STATE OF ARKANSAS

Arkansas Geological Commission

Norman F. Williams, Geologist-Director

INFORMATION CIRCULAR 20-E

GEOLOGY OF KNOXVILLE QUADRANGLE, JOHNSON AND POPE COUNTIES, ARKANSAS

by

E. A. Merewether

U. S. GEOLOGICAL SURVEY

Prepared in cooperation with the United States Geological Survey

Little Rock, Ark.

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GEOLOGY OF KNOXVILLE QUADRANGLE, JOHNSON AND POPE COUNTIES, ARKANSAS

by

E. A. MEREWETHER
U. S. Geological Survey

ABSTRACT

The Knoxville quadrangle is an area of about 61 square miles in Johnson and Pope Counties of northwestern Arkansas.

In the Knoxville quadrangle sedimentary rocks of the Morrow, Atoka, and Des Moines Series of Pennsylvania age are folded into generally east-west trending anticlines and synclines, and broken by normal faults striking approximately east-west.

Rocks of the Morrow Series are not exposed in the Knoxville quadrangle but have been penetrated by three wells drilled for gas. The most complete stratigraphic section of the Morrow Series is recorded on the sample log of the W. H. Tackett well (sec. 2, T. 8 N., R. 22 W.). The part of the Morrow Series penetrated by the Tackett well consists of 635 feet of sandstone, shale, siltstone, and limestone of the Bloyd Shale and Prairie Grove Member of the Hale Formation, undifferentiated, and the upper part of the Cane Hill Member of the Hale Formation.

The Atoka Series in the Knoxville quadrangle is the Atoka Formation and consists of about 50 percent shale, 25 percent siltstone, 25 percent sandstone, and minor amounts of coal and limestone. The thickness of the Atoka Formation ranges from about 4,650 feet at the northern boundary of the quadrangle to 6,750 feet near the southern boundary.

The Des Moines Series is represented by the Hartshorne Sandstone and the lower part of the McAlester Formation. The Hartshorne Sandstone is predominantly sandstone with a few interbedded units of siltstone and shale, and ranges in thickness from about 90 feet to about 200 feet. The part of the McAlester Formation found in the quadrangle is mostly shale but includes sandstone, siltstone, and two coal beds. The rocks of the McAlester Formation in the area of this report are approximately 570 feet thick.

The Quaternary System in the Knoxville quadrangle includes terrace deposits of probable Pleistocene age and alluvium assumed to be of Recent age. Terrace deposits of clay, silt, sand, pebbles, and cobbles are present at several levels in the quadrangle and have been found near many of the streams and creeks. Alluvium, consisting of clay, silt, sand, pebbles, and cobbles, has been deposited along most of the streams in the area.

The Knoxville quadrangle, in the Arkansas Valley section of the Ouachita province, contains several broad gently dipping folds and a complex system of normal faults. From north to south the major folds are the south limb of the Hagarville syncline; the Dover anticline; the Clarksville syncline; and the Knoxville anticline. The major faults are the Clarksville fault, with the downthrown block on the south side, the Big Piney Creek fault, with the downthrown block on the south side, the Hickeytown fault, with the downthrown block on the north side, and the Simmons Creek fault, with the downthrown block on the south side. In addition to the major faults in the Knoxville quadrangle there are many faults with slightly less displacement. The net effect of all the faulting is the uplift of the rocks at the northern end of the quadrangle relative to equivalent rocks at the southern end.

Natural gas, coal, building stone, road metal, and gravel, sand, and clay constitute the economic potential of the rocks in the Knoxville quadrangle. Commercial quantities of natural gas have been found in the Atoka Formation of the Eastern Knoxville, Knoxville, and Dover anticlines, and on the north side of the Clarksville fault. Coal deposits of possible commercial interest include a coal bed of the upper part of the Atoka and the Lower Hartshorne coal of the McAlester Formation.

Sandstone of quality adequate for building or decorative stone can probably be quarried from units in the Atoka, Hartshorne, or McAlester Formations in the Knoxville quadrangle. Road metal could be obtained from most of the sandstone beds or from the gravelly parts of terrace deposits and alluvium in the area of this report. The terrace deposits also contain sand and gravel useful as aggregate, and clay of possible value to the brick, pottery, tile, or lightweight aggregate industries.

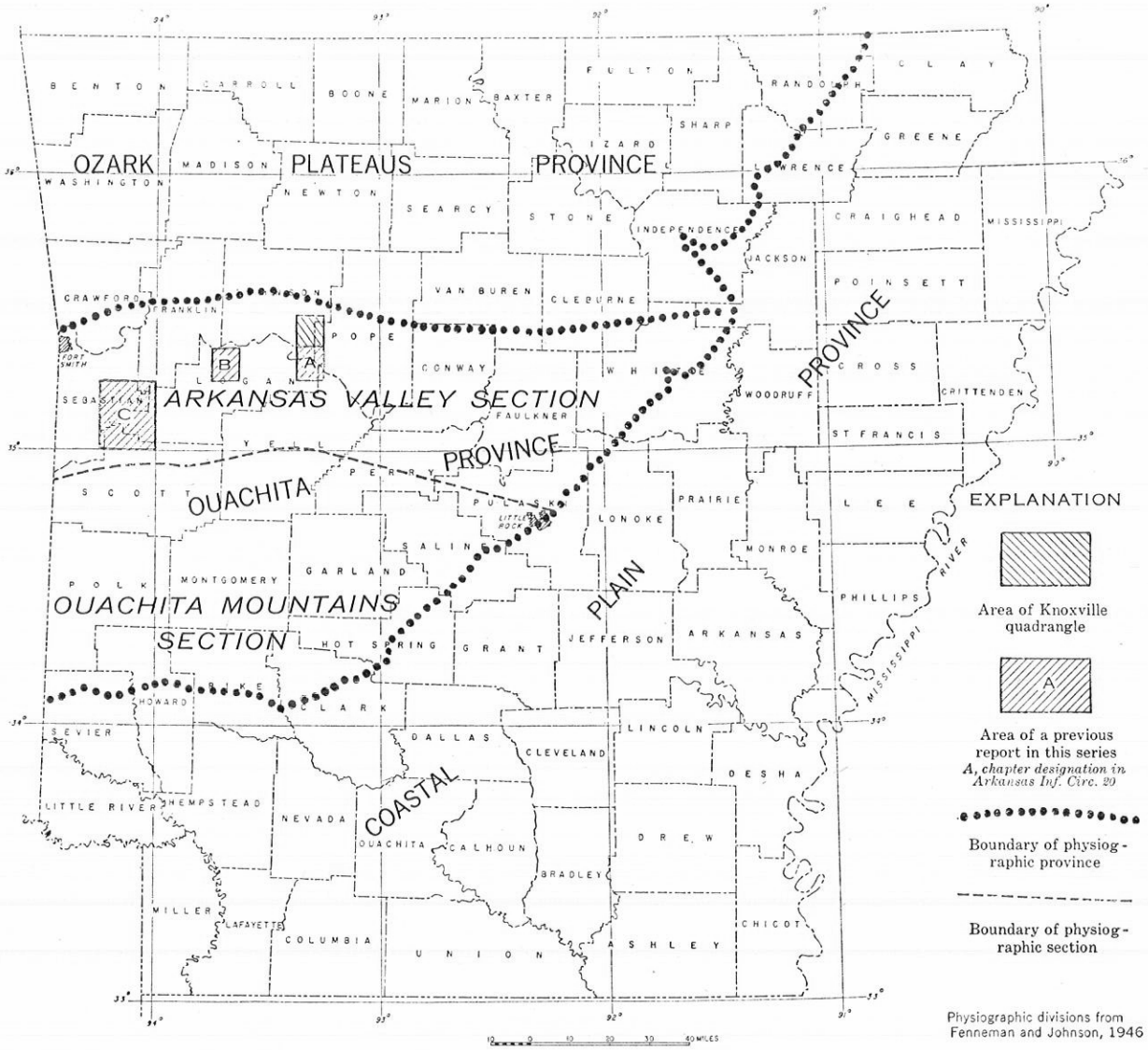
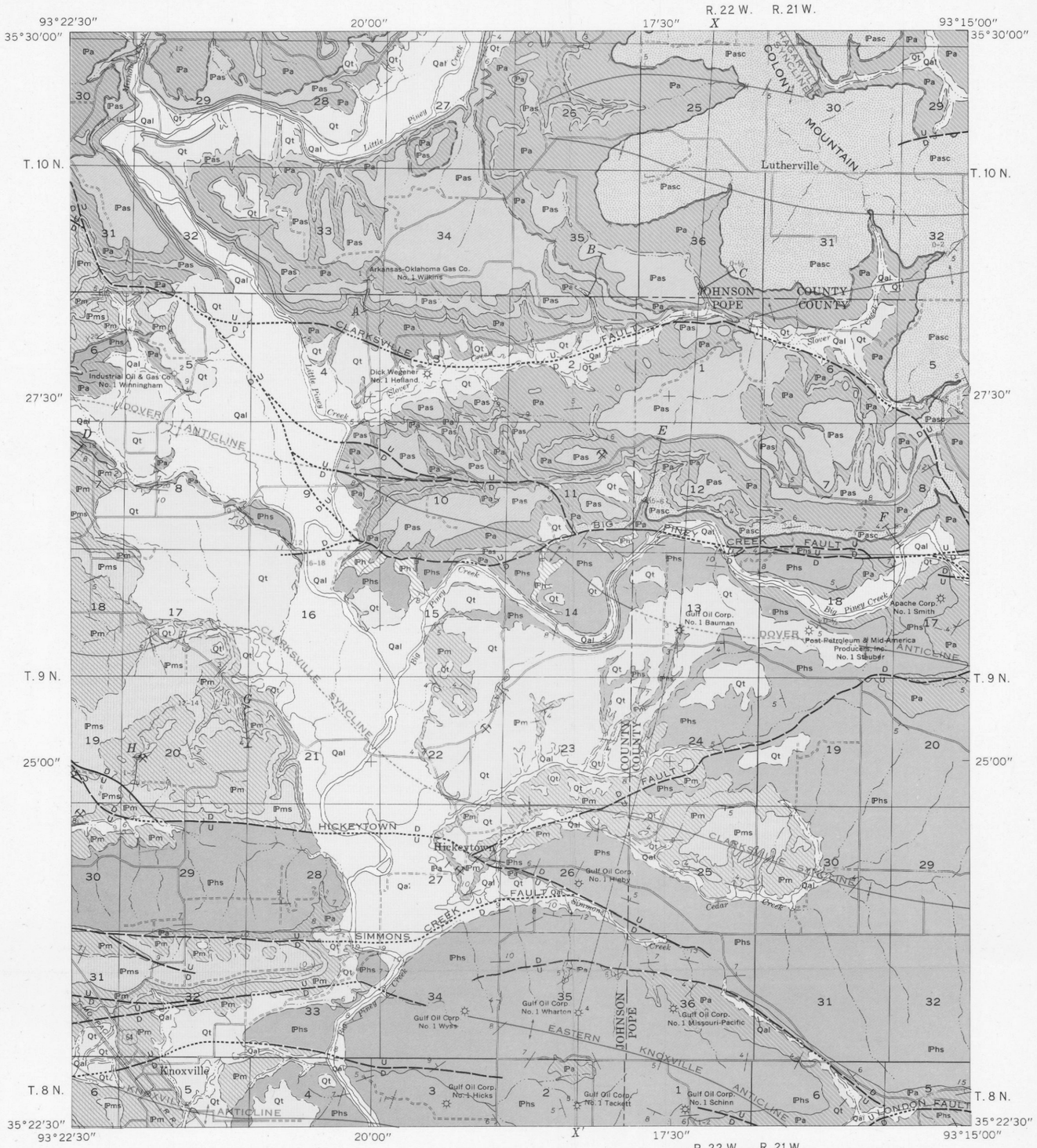


FIGURE 1–INDEX MAP OF ARKANSAS



Planimetric base compiled by E. A. Merewether from aerial photographs

Geology mapped in 1960

GEOLOGIC MAP OF KNOXVILLE QUADRANGLE, JOHNSON AND POPE COUNTIES, ARKANSAS

By
E. A. Merewether
U.S. Geological Survey
1963

SCALE 1:48000

1 0 1 2 3 MILES

3000 0 3000 6000 9000 12000 15000 FEET

1 5 0 1 2 3 KILOMETERS

EXPLANATION

QUATERNARY

Recent

Qal — Alluvium*

Deposits along stream channels. In some places includes part of the lowermost terrace

Pleistocene

Qt — Terrace deposits*

Alluvial deposits on several terrace levels

UNCONFORMITY

PENNSYLVANIAN

CARBONIFEROUS

Des Moines — Krebs Group

IPm / IPms — McAlester Formation

Alternating units of predominant sandstone or predominant shale.

IPm, *shale, siltstone, and thin beds of silty sandstone.*

IPms, *sandstone, silty sandstone, or interbedded sandstone, siltstone, and shale*

IPh / IPhs — Hartshorne Sandstone

Predominantly sandstone but with intercalated shale and siltstone in some places.

IPh, *shale, siltstone, and thin beds of sandstone or silty sandstone.*

IPhs, *sandstone, silty sandstone, or interbedded sandstone, siltstone, and shale*

Atoka

IPa / IPasc / IPas — Atoka Formation

Alternating units of predominant sandstone or predominant shale.

IPa, *shale, siltstone, and thin beds of sandstone or silty sandstone.*

IPasc, *sandstone, silty sandstone, and thin beds of siltstone and shale; zone* c.

IPas, *sandstone, silty sandstone, or interbedded sandstone, siltstone, and shale*

Contact
Dashed where approximately located

Coal bed
Dashed where approximately located

U / D — Fault

Dashed where approximately located; dotted where indefinitely located and concealed by alluvial deposits.
U, *upthrown side;* D, *downthrown side*

Axis of anticline
Dotted where concealed by alluvial deposits, where extension of anticline is not obvious

Axis of syncline
Dotted where concealed by alluvial deposits, where extension of syncline is not obvious

Strike and dip of beds*

Strike of vertical joint

Natural or man-made exposure of coal bed
Number is thickness of coal in inches where known

X — X' — Line of structural section shown on plate 4

A — Line of stratigraphic section
Specific section designated by letter symbol. Section shown on plate 2 and described in appendix

Quarry

WELL SYMBOLS

Company name and lease name shown. Number designates stratigraphic section shown on plate 2 or described in appendix

³☼ Producing gas well

☼ Well with show of gas

¹☼ Well with no show of gas

* Strike and dip symbols in areas of alluvial deposits were measured on bedrock exposures too small to be shown on this map

Section lines, township lines, and county lines are indicated for general orientation and identification but are not authenticated for legal purposes

INTRODUCTION

This report has been prepared by the U. S. Geological Survey in cooperation with the Arkansas Geological Commission. This description of the geology and mineral resources of the Knoxville quadrangle includes data pertinent to the exploitation of coal, natural gas, subsurface water, building stone, sand, gravel, and clay.

Knoxville quadrangle, in Johnson and Pope Counties, Ark. is bounded by 35°30′00″ N. and 35°22′30″ N. latitude, and by 93°22′30″ W. and 93°15′00″ W. longitude, and it includes an area of approximately 61 square miles. (See fig. 1.)

Knoxville, near the southwest corner of the quadrangle, is the largest town in the quadrangle and has a population of approximately 250 people. Lutherville is a smaller community near the northeast corner of the quadrangle. U. S. Highway 64 and the Missouri-Pacific Railroad cross the southwestern part of the quadrangle through Knoxville. County and private roads provide access to most parts of Knoxville quadrangle.

The elevation above sea level of the quadrangle ranges from about 320 feet at the southern boundary along Big Piney Creek, to about 1,020 feet, near the northern boundary in the northeastern part. The river called "Big Piney Creek" in this report has been named "Piney Creek" or "Big Piney Creek" on published maps of this region. The designation "Big Piney Creek" is preferred by the author because of its use by citizens of the area and by the State of Arkansas.

The surface geology of the quadrangle was mapped on aerial photographs at a scale of approximately 1:20,000. Geologic notations, including contact lines, fault trace lines, and strike and dip symbols, were located by inspection. Geologic, topographic, and cultural features were transferred from the photographs to a planimetric base map (scale 1:20,000) by use of a reflecting projector and a radial planimetric plotter. Scale and position control points used in the transfer are the U. S. Coast and Geodetic Survey London, Knoxville, and Lamar triangulation stations near the quadrangle, and the bench mark at Anne Chapel, 1½ miles north of the quadrangle. The control points were located on both the photographs and the planimetric base map and the photographs oriented to the map with a point-controlled radial triangulation net.

This description of the geology of the Knoxville quadrangle was influenced by earlier reports of both regional and local significance. A. J. Collier (1907) and Carey Croneis (1930) described the geology and delineated many of the major structural features in large areas that include the area of this report. The age and nomenclature assigned to the outcropping rocks in the Knoxville quadrangle is based upon the work of Hendricks and Read (1934), Hendricks, Dane, and Knechtel (1936), and Hendricks and Parks (1950), near the Arkansas-Oklahoma State line, and upon the conclusions of E. A. Merewether and Boyd R. Haley (1961) concerning the Delaware quadrangle, Arkansas.

Boyd R. Haley, U. S. Geological Survey, assisted in the fieldwork during 1960. Norman F. Williams, Arkansas Geological Commission, provided samples of drill cuttings from eight of the wells located in the Knoxville quadrangle. To these individuals the writer expresses his sincere appreciation.

STRATIGRAPHY

Sedimentary rocks of the Pennsylvanian and Quaternary Systems are exposed at the surface (pl. 1) and have been penetrated by gas wells in the Knoxville quadrangle. The rocks of Pennsylvanian age are, from oldest to youngest, the Morrow Series (subsurface only), the Atoka Series, and the Krebs Group of the Des Moines Series. These rocks are described in the appendix of this report and are represented graphically on plate 2.

The rocks of Quaternary age are stream terrace deposits of Pleistocene age (Hendricks and Parks, 1950, p. 78) and stream alluvium of Recent age.

The stratigraphic units of Pennsylvanian and Mississippian age exposed at the surface or believed to be present in the subsurface of the Knoxville quadrangle, and pertinent to this report, are presented with their ages and stratigraphic relations in table 1.

The stratigraphic terminology used in this report for rocks of Pennsylvanian age duplicates

that used for the rocks of the Delaware quadrangle, Arkansas, by Merewether and Haley (1961, table 1). The stratigraphic terminology used in this report for rocks of Mississippian age was originated by Adams (1904), p. 27 and 109).

The rocks described in this report that are not exposed at the surface were studied by examining the drill cuttings and electric logs from ten of the holes drilled for gas in the quadrangle. Stratigraphic sections based on logs from some of these wells are presented on plate 2 and described in the appendix. The names and locations of the wells in the quadrangle and the names of the drilling companies are given on plates 1 and 3.

PENNSYLVANIAN SYSTEM

Morrow Series

The Morrow Series in northwestern Arkansas consists of the Hale Formation and the overlying Bloyd Shale. Where exposed in northwestern Arkansas, the Morrow Series unconformably overlies the Pitkin Limestone of Mississippian age and is unconformably overlain by the Atoka Formation. The lower and upper contacts of the Morrow Series are not exposed in the Knoxville quandrangle though the upper contact has been penetrated by wells drilled for gas. As both contacts are unconforable where exposed, they are presumed to be the same in the area of this report.

Rocks of the Morrow Series were penetrated by three holes drilled for gas in the Knoxville quadrangle. The most complete sections occur in the Gulf Oil Corp. No. 1 W. H. Tackett well (well 5, pl. 2) in sec. 2, T. 8 N., R. 22 W. The Morrow Series in the Tackett well cannot be separated into the Bloyd and Hale Formations but can be divided into two units; the upper unit is the Bloyd Shale and Prairie Grove Member of the Hale Formation, undifferentiated, and the lower unit is the Cane Hill Member of the Hale Formation. The upper unit is 506 feet thick and consists of shale, slightly silty to silty shale, siltstone, very fine to coarse-grained sandstone and limy sandstone, and very fine to medium-grained sandy fossiliferous limestone. The fossils in the upper unit include crinoids, brachiopods, bryozoa, and spines. That part (129 feet) of the Cane Hill Member penetrated by the well consists of shale, very finely sandy siltstone, and well-cemented very silty very fine grained sandstone.

Rocks of the Morrow Series in the Gulf Oil Corp. No. 1 J. J. Bauman well (well 3, pl. 2), sec. 13, T. 9 N., R. 22 W., are stratigraphically equivalent to part of the upper unit of the Morrow Series in the Tackett well. The part (359 feet) of the Bloyd Shale and Prairie Grove Member of the Hale Formation, undifferentiated, in the Bauman well consists of slightly silty shale, argillaceous siltstone, sandy slightly limy siltstone, very fine to medium-grained silty sandstone, very fine to fine-grained slightly silty limy sandstone, and very fine to coarse-grained sandy fossiliferous limestone. Fossils in these rocks include crinoids, gastropods, and cephalopods.

Rocks probably of the Morrow Series in the Arkansas-Oklahoma Gas Co. No. 1 Wilkins well (well 1, pl. 2), in sec. 33, T. 10 N., R. 22 W., include the upper part of the Bloyd Shale and Prairie Grove Member of the Hale Formation, undifferentiated. The incomplete section (179 feet) of the Morrow Series in the Wilkins well consists of shale, very fine to fine-grained silty sandstone, very fine to coarse-grained silty sandstone, and very fine grained fossiliferous limestone. The fossiliferous rocks contain brachiopods.

The rocks of Morrow age penetrated by the Tackett, Bauman, and Wilkins wells are shown graphically on plate 2 and described in the appendix.

Atoka Series

The Atoka Series overlies the Morrow Series and underlies the Des Moines Series. In northwestern Arkansas the Atoka Series, comprised of the Atoka Formation, rests uncomfortably upon the Bloyd Shale of Morrow age and is overlain unconformably by the Hartshorne Sandstone of Des Moines age.

The contact of the Atoka Formation with the underlying Bloyd Shale is not exposed in the Knoxville quadrangle but was penetrated in the subsurface by three wells (wells 1, 3, 5, pl. 2). The lower boundary of the Atoka in these wells was selected on the basis of lithology. The basal sandstone of the Atoka Formation, the Greenland Sandstone Member, was named by Henbest (1953) from exposures in the Ozark uplift and described as a silty, ripple-marked, flaggy sandstone with shaly partings, and, locally, interfingering marine quartz-gravel conglomerate. The Greenland Sandstone Member overlies rocks of the Morrow Series, consisting mostly of shale, limy sandstone, sandy limestone, and limestone. In the Knoxville quadrangle, as in the Delaware quadrangle (Merewether and Haley, 1961, p. 6), a sequence of units very similar to the Greenland

Table 1.—Selected stratigraphic units in and near the Knoxville quadrangle, Arkansas

System		Series	Group	Formation	Member
CARBONIFEROUS	Pennsylvanian	Des Moines	Krebs	Boggy Formation	
				Savanna Formation	
				McAlester Formation	Lower Hartshorne coal bed
				Hartshorne Sandstone	
		Atoka		Atoka Formation	
		Morrow		Bloyd Shale	
				Hale Formation	Prairie Grove Member
					Cane Hill Member
	Mississippian	Chester		Pitkin Limestone	
				Fayetteville Shale	

Sandstone Member and underlying Morrow Series of the Ozarks is found in the subsurface. In the Knoxville quadrangle the base of the Atoka Formation is belived to be at the base of a sequence (150 to 230 feet thick) of interbedded sandstone and shale. The sandstone is very fine to medium grained, with scattered coarse and very coarse grains, granules, and pebbles of quartz; it is slightly limy, and slightly fossiliferous. The shale is slightly silty. The stratigraphic position of the lower boundary of the Atoka Formation in the area of this report is corroborated by the presence of possible bentonite beds in the lower part of the Atoka (Frezon and Schultz, 1961). Two possible bentonite beds were penetrated by the Tackett well, at depths of 5,790 and 6,740 feet, and the upper of these two is believed to have been penetrated by the Bauman well at a depth of 4,564 feet. The stratigraphic positions of the bentonite(?) beds, relative to the base of the Atoka Formation, in this quadrangle are very similar to those at many other localities in northwestern Arkansas (Merewether, 1961, fig. 182.1; and Haley, 1966, p. 4) and eastern Oklahoma.

