAGONER COUNTY, OKLAHOMA

RAYMOND W. GOVETT, Ph.D. 1959

PLATE 2







PENNSYLVANIAN
DES
KREBS GROUP
BOGGY
SAVANNA
McALESTER
HARTSHORNE
ATOKAN
ATOKA
MORROWAN
BLOYD
HALE
MISSISSIPPIAN
CHESTER
PITKIN
FAYETTEVILLE
MERAMEC
MAYES GROUP
HINDSVILLE
MOOREFIELD
OSAGE
KEOKUK
REEDS SPRING
TIAWAH LIMESTONE
TEBO COAL
TAFT SANDSTONES
TAFT SANDSTONES
WEIR-PITTSBURG COAL
INOLA LIMESTONES
BLUEJACKET COAL
SECOR ? COAL
BLUEJACKET SANDSTONE
DRYWOOD COAL
DONELEY LIMESTONE
ROWE COAL
SPIRO SANDSTONE
SAM CREEK LIMESTONE
SPANIARD LIMESTONE
WARNER SANDSTONE
ORDNANCE PLANT
LINDSEY BRIDGE
BAYOU MENARD
Cyclic, consisting of sandstone, shale, limestone and coal. About 140 feet thick. Divided into the following members: Taft sandstones, Inola limestones, Bluejacket sandstone at the base of the formation, and the Weir-Pittsburg, Bluejacket, Secor ? and other coals.
Cyclic, consisting of sandstone, shale, limestone and coal. 85 to 200 feet thick. Divided into the following members: Donely limestone, Spiro sandstone, Sam Creek limestone, Spaniard limestone at the base of the formation, and the Drywood and Rowe coals.
Black shale, siltstone and the Warner sandstone member at the base of the formation. 40 to 100 feet thick.
Black shale with clay-ironstone. About 20 feet thick.
Sandstone, shale and lenticular limestone. 120 to 375 feet thick. Contains the following members: Blackjack Creek, Webbers Falls, Georges Fork, Dirty Creek, Coody and Pope Chapel, all of which can not be differentiated in Wagoner County.
Gray, fossiliferous limestone interbedded with gray shale. 6 to 40 feet thick.
Gray, fossiliferous sandstone grading laterally into gray, fossiliferous limestone. 25 to 47 feet thick.
Gray, fossiliferous limestone. 20 to 30 feet thick.
Black shale and gray limestone. 35 to 70 feet thick.
Gray, medium crystalline, fossiliferous limestone. 12 to 36 feet thick.
Divided into 4 members, 3 of which crop out in the area. They are: the Ordnance Plant siltstones, Lindsey Bridge limestone and Bayou Menard limestone. The Tahlequah member is absent. Formation is 35 to 45 feet thick.
Massive, white to buff chert. A maximum of 38 feet is exposed.
Blue-gray limestone interbedded with dark gray chert. 20 feet exposed.