In the area of this report the Atoka Formation consists chiefly of dark-gray to grayish-black silty shale, dark-gray argillaceous siltstone, light- to medium-gray very fine grained sandy siltstone, and light- to medium-gray silty very fine to fine-grained sandstone. Minor amounts of very light to medium-gray fine- to medium-grained sandstone containing scattered coarse and very coarse quartz grains, light-gray limy standstone, medium- to dark-gray silty limestone, and coal are also present in the Atoka. (See pl. 2.)

Rocks (approximately 900 feet thick) of the upper part of the Atoka are exposed in the part of the Knoxville quadrangle north of the Big Piney Creek fault (pl. 1). Within this area one or more of the following features may be in the sandstone beds: sandstone or shale pebbles, subangular fragments of shale, carbonized or coalified plant fragments, stringers of coal, and borings resulting from the life processes of bottom-dwelling animals. In addition, on a larger scale, some of the standstone units contain lenses of shale pebble conglomerate, lenses of dark-gray shale, and contorted lenses of coal. The bedding is variable and may be regular, irregular, or lenticular, and the beds are very thin to massive. The sandstone may also be foreset bedded, cross-bedded, or convolute, and may display current ripple marks, current flow casts, or sediment flow structures. The lower contact of a sandstone bed may be gradational or sharp. At many places where the contact is sharp it outlines channels and cuts across the bedding of the unit below.

Good exposures of the sandstone units occur along the cliff on the north side of Big Piney Creek in sec. 12, T. 9 N., R. 22 W., along the main road in the southeast part of sec. 33, T. 10 N., R. 22 W., on the walls of the valley of Little Piney Creek (secs. 29, 30, 31, and 32, T. 10 N., R. 22 W.) in the northwestern part of the quadrangle, and on the steeper slopes of Colony Mountain in the northeastern part of the quadrangle.

Most of the mappable exposed sandstone units in the Atoka are continuous throughout the northern part of the Knoxville quadrangle and a few are sufficiently distinctive to be correlative with sandstones in the subsurface of the southern part of the quadrangle. Many of the exposed lithologic units cannot be correlated with equivalent rocks in the subsurface, as Merewether and Haley (1961, p. 7) have pointed out.

Zone s (pls. 2 and 4), a sandstone in the middle part of the Atoka, is not exposed within the Knoxville quadrangle but has been penetrated by wells drilled in this area. This sandstone, called the Tackett sandstone by geologists of oil and gas companies interested in the area of this report, is the gas-producing unit of the Knoxville gas field. Zone s of this report is believed to be continuous with the Tackett and Self sandstones as used by the Fort Smith Geological Society Stratigraphic Committee (1960). The surface and subsurface investigations of E. E. Glick, B. R. Haley, and E. A. Merewether in areas to the north and west lead to the conclusion that zone s of the Knoxville quadrangle is the unit called the Self or Tackett sandstone by geologists of oil and gas companies working in northwestern Arkansas.

A distinctive sandstone unit in the upper part of the Atoka Formation (zone c on plates 1, 2, and 4) has many characteristics in common with sandstone units in the Hartshorne and McAlester Formations. This sandstone unit, including interbedded siltstones and shales, is generally about 300 feet below the base of the Hartshorne Sandstone and ranges in thickness from about 70 feet to about 375 feet. The unit is either exposed at the surface or in the subsurface throughout the Knoxville quadrangle, excepting several square miles in the northwestern quarter. It forms the surface of most of the Colony Mountain mesa and is generally well exposed along the cliff at the edge of the mesa. In

SYSTEM: CARBONIFEROUS
SERIES: PENNSYLVANIAN
GROUP: Des Moines
FORMATION: Krebs, Atoka
MEMBER: McAlester, Hartshorne, Zone c, Zone s, Bloyd, Prairie Grove, Cane Hill, Hale, Morrow

FEET
1000
500
0

C
Slover Creek section east
Sec. 36, T. 10 N., R. 22 W.
Thickness in feet
0
400

B
Slover Creek section west
Sec. 35, T. 10 N., R. 22 W.
0
200

A
Lutherville road section
Sec. 4, T. 9 N., R. 22 W.
Sec. 33, T. 10 N. R. 22 W.
0
100

1
Arkansas-Oklahoma Gas Co.
No. 1 Wilkins
Sec. 33, T. 10 N., R. 22 W.
0
Total depth 4329 feet

2
Industrial Oil & Gas Co.
No. 1 Winningham
Sec. 5, T. 9 N., R. 22 W.
0
Total depth 3681 feet

E
Big Piney Creek section west
Sec. 12, T. 9 N., R. 22 W.
0
300

F
Big Piney Creek section east
Secs. 7 and 8, T. 9 N., R. 21 W.
0
300

D
East Lamar section
Sec. 7, T. 9 N., R. 22 W.
0
400

G
Knoxville-Hickeytown
road section
Sec. 20, T. 9 N., R. 22 W.
0
100

H
Southeast Lamar section
Sec. 20, T. 9 N., R. 22 W.
0
200

3
Gulf Oil Corp.
No. 1 Bauman
Sec. 13, T. 9 N., R. 22 W.
0
Spontaneous potential curve
Electrical log 16-inch normal resistivity curve
Total depth 5824 feet

4
Gulf Oil Corp.
No. 1 Wharton
Sec. 35, T. 9 N., R. 22 W.
0
Radioactivity-log Gamma-ray curve
Radioactivity log Neutron curve
Total depth 3400 feet

5
Gulf Oil Corp.
No. 1 Tackett
Sec. 2, T. 8 N., R. 22 W.
Thickness in feet
0
Spontaneous potential curve
Induction-electrical log 16-inch normal conductivity curve
Total depth 7525 feet

EXPLANATION

ROCK SYMBOLS

Sandstone
Siltstone
Shale
Limestone
Coal
Interbedded shale and siltstone
Covered interval in surface section; no sample interval in well section
Covered interval or no sample interval but probably containing shale

PARTICLE SYMBOLS

Sand
Silt
Concretions
Calcite
Chert
Dolomite

Correlation line between formations
Tentative correlation line within formation

Plate 2 STRATIGRAPHIC SECTIONS IN KNOXVILLE QUADRANGLE, JOHNSON AND POPE COUNTIES, ARKANSAS

By
E. A. Merewether
U.S. Geological Survey
1963

the northeastern quarter of the quadrangle this sandstone is light to medium gray, very fine to medium grained, porous to well cemented, and thin to massive bedded. It is commonly irregularly bedded, with foreset bedding, convolute bedding, and crossbedding. The lower part of the sandstone is a channel deposit overlying coal, shale, or conglomerate with a sharp contact. A coaly zone from 7 inches to a featheredge in thickness commonly underlies the sandstone. The coaly zone, generally a single bed but in some places a group of stringers, is rarely a few feet below the lower boundary of the sandstone or within the sandstone a few feet above the lower boundary. East of the quadrangle in the SW¼ sec. 16, T. 9 N., R. 21 W., the coal is 7 inches thick and occurs about 3 feet below the contact in a dark-gray shale. In the SE¼ sec. 7, T. 9 N., R. 21 W., the coal is 5 to 7 inches thick, overlies mudstone, and is overlain by the sandstone. In the SW¼ sec. 5, T. 9 N., R. 21 W., the coal bed is separated from the sandstone by a conglomerate bed 6 inches thick. The conglomerate contains pebbles of sandstone and shale, lenses of shale as much as 3 inches thick and 5 feet long, and coal stringers as much as ½ inch thick. The lower contact of the sandstone cuts downward into the conglomerate and the contact between the conglomerate and the underlying coal bed is sharp. The coal is 4 inches thick and underlain by shale. The sandstone directly above the contact in the SE¼ sec. 36, T. 10 N., R. 22 W., contains pebbles of shale as much as 4 inches in diameter and stringers of coal as much as ½ inch thick, and rests on shale with a sharp contact. The sandstone exposed in the SW¼ sec. 31, T. 10 N., R. 21 W., contains a thin coaly zone that cuts across the sandstone bedding. A thin wavy irregular coaly zone, as much as 10 to 15 feet above the lower surface of the sandstone, is in the NE¼ sec. 31, T. 10 N., R. 21 W.

The siltstone of the Atoka Formation exposed in the northern part of the Knoxville quadrangle generally is in beds less than 1 foot thick. Siltstone units commonly consist of thin interbedded layers of well-cemented and poorly-cemented siltstone, with ripple-marked bedding planes. Siltstone is also commonly interbedded with shale or sandstone in thin-bedded units.

The dark-gray to black shale of the upper part of the Atoka in the northern part of the quadrangle occurs either as thin interbeds with sandstone or siltstone, or in thick homogeneous units. The shale of the Atoka in some places in this area encloses coal stringers and thin zones of concretions.

Siltstone and shale are well exposed beneath the thick sandstone unit on the north side of Big Piney Creek in sec. 12, T. 9 N., R. 22 W., and in the southeast corner of sec. 7, T. 9 N., R. 21 W. Good exposures of siltstone and shale are also in the ravine at the upper end of Slover Creek in secs. 5 and 6, T. 9 N., R. 21 W., and along the main road in sec. 33, T. 10 N., R. 22 W.

Coal is at six horizons in the upper part of the Atoka in the Knoxville quadrangle. The three younger coaly units are exposed at the surface.

Invertebrate fossils are rare in the Atoka Formation of the Arkansas Valley. In the Knoxville quadrangle, a marine gastropod was found in a silty very fine grained sandstone of the upper part of the Atoka Formation in the NW¼NE¼ sec. 6, T. 9 N., R. 21 W. The fossil was tentatively identified as *Ananias (Ananias) welleri* or possibly *Worthenia tabulata* by Roger Batten of the University of Wisconsin, a part-time employee of the U. S. Geological Survey. The gastropod probably lived in shallow marine waters. Fragments of crinoid stems are in a thin sandstone in the SE¼SE¼ sec. 33, T. 10 N., R 22 W., along the Lutherville road. The bottom surface of another sandstone exposed at this locality exhibits abundant markings presumed to be the borings of a bottom-dwelling animal.

Invertebrate fossils were also found in drill cuttings from the gas wells. The fossils in the rocks penetrated by the Winningham well are as follows: crinoids, gastropods, and pelecypods in dark-gray shale at depths from 1,650 to 1,660 feet; bryozoa, ostracodes, crinoids, and gastropods in limy sandstone at depths from 2,227 to 2,250 feet. The fossils in drill cuttings from the Bauman well are as follows: gastropods, brachiopods, and crinoids in dark-gray shale from a depth of about 400 feet; bivalves, probably brachiopods, in limy very fine to medium-grained standstone with scattered coarser grains including granules and pebbles, from depths of 5,327 to 5,456 feet. The Higby well in sec. 26, T. 9 N., R. 22 W., penetrated a medium- to dark-gray limy shale containing crinoids at depths of 3,130 to 3,133 feet. The fossils from the Missouri-Pacific well in sec. 36, T. 9 N., R. 22 W., are as follows: crinoids, in very fine to fine-grained sandstone with scattered medium and coarse and coarse sand grains, at depths from 1,985 to 2,002 feet; bryozoa, in crystalline argillaceous limestone, at depths from 2,023 to 2,026 feet.

Plant fossils occur sporadically in the Atoka Formation in the area of this report. A large stigmaria partially enclosed in a sandstone is

exposed along Slover Creek in C NW¼ sec. 1, T. 9 N., R. 22 W. This fossil is embedded in the upper surface of the sandstone and is 4 to 5 feet below a coal bed. Fossil leaves are in a dark-gray shale of the upper part of the Atoka in a road cut in the SW¼NW¼SE¼ sec. 5, T. 9 N., R. 22 W.

The Atoka Formation is 6,750 feet thick in the Tackett well at the southern edge of the quadrangle. Approximately 3.8 miles north of the Tackett well, in the Bauman well, the Atoka is 5,300 feet thick. At the north edge of the quadrangle, about 4.7 miles north of the Bauman well, the thickness of the Atoka is estimated to be 4,650 feet.

The Atoka Formation, in the area of this report, thickens southward (see pl. 4) and consists of progressively more shale toward the south (Merewether, 1961). These related characteristics of the formation support the statements of Haley (1961, p. 6) and Glick (1961, p. 110), that the sediments were deposited in a downwarping basin and may have come mainly from the north. The greatest rate of thickening within the Atoka in the Knoxville quadrangle is in the approximate middle of the formation, as it is in the Delaware quadrangle to the south (Merewether and Haley, 1961, p. 7).

The Atoka Formation in the Arkansas Valley was deposited on the northern flank of a rapidly subsiding partially marine basin (Hendricks, 1937; Hendricks and Parks, 1950). The rocks younger than zone s, in the Atoka Formation of the Knoxville quadrangle, were probably deposited in environments ranging from near-shore shallow-water marine to near-shore continental. The close stratigraphic and geographic association of marine invertebrate fossils, plant fossils, coal beds, ripple-marked siltstone and sandstone beds, and irregularly bedded sandstone channel deposits at some places containing lenses of conglomerate, supports the belief that the environments of deposition were transitional, consisting of near-shore marine and continental types.

DES MOINES SERIES

Krebs Group

The Krebs Group, comprised of the Hartshorne Sandstone and the McAlester, Savanna, and Boggy Formations, was named by Oakes (1953) from localities in northeastern Oklahoma. Only the Hartshorne Sandstone and the lower part of the McAlester Formation crop out in the Knoxville quadrangle.

Hartshorne Sandstone. — The Hartshorne Sandstone in this quadrangle is continuous with the Hartshorne Sandstone of the Delaware quadrangle (Merewether and Haley, 1961, pl. 2) and equivalent to the Hartshorne Sandstone of Hendricks and Parks (1950, p. 73) and Haley (1961, p. 7). In the Knoxville quadrangle, as throughout the Arkansas coal basin, the Hartshorne Sandstone is the first continuous sandstone underlying the Lower Hartshorne coal bed.

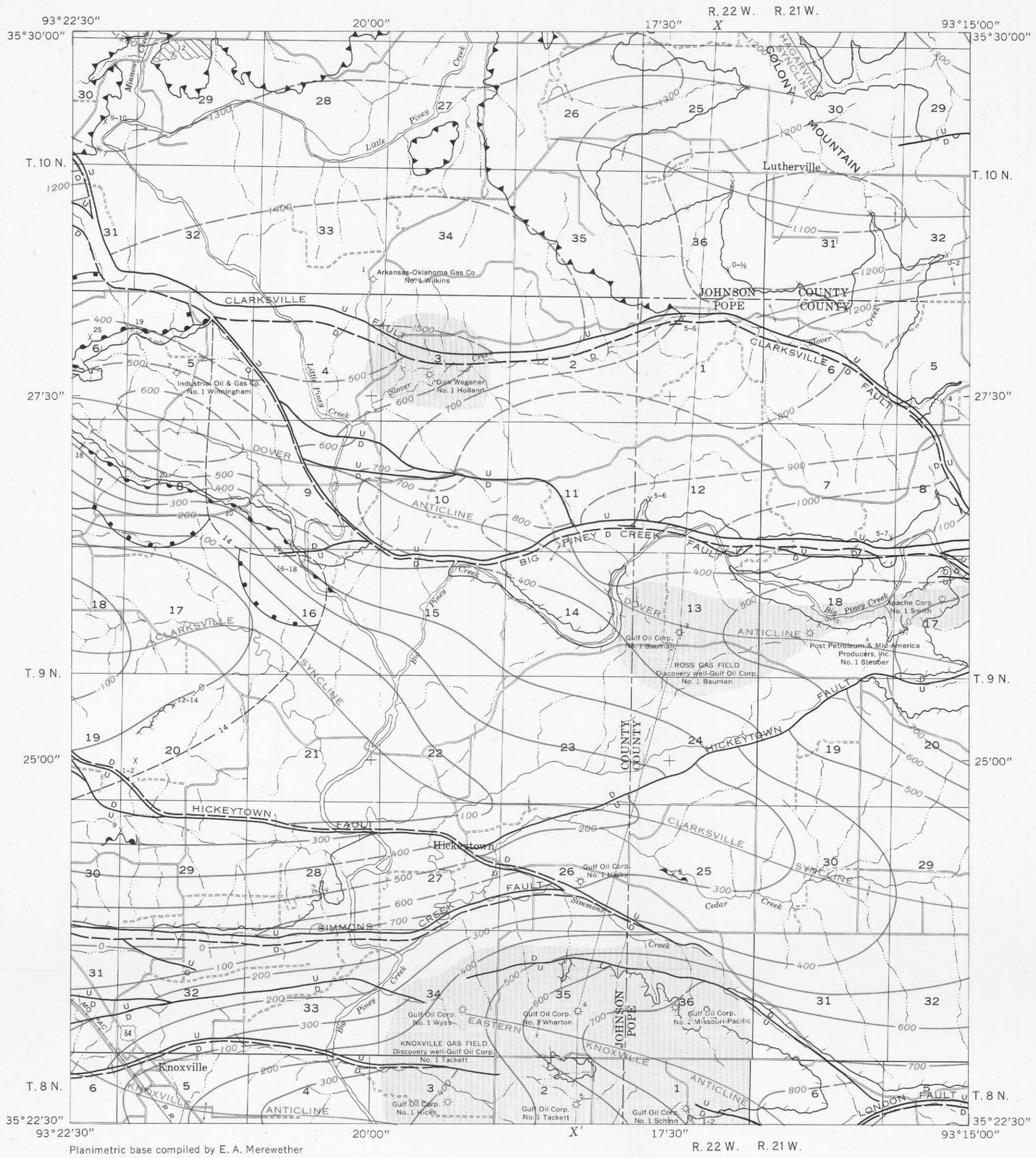
The contact between the Atoka Formation and the overlying Hartshorne Sandstone in the Knoxville quadrangle is probably a disconformity, although the formations may be slightly discordant. The contact is sharp where exposed and commonly outlines channels. A lens of conglomerate, as much as 27 inches thick and about ¼ mile long, occurs on and slightly above the Atoka-Hartshorne contact at the base of a cliff on the west side of Big Piney Creek in sec. 28, T. 9 N., R. 22 W. Other lenses of conglomerate, much smaller in extent, were observed elsewhere in the quadrangle. Within the lower few feet of the Hartshorne Sandstone in sec. 17, T. 9 N., R. 21 W., a thin bed of conglomerate overlies a zone containing parts of fossil trees. Small lenses and stringers of coal, a few inches thick and a few feet long, are also within the lowermost part of the Hartshorne Sandstone in a few places.

The structure contour lines shown on plate 3 are drawn on the base of the Hartshorne Sandstone.

The lithology of the Hartshorne Sandstone varies locally in the quadrangle but has no apparent regional trend. The Hartshorne consists of silty very fine grained sandstone, very fine to fine-grained sandstone with scattered medium sand grains, or fine- to coarse-grained sandstone with scattered very fine and very coarse sand grains. The sandstone beds are commonly light gray, but range from very light gray to medium gray. The formation is generally sandstone but can be mainly siltstone, and includes shale and minor amounts of conglomerate and coal. (See pl. 2.) Medium- to dark-gray silty shale occurs as thin interbeds in many sandstone or siltstone units.

The Hartshorne Sandstone in the Knoxville quadrangle ranges in thickness from about 90 feet to about 200 feet. Beds within the Hartshorne are thin bedded to massive, irregularly to regularly bedded, and often crossbedded, ripple marked, or foreset bedded.

Casts of the woody parts of trees are common in the Hartshorne Sandstone. Sigillaria is one



Planimetric base compiled by E. A. Merewether from aerial photographs

STRUCTURE CONTOUR, COAL BED, AND GAS FIELD MAP OF KNOXVILLE QUADRANGLE, JOHNSON AND POPE COUNTIES, ARKANSAS

By
E. A. Merewether
U.S. Geological Survey

1963

QUADRANGLE LOCATION

SCALE 1:48000

1 ½ 0 1 2 3 MILES
3000 0 3000 6000 9000 12000 15000 FEET
1 5 0 1 2 3 KILOMETERS

EXPLANATION

500 — — —
400 — — —
300 — — —

Structure contours drawn on the contact between the Atoka Formation and the Hartshorne Sandstone

Dashed where projected above surface; contour interval 100 feet; datum is mean sea level

U
D

Fault

Dashed where located on downthrown block.
U, *upthrown side;* D, *downthrown side*

Surface trace of the contoured horizon, the contact between the Atoka Formation and the Hartshorne Sandstone

Contact projected to the surface in areas where concealed by alluvial deposits

Syncline

Anticline

X ——— X′

Line of structural section shown on plate 4

COAL BEDS

Some coal bed outcrops terminated at surface trace of fault plane

Unnamed coal bed in the McAlester Formation

Hartshorne coal bed

Unnamed coal bed in the Atoka Formation

Unnamed coal bed in the Atoka Formation

X 10

Exposure of coal

Number indicates thickness of coal in inches

Mined area

14

Hartshorne coal thickness line

Number indicates thickness of coal in inches

Boundary between measured and indicated reserves and inferred reserves of coal

Square on side of area of measured and indicated reserves of coal

WELL SYMBOLS

Company name and lease name shown. Number designates stratigraphic section shown on plate 2 and described in appendix

☼ 3

Producing gas well

☼

Well with show of gas

☼ 1

Well with no show of gas

Gas field

Name of field and name of discovery well shown

Section lines, township lines, and county lines are indicated for general orientation and identification but are not authenticated for legal purposes

of the most abundant of the recognizable tree fossils and was observed in the NW¼NE¼ sec. 7, T. 9 N., R. 22 W. Pieces of tree fossils are in the lower part of the Hartshorne in the NW¼ sec. 17, T. 9 N., R. 21 W.

The Hartshorne Sandstone is a widespread and distinctive unit in northwestern Arkansas (Haley, 1961, p. 7). In general, it is lighter colored, coarser grained, less silty or clayey, and more massive than most sandstone units in the Atoka or McAlester Formations. In some areas, however, units in the Atoka and McAlester Formations have many of the typical Hartshorne characteristics. Identification of the Hartshorne is best accomplished by mapping the unit from an area where terminology has been established.

McAlester Formation.—The McAlester Formation in the Knoxville quadrangle is stratigraphically equivalent to the McAlester Shale in the Fort Smith district (Hendricks and Parks, 1950, p. 74), and to the McAlester Formation of the Delaware quadrangle (Merewether and Haley, 1961, p. 9), and Paris quadrangle (Haley, 1961, p. 7). The McAlester Formation conformably overlies the Hartshorne Sandstone and, in areas near the Knoxville quadrangle, is uncomfortably overlain by the Savanna Formation. The McAlester is the youngest Pennsylvanian formation in the Knoxville quadrangle. The part of the McAlester Formation present in the Knoxville quadrangle is approximately 570 feet thick.

The McAlester Formation in the area of this report consists of sandstone, siltstone, shale, and coal. (See pl. 2.) The sandstone beds are light to medium gray, very fine to fine grained, quartzose to very silty, porous to well cemented, and some contain fossil plant fragments and zones of shale pebbles. The sandstones are generally thin bedded, are regularly to irregularly bedded, and some are crossbedded, foreset bedded, or ripple marked. Sediment flow features occur in a few places.

Siltstone in the McAlester is medium gray to to dark gray, commonly argillaceous, very finely sandy in some places, irregularly bedded, and thin bedded.

The shale of the McAlester Formation is medium gray to grayish black, silty in places, and commonly contains ironstone concretions or plant fossils. Sediment flow features occur at a few localities.

At least two coal beds, including the Lower Hartshorne coal, are in the McAlester in the area of this report.

The writer did not find invertebrate fossils in rocks of the McAlester Formation in the Knoxville quadrangle. George H. Girty (Collier, 1907, p. 32) listed a gastropod, **Euomphalus catilloides?**, collected from shale, probably of the lower part of the McAlester Formation, near the junction of Big Piney and Little Piney Creeks. The roots, trunks, leaves, or smaller fragments of fossil plants are common in rocks of the McAlester Formation. The shale above the Lower Hartshorne coal bed contains well-preserved fossil leaves at several localities in the Knoxville quadrangle. The fossil ferns listed by David White (Collier, 1907, p. 31) were probably collected from the lower part of the McAlester Formation. The dark-gray shale overlying the Lower Hartshorne coal bed in the NE ¼ sec. 7, T. 9 N., R. 22 W. contains abundant plant fossils, including the leaves of sigillaria, lepidodendron, and the ferns pecopteris, neuropteris, and alethopteris. Macerated or coalified plant fragments are a common constituent of rocks of the McAlester Formation in the area of this report.

One of the thicker sandstone units in the McAlester is well exposed along a cliff on the west side of Big Piney Creek in secs. 21 and 28, T. 9 N., R. 22 W. Many characteristics of this sandstone are common to those of the Hartshorne Sandstone and a thick sandstone in the upper part of the Atoka Formation (zone c). This McAlester sandstone is light to medium gray, very fine to fine grained, silty, and in places has numerous irregularly shaped small lenses of shale imbedded, parallel to bedding planes in the sandstone, in the lower part of the unit. The sandstone is irregularly bedded, crossbedded, foreset bedded, and has a sharp lower contact with shale. The lower contact is irregular with many small well-developed channels. At one place a lens of coal 2 inches thick and 3 feet long occurs on the contact. The lower surface of the sandstone at the contact has well-developed current flow casts, including flute casts and groove casts.

QUATERNARY SYSTEM

Terrace Deposits

Deposits of unconsolidated alluvial material are on several terrace levels and along the larger streams in the Knoxville quadrangle. The terrace material was probably deposited by streams flowing southward from the Ozark uplift to the Arkansas River. Several contributing factors prevent the positive recognition of all terrace levels. The contacts between the terrace deposits and the underlying rock are rarely exposed. The

terrace deposits commonly rest upon sloping erosional surfaces. It is not possible to ascertain which, if any, of the nearby streams deposited the terrace material.

As many as five terrace levels may be present. The lowest is from 10 to 20 feet above the adjacent alluvium of Recent age and is well developed at the junction of Slover and Little Piney Creeks. The next older is from 30 to 40 feet above the alluvium of Recent age and may be observed in the vicinity of Hickeytown. The third terrace level is from 80 to 90 feet above the flood plain of Recent age and is represented by the tops of the buttes in the SE¼ sec. 23, T. 9 N., R. 22 W. The fourth is about 200 feet above the flood plain and is well developed on both sides of Big Piney Creek in sec. 14, T. 9 N., R. 22 W. The oldest terrace level is about 280 feet above alluvium of Recent age and is present in the NE¼ sec. 32, T. 10 N., R. 22 W.

The terrace deposits consist of clay, silt, sand, and pebbles and cobbles of siltstone and sandstone. Recognition of the older terrace deposits is based on the presence of pebbles and cobbles and on the height of a deposit above the nearest major stream. The terrace deposits are not differentiated on plate 1.

Some of the terrace deposits in the Knoxville quadrangle are probably equivalent to terrace deposits in the Fort Smith district (Hendricks and Parks, 1950, p. 78) that were correlated with the Gerty Sand of Oklahoma. The Gerty Sand was deposited during the Pleistocene (Miser, 1954). The terrace deposits of the upper two or three terrace levels in the area of this report may be older than any described by Hendricks and Parks in the Fort Smith district.

Alluvium

The alluvium deposited by the rivers and creeks in the Knoxville quadrangle is comprised of clay, silt, sand, granules, and pebbles and cobbles of siltstone and sandstone. The flood plain, the surface of the alluvium, slopes gently toward the stream channel.

STRUCTURE

The Knoxville quadrangle is approximately in the north-central part of the Arkansas Valley section of the Ouachita province (fig. 1). The structure of the rocks in and near the quadrangle consists of a series of east-west-trending gently sloping folds and east-west-trending normal faults.

Folds

The three major anticlines in the area of this report are the Knoxville anticline and Eastern Knoxville anticline in the southern part of the quadrangle and the Dover anticline in the central part of the quadrangle. The anticlines are generally symmetrical. The axes of the Knoxville and Eastern Knoxville anticlines in this quadrangle are separate, in contrast to the axis shown by Croneis (1930, pl. 1-A) in this part of the Arkansas Valley. The axes shown on plates 1 and 3 of this report represent details in the configuration of a single large anticline, consequently it seems inadvisable to name each segment of the Knoxville anticline. However, one segment is here renamed the "Eastern Knoxville anticline."

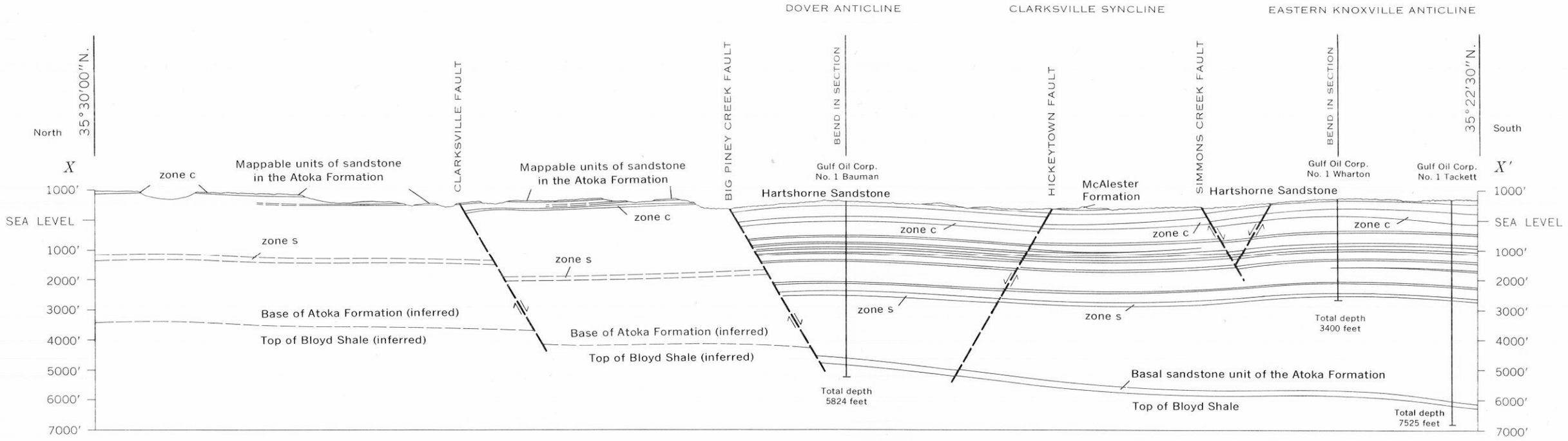
The two major synclines in the quadrangle are the Clarksville syncline and the Hagarville syncline. The axis of the Clarksville syncline crosses the lower half of the quadrangle, between the Knoxville and Dover anticlines, in an irregularly curved line. The north limb of the Clarksville syncline is steeper than the south limb in the western part of the quadrangle, whereas the south limb is the steeper limb in the eastern part of the quadrangle. The axis of the Hagarville syncline extends into the northeastern corner of the quadrangle from the northwest.

The attitudes of the rocks in the quadrangle are affected by the regional thickening of the Atoka Formation. The amount of dip increases with depth in south-dipping beds and decreases with depth in north-dipping beds. The cross section on plate 3 of this report illustrates the writer's interpretation of the structure at depth in the Knoxville quadrangle.

Faults

The faults in the Knoxville quadrangle are normal and the surface traces of the faults, illustrated on plate 1, are irregularly curved lines trending generally east-west. Most of the fault planes dip south and the upthrown side of these faults is the north side. The net result of all the faulting in the quadrangle is the uplift of rocks, approximately 900 to 1,000 feet, in the northernmost part of the quadrangle relative to correlative rocks in the southern part.

Fault planes are not exposed in the Knoxville quadrangle. The surface trace of a fault plane is usually located by the discontinuity of recognizable rock units, by anomalous dips, by anomalous topographic features, or by a combination of these features. The dips of fault planes observed



STRUCTURAL SECTION IN KNOXVILLE QUADRANGLE, JOHNSON AND POPE COUNTIES, ARKANSAS

(Quaternary deposits not shown)

By

E. A. Merewether

U.S. Geological Survey

1963

1 ½ 0 1

DATUM IS MEAN SEA LEVEL

near the quadrangle range from 45° to 80° but are generally from 55° to 60°. The author has arbitrarily assigned a dip of 60° to fault planes within the quadrangle.

The London fault, near the southeastern corner of the quadrangle, is a south-dipping fault with the downthrown block on the south side. The fault plane is not exposed in the area of this report but has been described by Merewether and Haley (1961, p. 10) from exposures in the Delaware quadrangle to the south. Displacement along the eastern part of the London fault is probably about 150 feet.

In the southeastern part of the Knoxville quadrangle (secs. 34, 35, and 36, T. 9 N., R. 22 W.; sec. 31, T. 9 N., R. 21 W.; secs. 5 and 6, T. 8 N., R. 21 W.), the surface trace of an unnamed fault branches from the London fault and trends approximately northwest, paralleling the axis of the Eastern Knoxville anticline in that area. The fault plane of this unnamed fault probably dips north and the downthrown side of the fault is on the north. The fault plane is not exposed, though it can be located in places within a north-south distance of about 50 feet. The maximum displacement along this fault is estimated to be about 120 feet, near the middle of the fault's surface trace.

Three south-dipping normal faults occur on the north flank of the Knoxville anticline in the southwestern part of the quadrangle. The surface traces of the three faults trend approximately east-west and extend from west of the quadrangle through about the western half of the quadrangle (secs. 26, 27, 30, 31, 32, 33, and 34, T. 9 N., R. 22 W., and secs. 2, 3, 4, 5, and 6, T. 8 N., R. 22 W.). The middle fault of the three probably bifurcates near the western boundary of the quadrangle (secs. 31 and 32, T. 9 N., R. 22 W.). The downthrown sides of the faults are on the south side of the fault planes. The fault plane of the southernmost of the three is not exposed, though it can be located along Big Piney Creek in the SE¼ sec. 33, T. 9 N., R. 22 W. within a north-south distance of about 100 feet. The maximum displacement within the quadrangle along the southernmost of these three faults is probably about 230 feet. The fault plane of the middle fault of the three is not exposed but can be inferred, within a north-south distance of about 200 feet, to cross Big Piney Creek in the NE¼ sec. 33, T. 9 N., R. 22 W. The maximum displacement along the middle fault in the quadrangle is probably about 100 feet. The northernmost fault of the three, the Simmons Creek fault, lies along an east-flowing tributary of Big Piney Creek in the NE¼ sec. 32, T. 9 N., R. 22 W. At this locality the fault plane probably lies within 100 feet of its mapped position. The maximum displacement along the Simmons Creek fault in the quadrangle is approximately 625 feet.

The Hickeytown fault crosses the southern part of the Knoxville quadrangle, apparently branching near the Simmons Creek fault. The fault plane is not exposed but can be located within a north-south distance of about 50 feet on the bluff west of Big Piney Creek (N½ sec. 28, T. 9 N., R. 22 W.) The Hickeytown fault is probably a normal fault with the downthrown side on the north. The maximum displacement along the fault is probably in sec. 27, T. 9 N., R. 22 W. east of Big Piney Creek and may be as much as 250 feet. In the middle of the quadrangle along the fault (secs. 24 and 26, T. 9 N., R. 22 W.) the displacement is probably less than 40 feet. Displacement along the fault increases from the middle of the quadrangle eastward and may be as much as 140 feet at the eastern boundary of the quadrangle (secs. 17 and 20, T. 9 N., R. 21 W.)

The Big Piney Creek fault trends west from the middle of the eastern boundary of the quadrangle (S½ sec. 8, T. 9 N., R. 21 W.), splits into three faults near the center of the quadrangle (secs. 10 and 11, T. 9 N., R. 22 W.), rejoins 2½ miles northwest of the quadrangle center (secs. 4 and 9, T. 9 N., R. 22 W.), and combines with the Clarksville fault in the northwestern part of the quadrangle (sec. 5, T. 9 N., R. 22 W.). The fault plane is not exposed but can be located within a north-south distance of about 50 feet at several places along Big Piney Creek and east of Little Piney Creek. The Big Piney Creek fault is a south-dipping normal fault with the downthrown block on the south side. The displacement along the fault decreases from about 650 feet at the eastern boundary of the quadrangle (sec. 8, T. 9 N., R. 21 W.) to about 100 feet near its western end (sec. 5, T. 9 N., R. 22 W.).

The Clarksville fault is an east-west trending normal fault that crosses the northern part of the quadrangle. The fault plane probably dips south; the downthrown block is on the south side. The Clarksville fault joins the Big Piney Creek a short distance east of the quadrangle, unites with the western end of the Big Piney Creek fault in the northwestern part of the quadrangle (sec. 5, T. 9 N., R. 22 W.), and bifurcates near the western boundary of the quadrangle (sec. 31, T. 10 N., R. 22 W.). The fault plane is not exposed but can be located within a north-south distance of about 50 feet at a few places. Displacement along the fault ranges from about 1,100 feet,

near the western boundary of the quadrangle (sec. 31, T. 10 N., R. 22 W.), to about 50 feet near the eastern boundary of the quadrangle (sec. 8, T. 9 N., R. 21 W.). The amount of displacement along the fault decreases toward the east.

The western end of an unnamed east-west trending fault is in sec. 29, T. 10 N., R. 21 W., near the northeastern corner of the quadrangle. The fault plane of this normal fault dips south and the downthrown block is on the south side. The fault plane is not exposed but can be located within a north-south distance of about 10 feet at one locality. The maximum displacement along this fault in the Knovxille quadrangle is estimated to be less than 75 feet.

GEOMORPHOLOGY

The topography of the Knoxville quadrangle has been formed by the erosion of folded and faulted sedimentary rocks. The land forms related to anticlines are as follows: anticlinal ridge (the Knoxville anticline in secs. 34 and 35, T. 9 N., R. 22 W., and secs. 3 and 2, T. 8 N., R. 22 W.), complicated by normal faulting at the eastern end; breached anticline (the inlier of shale surrounded by sandstone in NE¼ sec. 2, T. 8 N., R. 22 W.), in an early stage of development; anticlinal valley (along the axis of the Dover anticline in secs. 5, 6, 7, and 8, T. 9 N., R. 22 W.). Cuestas are common in the Knoxville quadrangle. The Hartshorne and McAlester sandstones on the north flank of the Dover anticline, in secs. 5 and 6, T. 9 N., R. 22 W., cap small well-developed cuestas. The land forms related to synclines are as follows: mesa (sec. 25, T. 9 N., R. 22 W., and sec. 30, T. 9 N., R. 21 W.); butte (SW¼ sec. 23, T. 9 N., R. 22 W.); synclinal valley (the drainage basin of Cedar Creek in the Clarksville syncline in the southeastern part of the quadrangle). The anticlinal ridges and synclinal valley, as in the Delaware quadrangle to the south (Merewether and Haley, 1961, p. 3), are probably resequent (land forms similar in shape to those originating from the erosion of an initial surface but carved out during a later period of erosion) and result, at least in part, from the unusual resistance to erosion of the Hartshorne Sandstone. Land forms have also resulted from the normal faulting in the Knoxville quadrangle. Fault-line scarps, usually resequent, are common and good examples are in the S½ sec. 33, T. 9 N., R. 22 W. and north of Big Piney Creek in sec. 18, T. 9 N., R. 21 W. Fault-line valleys are also a common feature, the valley of Slover Creek in the northern part of the quadrangle is a good example.

The drainage pattern in most of the Knoxville quadrangle is dendritic. The drainage on the flanks of the faulted anticlines and synclines at some places has a poorly developed trellis pattern and that on the Knoxville anticline in the south-central part of the quadrangle has a radial pattern. Big Piney Creek and Little Piney Creek, the largest streams in the quadrangle, are probably superposed. Both creeks have formed entrenched meanders, in resistant sandstone units, and cross the structural trend of the area. The position of Big Piney Creek in secs. 12, 13, 14, and 15, T. 9 N., R. 22 W., and secs. 8, 17, and 18, T. 9 N., R. 21 W., however, was primarily controlled by the location of the fractured rocks along the Big Piney Creek fault. Most of the other major creeks in the area of this report are subsequent streams and flow along fault traces or on units of less resistant rocks. Resequent and obsequent streams are also present in the quadrangle.

ECONOMIC GEOLOGY

Coal

Coal beds are in the Atoka and McAlester Formations in the Knoxville quadrangle. A coal bed in the Atoka Formation has been mined near Minnow Creek, in the northwestern part of the quadrangle. The Lower Hartshorne coal bed of the McAlester Formation has been mined near the western boundary of the quadrangle on the Dover anticline and is the only coal bed in the area of this report of sufficient thickness (14 inches or more) to warrant an estimate of reserves. The location and thickness of all exposed coal beds are shown on plates 1 and 3.

The coal in the northeastern part of the quadrangle is of low-volatile bituminous rank and the coal in the remainder of the quadrangle is semianthracite. The coal in the Knoxville quadrangle has not been sampled and analyzed for rank determination. The rank of the coal in the area of this report was determined by Haley (1960, pl. 62) in a study of the Arkansas Valley coal field. Haley assumed the coal to be bituminous and semianthracite on the basis of the percentage of dry, mineral-matter-free fixed carbon in coal samples from coal beds near the Knoxville quadrangle.

Coal beds in the Atoka Formation

The upper part of the Atoka Formation in the Knoxville quadrangle contains six coal beds. Most of these are thin and of small extent.

The oldest coal bed in the Atoka Formation is not exposed at the surface in the Knoxville quadrangle but was penetrated by the Winningham

well in sec. 5, T. 9 N., R. 22 W., at a depth of 1,640 feet, about 1,690 feet beneath the base of the Hartshorne Sandstone. A younger coal bed has been found in most of the wells on the Knoxville anticline and may be present in the Bauman well. This coal was penetrated in the Tackett well at a depth of 1,320 feet, 1,180 feet below the Hartshorne Sandstone. A third coal bed was penetrated by the Hicks well in sec. 3, T. 8 N., R. 22 W. at a depth of 1,065 feet, 921 feet beneath the lower boundary of the Hartshorne. The oldest exposed coal of Atoka age in the area of this report crops out north of the Clarksville fault and was penetrated by the Bauman well at a depth of 937 feet, 781 feet below the Hartshorne. This coal bed ranges in thickness from 5 to 12 inches and has been mined by stripping in the NW¼ sec. 29, T. 10 N., R. 22 W. A widespread coaly zone, previously described in this report, is well exposed at the base of the thick sandstone (zone c) capping Colony Mountain. This coal ranges in thickness from 0 to 7 inches and has been penetrated by the Bauman well at a depth of 584 feet, 428 feet beneath the Hartshorne, and the Higby well at a depth of 636 feet. The youngest coaly zone in the Atoka in this quadrangle consists of stringers and lenses of coal as much as 8 inches in thickness. This zone, previously described by Merewether and Haley (1961, p. 11), is about 20 feet below the base of the Hartshorne Sandstone in the NW¼SE¼ sec. 1, T. 8 N., R. 22 W.

Coal beds in the McAlester Formation

The McAlester Formation in the Knoxville quadrangle contains two coal beds: the Lower Hartshorne coal, and a younger unnamed coal. Thin lenses of coal occur sporadically in the McAlester Formation.

The Lower Hartshorne coal bed is in three areas within the Knoxville quadrangle and is stratigraphically less than 15 feet above the Hartshorne Sandstone. The coal is about 5 inches thick along Cedar Creek in sec. 25, T. 9 N., R. 22 W. and is 9 inches thick in a creek bed in sec. 29, T. 9 N., R. 22 W. The Lower Hartshorne coal bed, ranging in thickness from 10 to 25 inches, is exposed along the flanks of the Dover anticline in the northwestern part of the quadrangle (secs. 5, 6, 7, 8, 9, and 16, T. 9 N., R. 22 W.).

The Lower Hartshorne coal bed is more than 14 inches thick within an area of 2,516 acres in the west-central part of the quadrangle. The overburden ranges in thickness from a featheredge to about 630 feet. Within the area enclosed by the 14-inch coal thickness line (pl. 3) in the west-central part of the quadrangle, the Lower Hartshorne coal bed contains an estimated 900,000 short tons of measured reserves, 1,400,000 short tons of indicated reserves, and 5,700,000 short tons of inferred reserves. The small amount of coal mined in this area during past years does not reduce these reserve estimates significantly.

An unnamed coal bed of the McAlester Formation, younger than the Lower Hartshorne coal, crops out in sec. 20, T. 9 N., R. 22 W. This coal is not well exposed but is reported to have a thickness of 12 to 14 inches.

Oil and gas

Crude oil has not been found in or near the Knoxville quadrangle, but the rocks with the most potential are pre-Pennsylvanian in age and have not been adequately tested. However, a relation between the degree of metamorphism in a coal and the possibility of the occurrence of petroleum in associated beds, was described by C. D. White (1915). Oil in commercial quantities has not been found in regions containing coal of low-volatile bituminous or semianthracite rank. The rank of the coal in the Knoxville quadrangle indicates that oil will not be found in this area.

Most of the natural gas in the Arkansas Valley and all the natural gas in the Knoxville quadrangle is found in rocks of Pennsylvanian age. Rocks of Pennsylvanian age have been the primary target of those drilling for oil and gas in the area of this report.

Commercial quantities of natural gas have been found in the Knoxville and Dover anticlines in the Knoxville quadrangle. Gas is produced from a widespread sandstone (zone s on pl. 4) in the middle of the Atoka Formation at the Knoxville gas field. Wells of the Ross gas field on the Dover anticline produce gas from a sandstone in the lower part of the Atoka. The Dick Wegener No. 1 Lena Holland well (NE¼SW¼ sec. 3, T. 9 N., R. 22 W.) was drilled through the south-dipping Clarksville fault on the north flank of the Dover anticline and produces gas from the lower part of the Atoka. The location of commercial deposits of gas in the area of this report apaprently results primarily from the structure and secondarily from the permeability and porosity of sandstone units.

The Gulf Oil Corp. drilled seven wells on the Knoxville anticline in the quadrangle and six of these produce commercial quantities of gas. The capacities of the producing wells are reported to range from 1.25 million cubic feet per day to 8 million cubic feet per day, averaging 4.29 million cubic feet per day. The base of the gas-producing

sandstone of the Knoxville field (zone s) lies 3,100 to 3,240 feet below the top of the Atoka Formation.

The Ross field on the Dover anticline includes three commercial gas wells. The discovery well, Gulf Oil Corp. No. 1 Bauman, is reported to have a producing capacity of 5 million cubic feet per day. The Post Petroleum and Mid-America Producers, Inc. No. 1 Steuber well (sec. 18, T. 9 N., R. 21 W.) is reported to have a producing capacity of 4 million cubic feet per day. The Apache Corp. No. 1 Smith well (sec. 17, T. 9 N., R. 21 W.) is reported to have a producing capacity of 4.7 million cubic feet per day. The gas-producing sandstone of the Ross field is about 4,380 feet below the top of the Atoka in the Bauman well.

The Dick Wegener No. 1 Lena Holland well is reported to have a producing capacity of about 43 million cubic feet of gas per day. The three gas-bearing units are reported to be at depths of 2,875, 2,982, and 3,020 feet and are probably in the lower part of the Atoka Formation.

The larger anticlines in the Knoxville quadrangle have been explored rather extensively for gas. It is possible that future drilling in the area of this report will reveal accumulations of gas in porous beds sealed by faults.

Building stone

Sandstone suitable for use as building stone may be in the Atoka, Hartshorne, or McAlester Formations. A sandstone in the upper part of the Atoka Formation has been quarried on a hilltop in the NE¼ sec. 11, T. 9 N., R. 22 W. A small quarry in a sandstone of the McAlester Formation is on a hilltop in the SW¼ sec. 20, T. 9 N., R. 22 W. An older McAlester sandstone has been quarried in the NE¼ sec. 30, T. 9 N., R. 22 W.

The Hartshorne Sandstone is the most common source of building stone in the Arkansas Valley, though it has not been quarried in the Knoxville quadrangle. Many quarries in the Hartshorne are located on the Prairie View, London, and Knoxville anticlines, in the adjoining Delaware quadrangle to the south. The abundance of quarries in the Delaware quadrangle and the proximity of many of these to the Hartshorne Sandstone exposed on the Knoxville anticline in the Knoxville quadrangle, indicates that building stone may be found on the Knoxville anticline in the area of this report. The Hartshorne Sandstone exposed along the Dover anticline is generally massive or irregularly bedded, and is probably inadequate for use as flagstone or building stone.

Road metal

Road metal in the Arkansas Valley may be crushed sandstone or siltstone, shale, or stream or terrace gravel. Most of the sandstones in the Knoxville quadrangle could be crushed for use as road metal. The dark-gray shales of the Atoka and McAlester Formations are sometimes used to surface dirt roads and shale has been removed from a roadcut in the NW¼SE¼ sec. 27, T. 9 N., R. 22 W., for this purpose. Alluvium and terrace deposits containing gravel are common in the Knoxville quadrangle, and gravel has been removed from a terrace in the SE¼NE¼ sec. 22, T. 9 N., R. 22 W.

Gravel, sand, and clay

The alluvium and terrace deposits of the Knoxville quadrangle contain large amounts of sand and gravel. Deposits of clay suitable for use in making brick or tile may be in the alluvium and terrace deposits along Big Piney Creek, Little Piney Creek, or Minnow Creek. In other places in the Arkansas Valley, clay is obtained from weathered shale units that underlie terrace deposits or permeable sandstones. The shale units covered by terrace deposits in the Knoxville quadrangle may also be of commercial interest, though none have been considered sufficiently attractive to date to warrant development.

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APPENDIX

The stratigraphic sections described below are represented graphically on plate 2 and located geographically on plate 1. The surface stratigraphic sections are designated on plates 1 and 2 by letters, and the subsurface stratigraphic sections are noted on the two plates by numbers.

The description of the lithology in the surface sections resulted from field studies. The description of the lithology in the subsurface sections was obtained by the concurrent examination of drill cuttings under a binocular microscope and a study of the electrical logs from each well.

The colors included in the lithologic descriptions correspond to colors of the Rock Color Chart issued by the National Research Council (Goddard, 1948). The grain sizes of rocks in these sections were classified according to the Wentworth (1922) grade scale. The lithologic descriptions of the rocks in each of the following stratigraphic sections are listed so that the youngest rock unit is described first and the oldest rock unit is last.

SURFACE STRATIGRAPHIC SECTIONS

Section A

Lutherville road section

Sec. 4, T. 9 N., R. 22 W. Sec. 33, T. 10 N., R. 22 W., Johnson County, Ark. Upper part of Atoka Formation.

Thickness in feet	Interval in feet	Description
		Pennsylvanian System **Upper part of Atoka Formation**
6.0	0- 6.0	Shale, very light gray, weathered.
7.8	6.0- 13.8	Sandstone, light-gray, very fine to fine-grained, well-cemented, irregularly bedded, ripple-marked, beds 1-6 in. thick.
3.2	13.8- 17.0	Shale, grayish-black, beds as much as ⅛ in. thick in units as much as 2 in. thick; and sandstone, light- to medium-gray, fine-grained, irregularly bedded, beds ½-6 in. thick; unit approximately 60 percent sandstone.
12.6	17.0- 29.6	Sandstone, light- to medium-gray, very fine to fine-grained, well-cemented, shale pebbles as much as ¼ in. in diameter, pebbles more abundant toward top of unit, irregularly bedded, ripple-marked, crossbedded, beds 1-10 in. thick.
4.0	29.6- 33.6	Sandstone, light- to medium-gray, fine- to medium-grained, silty, finely to medium micaceous, sandstone pebbles as much as 2 in. in diameter, shale pebbles as much as ½ in. in diameter, shale pebbles in upper 6 in., irregularly bedded, beds 1-20 in. thick.
4.3	33.6- 37.9	Sandstone, light-gray, fine-grained, abundant coalified plant fragments, one bed, overlies shale with a sharp contact.
0.8	37.9- 38.7	Shale, black, beds as much as ⅛ in. thick.
5.0	38.7- 43.7	Shale, dark-gray, beds as much as ⅛ in. thick, units as much as 10 in. thick; and sandstone, medium-gray, very fine grained, very silty, finely micaceous, irregularly bedded, beds as much as ½ in. thick; unit is 80 percent shale at base and 30 percent shale at top.
4.0	43.7- 47.7	Shale, dark-gray to grayish-black, beds as much as ¼ in. thick.
0.6	47.7- 48.3	Sandstone, brownish-black, fine- to medium-grained, may have been limy, ferruginous, weathered.
1.6	48.3- 49.9	Shale, dark-gray, slightly silty, beds 1/16-⅛ in. thick.
6.2	49.9- 56.1	Sandstone, medium- to dark-gray, very fine to fine-grained, abundant fine grains of chert, well-cemented, abundant borings on bottoms of beds, irregularly bedded, ripple-marked, beds ½-8 in. thick.
46.0	56.1-102.1	Shale, dark-gray, beds 1/16-¼ in. thick.
5.0	102.1-107.1	Shale, dark-gray; and sandstone, as below; uppermost 10 in. of unit is sandstone.
2.6	107.1-109.7	Sandstone, medium-gray, very fine to fine-grained, silty, finely micaceous, pebbles of black shale with dimensions of approximately ⅛ in. by 1 in. by 1 in., irregularly bedded, ripple-marked.
4.0	109.7-113.7	Shale, dark-gray, beds 1/16-¼ in. thick, units 8 in. thick; and sandstone, medium-gray, very fine grained, very silty, beds as much as 2 in. thick, units as much as 10 in. thick, irregularly bedded, ripple-marked; unit is probably 50 percent shale.

Thickness in feet	Interval in feet	Description
		Upper part of Atoka Formation
5.8	113.7-119.5	Shale, dark-gray, beds ⅛-¼ in. thick.
2.2	119.5-121.7	Sandstone, medium-gray, medium-grained, scattered coarse sand grains, probably was limy, crinoid fragments, regularly bedded, beds ¼-8 in. thick, weathered.
1.5	121.7-123.2	Sandstone, medium- to dark-gray, very fine grained, very silty, irregularly bedded, beds ¼-1 in. thick.
20.0	123.2-143.2	Shale, dark-gray, beds 1/16-¼ in. thick, weathered.

Section B
Slover Creek section (west)

Sec. 35, T. 10 N., R. 22 W., Johnson County, Ark. Upper part of Atoka Formation.

Thickness in feet	Interval in feet	Description
		Pennsylvanian System
		Upper part of Atoka Formation
12.0	0- 12.0	Sandstone, light-gray, fine-grained, scattered rounded medium sand grains, finely micaceous, shale pebbles as much as ¼ in. thick in the upper part of the unit, beds as much as 6 in. thick.
63.2	12.0- 75.2	Covered interval.
17.2	75.2- 92.4	Covered interval, probably sandstone as below.
14.5	92.4-106.9	Sandstone, light-gray, fine-grained, well-cemented, abundant fine grains of chert, irregularly bedded, beds 6-10 in. thick.
11.5	106.9-118.4	Covered interval.
4.0	118.4-122.4	Sandstone, medium-gray, fine-grained, finely micaceous, irregularly bedded, ripple-marked, beds 2-6 in. thick.
13.5	122.4-135.9	Covered interval.
20.2	135.9-156.1	Sandstone, medium-gray, very fine grained, very silty, finely micaceous, irregularly bedded, beds as much as 4 in. thick; and shale, dark-gray, silty, finely micaceous, in units 1/16-2 in. thick; unit is probably 40 percent sandstone, sandstone beds are thickest at the top of the unit and comprise about 80 percent of the upper part of the unit.
17.2	156.1-173.3	Covered interval, probably dark-gray shale.
4.0	173.3-177.3	Shale, dark-gray to grayish-black, beds as much as ¼ in. thick.
17.2	177.3-194.5	Covered interval.
10.0	194.5-204.5	Sandstone, medium-gray, very fine to fine-grained, well-cemented, irregularly bedded, ripple-marked, beds 1-10 in. thick.

Section C
Slover Creek section (east)

Sec. 36, T. 10 N., R. 22 W., Johnson County Ark. Upper part of Atoka Formation.

Thickness in feet	Interval in feet	Description
		Pennsylvanian System
		Upper part of Atoka Formation
63.2	0- 63.2	Sandstone, very light gray, fine-grained, irregularly bedded, beds 2-24 in. thick.
0.8	63.2- 64.0	Sandstone, light-gray, fine-grained, abundant fine grains of chert, regularly bedded.
11.5	64.0- 75.5	Sandstone, very light gray, fine-grained, quartzose, beds 6-24 in. thick.
3.0	75.5- 78.5	Sandstone, light-gray, fine-grained, regularly bedded, beds 1-6 in. thick.
5.8	78.5- 84.3	Sandstone, light-gray, fine- to medium-grained, shale pebbles as much as 4 in. thick at base of unit, coal streaks as much as ½ in. thick at base of unit, beds as much as 4 in. thick, unit overlies shale with a sharp contact. Base of unit is base of zone c.
0.5	84.3- 84.8	Shale, black, beds as much as ⅛ in. thick.
230.0	84.8-314.8	Covered interval.
5.8	314.8-320.6	Sandstone, light-gray, fine-grained, quartzose, scattered carbonized plant fragments, poorly exposed.
11.5	320.5-332.1	Covered interval.
34.5	332.1-366.6	Sandstone, light- to medium-gray, fine-grained, abundant fine grains of chert, irregularly bedded, beds 2-10 in. thick.
		End of section.

Section D
East Lamar section

Sec. 7, T. 9 N., R. 22 W., Johnson County, Ark. Lower part of McAlester Formation and upper part of Hartshorne Sandstone.

Thickness in feet	Interval in feet	Description
		Pennsylvanian System
		Lower part of McAlester Formation
20.2	0- 20.0	Sandstone, light- to medium-gray, very fine to fine-grained, quartzose, irregularly bedded, sediment flow features, beds 1-6 in. thick.
51.8	20.0- 71.8	Covered interval, probably dark-gray shale.
17.2	71.8- 89.0	Shale, dark-gray, ironstone concretions ½ in. by 3 in., poorly exposed.
5.8	89.0- 94.8	Sandstone, medium-gray, very fine grained, very silty, finely to medium micaceous, irregularly bedded, crossbedded, ripple-marked, beds ¼-3 in. thick.
80.5	94.8-175.3	Shale, dark-gray, poorly exposed.
6.0	175.3-181.3	Shale, dark-gray, weathered.
70.0	181.3-251.3	Covered interval.
15.0	251.3-266.3	Sandstone, medium-gray, very fine grained, silty, poorly exposed.
76.8	266.3-343.1	Covered interval.
34.5	343.1-377.6	Shale, dark-gray, abundant ironstone concretions ½-3 in. in diameter, beds $\frac{1}{16}$-½ in. thick, abundant plant fossils: sigillaria, lepidodendron, and ferns (pecopteris, neuropteris, and alethopteris).
1.5	377.6-379.1	Coal, 30 percent vitrain, thin-banded.
3.0	379.1-382.1	Shale, dark-gray, fossil plant fragments, beds $\frac{1}{16}$-⅛ in. thick.
11.5	382.1-393.6	Shale, medium- to dark-gray, slightly very finely sandy, silty, beds $\frac{1}{16}$-⅛ in. thick; base of unit is base of McAlester Formation.
		Upper part of Hartshorne Sandstone
4.7	393.6-398.3	Sandstone, light-gray, very fine to fine-grained, silty, finely to coarsely micaceous, plant fossils (sigillaria), crossbedded, ripple-marked, beds ¼-6 in. thick.
1.7	398.3-400.0	Sandstone, light- to medium-gray, very fine grained, very silty, finely micaceous, irregularly bedded, beds $\frac{1}{16}$-2 in. thick.
		End of section.

Section E
Big Piney Creek section (west)

Sec. 12, T. 9 N., R. 22 W., Pope County, Ark. Upper part of Atoka Formation.

Thickness in feet	Interval in feet	Description
		Pennsylvanian System
		Upper part of Atoka Formation
20.2	0- 20.2	Sandstone, light-gray, fine- to medium-grained, beds as much as 3 ft. thick, poorly exposed.
59.8	20.2- 80.0	Covered interval.
7.5	80.0- 87.5	Sandstone, medium-gray, very fine grained, very silty, beds as much as 8 in. thick, poorly exposed.
22.4	87.5-109.9	Covered interval.
7.8	109.9-117.7	Shale, grayish-black.
37.4	117.7-155.1	Covered interval.
10.4	155.1-165.5	Sandstone, light- to meduim-gray, very fine to fine-grained, silty, finely micaceous, irregularly bedded, beds 1-6 in. thick.
44.8	165.5-210.3	Covered interval.
81.0	210.3-291.3	Sandstone, medium-gray, very fine to fine-grained, abundant fine grains of chert, well-cemented, crossbedded, uppermost 30 ft. contorted by sediment flow, beds 2-12 in. thick. Top of unit is top of zone c.
1.5	291.3-292.8	Siltstone, medium-gray, irregularly bedded, beds as much as ½ in. thick; and sandstone, medium-gray, very fine grained, beds as much as 6 in. thick.
4.0	292.8-296.8	Sandstone, medium-gray, very fine grained, well-cemented, crossbedded, beds 2-10 in. thick. Base of unit is base of zone c.
0.5	296.8-297.3	Coal, all vitrain, medium-banded.
		Mudstone, medium-gray.
2.0	297.3-299.3	End of section.

Section F

Big Piney Creek section (east)

Secs. 7 and 8, T. 9 N., R. 21 W., Pope County, Ark. Upper part of Atoka Formation.

Thickness in feet	Interval in feet	Description
		Pennsylvanian System **Upper part of Atoka Formation**
0.4	0- 0.4	Sandstone, very light gray, very fine grained, slightly very finely micaceous.
1.8	0.4- 2.2	Sandstone, light-gray, very fine to fine-grained, abundant very fine to fine grains of chert, irregularly bedded, beds as much as 3 in. thick.
8.2	2.2- 10.4	Sandstone, light-gray to medium light-gray, very fine to fine-grained, very finely to medium micaceous, scattered thin streaks of carbonaceous material, very irregularly bedded, beds as much as 10 in. thick.
1.2	10.4- 11.6	Sandstone, medium light-gray, very fine to fine-grained, irregularly bedded.
1.4	11.6- 13.0	Sandstone, medium-gray to medium dark-gray, very fine to fine-grained, very slightly finely micaceous, scattered chert grains, poorly developed bedding, beds 2-5 in. thick.
1.2	13.0- 14.2	Sandstone, medium-gray, very fine to fine-grained, slightly silty, scattered chert grains, well-cemented, beds 1-5 in. thick.
0.5	14.2- 14.7	Sandstone, light-gray, very fine to fine-grained, scattered chert grains.
0.8	14.7- 15.5	Sandstone, pinkish-gray to light-gray, fine-grained.
3.0	15.5- 18.5	Sandstone, medium-gray, fine-grained, well-cemented in part, poorly developed bedding, beds 2-12 in. thick.
3.8	18.5- 22.3	Sandstone, light- to medium-gray, fine-grained, scattered medium sand grains, very slightly finely micaceous, scattered blebs of carbonaceous material, regularly to irregularly bedded, beds 9-21 in. thick.
1.8	22.3- 24.1	Sandstone, medium-gray, very fine to fine-grained, slightly silty.
1.2	24.1- 25.3	Sandstone, medium light-gray, very fine grained, slightly silty, scattered fine sand grains, poorly developed foreset bedding, poorly developed bottom markings.
0.8	25.3- 26.1	Sandstone, medium-gray, very fine grained, silty, very slightly very finely micaceous, scattered blebs of carbonaceous material, ripple-marked in lowermost 3 in.
4.4	26.1- 30.5	Sandstone, medium-gray, very fine grained, well-cemented, irregularly bedded, convolute-bedded in part, all one bed in part.
2.4	30.5- 32.9	Sandstone, medium-gray, very fine grained, silty, lower contact surface irregular with bottom markings, all one bed.
1.2	32.9- 34.1	Sandstone, medium-gray, very fine grained, silty, slightly very finely micaceous, lower contact surface regular to irregular, all one bed.
0.5	34.1- 34.6	Sandstone, medium-gray, very fine grained, silty, slightly very finely micaceous, scattered blebs of carbonaceous material, very well cemented, all one bed, lower contact surface slightly irregular. Base of unit is base of zone c.
0.6	34.6- 35.2	Coal, 90 to 95 percent vitrain.
4.2	35.2- 39.4	Mudstone, light brownish-gray to medium-gray to dark-gray, slightly very finely to finely micaceous, streaks of carbonaceous and coaly material, all one bed, weathered in lower part.
2.7	39.4- 42.1	Covered interval, probably dark-gray to grayish-black shale.
1.3	42.1- 43.4	Siltstone, medium- to dark-gray, argillaceous, slightly finely to very finely micaceous, macerated plant fragments.
2.3	43.4- 45.7	Shale, dark-gray, slightly very finely micaceous.
4.2	45.7- 49.9	Siltstone, brownish-gray to dark-gray, very argillaceous in part, almost very fine grained sandstone in part, slightly very finely micaceous.
4.4	49.9- 54.3	Siltstone, brownish-gray to dark-gray, argillaceous in part, very finely to finely micaceous.
14.1	54.3- 68.4	Siltstone, brownish-gray to dark-gray, very argillaceous, some bedding planes are ripple-marked.
1.8	68.4- 70.2	Siltstone, medium-gray to dark-gray, very finely sandy in part, argillaceous in part, slightly very finely to very finely micaceous, bedding planes are ripple-marked.
2.2	70.2- 72.4	Siltstone, medium-gray to dark-gray, argillaceous, very thin bedded, ripple-marked.
10.3	72.4- 82.7	Siltstone, medium-gray to dark-gray, silt particles range from near clay size to near very fine grained sand size, well-cemented in part, ripple-marked, beds as much as 2 in. thick, coarser-grained better-cemented phase predominates near the top.
2.4	82.7- 85.1	Sandstone, medium light-gray to medium-gray, very fine grained, silty, slightly finely to very finely micaceous, well-cemented, thin shale fragments, regularly bedded, ripple-marked, beds 1-7 in. thick.
23.5	85.1-108.6	Siltstone, medium dark-gray, silt particles range from near clay size to near very fine grained sand size, slightly very finely micaceous, well-cemented in part, ripple-marked, beds as much as 3 in. thick.

Thickness in feet	Interval in feet	Description
		Upper part of Atoka Formation
10.1	108.6-118.7	Siltstone, medium-gray to dark-gray, argillaceous in part, slightly very finely micaceous, well-cemented in part, ripple-marked.
0.3	118.7-119.0	Sandstone, very fine to fine-grained, slightly silty to very silty, shale fragments, ripple-marked.
0.8	119.0-119.8	Siltstone, medium-gray to medium dark-gray, alternating well-cemented and poorly cemented beds, ripple-marked.
0.4	119.8-120.2	Sandstone, light-gray to medium light-gray, fine-grained, subangular grains, slightly finely to very finely micaceous, scattered shale blebs and plant fragments, ripple-marked.
1.4	120.2-121.6	Shale, dark-gray.
1.0	121.6-122.6	Siltstone, medium-gray, slightly very finely micaceous, ripple-marked.
18.5	122.6-141.1	Shale, dark-gray, slightly silty to very silty, scattered lenticular concretions as much as 3 in. thick; and siltstone, medium-gray, finely micaceous, lenses as much as 2 in. thick; the siltstone lenses are scattered through the shale.
1.5	141.1-142.6	Siltstone, medium dark-gray, slightly very finely micaceous, zone of concretions 2 in. thick at top of unit.
5.2	142.6-147.8	Shale, dark-gray, slightly silty, abundant concretions.
6.2	147.8-154.0	Covered interval, probably shale as below.
2.0	154.0-156.0	Shale, medium-gray to dark-gray, slightly silty to very silty.
14.7	156.0-170.7	Covered interval.
1.0	170.7-171.7	Shale, dark-gray, silty.
11.3	171.7-183.0	Covered interval, probably shale as above.
10.3	183.0-193.3	Shale, medium-gray to dark-gray, very silty, slightly very finely micaceous.
12.0	193.3-205.3	Shale, dark-gray to grayish-black, slightly silty.
22.2	205.3-227.5	Covered interval, probably shale as below.
6.8	227.5-234.3	Shale, dark-gray to grayish-black, slightly silty in part; and siltstone, light brownish-gray to medium dark-gray, very finely sandy, beds and lenses about 1 in. thick; siltstone units scattered through the shale.
0.2	234.3-234.5	Siltstone, light brownish-gray to medium dark-gray, very finely sandy, weathered.
29.8	234.5-264.3	Shale, dark-gray to grayish-black, very slightly silty to silty, very slightly very finely micaceous.
0.7	264.3-265.0	Shale, dark-gray, slightly very finely micaceous, abundant well-cemented concretions.
0.5	265.0-265.5	Shale, dark-gray.
0.2	265.5-265.7	Siltstone, medium- to dark-gray, slightly very finely micaceous, argillaceous.
3.2	265.7-268.9	Shale, dark-gray, slightly silty.
7.6	268.9-276.5	Covered interval.
0.8	276.5-277.3	Siltstone, medium- to dark-gray to light brownish-gray, slightly very finely micaceous, argillaceous.
4.3	277.3-281.6	Covered interval, probably siltstone as above.
0.7	281.6-282.3	Siltstone, medium dark-gray to dark-gray, slightly very finely sandy, very finely to finely micaceous, well-cemented.
5.7	282.3-288.0	Siltstone, medium dark-gray, very slightly very finely micaceous, well-cemented in part, ripple-marked, beds as much as 4 in. thick.
13.6	288.0-301.6	Siltstone, brownish-gray to dark-gray, argillaceous in part, very finely sandy in part, slightly very finely micaceous, well-cemented in part.
		End of section.

Section G

Knoxville-Hickeytown road section

Sec. 20, T. 9 N., R. 22 W., Johnson County, Ark. Lower part of McAlester Formation.

Thickness in feet	Interval in feet	Description
		Pennsylvanian System
		Lower part of McAlester Formation
19.2	0- 19.2	Sandstone, light- to medium-gray, fine- to medium-grained, porous, irregularly bedded, beds 2-6 in. thick.
12.0	19.2- 31.2	Shale, medium-gray, silty, very finely sandy, very finely micaceous, plant impressions, sediment flow features.

Thickness in feet	Interval in feet	Description
		Lower part of McAlester Formation
15.0	31.2- 46.2	Sandstone, siltstone, and shale, as below, lower 5 ft. poorly exposed.
6.0	46.2- 52.2	Sandstone, light- to medium-gray, very fine grained, argillaceous, silty, beds as much as 8 in. thick; siltstone, medium-gray, argillaceous, beds as much as ½ in. thick; and shale, medium-gray, silty, beds as much as ¼ in. thick, zones as much as 3 in. thick; unit is probably 40 percent sandstone, 30 percent siltstone, and 30 percent shale.
6.0	52.2- 58.2	Sandstone, light-gray, very fine to fine-grained, silty, irregularly bedded, beds ½-6 in. thick.
2.8	58.2- 61.0	Sandstone, medium-gray, very fine to fine-grained, silty, abundant fine grains of chert, beds 2-18 in. thick.
2.8	61.0- 63.8	Sandstone, medium-gray, very fine grained, silty, irregularly bedded, beds 2-14 in. thick; and shale, dark-gray, bed 2 in. thick 6 in. from top of unit.
13.5	63.8- 77.3	Siltstone, medium-gray, irregularly bedded, beds ⅛-1 in. thick.
28.8	77.3-106.1	Covered interval, upper 11.5 ft. may be siltstone as above.
8.0	106.1-114.1	Sandstone, poorly exposed, as below.
5.8	114.1-119.9	Sandstone, medium-gray, very fine grained, very silty, finely to medium micaceous, ripple-marked, beds 2-10 in. thick.
17.2	119.9-137.1	Shale, dark-gray, weathered.
		End of section.

Section H

Southeast Lamar section

Sec. 20, T. 9 N., R. 22 W., Johnson County, Ark. Lower part of McAlester Formation.

Thickness in feet	Interval in feet	Description
		Pennsylvanian System
		Lower part of McAlester Formation
22.0	0.- 22.0	Sandstone, medium-gray, very fine to fine-grained, silty, finely micaceous, regularly to irregularly bedded, beds 1-4 in. thick.
5.8	22.0- 27.8	Covered interval.
11.5	27.8- 39.3	Sandstone, meduim-gray, very fine grained, quartzose, regularly bedded, beds 1-2 in. thick.
11.5	39.3- 50.8	Covered interval.
17.2	50.8- 68.0	Shale, dark-gray to grayish-black, scattered ironstone concretions as large as ½ in. by 3 in., beds as much as ¼ in. thick.
17.2	68.0- 85.2	Shale, medium-gray, silty, beds as much as ½ in. thick; and claystone, beds as much as 2 in. thick; unit is largely shale.
0.2	85.2- 85.4	Coal, poorly exposed.
5.0	85.4- 90.4	Shale, dark-gray, poorly exposed.
23.0	90.4-113.4	Covered interval.
4.0	113.4-117.4	Sandstone, medium-gray, very fine grained, very silty, irregularly bedded, beds as much as 10 in. thick.
11.5	117.4-128.9	Covered interval.
2.0	128.9-130.9	Siltstone, medium-gray, very finely sandy, finely micaceous, irregularly bedded, beds as much as ½ in. thick.
28.8	130.9-159.7	Covered interval, lower 11.5 ft. may be sandstone as below.
4.0	159.7-163.7	Sandstone, medium-gray, very fine to fine-grained, finely to medium micaceous, irregularly bedded, beds 2-8 in. thick.
3.0	163.7-166.7	Sandstone, medium-gray, very fine grained, very argillaceous, very silty, finely micaceous, irregularly bedded, beds ½-6 in. thick.
0.7	166.7-167.4	Sandstone, medium-gray, very fine to fine-grained, silty, irregularly bedded, ripple-marked.
		End of section.

SUBSURFACE STRATIGRAPHIC SECTIONS

Section 1

Arkansas-Oklahoma Gas Co. No. 1 Wilkins

Sec. 33, T. 10 N., R. 22 W., Johnson County, Ark. Elevation: 650 ft. (est.); total depth: 4,329 ft. Rock samples examined and logged by Wayne A. Chisholm. Middle and lower parts of Atoka Formation, and upper part of Bloyd Shale and Prairie Grove Member of Hale Formation undifferentiated.

Thickness in feet	Interval in feet	Description
		Pennsylvanian System **Middle and lower parts of Atoka Formation**
25	0- 25	(No sample.)
7	25- 32	Sandstone, light brownish-gray, fine-grained, silty, scattered very coarse sand grains, subrounded sand grains.
23	32- 55	(No sample.)
5	55- 60	Sandstone, light brownish-gray, fine- to medium-grained, scattered very coarse sand grains, subrounded sand grains, scattered dark-brown pebbles.
25	60- 85	(No sample.)
5	85- 90	Shale, dark-gray, micaceous; and sandstone, light brownish-gray to dark gray, fine- to medium-grained, very silty.
35	90- 125	(No sample.)
5	125- 130	Shale and sandstone, as above.
25	130- 155	Sandstone, light brownish-gray, fine-grained, silty, slightly limy, micaceous; and shale, dark-gray, micaceous.
20	155- 175	(No sample.)
5	175- 180	Sandstone, light brownish-gray, fine-grained, silty, slightly limy; and shale, dark-gray, micaceous.
15	180- 195	(No sample.)
5	195- 200	Sandstone and shale, as above.
20	200- 220	(No sample.)
5	220- 225	Shale, dark-gray, micaceous; and trace of sandstone, fine grained, silty.
25	225- 250	(No sample.)
5	250- 255	Shale and sandstone, as above.
65	255- 320	(No sample.)
5	320- 325	Shale, dark-gray, micaceous; and trace of sandstone, gray, very fine grained, very silty.
35	325- 360	(No sample.)
5	360- 365	Shale, dark-gray, silty, micaceous; and sandstone, gray, fine-grained, very silty.
15	365- 380	(No sample.)
10	380- 390	Shale, dark-gray, micaceous; and sandstone, gray, fine-grained, very silty.
10	390- 400	Sandstone, light brownish-gray to dark-gray, very fine to fine-grained, very silty, subangular to subrounded sand grains, secondary quartz; and trace of shale, dark-gray.
50	400- 450	(No sample.)
10	450- 460	Sandstone, grayish-brown, fine-grained, very silty; and trace of shale, dark-gray, micaceous.
30	460- 490	(No sample.)
10	490- 500	Shale, dark-gray, micaceous; and trace of sandstone, gray, very fine to fine-grained, silty.
25	500- 525	Shale, dark-gray.
50	525- 575	Shale, dark-gray, micaceous.
15	575- 590	Sandstone, gray, very fine to medium-grained, subrounded sand grains, secondary quartz; and shale, black, micaceous.
10	590- 600	(No sample.)
5	600- 605	Sandstone, light brownish-gray, fine-grained, silty.
20	605- 625	(No sample.)
5	625- 630	Shale, dark-gray, micaceous.
70	630- 700	(No sample.)
8	700- 708	Shale, as above.
12	708- 720	(No sample.)
12	720- 732	Sandstone, gray, very fine grained, silty; and shale, dark-gray.
5	732- 737	Sandstone, very light to medium-gray, fine-grained, subrounded sand grains.
8	737- 745	(No sample.)

Thickness in feet	Interval in feet	Description
		Middle and lower parts of Atoka Formation
5	745- 750	Sandstone, light-gray, very fine to fine-grained.
28	750- 778	Sandstone, light-gray, very fine to fine-grained; and trace of shale, dark-gray.
17	778- 795	Shale, dark-gray, micaceous; and sandstone, gray, very fine to fine-grained, silty, slightly limy.
25	795- 820	(No sample.)
5	820- 825	Sandstone, brownish-gray, very fine to fine-grained, silty; and shale, dark-gray.
75	825- 900	(No sample.)
5	900- 905	Shale, dark-gray; and sandstone, dark brownish-gray, very fine to fine-grained, silty.
25	905- 930	(No sample.)
25	930- 955	Sandstone, light- to brownish-gray, very fine to fine-grained, silty; and shale, dark-gray, micaceous.
28	955- 983	Shale, dark-gray, micaceous, scattered pyrite crystals; and sandstone, medium- to dark-gray, very fine to fine-grained, silty, scattered pyrite crystals.
27	983-1010	Shale, dark-gray; and trace of sandstone, gray, fine-grained.
25	1010-1035	(No sample.)
10	1035-1045	Shale, dark-gray.
25	1045-1070	(No sample.)
5	1070-1075	Shale, dark-gray, micaceous.
50	1075-1125	(No sample.)
5	1125-1130	Shale, dark-gray, micaceous, scattered pyrite crystals; and sandstone, gray, very fine to fine-grained, silty, scattered pyrite crystals.
35	1130-1165	Shale, dark-gray, micaceous; and trace of sandstone, gray, very fine to fine-grained, silty.
4	1165-1169	(No sample.)
25	1169-1194	Shale, dark-gray, very micaceous; and sandstone, light-gray, fine- to coarse-grained, very silty, scattered very coarse sand grains, poorly sorted.
11	1194-1205	(No sample.)
5	1205-1210	Sandstone, light-gray, fine- to coarse-grained, silty, poorly sorted; and shale, dark-gray.
22	1210-1232	(No sample.)
10	1232-1242	Shale, dark-gray; and siltstone, gray.
38	1242-1280	(No sample.)
20	1280-1300	Shale, dark-gray, micaceous; and sandstone, medium- to dark-gray, very fine grained, very silty.
20	1300-1320	(No sample.)
5	1320-1325	Shale, dark-gray; and siltstone.
18	1325-1343	(No sample.)
21	1343-1364	Shale, dark-gray, micaceous; and siltstone, dark-gray, sandy.
30	1364-1394	Shale, dark-gray.
6	1394-1400	(No sample.)
25	1400-1425	Shale, dark-gray; siltstone, gray; and sandstone, gray, very fine grained.
25	1425-1450	Shale, dark-gray.
25	1450-1475	Shale, dark-gray; and sandstone, light- to medium-gray, very fine grained, very silty.
30	1475-1505	(No sample.)
10	1505-1515	Shale, dark-gray.
20	1515-1535	(No sample.) Probably includes top of zone s.
10	1535-1545	Sandstone, light-gray, very fine to fine-grained, subrounded sand grains; and trace of shale, dark-gray.
10	1545-1555	Sandstone, gray, very fine grained, silty.
15	1555-1570	Sandstone, gray, very fine to fine-grained, silty, micaceous.
5	1570-1575	(No sample.)
10	1575-1585	Sandstone, light- to medium-gray, very fine to fine-grained, silty, micaceous.
15	1585-1600	(No sample.) Probably includes base of zone s.
5	1600-1605	Shale, dark-gray.
5	1605-1610	Shale, medium-gray, silty.
20	1610-1630	(No sample.)
20	1630-1650	Shale, dark-gray, micaceous; shale, medium-gray, silty; and sandstone, gray, very fine grained, silty.
200	1650-1850	(No sample.)
5	1850-1855	Sandstone, light- to medium-gray, very fine to fine-grained, silty; and shale, dark-gray.

Thickness in feet	Interval in feet	Description
		Middle and lower parts of Atoka Formation
15	1855-1870	(No sample.)
5	1870-1875	Sandstone and shale, as above.
25	1875-1900	(No sample.)
5	1900-1905	Sandstone and shale, as above.
20	1905-1925	(No sample.)
5	1925-1930	Sandstone and shale, as above.
20	1930-1950	(No sample.)
3	1950-1953	Sandstone and shale, as above.
17	1953-1970	(No sample.)
5	1970-1975	Shale, light- to medium-gray, silty; and shale, dark-gray.
5	1975-1980	(No sample.)
15	1980-1995	Sandstone, light- to medium-gray, very fine grained, very silty; and shale, dark-gray.
5	1995-2000	(No sample.)
13	2000-2013	Shale, light- to medium-gray, silty; and shale, dark-gray.
3	2013-2016	Shale, light- to medium-gray, silty.
27	2016-2043	Shale, light- to medium-gray, silty; and shale, dark-gray.
9	2043-2052	Shale, dark-gray; and shale, light- to medium-gray, silty.
18	2052-2070	Shale, dark-gray.
4	2070-2074	Shale, dark-gray; and shale, medium-gray, sandy, silty.
9	2074-2083	Shale, dark-gray; and sandstone, gray, very fine grained, silty.
15	2083-2098	Shale, dark-gray; and siltstone, gray.
12	2098-2110	Shale, dark-gray.
3	2110-2113	(No sample.)
18	2113-2131	Shale, dark-gray.
4	2131-2135	(No sample.)
8	2135-2143	Shale, as above.
2	2143-2145	(No sample.)
4	2145-2149	Shale, as above.
1	2149-2150	(No sample.)
33	2150-2183	Shale, dark-gray.
2	2183-2185	(No sample.)
8	2185-2193	Shale, as above.
2	2193-2195	Siltstone, light-gray, sandy.
27	2195-2222	Sandstone, light-gray, very fine grained, very silty.
33	2222-2255	Siltstone, light-gray, sandy.
4	2255-2259	Sandstone, gray, very fine to fine-grained, silty; and shale, dark-gray.
11	2259-2270	Sandstone, gray, very fine to fine-grained, silty, slightly limy.
3	2270-2273	Shale, dark-gray.
2	2273-2275	(No sample.)
15	2275-2290	Sandstone, brownish-gray to gray, very fine to fine-grained, silty, slightly limy; and shale, dark-gray.
15	2290-2305	Sandstone, gray, very fine grained, silty, slightly limy, micaceous.
18	2305-2323	Shale, light- to medium-gray, silty.
10	2323-2333	Shale, as above; and trace of sandstone, light-gray, very fine grained.
7	2333-2340	Shale, dark-gray; and sandstone, light-gray, very fine grained.
28	2340-2368	Shale, dark-gray; and sandstone, dark-gray, very fine grained, very silty.
37	2368-2405	Shale, dark-gray.
10	2405-2415	(No sample.)
35	2415-2450	Shale, as above.
11	2450-2461	Sandstone, light- to medium-gray, very fine grained, silty; and shale, dark-gray.
12	2461-2473	Shale, light- to medium-gray, sandy, silty; and shale, dark-gray.
8	2473-2481	Shale, dark-gray; and shale, light-gray, sandy, silty.
29	2481-2510	Shale, gray, sandy, silty; and shale, dark-gray.
5	2510-2515	Sandstone, gray, very fine grained; very silty; and shale, light-gray, sandy, silty.
5	2515-2520	Sandstone, brownish-gray, very fine grained, silty; and shale, dark-gray.
20	2520-2540	Shale, brownish-gray, sandy, silty; and shale, dark-gray.

Thickness in feet	Interval in feet	Description
		Middle and lower parts of Atoka Formation
8	2540-2548	Shale, light-gray, sandy, silty.
27	2548-2575	Shale, dark-gray.
10	2575-2585	Shale, dark-gray; and sandstone, gray, very fine grained, silty.
15	2585-2600	Sandstone, light-gray, fine- to medium-grained, scattered coarse sand grains, subangular sand grains, secondary quartz; and shale, dark-gray.
30	2600-2630	Shale, dark-gray; and sandstone, light- to dark-gray, very fine to fine-grained, very silty.
30	2630-2660	Shale, dark-gray; and sandstone, light-gray, very fine to medium-grained, silty.
53	2660-2713	Shale, dark-gray; and shale, gray, silty.
10	2713-2723	Shale, dark-gray; shale, gray, sandy, silty, and sandstone, gray, very fine grained, very silty.
15	2723-2738	Shale, dark-gray, micaceous; and shale, gray, sandy, silty.
72	2738-2810	Shale, grayish-brown to gray, sandy, silty; and shale, dark-gray.
25	2810-2835	Shale, dark-gray.
17	2835-2852	Shale, gray, sandy, silty; and shale, dark-gray.
3	2852-2855	Shale, dark-gray.
10	2855-2865	Shale, gray, sandy, silty; and shale, dark-gray.
16	2865-2881	Shale, dark-gray; and sandstone, dark-gray, very fine grained, very silty.
19	2881-2900	Shale, dark-gray; and sandstone, medium- to dark-gray, very fine grained, very silty.
60	2900-2960	Shale, dark-gray.
19	2960-2979	Shale, dark-gray; and trace of sandstone, dark-gray, very fine grained, very silty.
28	2979-3007	Shale, gray, sandy, silty; sandstone, gray, very fine grained, very silty; and shale, dark-gray.
108	3007-3115	Shale, dark-gray.
65	3115-3180	Shale, dark-gray; and sandstone, light-gray, very fine grained, very silty.
796	3180-3976	(No sample.) Interval includes contact between Atoka Formation and Morrow Series.
		Upper part of Bloyd Shale and Prairie Grove Member of Hale Formation, undifferentiated
4	3976-3980	Shale, dark-gray; and sandstone, gray, very fine to fine-grained.
43	3980-4023	Shale, dark-gray, micaceous; and sandstone, brownish-gray, very fine to fine-grained, silty.
10	4023-4033	Shale, dark-gray.
7	4033-4040	Sandstone, light-gray, very fine grained, very silty.
10	4040-4050	Shale, dark-gray; and sandstone, light-gray, very fine grained, very silty.
11	4050-4061	Sandstone, light brownish-gray, very fine to coarse-grained, silty, poorly sorted, subangular to subrounded sand grains.
9	4061-4070	Sandstone, light-brown, fine- to medium-grained.
10	4070-4080	Sandstone, light-brown, very fine to fine-grained.
8	4080-4088	Sandstone, light-brown, fine- to coarse-grained; and shale, dark-gray.
26	4088-4114	Sandstone, light-brown, very fine to very coarse grained, silty; and shale, dark-gray.
8	4114-4122	Sandstone, light-brown, very fine to coarse-grained.
14	4122-4136	Sandstone, light-brown, very fine to medium-grained.
8	4136-4144	Limestone, light- to medium-gray, very finely granular; and sandstone, light-brown, very fine to medium-grained.
6	4144-4150	Limestone, as above, with brachiopod fragments; and sandstone, as above.
5	4150-4155	Shale, dark-gray; limestone, granular; and sandstone.
174	4155-4329	(No sample.)
	4329	Total depth.

Section 2

Industrial Oil and Gas Co. No. 1 Winningham

Sec. 5, T. 9 N., R. 22 W., Johnson County, Ark. Elevation: 456 ft.; total depth: 3,681 ft. Rock samples examined and logged by Sherwood E. Frezon. Middle part of Atoka Formation.

Thickness in feet	Interval in feet	Description
		Pennsylvanian System **Middle part of Atoka Formation**
50	0- 50	(No sample.)
100	50- 150	Sandstone, dark-gray, very fine grained, very silty, slightly micaceous; and shale, dark-gray to black, micaceous.
20	150- 170	(No sample.)
10	170- 180	Sandstone, dark-gray, very fine grained, silty; and shale, dark-gray to black.
10	180- 190	Sandstone, light gray to light yellowish-gray, very fine to fine-grained, friable.
24	190- 214	(No sample.) Probably includes top of zone c.
24	214- 238	Sandstone, very light to light-gray, fine- to medium-grained, scattered coarse sand grains, rounded sand grains with secondary quartz on some grains, slightly micaceous, friable.
2	238- 240	(No sample.)
19	240- 259	Sandstone, gray, fine-grained, micaceous.
41	259- 300	Sandstone, dark-gray, fine-grained, silty, micaceous; and shale, dark-gray to black, micaceous.
43	300- 343	(No sample.)
32	343- 375	Sandstone, gray, fine-grained, slightly silty, micaceous; and shale, black, micaceous.
25	375- 400	(No sample.) Probably includes base of zone c.
25	400- 425	Shale, black, micaceous.
25	425- 450	(No sample.)
50	450- 500	Sandstone, gray, fine-grained, silty, micaceous; and shale, black.
48	500- 548	(No sample.)
12	548- 560	Shale, black, micaceous; and sandstone, dark-gray, fine-grained, silty.
60	560- 620	Shale, black, micaceous.
30	620- 650	(No sample.)
26	650- 676	Shale, black, micaceous.
24	676- 700	(No sample.)
20	700- 720	Sandstone, light-gray to yellowish-gray, fine- to medium-grained, rounded sand grains, secondary quartz, friable.
20	720- 740	(No sample.)
10	740- 750	Shale, black, micaceous.
14	750- 764	(No sample.)
6	764- 770	Sandstone, gray, fine-grained, silty, secondary quartz, friable.
35	770- 805	Shale, black, micaceous, slightly pyritic in lower 10 feet.
5	805- 810	(No sample.)
20	810- 830	Shale, black, micaceous, slightly pyritic.
10	830- 840	(No sample.)
10	840- 850	Sandstone, light-gray, fine- to medium-grained, slightly silty.
10	850- 860	Sandstone, light-gray, fine- to medium-grained, slightly silty, micaceous.
10	860- 870	Sandstone, light-gray, fine- to medium-grained, micaceous.
40	870- 910	(No sample.)
20	910- 930	Shale, black, micaceous.
10	930- 940	Shale, black, micaceous; and sandstone, dark-gray, fine-grained.
10	940- 950	(No sample.)
10	950- 960	Shale, black, micaceous.
70	960-1030	(No sample.)
10	1030-1040	Shale, black, micaceous; and sandstone, light- to medium-gray, fine-grained, silty, micaceous.
5	1040-1045	(No sample.)
20	1045-1065	Sandstone, light-gray, fine-grained, micaceous.
5	1065-1070	(No sample.)
10	1070-1080	Sandstone, dark-gray, very silty, slightly micaceous.
10	1080-1090	Sandstone, dark-gray, very silty, slightly micaceous; and shale, black, micaceous.

Thickness in feet	Interval in feet	Description
		Middle part of Atoka Formation
10	1090-1100	(No sample.)
10	1100-1110	Shale, black, micaceous; and sandstone, dark-gray, very fine to fine-grained.
10	1110-1120	(No sample.)
30	1120-1150	Shale, black, micaceous; and trace of sandstone, dark-gray, very fine to fine-grained.
20	1150-1170	Sandstone, light-gray, fine- to medium-grained, slightly silty, rounded sand grains with secondary quartz, friable.
30	1170-1200	(No sample.)
50	1200-1250	Sandstone, light- to medium-gray, fine- to medium-grained, slightly silty, very slightly micaceous, secondary quartz.
70	1250-1320	(No sample.)
10	1320-1330	Shale, black, micaceous; siltstone; and sandstone, very fine grained.
30	1330-1360	(No sample.)
10	1360-1370	Sandstone, light- to medium-gray, silty, slightly micaceous.
10	1370-1380	Sandstone, light- to medium-gray, very silty, slightly micaceous.
5	1380-1385	(No sample.)
10	1385-1395	Shale, black, sandy, micaceous; and shale, black, micaceous.
35	1395-1430	(No sample.)
20	1430-1450	Shale, black, sandy, micaceous.
20	1450-1470	Shale, black, slightly sandy, micaceous.
5	1470-1475	(No sample.)
10	1475-1485	Shale, black, micaceous.
10	1485-1495	(No sample.)
15	1495-1510	Shale, as above.
10	1510-1520	(No sample.)
6	1520-1526	Shale, as above.
6	1526-1532	Sandstone, light- to medium-gray, fine-grained.
38	1532-1570	Shale, as above.
5	1570-1575	(No sample.)
4	1575-1579	Shale, as above.
5	1579-1584	Sandstone, gray, fine- to medium-grained, slightly limy.
22	1584-1606	Sandstone, gray, fine- to medium-grained, very slightly limy.
4	1606-1610	Sandstone, dark-gray, silty.
20	1610-1630	Sandstone, light- to dark-gray, fine-grained; and shale, black, micaceous.
9	1630-1639	Sandstone, dark-gray to black, fine- to meduim-grained, silty, gastropods.
3	1639-1642	Coal.
8	1642-1650	Shale, black, sandy, silty, micaceous.
6	1650-1656	Shale, black, slightly sandy, silty, finely micaceous, crinoids, gastropods, and pelecypods.
4	1656-1660	Shale, black, micaceous, gastropods.
10	1660-1670	(No sample.)
10	1670-1680	Shale, black, sandy, slightly silty, micaceous.
70	1680-1750	Shale, black, micaceous.
20	1750-1770	Shale, black, slightly sandy, slightly silty, micaceous.
10	1770-1780	(No sample.)
20	1780-1800	Shale, as above.
10	1800-1810	Shale, black, micaceous.
30	1810-1840	Shale, black, micaceous; siltstone; and sandstone, very fine to fine-grained.
20	1840-1860	(No sample.)
30	1860-1890	Shale, siltstone, and sandstone, as above.
10	1890-1900	Shale, black, micaceous; and sandstone, light- to very dark gray, very fine to fine-grained.
50	1900-1950	Sandstone, very dark gray to black, very fine to fine-grained, silty, micaceous; and siltstone, argillaceous, micaceous.
10	1950-1960	(No sample.)
35	1960-1995	Sandstone and siltstone, as above.
5	1995-2000	(No sample.)
10	2000-2010	Shale, black, micaceous; and sandstone, gray, very fine to fine-grained, silty, slightly limy, micaceous.
10	2010-2020	Sandstone, gray, very fine to fine-grained, silty, slightly micaceous.
10	2020-2030	(No sample.)
15	2030-2045	Sandstone, medium- to dark-gray, fine- to medium-grained, silty.
25	2045-2070	(No sample.)
10	2070-2080	Sandstone, dark-gray, fine- to medium-grained, silty; and shale, black, micaceous.
20	2080-2100	(No sample.)
10	2100-2110	Shale, black, micaceous; siltstone; and sandstone, very fine to fine-grained.
10	2110-2120	Shale, black, micaceous.
40	2120-2160	Shale, black, micaceous; siltstone; and sandstone, very fine to fine-grained.

Thickness in feet	Interval in feet	Description
		Middle part of Atoka Formation
20	2160-2180	(No sample.)
20	2180-2200	Shale, siltstone, and sandstone, as above.
5	2200-2205	(No sample.)
5	2205-2210	Sandstone, light- to light brownish-gray, fine-grained, slightly limy.
10	2210-2220	Sandstone, light- to light brownish-gray, fine-grained, slightly silty, slightly limy.
7	2220-2227	Sandstone, light- to light yellowish-gray, fine-grained, silty; and trace of shale, black, micaceous.
13	2227-2240	Sandstone, light- to dark-gray, fine- to medium- grained, scattered coarse and very coarse sand grains, limy, bryozoa, ostracodes, gastropods, and crinoids.
5	2240-2245	(No sample.)
5	2245-2250	Sandstone, as above.
6	2250-2256	Sandstone, light- to yellowish-gray, fine-grained, slightly silty.
8	2256-2264	Sandstone, medium- to dark-gray, silty, micaceous.
21	2264-2285	Sandstone, medium to dark-gray, silty, micaceous; and shale, black, micaceous.
5	2285-2290	(No sample.)
10	2290-2300	Sandstone and shale, as above.
20	2300-2320	(No sample.)
10	2320-2330	Shale, black, slightly sandy, silty, micaceous.
60	2330-2390	Shale, black, micaceous.
10	2390-2400	(No sample.)
10	2400-2410	Shale, black, micaceous; and sandstone, light-gray.
10	2410-2420	(No sample.)
10	2420-2430	Shale and sandstone, as above.
20	2430-2450	Shale, grayish-black to black, micaceous; and sandstone, very fine to fine-grained.
10	2450-2460	(No sample.)
20	2460-2480	Shale and sandstone, as above.
10	2480-2490	(No sample.)
22	2490-2512	Shale and sandstone, as above.
8	2512-2520	Sandstone, light- to medium-gray, fine- to medium-grained, slightly silty. Top of unit is top of zone s.
20	2520-2540	(No sample.)
10	2540-2550	Sandstone, light-gray, fine- to medium-grained, scattered black shale granules.
20	2550-2570	(No sample.)
10	2570-2580	Shale, black, very sandy, silty, micaceous.
20	2580-2600	(No sample.)
10	2600-2610	Sandstone, light-gray, fine- to medium-grained, slightly limy.
10	2610-2620	Sandstone, dark-gray to black, fine-grained, very silty, micaceous.
20	2620-2640	Sandstone, dark-gray to black, fine-grained, very silty, micaceous; and shale, black. Base of unit is base of zone s.
30	2640-2670	Shale, grayish-black to black, micaceous; siltstone; and sandstone, very fine grained.
30	2670-2700	Shale, grayish-black to black, micaceous; and trace of sandstone, very light gray, fine-grained.
40	2700-2740	Shale, black, micaceous; siltstone; and sandstone, very fine grained.
30	2740-2770	Shale, black, micaceous.
30	2770-2800	Shale, black, micaceous; siltstone; and sandstone, very fine grained.
50	2800-2850	Shale, black, micaceous.
25	2850-2875	Shale, black, micaceous; and sandstone, light- to medium-gray, medium-grained.
5	2875-2880	(No sample.)
2	2880-2882	Shale, as above.
8	2882-2890	Sandstone, light-gray, fine-grained.
5	2890-2895	(No sample.)
20	2895-2915	Sandstone, gray, fine-grained; siltstone; and shale, black, micaceous.
10	2915-2925	(No sample.)
25	2925-2950	Sandstone, siltstone, and shale.
40	2950-2990	Sandstone, gray, fine-grained; and shale, black, micaceous.
10	2990-3000	(No sample.)
20	3000-3020	Sandstone, gray, fine-grained, silty.
5	3020-3025	(No sample.)
10	3025-3035	Sandstone, very light gray, medium-grained, rounded sand grains, secondary quartz, friable.
15	3035-3050	(No sample.)
50	3050-3100	Sandstone, light- to yellowish-gray, fine- to medium-grained, silty, scattered grains and streaks of black shale.
40	3100-3140	(No sample.)

Thickness in feet	Interval in feet	Description
		Middle part of Atoka Formation
30	3140-3170	Sandstone, light- to light yellowish-gray, fine- to meduim-grained, silty; and shale, black, micaceous.
10	3170-3180	Sandstone, light-gray, fine-grained, rounded sand grains, secondary quartz, friable.
15	3180-3195	(No sample.)
10	3195-3205	Sandstone, dark-gray to black, fine-grained, very silty, slightly micaceous; and shale, black, micaceous.
10	3205-3215	(No sample.)
15	3215-3230	Sandstone and shale, as above.
10	3230-3240	(No sample.)
30	3240-3270	Sandstone, light- to medium-gray, fine- to medium-grained, silty, slightly micaceous; and shale, black, micaceous.
35	3270-3305	(No sample.)
5	3305-3310	Sandstone, light- to medium-gray, fine- to medium-grained, silty, slightly micaceous.
15	3310-3325	(No sample.)
20	3325-3345	Sandstone, light- to dark-gray, silty, slightly micaceous; and shale, black, micaceous.
10	3345-3355	(No sample.)
15	3355-3370	Sandstone and shale, as above.
19	3370-3389	(No sample.)
9	3389-3398	Sandstone and shale, as above.
12	3398-3410	(No sample.)
15	3410-3425	Sandstone, dark-gray to black, fine-grained, very silty; and shale, black, micaceous.
15	3425-3440	(No sample.)
10	3440-3450	Shale, black, very sandy, micaceous.
20	3450-3470	(No sample.)
30	3470-3500	Shale, black, slightly sandy, micaceous.
15	3500-3515	(No sample.)
15	3515-3530	Shale, as above.
8	3530-3538	(No sample.)
2	3538-3540	Shale, as above.
5	3540-3545	(No sample.)
10	3545-3555	Sandstone, light-gray, fine-grained, slightly micaceous.
5	3555-3560	Sandstone, light-gray, fine-grained, silty, slightly micaceous.
5	3560-3565	(No sample.)
10	3565-3575	Sandstone, gray, fine-grained, silty, micaceous.
20	3575-3595	(No sample.)
15	3595-3610	Sandstone, dark-gray to black, silty, slightly limy.
10	3610-3620	(No sample.)
37	3620-3657	Sandstone, light- to dark-gray, very fine to fine-grained; and shale, black, micaceous.
24	3657-3681	Shale, black, sandy, micaceous.
	3681	Total depth.

Section 3

Gulf Oil Corp. No. 1 J. J. Bauman

Sec. 13, T. 9 N., R. 22 W., Pope County, Ark. Elevation: 616 ft.; total depth: 5,824 ft. Rock samples examined and logged by E. A. Merewether. Lower part of Hartshorne Sandstone, Atoka Formation, and upper part of Bloyd Shale and Prairie Grove Member of Hale Formation undifferentiated.

Thickness in feet	Interval in feet	Description
		Pennsylvanian System
		Lower part of Hartshorne Sandstone
15	0- 15	Sandstone, white to dark yellowish-orange, very fine to fine-grained, slightly silty, scattered coarse to very coarse sand grains, slightly very finely to finely micaceous weathered.
8	15- 23	Sandstone, medium-gray, very fine to fine-grained, very silty, abundantly very finely to medium-micaceous, scattered carbonaceous fragments.
2	23- 25	Shale, dark-gray.
8	25- 33	Sandstone, white to light-gray, very fine to fine-grained, slightly silty.
9	33- 42	Sandstone, white to dark yellowish-orange, very fine to fine-grained, slightly silty, scattered coarse sand grains, slightly finely micaceous, drills free.
10	42- 52	Sandstone, white to light-gray, very fine to medium-grained, scattered coarse sand grains, drills free.
11	52- 63	Sandstone, light-gray to pale yellowish-orange, very fine to coarse-grained, finely to medium-micaceous, scattered carbonaceous fragments.
27	63- 90	Sandstone, light-gray, medium- to very coarse grained, scattered granules and pebbles of quartz and sandstone, scattered carbonaceous streaks and particles, concretions, drills free.
10	90- 100	(No sample.)
56	100- 156	Sandstone, white to medium-gray, fine- to coarse-grained, scattered very coarse sand grains, rounded and subrounded sand grains, scattered coaly particles, scattered carbonized plant fragments in lower 30 ft., drills free; base of unit is base of Hartshorne Sandstone.
		Atoka Formation
18	156- 174	Shale, dark-gray, very finely micaceous, scattered pyrite crystals, concretions.
16	174- 190	Siltstone, dark-gray, argillaceous, very finely micaceous, scattered pyrite crystals.
10	190- 200	(No sample.)
23	200- 223	Siltstone, medium- to dark-gray, argillaceous, very finely micaceous.
13	223- 236	Shale, medium- to dark-gray, silty, very finely micaceous, scattered pyrite crystals.
7	236- 243	Siltstone, medium- to dark-gray, argillaceous in part, very finely micaceous.
30	243- 273	Shale, dark-gray, silty in part, very finely micaceous, scattered calcite fragments and pyrite crystals, concretions.
14	273- 287	Siltstone, medium-gray, very finely micaceous.
6	287- 293	Shale, dark-gray, very finely micaceous, scattered pyrite crystals.
10	293- 303	Siltstone, medium- to dark-gray, argillaceous in part, very finely to finely micaceous.
4	303- 307	Shale, dark-gray, slightly silty, very finely micaceous, scattered calcite fragments and pyrite crystals.
6	307- 313	Siltstone, as above.
22	313- 335	Shale, as above.
7	335- 342	Siltstone, medium- to dark-gray, very finely micaceous, scattered calcite fragments and pyrite crystals, concretions.
4	342- 346	Sandstone, medium- to dark gray, very fine grained, very silty, very finely to finely micaceous, scattered pyrite crystals.
8	346- 354	Shale, dark-gray, very finely micaceous.
9	354- 363	Siltstone, medium- to dark-gray, argillaceous, very finely micaceous.
4	363- 367	Shale, dark-gray, silty in part, very finely to finely micaceous in part, scattered pyrite crystals.
7	367- 374	Sandstone, medium- to dark-gray, very fine grained, silty, very finely to finely micaceous.
7	374- 381	Shale, dark-gray, silty, very finely micaceous.
4	381- 385	Siltstone, medium- to dark-gray, argillaceous, very finely to finely micaceous.
10	385- 395	Sandstone, light- to medium-gray, very fine grained, very silty, slightly limy to limy, very finely to finely micaceous, scattered pyrite crystals.
13	395- 408	Shale, dark-gray, silty, very finely micaceous, crinoids, gastropods, and brachiopods, concretions.
8	408- 416	Siltstone, medium-gray, very finely sandy, very finely micaceous, scattered pyrite crystals, concretions.
7	416- 423	Siltstone, medium- to dark-gray, very finely micaceous.
10	423- 433	Siltstone, medium-gray, very finely sandy, very finely micaceous.
9	433- 442	Sandstone, light- to medium-gray, very fine to fine-grained, slightly silty.

Thickness in feet	Interval in feet	Description
		Atoka Formation
22	442- 464	Siltstone, medium- to dark-gray, argillaceous, very slightly limy, very finely to medium-micaceous.
20	464- 484	Shale, dark-gray, silty, very finely micaceous, coaly streaks, carbonized plant impressions, concretions.
9	484- 493	Siltstone, medium- to dark-gray, argillaceous, very finely to finely micaceous, scattered pyrite crystals.
11	493- 504	Sandstone, light- to medium-gray, very fine to fine-grained, scattered medium sand grains, silty in part, slightly very finely to finely micaceous. Top of unit is top of zone c.
2	504- 506	Shale, dark-gray to grayish-black, very finely micaceous, coaly streaks.
52	506- 558	Sandstone, light- to medium-gray, very fine to fine-grained, scattered medium sand grains, slightly very finely to finely micaceous, scattered calcite fragments, concretions, drills free.
4	558- 562	Shale, dark-gray to grayish-black, very finely micaceous; and siltstone, dark-gray to grayish-black, argillaceous, very finely micaceous.
16	562- 578	Sandstone, light- to medium-gray, fine-grained, scattered medium and coarse sand grains, slightly very finely micaceous, concretions. Base of unit is base of zone c.
6	578- 584	Shale, dark-gray to black, very finely micaceous, carbonaceous and coaly streaks, plant impressions, concretions.
1	584- 585	Coal.
4	585- 589	Siltstone, medium- to dark-gray, argillaceous in part, very finely sandy in part, very finely micaceous, concretions.
4	589- 593	Sandstone, medium-gray, very fine to fine-grained.
10	593- 603	Siltstone, medium- to dark-gray, argillaceous, very finely to finely micaceous.
6	603- 609	Siltstone, medium- to dark-gray, very finely sandy, very finely to finely micaceous, scattered pyrite crystals.
5	609- 614	Shale, dark-gray, silty, very finely micaceous.
4	614- 618	Siltstone, medium- to dark-gray, very finely to finely micaceous.
7	618- 625	Sandstone, medium-gray, very fine to fine-grained; very finely to finely micaceous, scattered pyrite crystals, concretions.
7	625- 632	Shale, dark-gray, silty in part, very finely to finely micaceous, coaly streaks in part.
11	632- 643	Sandstone, medium-gray, very fine to fine-grained, very finely micaceous, coaly streaks, plant fossil impressions, concretions.
3	643- 646	Siltstone, medium- to dark-gray, argillaceous in part, very finely to medium-micaceous.
8	646- 654	Shale, dark-gray, silty in part, very finely micaceous.
5	654- 659	Sandstone, medium-gray, very fine to fine-grained, silty.
18	659- 677	Shale, medium- to dark-gray, silty, slightly very finely micaceous, scattered pyrite crystals.
3	677- 680	Siltstone, medium- to dark-gray, argillaceous.
20	680- 700	Shale, as above.
27	700- 727	Shale, dark-gray, slightly silty, very finely to finely micaceous, scattered pyrite crystals, scattered calcite fragments in lower 5 feet.
6	727- 733	Siltstone, medium- to dark-gray, argillaceous, very finely to finely micaceous.
10	733- 743	Shale, medium- to dark-gray, silty, very finely to finely micaceous.
14	743- 757	Siltstone, medium- to dark-gray, argillaceous, very finely to finely micaceous, scattered pyrite crystals.
8	757- 765	Shale, dark-gray, very finely micaceous.
12	765- 777	Siltstone, medium- to dark-gray, argillaceous, very finely to finely micaceous.
9	777- 786	Shale, dark-gray, silty, very finely micaceous.
7	786- 793	Siltstone, medium- to dark-gray, argillaceous, very finely to finely micaceous, very slightly limy.
13	793- 806	Shale, dark-gray, silty, very finely to finely micaceous, scattered pyrite crystals.
7	806- 813	Siltstone, medium- to dark-gray, argillaceous, very finely micaceous.
4	813- 817	Shale, medium- to dark-gray, silty, very finely micaceous.
3	817- 820	Siltstone, medium- to dark-gray, very finely sandy, very finely micaceous.
6	820- 826	Shale, as above.
6	826- 832	Siltstone, medium- to dark-gray, argillaceous, very finely micaceous.
4	832- 836	Shale, as above, scattered pyrite crystals.
7	836- 843	Siltstone, medium- to dark-gray, very finely sandy, very finely micaceous.
3	843- 846	Siltstone, medium- to dark-gray, very finely micaceous.
7	846- 853	Shale, dark-gray, silty, very finely micaceous.
5	853- 858	Siltstone, medium- to dark-gray, very finely micaceous, scattered pyrite crystals.
6	858- 864	Shale, as above.

Thickness in feet	Interval in feet	Description
		Atoka Formation
7	864- 871	Siltstone, medium- to dark-gray, slightly very finely sandy, very finely micaceous.
4	871- 875	Shale, as above, scattered pyrite crystals.
3	875- 878	Siltstone, medium- to dark-gray, argillaceous in part, very finely micaceous, scattered pyrite crystals.
30	878- 908	Shale, as above.
15	908- 923	Siltstone, medium- to dark-gray, argillaceous in part, very finely micaceous.
12	923- 935	Shale, dark-gray, slightly silty, very finely micaceous, plant impressions.
2	935- 937	Siltstone, as above.
1	937- 938	Coal.
17	938- 955	Shale, dark-gray, slightly silty in part, very finely micaceous, scattered pyrite crystals.
3	955- 958	Siltstone, medium- to dark-gray, very finely sandy, very finely micaceous.
5	958- 963	Sandstone, medium-gray, very fine grained, silty, very finely to finely micaceous.
15	963- 978	Shale, dark-gray, slightly silty in part, very finely micaceous, scattered pyrite crystals.
5	978- 983	Siltstone, medium- to dark-gray, very finely micaceous.
17	983-1000	Shale, as above.
10	1000-1010	(No sample.)
6	1010-1016	Shale, dark-gray, silty in part, very finely micaceous.
7	1016-1023	Siltstone, medium- to dark-gray, argillaceous, very finely to medium-micaceous, scattered pyrite crystals.
4	1023-1027	Shale, dark-gray, very finely micaceous.
3	1027-1030	Sandstone, light- to medium-gray, very fine to fine-grained, silty, slightly very finely to finely micaceous.
4	1030-1034	Siltstone, medium- to dark-gray, very finely to finely micaceous.
14	1034-1048	Shale, dark-gray, slightly silty, very finely micaceous, scattered pyrite crystals.
4	1048-1052	Siltstone, medium- to dark-gray, very argillaceous, very finely to finely micaceous.
52	1052-1104	Shale, dark-gray, slightly silty, very finely micaceous, scattered pyrite crystals, scattered calcite fragments in lower 25 ft., concretions in lower 10 ft.
10	1104-1114	Siltstone, medium- to dark-gray, argillaceous, very finely to finely micaceous, scattered pyrite crystals.
22	1114-1136	Shale, dark-gray, slightly silty, very finely micaceous, scattered pyrite crystals and calcite fragments, concretions.
7	1136-1143	Siltstone, medium-gray, very finely sandy, very finely micaceous.
3	1143-1146	Shale, dark-gray, silty, very finely micaceous.
17	1146-1163	Sandstone, light- to medium-gray, very fine to fine-grained, slightly silty, scattered medium sand grains, very slightly limy, very finely to finely micaceous, scattered calcite fragments.
4	1163-1167	Siltstone, medium- to dark-gray, argillaceous in part, very finely to finely micaceous.
9	1167-1176	Shale, dark-gray, silty in part, very finely micaceous, scattered pyrite crystals.
8	1176-1184	Siltstone, medium- to dark-gray, argillaceous in part, very finely to finely micaceous.
12	1184-1196	Shale, dark-gray, silty in part, very finely micaceous.
4	1196-1200	Siltstone, medium- to dark-gray, argillaceous, very finely to finely micaceous.
10	1200-1210	(No sample.)
41	1210-1251	Shale, dark-gray, slightly silty, very finely micaceous, scattered calcite fragments.
33	1251-1284	Shale, dark-gray to grayish-black, very finely micaceous.
16	1284-1300	Siltstone, medium-gray, scattered pyrite crystals.
23	1300-1323	Shale, dark-gray, to grayish-black, very finely micaceous, scattered pyrite crystals.
4	1323-1327	Shale, dark-gray, silty, very finely micaceous, scattered pyrite crystals.
22	1327-1349	Shale, dark-gray, very finely micaceous, scattered pyrite crystals and calcite fragments.
11	1349-1360	Sandstone, light- to medium-gray, very fine to fine-grained.
3	1360-1363	Shale, dark-gray to grayish-black, very finely micaceous.
7	1363-1370	Sandstone, as above, scattered pyrite crystals.
13	1370-1383	Shale, dark-gray to grayish-black, very finely micaceous.
8	1383-1391	Sandstone, light- to medium-gray, very fine grained, silty.
6	1391-1397	Shale, dark-gray to grayish-black, very finely micaceous.
6	1397-1403	Sandstone, medium-gray, very fine grained, very silty.
4	1403-1407	Shale, dark-gray, very finely micaceous.
9	1407-1416	Sandstone, as above.
89	1416-1505	Shale, dark-gray, very finely micaceous, scattered pyrite crystals in lower 15 ft.
6	1505-1511	Siltstone, medium-gray, very finely sandy, scattered pyrite crystals.
5	1511-1516	Shale, dark-gray, silty, very finely micaceous.
18	1516-1534	Sandstone, light- to medium-gray, very fine to fine-grained, slightly medium micaceous.
4	1534-1538	Shale, dark-gray, slightly silty, very finely micaceous.
7	1538-1545	Sandstone, as above.
6	1545-1551	Shale, as above.
15	1551-1566	Sandstone, light- to medium-gray, very fine to fine-grained, slightly silty.

Thickness in feet	Interval in feet	Description
		Atoka Formation
8	1566-1574	Shale, dark-gray, slightly silty, very finely micaceous.
3	1574-1577	Sandstone, medium-gray, very fine grained, silty.
40	1577-1617	Shale, dark-gray, very finely micaceous, scattered pyrite crystals.
2	1617-1619	Siltstone, medium- to dark-gray, argillaceous.
7	1619-1626	Shale, as above.
1	1626-1627	Siltstone, as above.
6	1627-1633	Shale, as above.
4	1633-1637	Siltstone, as above.
25	1637-1662	Shale, as above.
15	1662-1677	Siltstone, medium- to dark-gray, argillaceous, scattered pyrite crystals.
8	1677-1685	Shale, as above.
19	1685-1704	Sandstone, medium-gray, very fine to fine-grained.
8	1704-1712	Shale, dark-gray, very silty, very finely micaceous; and siltstone, medium-gray.
4	1712-1716	Sandstone, medium-gray, very fine to fine-grained.
8	1716-1724	Shale, dark-gray.
17	1724-1741	Sandstone, medium-gray, very fine to fine-grained, silty.
41	1741-1782	Shale, dark-gray, silty, very finely micaceous, scattered calcite fragments in upper 10 ft., scattered pyrite crystals in lower 10 ft.
1	1782-1783	Siltstone, medium- to dark-gray.
9	1783-1792	Shale, as above.
2	1792-1794	Siltstone, as above.
9	1794-1803	Shale, as above.
2	1803-1805	Siltstone, medium- to dark-gray, argillaceous.
15	1805-1820	Shale, dark-gray, slightly silty in part, scattered pyrite crystals.
7	1820-1827	Limestone, medium- to dark-gray, silty.
135	1827-1962	Shale, dark-gray, slightly silty in part, very finely micaceous, scattered pyrite crystals.
4	1962-1966	Siltstone, medium-gray, scattered pyrite crystals and calcite fragments.
2	1966-1968	Shale, as above.
27	1968-1995	Sandstone, very light gray, very fine grained, slightly silty, scattered calcite fragments, drills free.
9	1995-2004	Sandstone, very light gray, very fine to fine-grained, slightly silty, scattered medium and coarse sand grains.
9	2004-2013	Sandstone, very light gray, very fine to fine-grained, scattered calcite fragments.
40	2013-2053	Shale, dark-gray to grayish-black, slightly silty, very finely micaceous, scattered pyrite crystals and calcite fragments.
4	2053-2057	Siltstone, medium-gray, scattered pyrite crystals.
7	2057-2064	Shale, as above.
6	2064-2070	Sandstone, light- to medium-gray, very fine to fine-grained, slightly silty.
5	2070-2075	Shale, dark-gray, slightly silty.
9	2075-2084	Sandstone, as above.
25	2084-2109	Shale, as above, scattered calcite fragments in lower 5 ft.
13	2109-2122	Siltstone, medium- to dark-gray, argillaceous, slightly very finely sandy, very finely to coarsely micaceous.
51	2122-2173	Shale, dark-gray, silty, very finely micaceous, scattered pyrite crystals, scattered calcite fragments in lower 10 ft.
4	2173-2177	Siltstone, medium- to dark-gray, argillaceous.
12	2177-2189	Shale, as above.
4	2189-2193	Siltstone, as above.
42	2193-2235	Shale, as above.
8	2235-2243	Siltstone, medium-gray, slightly very finely sandy.
14	2243-2257	Shale, dark-gray, slightly silty, very finely micaceous, scattered pyrite crystals.
13	2257-2270	Siltstone, medium-gray, very finely sandy, scattered pyrite crystals.
15	2270-2285	Shale, dark-gray, slightly silty, very finely micaceous, scattered pyrite crystals and calcite fragments.
11	2285-2296	Siltstone, medium-gray, very finely sandy (almost a very fine grained sandstone).
11	2296-2307	Shale, dark-gray, silty, very finely to finely micaceous, scattered pyrite crystals.
4	2307-2311	Siltstone, medium-gray.
3	2311-2314	Shale, dark-gray, very silty, very finely micaceous.
16	2314-2330	Sandstone, light- to medium-gray, very fine grained, silty, finely micaceous.
3	2330-2333	Shale, dark-gray, slightly silty, very finely micaceous.
1	2333-2334	Siltstone, medium-gray, very finely sandy.
9	2334-2343	Shale, as above.
2	2343-2345	Sandstone, medium-gray, very fine grained, silty.
6	2345-2351	Shale, dark-gray, silty, very finely micaceous.
3	2351-2354	Siltstone, medium-gray, very finely sandy, very finely to medium micaceous.

Thickness in feet	Interval in feet	Description
		Atoka Formation
4	2354-2358	Shale, as above.
8	2358-2366	Siltstone, as above.
5	2366-2371	Shale, as above.
2	2371-2373	Siltstone, as above.
3	2373-2376	Shale, as above.
2	2376-2378	Siltstone, as above.
4	2378-2382	Shale, as above.
4	2382-2386	Siltstone, as above.
3	2386-2389	Shale, as above.
4	2389-2393	Siltstone, as above.
7	2393-2400	Shale, as above.
4	2400-2404	Siltstone, as above.
54	2404-2458	Shale, dark-gray, slightly silty, very finely micaceous, scattered pyrite crystals in lower 10 ft.
6	2458-2464	Siltstone, medium-gray, very finely sandy (almost a very fine grained sandstone).
20	2464-2484	Sandstone, medium-gray, very fine grained, very silty, finely micaceous.
10	2484-2494	Shale, dark-gray.
9	2494-2503	Siltstone, medium- to dark-gray, very finely sandy.
2	2503-2505	Shale, dark-gray, slightly silty.
2	2505-2507	Siltstone, medium- to dark-gray.
6	2507-2513	Shale, as above.
3	2513-2516	Siltstone, as above.
11	2516-2527	Shale, as above.
6	2527-2533	Siltstone, medium-gray, slightly very finely sandy.
4	2533-2537	Shale, as above.
3	2537-2540	Siltstone, as above.
3	2540-2543	Shale, as above.
3	2543-2546	Siltstone, as above.
5	2546-2551	Shale, as above.
2	2551-2553	Siltstone, as above.
5	2553-2558	Shale, as above.
3	2558-2561	Siltstone, as above.
7	2561-2568	Shale, as above.
4	2568-2572	Siltstone, as above.
10	2572-2582	Shale, as above.
2	2582-2584	Siltstone, as above.
3	2584-2587	Shale, as above.
3	2587-2590	Siltstone, as above.
6	2590-2596	Shale, as above.
3	2596-2599	Siltstone, as above.
11	2599-2610	Shale, dark-gray, slightly silty, slightly very finely micaceous.
53	2610-2663	Shale, dark-gray, slightly silty in part, scattered pyrite crystals.
10	2663-2673	Siltstone, medium-gray.
15	2673-2688	Shale, dark-gray, slightly silty, slightly very finely micaceous, scattered pyrite crystals.
8	2688-2696	Sandstone, light- to medium-gray, very fine grained, silty.
8	2696-2704	Shale, dark-gray.
29	2704-2733	Sandstone, light-gray, very fine grained, slightly silty, slightly limy.
7	2733-2740	Shale, dark-gray, silty.
26	2740-2766	Siltstone, medium- to dark-gray, argillaceous in part.
17	2766-2783	Siltstone, medium-gray, slightly very finely sandy.
8	2783-2791	Siltstone, dark-gray, argillaceous, slightly very finely micaceous.
13	2791-2804	Siltstone, medium-gray, slightly very finely sandy.
11	2804-2815	Shale, as above.
17	2815-2832	Shale, dark-gray.
4	2832-2836	Shale, dark-gray, silty.
47	2836-2883	Shale, dark-gray, slightly very finely micaceous, scattered pyrite crystals.
22	2883-2905	Siltstone, medium- to dark-gray, very argillaceous.
31	2905-2936	Shale, dark-gray, scattered pyrite crystals.
14	2936-2950	Sandstone, medium-gray, very fine grained, slightly silty.
16	2950-2966	Shale, dark-gray, silty.
4	2966-2970	Siltstone, medium-gray, very finely sandy.
6	2970-2976	Shale, dark-gray, silty, slightly very finely micaceous, scattered calcite fragments.
7	2976-2983	Shale, dark-gray.
9	2983-2992	Shale, dark-gray, silty.
34	2992-3026	Shale, dark-gray, plant impressions, scattered calcite fragments in lower 15 ft.

Thickness in feet	Interval in feet	Description
		Atoka Formation
4	3026-3030	Sandstone, medium-gray, very fine to fine-grained, slightly silty. Top of unit is top of zone s.
3	3030-3033	Shale, dark-gray, silty.
4	3033-3037	Sandstone, as above.
3	3037-3040	Shale, as above.
21	3040-3061	Sandstone, as above.
3	3061-3064	Shale, dark-gray, scattered anhydrite fragments.
6	3064-3070	Sandstone, as above.
20	3070-3090	Shale, dark-gray, silty, scattered anhydrite fragments.
20	3090-3110	(No sample.)
20	3110-3130	Sandstone, light- to medium-gray, very fine to medium-grained, slightly silty, very finely to very coarsely micaceous, scattered pyrite crystals and anhydrite fragments.
9	3130-3139	Sandstone, light- to medium-gray, very fine to medium-grained, slightly silty, limy, very finely to very coarsely micaceous.
5	3139-3144	Shale, grayish-black, splintery fracture.
6	3144-3150	Sandstone, medium- to dark-gray, very fine to fine-grained, silty, very finely to finely micaceous.
10	3150-3160	(No sample.)
5	3160-3165	Sandstone, as above. Base of unit is base of zone s.
10	3165-3175	Shale, dark-gray, very finely micaceous.
7	3175-3182	Siltstone, medium- to dark-gray, very finely sandy, very finely to medium micaceous.
4	3182-3186	Shale, as above.
7	3186-3193	Siltstone, as above.
9	3193-3202	Shale, dark-gray, slightly silty, very finely micaceous.
10	3202-3212	Sandstone, medium- to dark-gray, very fine grained, silty, very finely to medium micaceous.
2	3212-3214	Siltstone, dark-gray, argillaceous in part, very finely to finely micaceous, scattered pyrite crystals.
8	3214-3222	Siltstone, medium- to dark-gray, very finely sandy (almost a sandstone), very finely to finely micaceous.
7	3222-3229	Shale, dark-gray, slightly silty, scattered anhydrite fragments.
4	3229-3233	Siltstone, medium- to dark-gray, very finely to finely sandy, very slightly limy, very finely to finely micaceous.
2	3233-3235	Shale, dark-gray, silty, very finely micaceous, scattered anhydrite fragments.
4	3235-3239	Sandstone, light- to medium-gray, very fine to fine-grained.
24	3239-3263	Siltstone, medium- to dark-gray, argillaceous, very finely micaceous, scattered anhydrite fragments.
11	3263-3274	Shale, dark-gray, silty, very finely micaceous.
10	3274-3284	Siltstone, medium- to dark-gray, very finely sandy.
50	3284-3334	Shale, dark-gray, very finely micaceous, scattered pyrite crystals and anhydrite fragments, concretions.
23	3334-3357	Shale, dark-gray, slightly silty, slightly very finely to finely micaceous, scattered pyrite crystals.
7	3357-3364	Siltstone, medium- to dark-gray, argillaceous, very finely micaceous.
39	3364-3403	Shale, dark-gray.
8	3403-3411	Siltstone, medium- to dark-gray, argillaceous, very finely micaceous.
21	3411-3432	Shale, dark-gray, slightly very finely micaceous, scattered anhydrite fragments.
4	3432-3436	Siltstone, medium- to dark-gray, very finely sandy, very finely micaceous, scattered pyrite crystals.
3	3436-3439	Shale, dark-gray, slightly very finely micaceous, plant impressions.
37	3439-3476	Sandstone, medium-gray, very fine grained, silty, very slightly limy, very finely micaceous, scattered pyrite crystals.
24	3476-3500	Siltstone, medium- to dark-gray, slightly very finely sandy, argillaceous, scattered pyrite crystals and anhydrite fragments.
4	3500-3504	Shale, dark-gray.
5	3504-3509	Siltstone, as above.
3	3509-3512	Shale, as above.
5	3512-3517	Siltstone, medium-gray, very finely sandy.
3	3517-3520	Shale, as above.
4	3520-3524	Sandstone, medium-gray, very fine grained, silty.
9	3524-3533	Shale, dark-gray, very finely micaceous, scattered pyrite crystals, splintery fracture.
3	3533-3536	Sandstone, light- to medium-gray, very fine grained, silty, pyrite crystals.
33	3536-3569	Shale, dark-gray, slightly silty, slightly very finely micaceous, scattered pyrite crystals.
12	3569-3581	Sandstone, medium- to dark-gray, very fine grained, silty, well-cemented.
7	3581-3588	Shale, as above.

Thickness in feet	Interval in feet	Description
		Atoka Formation
7	3588-3595	Siltstone, dark-gray, very finely sandy (almost a very fine sandstone), very finely micaceous, scattered pyrite crystals.
13	3595-3608	Shale, as above.
7	3608-3615	Siltstone, medium- to dark-gray, very finely sandy, slightly very finely micaceous.
10	3615-3625	Siltstone, medium- to dark-gray, argillaceous in part.
32	3625-3657	Shale, dark-gray, slightly very finely micaceous, scattered pyrite crystals in lower 10 ft.
38	3657-3695	Sandstone, medium- to dark-gray, very fine grained, silty, very finely to finely micaceous, scattered pyrite crystals in upper 10 ft., well-cemented.
28	3695-3723	Sandstone, medium- to dark-gray, very fine grained, silty, limy, very finely to finely micaceous, well-cemented.
22	3723-3745	Siltstone, medium- to dark-gray, very finely sandy, scattered pyrite crystals in upper 10 ft., well-cemented.
22	3745-3767	Shale, dark-gray, slightly silty, very finely micaceous.
16	3767-3783	Siltstone, medium- to dark-gray, very finely sandy, scattered pyrite crystals.
4	3783-3787	Shale, as above.
6	3787-3793	Siltstone, medium- to dark-gray, very finely sandy, very finely micaceous, scattered anhydrite fragments.
4	3793-3797	Shale, as above.
6	3797-3803	Siltstone, medium- to dark-gray, very finely micaceous.
8	3803-3811	Shale, as above.
6	3811-3817	Siltstone, medium- to dark-gray.
15	3817-3832	Siltstone, medium- to dark-gray, very finely sandy.
8	3832-3840	Siltstone, brownish-gray, argillaceous to sandy.
10	3840-3850	Shale, dark-gray, very finely micaceous.
10	3850-3860	Siltstone, medium- to dark-gray, very finely micaceous.
5	3860-3865	Shale, dark-gray, slightly silty, very finely micaceous.
4	3865-3869	Siltstone, medium- to dark-gray, very finely sandy.
5	3869-3874	Siltstone, brownish-gray, argillaceous to sandy.
8	3874-3882	Shale, dark-gray, slightly silty, very finely micaceous.
6	3882-3888	Siltstone, medium- to dark-gray, very finely sandy, very finely to finely micaceous, scattered pyrite crystals.
6	3888-3894	Sandstone, medium- to dark-gray, very fine grained, slightly silty.
4	3894-3898	Shale, dark-gray, silty.
5	3898-3903	Sandstone, as above.
3	3903-3906	Shale, as above.
4	3906-3910	Siltstone, medium- to dark-gray.
9	3910-3919	Shale, dark-gray, very finely micaceous.
8	3919-3927	Sandstone, medium- to dark-gray, very fine grained, silty, scattered pyrite crystals.
3	3927-3930	Shale, as above.
10	3930-3940	Sandstone, medium- to dark-gray, very fine grained, silty.
6	3940-3946	Siltstone, medium- to dark-gray, very finely sandy.
7	3946-3953	Shale, dark-gray, splintery fracture.
10	3953-3963	Sandstone, light- to medium-gray, very fine grained, silty in part, slightly very finely micaceous.
17	3963-3980	(No sample.)
9	3980-3989	Siltstone, medium- to dark-gray.
8	3989-3997	Siltstone, medium- to dark gray, very finely sandy, very finely micaceous.
13	3997-4010	Shale, dark-gray, silty.
7	4010-4017	Sandstone, light- to medium-gray, very fine grained, slightly silty.
6	4017-4023	Siltstone, medium- to dark-gray, argillaceous.
8	4023-4031	Sandstone, light- to dark-gray, very fine grained, silty, scattered pyrite crystals.
9	4031-4040	Siltstone, medium- to dark-gray, argillaceous, very finely micaceous.
5	4040-4045	Sandstone, light- to medium-gray, very fine grained, silty.
9	4045-4054	Siltstone, medium- to dark-gray, argillaceous, very finely micaceous.
6	4054-4060	Shale, dark-gray, slightly silty.
4	4060-4064	Siltstone, medium- to dark-gray, very finely sandy, very finely micaceous.
11	4064-4075	Siltstone, medium- to dark-gray, argillaceous, very finely micaceous.
9	4075-4084	Shale, dark-gray, silty, slightly very finely micaceous.
9	4084-4093	Siltstone, medium- to dark-gray, argillaceous, sandy in part, very finely micaceous.
5	4093-4098	Shale, dark-gray, slightly silty, splintery fracture.
6	4098-4104	Siltstone, medium- to dark-gray, argillaceous, very finely micaceous.
8	4104-4112	Shale, as above.
6	4112-4118	Sandstone, medium- to dark-gray, very fine grained, very silty, very finely micaceous.
6	4118-4124	Shale, as above.
8	4124-4132	Siltstone, medium- to dark-gray, slightly very finely sandy, scattered calcite fragments.
7	4132-4139	Shale, as above.

Thickness in feet	Interval in feet	Description
		Atoka Formation
5	4139-4144	Sandstone, medium- to dark-gray, very fine grained, very silty.
9	4144-4153	Shale, dark-gray, slightly silty, conchoidal and splintery fracture.
5	4153-4158	Siltstone, medium- to dark-gray, slightly very finely sandy, scattered pyrite crystals, concretions.
15	4158-4173	Shale, as above.
6	4173-4179	Siltstone, medium- to dark-gray, very finely sandy.
4	4179-4183	Siltstone, medium- to dark-gray.
14	4183-4197	Shale, dark-gray, slightly silty, conchoidal and splintery fracture, concretions.
8	4197-4205	Siltstone, medium- to dark-gray, very finely sandy, very finely micaceous.
5	4205-4210	Shale, as above.
5	4210-4215	Siltstone, medium- to dark-gray, very finely sandy, scattered pyrite crystals.
7	4215-4222	Shale, as above.
8	4222-4230	Siltstone, medium- to dark-gray, very finely sandy.
4	4230-4234	Shale, dark-gray, slightly silty, very finely micaceous.
14	4234-4248	Siltstone, medium- to dark-gray, argillaceous, scattered pyrite crystals.
11	4248-4259	Shale, dark-gray, slightly silty.
7	4259-4266	Siltstone, as above.
50	4266-4316	Shale, dark-gray, slightly silty in part.
15	4316-4331	Siltstone, medium- to dark-gray, very finely sandy (almost a sandstone).
4	4331-4335	Siltstone, light brownish-gray; and shale, light brownish-gray to brownish-gray.
2	4335-4337	Shale, dark-gray, slightly silty.
5	4337-4342	Siltstone, medium- to dark-gray, argillaceous.
4	4342-4346	Shale, as above.
22	4346-4368	Siltstone, medium- to dark-gray, very finely sandy in part.
6	4368-4374	Siltstone, medium- to dark-gray, argillaceous, very finely micaceous, scattered pyrite crystals.
9	4374-4383	Shale, as above.
8	4383-4391	Siltstone, as above.
15	4391-4406	Shale, as above.
5	4406-4411	Siltstone, medium- to dark-gray, argillaceous.
32	4411-4443	Shale, as above.
3	4443-4446	Siltstone, medium- to dark-gray.
20	4446-4466	Shale, as above.
4	4466-4470	Siltstone, medium- to dark-gray.
6	4470-4476	Shale, dark-gray, slightly silty, scattered pyrite crystals.
8	4476-4484	Sandstone, medium- to dark-gray, very fine grained, very silty.
7	4484-4491	Shale, dark-gray, slightly silty, scattered pyrite crystals, concretions.
15	4491-4506	Siltstone, medium- to dark-gray, very finely sandy (almost a sandstone), slightly very finely micaceous, scattered pyrite crystals in lower 2 ft.
17	4506-4523	Siltstone, medium- to dark-gray, very finely sandy.
7	4523-4530	Shale, dark-gray, slightly silty.
7	4530-4537	Sandstone, medium-gray, very fine grained, slightly silty.
13	4537-4550	Siltstone, medium- to dark-gray, slightly very finely sandy.
7	4550-4557	Shale, dark-gray, silty in part, splintery fracture.
6	4557-4563	Sandstone, medium- to dark-gray, very fine to fine-grained, silty, very finely to finely micaceous.
1	4563-4564	Claystone, light greenish-gray, conchoidal fracture, waxy luster (bentonite?).
5	4564-4569	Shale, dark-gray, slightly silty, scattered pyrite crystals.
5	4569-4574	Sandstone, medium- to dark-gray, very fine to medium-grained, silty, slightly limy, very finely micaceous.
12	4574-4586	Sandstone, medium- to dark-gray, very fine grained, very silty, well-cemented.
7	4586-4593	Siltstone, medium- to dark-gray, very finely sandy, well-cemented.
3	4593-4596	Shale, as above.
7	4596-4603	Siltstone, as above.
3	4603-4606	Siltstone, medium- to dark-gray, well-cemented.
8	4606-4614	Shale, dark-gray, slightly silty, splintery fracture.
20	4614-4634	Sandstone, medium-gray, very fine to fine-grained, slightly silty, slightly limy in part, scattered pyrite crystals in lower 2 ft.
10	4634-4644	Siltstone, medium- to dark-gray, very finely to finely micaceous.
11	4644-4655	Shale, as above.
10	4655-4665	Siltstone, medium- to dark-gray, very finely sandy, very finely micaceous.
3	4665-4668	Siltstone, medium- to dark-gray, very finely micaceous.
8	4668-4676	Siltstone, light brownish-gray to brownish-gray.
6	4676-4682	Shale, as above.
4	4682-4686	Siltstone, medium- to dark-gray, slightly very finely sandy.

Thickness in feet	Interval in feet	Description
		Atoka Formation
19	4686-4705	Shale, as above.
18	4705-4723	Sandstone, medium- to dark-gray, very fine grained, silty, very slightly limy, scattered pyrite crystals in upper 5 ft.
2	4723-4725	Siltstone, medium- to dark-gray.
2	4725-4727	Siltstone, brownish-gray.
3	4727-4730	Shale, brownish-gray.
3	4730-4733	Shale, dark-gray, slightly silty, splintery fracture.
3	4733-4736	Siltstone, medium- to dark-gray.
6	4736-4742	Shale, dark-gray, slightly silty.
11	4742-4753	Siltstone, as above.
60	4753-4813	Shale, dark-gray to grayish-black, scattered pyrite crystals, concretions.
7	4813-4820	Sandstone, light- to medium-gray, very fine to fine-grained, limy.
5	4820-4825	Sandstone, light brownish-gray, very fine to fine-grained, scattered medium sand grains, drills free.
8	4825-4833	Shale, as above.
13	4833-4846	Siltstone, medium- to dark-gray, argillaceous.
4	4846-4850	Shale, as above.
30	4850-4880	(No sample.) Probably shale.
16	4880-4896	Sandstone, light brownish-gray, very fine to fine-grained, drills free.
14	4896-4910	Shale, dark-gray, silty, very finely micaceous in part.
15	4910-4925	Sandstone, medium-gray, very fine grained, silty, very finely micaceous, well-cemented.
29	4925-4954	Shale, dark-gray, silty in part, very finely micaceous in part.
19	4954-4973	Siltstone, medium- to dark-gray, very finely sandy, very finely to finely micaceous.
9	4973-4982	Siltstone, medium- to dark-gray, very finely micaceous.
11	4982-4993	Shale, dark-gray, slightly silty.
7	4993-5000	Siltstone, medium- to dark-gray, argillaceous, very finely micaceous.
16	5000-5016	Shale, dark-gray, silty, very slightly very finely micaceous.
8	5016-5024	Siltstone, medium- to dark-gray, argillaceous, very finely micaceous.
7	5024-5031	Shale, as above.
11	5031-5042	Siltstone, medium- to dark-gray, slightly very finely sandy, argillaceous, very finely micaceous.
7	5042-5049	Siltstone, medium- to dark-gray, very finely sandy, very finely micaceous.
6	5049-5055	Shale, dark-gray.
9	5055-5064	Siltstone, medium- to dark-gray, very finely sandy.
18	5064-5082	Shale, dark-gray, very silty, slightly very finely micaceous.
38	5082-5120	Shale, dark-gray, slightly silty, slightly very finely micaceous.
7	5120-5127	Siltstone, medium- to dark-gray, very finely sandy, very finely micaceous.
11	5127-5138	Shale, dark-gray.
12	5138-5150	Siltstone, medium- to dark-gray, slightly very finely sandy, very finely micaceous, scattered pyrite crystals.
6	5150-5156	Shale, dark-gray, slightly silty, slightly very finely micaceous, scattered pyrite crystals.
4	5156-5160	Siltstone, as above.
4	5160-5164	Shale, dark-gray, slightly silty, slightly very finely micaceous.
3	5164-5167	Siltstone, as above.
20	5167-5187	Shale, as above.
8	5187-5195	Sandstone, medium- to dark-gray, very fine to fine-grained, silty, very finely micaceous.
33	5195-5228	Shale, dark-gray, slightly silty, scattered pyrite crystals in lower 10 ft.
22	5228-5250	Sandstone, medium- to dark-gray, very fine to fine-grained, slightly silty, well-cemented.
14	5250-5264	Siltstone, medium- to dark-gray, very finely sandy, well-cemented.
5	5264-5269	Shale, dark-gray, slightly silty in part, scattered pyrite crystals.
45	5269-5314	Sandstone, medium- to dark-gray to brownish-gray, very fine to medium-grained, scattered coarse and very coarse sand grains, slightly limy to limy, drills free.
13	5314-5327	Shale, dark-gray, slightly very finely micaceous.
30	5327-5357	Sandstone, light- to medium-gray, very fine to medium-grained, slightly limy to very limy, scattered pyrite crystals, porous, brachiopods.
12	5357-5369	Shale, dark-gray to grayish-black, slightly silty, abundant brown flakes of iron or manganese oxide, splintery fracture.
12	5369-5381	Sandstone, light- to medium-gray, very fine to medium-grained, scattered coarse and very coarse sand grains, slightly limy, scattered pyrite crystals.
5	5381-5386	Shale, dark-gray, slightly silty, slightly very finely micaceous, scattered pyrite crystals.
7	5386-5393	Sandstone, light-gray, very fine to fine-grained, scattered medium to very coarse sand grains, very slightly limy, scattered pyrite crystals.
2	5393-5395	Shale, as above.
2	5395-5397	Sandstone, very light-gray to medium-gray, very fine to medium-grained, scattered coarse to very coarse sand grains, scattered granules and pebbles.

Thickness in feet	Interval in feet	Description
		Atoka Formation
5	5397-5402	Shale, dark-gray, slightly silty, scattered coal fragments, splintery fracture.
18	5402-5420	Sandstone, light- to medium-gray, very fine to medium-grained, scattered coarse to very coarse sand grains, scattered granules and pebbles, very slightly limy to limy.
4	5420-5424	Shale, dark-gray, slightly silty, splintery fracture, scattered pyrite crystals.
32	5424-5456	Sandstone, light- to medium-gray, very fine to medium-grained, scattered coarse to very coarse sand grains, scattered granules and pebbles, very slightly limy to limy, scattered pyrite crystals, porous, fossiliferous; base of unit is base of Atoka Formation.
		Upper part of Bloyd Shale and Prairie Grove Member of Hale Formation, undifferentiated
18	5456-5474	Shale, dark-gray to grayish-black, slightly silty, splintery fracture.
10	5474-5484	Limestone, medium- to dark-gray, very finely to coarsely sandy, scattered calcite crystals and fragments, scattered pyrite crystals, oolitic, cephalopods, gastropods, and crinoids.
19	5484-5503	Shale, dark-gray, slightly silty.
10	5503-5513	Siltstone, medium- to dark-gray, very finely sandy, slightly limy, scattered pyrite crystals, concretions.
12	5513-5525	Shale, medium-gray to grayish-black, slightly silty to very silty, very finely micaceous, scattered slickensided fragments.
18	5525-5543	Siltstone, medium- to dark-gray, argillaceous, very finely micaceous, abundant moderate brown flakes of iron or manganese oxide.
17	5543-5560	Shale, dark-gray to grayish-black, slightly silty, scattered pyrite crystals, scattered slickensided fragments.
10	5560-5570	Sandstone, light-gray, very fine grained, very slightly limy, slightly finely micaceous.
25	5570-5595	Siltstone, medium- to dark-gray, very finely sandy in part, very finely micaceous, scattered pyrite crystals in lower 5 ft.
9	5595-5604	Shale, dark-gray to grayish-black, slightly silty, slightly very finely micaceous.
31	5604-5635	Sandstone, medium- to dark-gray, very fine to medium-grained, argillaceous to silty, scattered coarse grains in part, very finely to medium micaceous, streaks of chalcedony, scattered pyrite crystals in lower 5 ft.
19	5635-5654	Shale, dark-gray to grayish-black, slightly silty, scattered pyrite crystals, splintery fracture.
40	5654-5694	Sandstone, medium- to dark-gray, very fine to fine-grained, argillaceous to silty, very finely to medium micaceous, scattered pyrite crystals in lower 10 ft.
41	5694-5735	Shale, dark-gray to grayish-black, slightly silty, scattered pyrite crystals, moderate brown flakes of iron or manganese oxide.
7	5735-5742	Sandstone, medium- to dark-gray, very fine grained, slightly argillaceous, slightly silty, slightly limy to limy.
4	5742-5746	Shale, as above.
10	5746-5756	Sandstone, light- to medium-gray, very fine to fine-grained, limy to very limy.
4	5756-5760	Shale, as above.
4	5760-5764	Sandstone, light- to medium dark-gray, very fine to fine-grained, limy.
10	5764-5774	Shale, as above.
6	5774-5780	Sandstone, as above.
5	5780-5785	Shale, as above.
12	5785-5797	Sandstone, as above.
3	5797-5800	Shale, as above.
10	5800-5810	(No sample.)
3	5810-5813	Sandstone, as above.
2	5813-5815	Shale, as above.
9	5815-5824	(No sample.)
	5824	Total depth.

Section 4

Gulf Oil Corp. No. 1 Wharton

Sec. 35, T. 9 N., R. 22 W., Johnson County, Ark. Elevation: 737 ft.; total depth: 3,400 ft. Rock samples examined and logged by Boyd R. Haley. Lower part of Hartshorne Sandstone and upper part of Atoka Formation.

Thickness in feet	Interval in feet	Description
		Pennsylvanian System **Lower part of Hartshorne Sandstone**
5	0- 5	Sandstone, very light gray, fine- to medium-grained, subrounded grains, medium to coarsely micaceous.
14	5- 19	Sandstone, very light gray, medium-grained, subangular grains, medium micaceous, porous, drills free.
10	19- 29	Sandstone, very light gray, fine- to medium-grained, subrounded grains, porous, drills free.
21	29- 50	Sandstone, very light gray, very fine to medium-grained, scattered coal fragments, drills free.
8	50- 58	Sandstone, light-gray, very fine to fine-grained, silty, finely micaceous, well-cemented; base of unit is base of Hartshorne Sandstone.
		Upper part of Atoka Formation
2	58- 60	Shale, dark-gray, silty, very finely micaceous.
3	60- 63	Siltstone, medium-gray, very finely micaceous.
2	63- 65	Shale, as above.
2	65- 67	Siltstone, as above.
2	67- 69	Shale, as above.
7	69- 76	Siltstone, as above.
3	76- 79	Shale, as above.
6	79- 85	Siltstone, as above.
2	85- 87	Shale, as above.
5	87- 92	Siltstone, as above.
2	92- 94	Shale, as above.
4	94- 98	Siltstone, as above.
8	98- 106	Shale, as above.
2	106- 108	Siltstone, as above.
2	108- 110	Shale, as above.
3	110- 113	Siltstone, as above.
9	113- 122	Shale, as above; grayish-black concretions.
1	122- 123	Siltstone, as above.
5	123- 128	Shale, dark-gray, silty, very finely micaceous, scattered pyrite crystals.
2	128- 130	Siltstone, as above.
37	130- 167	Shale, dark-gray, very finely micaceous.
9	167- 176	Sandstone, very light gray, very fine to fine-grained, silty, slightly limy, iron-oxide coated sand grains.
4	176- 180	Shale, dark-gray, very finely micaceous, scattered pyrite crystals.
3	180- 183	Siltstone, as above.
9	183- 192	Shale, as above.
6	192- 198	Siltstone, as above.
55	198- 253	Shale, medium- to dark-gray, slightly silty, very finely micaceous.
3	253- 256	Siltstone, medium-gray, very finely sandy, very slightly limy, very finely micaceous.
7	256- 263	Shale, as above.
3	263- 266	Sandstone, light- to medium-gray, very fine to fine-grained, silty, very slightly limy, very finely to finely micaceous.
9	266- 275	Shale, dark-gray, very finely micaceous.
2	275- 277	Sandstone, light- to medium-gray, very fine grained, silty, very finely micaceous.
3	277- 280	Shale, as above.
2	280- 282	Sandstone, light-gray, very fine to fine-grained, silty, slightly limy.
1	282- 283	Shale, as above.
5	283- 288	Sandstone, as above.
4	288- 292	Shale, as above.
2	292- 294	Siltstone, medium-gray, very finely micaceous.
2	294- 296	Shale, as above.
4	296- 300	Siltstone, as above.
7	300- 307	Shale, as above.
5	307- 312	Siltstone, as above.
4	312- 316	Shale, as above.
2	316- 318	Siltstone, as above.

Thickness in feet	Interval in feet	Description
		Upper part of Atoka Formation
8	318- 326	Shale, as above.
3	326- 329	Sandstone, light-gray, very fine grained, very silty, slightly limy, finely micaceous.
7	329- 336	Siltstone, medium-gray, finely micaceous.
2	336- 338	Sandstone, as above.
5	338- 343	Siltstone, as above.
7	343- 350	Sandstone, light-gray, fine-grained, slightly silty, very slightly limy, finely micaceous, porous. Top of unit is top of zone c.
20	350- 370	Sandstone, light- to medium-gray, very fine to fine-grained, slightly silty, scattered rounded medium sand grains, finely micaceous.
6	370- 376	Siltstone, medium-gray, very finely sandy, finely micaceous.
4	376- 380	Sandstone, light- to medium-gray, very fine grained, silty, finely micaceous.
3	380- 383	Siltstone, medium-gray, very finely micaceous.
2	383- 385	Shale, dark-gray, very finely micaceous.
3	385- 388	Siltstone, as above.
9	388- 397	Shale, as above.
7	397- 404	Shale, medium-gray, very silty, finely micaceous.
6	404- 410	Sandstone, light-gray, very fine grained, very silty, finely micaceous.
10	410- 420	Siltstone, medium-gray, very finely to finely micaceous.
4	420- 424	Sandstone, medium-gray, very fine grained, very silty, finely micaceous.
26	424- 450	Siltstone, light- to medium-gray, very finely sandy in part, finely micaceous.
3	450- 453	Sandstone, light-gray, very fine grained, very silty, finely micaceous.
1	453- 454	Siltstone, medium-gray, finely micaceous.
2	454- 456	Sandstone, as above.
4	456- 460	Siltstone, as above.
3	460- 463	Sandstone, as above.
3	463- 466	Siltstone, as above.
2	466- 468	Sandstone, as above.
2	468- 470	Siltstone, as above.
2	470- 472	Sandstone, as above.
4	472- 476	Siltstone, as above.
4	476- 480	Sandstone, light-gray, very fine grained, slightly silty, some iron-oxide coated sand grains.
20	480- 500	Sandstone, light-gray, very fine to fine-grained, silty, finely micaceous, some iron-oxide coated sand grains.
3	500- 503	Sandstone, light-gray, fine- to medium-grained, slightly silty, abundant subrounded coarse sand grains.
7	503- 510	Shale, dark-gray, very finely to finely micaceous.
3	510- 513	Sandstone, light-gray, fine-grained, slightly silty, scattered medium sand grains, finely micaceous.
2	513- 515	Shale, as above.
5	515- 520	Sandstone, light-gray, very fine to fine-grained, silty, finely micaceous.
7	520- 527	Shale, as above.
5	527- 532	Sandstone, light-gray, very fine to fine-grained, silty, very finely micaceous.
16	532- 548	Shale, as above.
5	548- 553	Sandstone, light-gray, very fine grained, silty, finely micaceous.
3	553- 556	Shale, as above.
3	556- 559	Sandstone, light-gray, very fine to fine-grained, silty, finely micaceous, iron-oxide coated sand grains.
3	559- 562	Shale, as above.
3	562- 565	Sandstone, light-gray, very fine grained, very silty, very finely micaceous. Base of unit is base of zone c.
58	565- 623	Shale, dark-gray, very finely to finely micaceous, scattered pyrite crystals.
11	623- 634	Siltstone, medium- to dark-gray, finely micaceous.
104	634- 738	Shale, dark-gray, slightly silty, finely micaceous, scattered pyrite crystals; and siltstone, medium- to dark-gray, very finely micaceous.
42	738- 780	Shale, dark-gray, very finely to finely micaceous.
10	780- 790	(No sample.)
25	790- 815	Siltstone, dark-gray, very finely sandy in part, finely micaceous.
25	815- 840	Shale, dark-gray to grayish-black, very finely to finely micaceous.
30	840- 870	(No sample.)
23	870- 893	Shale, dark-gray, very finely micaceous.
3	893- 896	Siltstone, dark-gray, very finely micaceous, well-cemented.
187	896-1083	Shale, dark-gray to grayish-black, very finely micaceous, scattered pyrite crystals.
9	1083-1092	Sandstone, very light gray, very fine to fine-grained.
1	1092-1093	Shale, dark-gray, silty, very finely micaceous.

Thickness in feet	Interval in feet	Description
		Upper part of Atoka Formation
14	1093-1107	Sandstone, very light gray, very fine grained, silty.
1	1107-1108	Shale, as above.
2	1108-1110	Sandstone, as above.
1	1110-1111	Shale, as above.
1	1111-1112	Sandstone, as above.
6	1112-1118	Shale, dark-gray, very finely micaceous.
6	1118-1124	Sandstone, light-gray, very fine to fine-grained, silty, scattered subrounded medium sand grains.
10	1124-1134	Shale, as above.
6	1134-1140	Sandstone, light-gray, very fine grained, silty, scattered fine to medium sand grains.
53	1140-1193	Shale, as above.
3	1193-1196	Siltstone, medium-gray, very finely micaceous.
1	1196-1197	Shale, dark-gray, very finely micaceous, scattered pyrite crystals.
2	1197-1199	Siltstone, as above.
1	1199-1200	Shale, as above.
4	1200-1204	Siltstone, as above.
1	1204-1205	Shale, as above.
2	1205-1207	Siltstone, as above.
33	1207-1240	Shale, as above.
2	1240-1242	Siltstone, as above.
6	1242-1248	Shale, dark-gray, very finely micaceous.
2	1248-1250	Siltstone, as above.
2	1250-1252	Shale, as above.
2	1252-1254	Siltstone, as above.
1	1254-1255	Shale, as above.
2	1255-1257	Siltstone, as above.
9	1257-1266	Shale, as above.
4	1266-1270	Siltstone, as above.
10	1270-1280	Shale, as above.
3	1280-1283	Sandstone, light-gray, very fine grained, silty, scattered fine to medium sand grains.
5	1283-1288	Shale, medium- to dark-gray, very finely micaceous.
4	1288-1292	Sandstone, light-gray, very fine to medium-grained, subangular to subrounded sand grains.
1	1292-1293	Shale, medium-gray, silty, finely micaceous.
3	1293-1296	Sandstone, as above.
1	1296-1297	Shale, as above.
9	1297-1306	Sandstone, as above.
6	1306-1312	Shale, dark-gray to grayish-black, very finely micaceous.
1	1312-1313	Coal.
4	1313-1317	Shale, as above.
5	1317-1322	Siltstone, light- to medium-gray, very finely micaceous, well-cemented in part.
2	1322-1324	Shale, as above.
11	1324-1335	Sandstone, very light-gray, fine- to medium-grained, drills free.
7	1335-1342	Siltstone, light- to medium-gray, finely micaceous.
8	1342-1350	Shale, dark-gray, slightly silty, very finely micaceous.
8	1350-1358	Shale, dark-gray, very finely micaceous.
7	1358-1365	Siltstone, light- to medium-gray, very finely micaceous.
16	1365-1381	Shale, medium- to dark-gray, slightly silty, very finely micaceous.
5	1381-1386	Siltstone, light-gray, very finely to finely sandy, scattered rounded medium sand grains, very finely micaceous.
61	1386-1447	Shale, dark-gray, very finely micaceous, granules of very light-gray anhydrite in lower 20 ft.
20	1447-1467	Shale, dark-gray to grayish-black, very finely micaceous, scattered pyrite crystals.
11	1467-1478	Sandstone, light-gray, very fine to fine-grained, silty.
4	1478-1482	Shale, dark-gray.
4	1482-1486	Siltstone, light- to medium-gray, very finely sandy, finely micaceous.
13	1486-1499	Sandstone, light-gray, very fine-grained, silty, very finely micaceous.
1	1499-1500	Shale, dark-gray, very finely micaceous, scattered pyrite crystals.
3	1500-1503	Siltstone, light- to medium-gray, very finely sandy.
5	1503-1508	Shale, as above.
2	1508-1510	Siltstone, as above.
3	1510-1513	Shale, as above.
11	1513-1524	Sandstone, light-gray, very fine grained, very silty, very finely micaceous.
4	1524-1528	Shale, dark-gray, very finely micaceous.
8	1528-1536	Sandstone, very light-gray, very fine to fine-grained, slightly silty.

Thickness in feet	Interval in feet	Description
		Upper part of Atoka Formation
2	1536-1538	Shale, as above.
14	1538-1552	Shale, dark-gray, very finely micaceous; and sandstone, light-gray, very fine grained, very silty.
14	1552-1566	Shale, dark-gray, very finely micaceous.
10	1566-1576	Sandstone, very light-gray, very fine to fine-grained, scattered pyrite crystals, drills free.
104	1576-1680	Shale, dark-gray to grayish-black, very finely micaceous, scattered pyrite crystals in upper 30 ft.
4	1680-1684	Sandstone, light-gray, very fine grained, very silty, very finely micaceous.
1	1684-1685	Siltstone, medium-gray, finely micaceous.
12	1685-1697	Sandstone, light-gray, very fine to fine-grained, slightly silty.
5	1697-1702	Siltstone, as above.
4	1702-1706	Sandstone, as above.
2	1706-1708	Siltstone, as above.
7	1708-1715	Sandstone, as above.
1	1715-1716	Siltstone, as above.
6	1716-1722	Sandstone, as above.
6	1722-1728	Shale, dark-gray, very finely micaceous.
9	1728-1737	Sandstone, light- to medium-gray, very fine-grained, very silty.
3	1737-1740	Shale, as above.
18	1740-1758	Sandstone, light-gray, very fine to fine-grained, slightly silty, scattered rounded medium sand grains.
239	1758-1997	Shale, as above.
3	1997-2000	Siltstone, medium- to dark-gray, very finely micaceous.
13	2000-2013	Shale, as above.
7	2013-2020	Sandstone, very light-gray, fine- to medium-grained, subangular to rounded sand grains, slightly limy.
26	2020-2046	Sandstone, very light-gray, very fine to fine-grained, silty, abundant rounded medium sand grains, very slightly limy.
6	2046-2052	Shale, as above.
12	2052-2064	Sandstone, light-gray, very fine-grained, very silty, very finely micaceous, well-cemented.
79	2064-2143	Shale, dark-gray to grayish-black, very finely micaceous, scattered pyrite crystals.
3	2143-2146	Siltstone, medium-gray, almost very fine grained sandstone, very finely micaceous, well-cemented.
60	2146-2206	Shale, dark-gray to grayish-black, very finely micaceous, slightly medium to very coarsely micaceous, scattered pyrite crystals.
68	2206-2274	Shale, dark-gray, very finely to finely micaceous, scattered pyrite crystals.
16	2274-2290	Shale, dark-gray to grayish-black, very finely micaceous, scattered pyrite crystals.
3	2290-2293	Sandstone, medium-gray, very fine grained, very silty.
31	2293-2324	Shale, dark-gray to grayish-black, very finely micaceous.
4	2324-2328	Sandstone, light-gray, very fine to fine-grained, silty, abundant rounded medium sand grains.
8	2328-2336	Shale, dark-gray, very finely micaceous, scattered pyrite crystals.
4	2336-2340	Siltstone, medium-gray, very finely micaceous.
8	2340-2348	Shale, as above.
2	2348-2350	Siltstone, as above.
7	2350-2357	Shale, as above.
3	2357-2360	Siltstone, as above.
27	2360-2387	Shale, as above.
8	2387-2395	Siltstone, light- to medium-gray, almost very fine grained sandstone, very finely micaceous.
5	2395-2400	Shale, as above.
5	2400-2405	Siltstone, light-gray, very finely sandy, very finely micaceous, scattered pyrite crystals.
10	2405-2415	Sandstone, very light gray, very fine grained, silty, scattered fine to medium sand grains.
2	2415-2417	Shale, dark-gray, slightly silty, very finely micaceous.
6	2417-2423	Sandstone, as above.
1	2423-2424	Shale, as above.
3	2424-2427	Sandstone, as above.
7	2427-2434	Shale, dark-gray, very finely micaceous.
3	2434-2437	Sandstone, light-gray, very fine grained, very silty.
2	2437-2439	Shale, as above.
2	2439-2441	Sandstone, as above.
1	2441-2442	Shale, as above.
5	2442-2447	Siltstone, medium-gray, very finely micaceous.
1	2447-2448	Shale, as above.
5	2448-2453	Siltstone, as above.
4	2453-2457	Shale, as above.

Thickness in feet	Interval in feet	Description
		Upper part of Atoka Formation
4	2457-2461	Siltstone, as above.
3	2461-2464	Shale, as above.
3	2464-2467	Siltstone, as above.
11	2467-2478	Shale, as above.
6	2478-2484	Siltstone, as above.
1	2484-2485	Shale, as above.
2	2485-2487	Siltstone, as above.
2	2487-2489	Shale, as above.
1	2489-2490	Siltstone, as above.
4	2490-2494	Shale, dark-gray to grayish-black, very finely micaceous.
4	2494-2498	Shale, dark-gray, silty, very finely micaceous.
2	2498-2500	Shale, dark-gray to grayish-black, very finely micaceous.
3	2500-2503	Shale, dark-gray, silty, very finely micaceous.
3	2503-2506	Shale, dark-gray to grayish-black, very finely micaceous.
1	2506-2507	Shale, dark-gray, silty, very finely micaceous.
28	2507-2535	Shale, dark-gray to grayish-black, very finely micaceous.
3	2535-2538	Siltstone, very light gray, very finely micaceous, fine to medium anhydrite crystals.
2	2538-2540	Shale, as above.
6	2540-2546	Siltstone, light-gray, slightly very finely sandy, very finely micaceous, anhydrite crystals.
2	2546-2548	Shale, as above.
12	2548-2560	Siltstone, as above.
4	2560-2564	Shale, dark-gray, very finely to finely micaceous.
4	2564-2568	Siltstone, light- to medium-gray, finely micaceous, almost very fine grained sandstone.
1	2568-2569	Shale, as above.
7	2569-2576	Siltstone, as above.
2	2576-2578	Shale, as above.
5	2578-2583	Siltstone, as above.
3	2583-2586	Shale, as above.
8	2586-2594	Siltstone, as above.
1	2594-2595	Shale, as above.
4	2595-2599	Siltstone, as above.
4	2599-2603	Shale, as above.
4	2603-2607	Siltstone, as above.
33	2607-2640	Shale, as above.
23	2640-2663	Shale, dark-gray to grayish-black, very finely micaceous.
57	2663-2720	Shale, dark-gray, very finely to finely micaceous, scattered pyrite crystals.
33	2720-2753	Shale, dark-gray to grayish-black, very finely micaceous.
33	2753-2786	Shale, dark-gray, very finely to finely micaceous, scattered pyrite crystals.
24	2786-2810	Sandstone, very light gray, very fine grained, almost silt-size grains, very silty, well-cemented.
20	2810-2830	Siltstone, light-gray, very finely micaceous, well-cemented.
16	2830-2846	Siltstone, medium-gray, very finely micaceous.
11	2846-2857	Shale, dark-gray, very finely micaceous.
12	2857-2869	Shale, grayish-black, very finely micaceous, scattered pyrite crystals.
34	2869-2903	Shale, dark-gray, very finely micaceous; and siltstone, medium-gray, very finely micaceous.
7	2903-2910	Shale, grayish-black, very finely micaceous.
6	2910-2916	Shale, dark-gray, very finely micaceous.
4	2916-2920	Shale, grayish-black, very finely micaceous.
13	2920-2933	Shale, dark-gray, very finely micaceous.
2	2933-2935	Shale, grayish-black, very finely micaceous.
6	2935-2941	Shale, dark-gray, very finely micaceous.
29	2941-2970	Shale, dark-gray, to grayish-black, very finely micaceous.
40	2970-3010	Shale, grayish-black, very finely micaceous, scattered pyrite crystals.
32	3010-3042	Shale, dark-gray to grayish-black, very finely micaceous.
33	3042-3075	Shale, grayish-black, very finely micaceous, pyritic concretions in lower 15 ft.
11	3075-3086	Sandstone, light- to medium-gray, very fine grained, silty, well-cemented.
10	3086-3096	Siltstone, light- to medium-gray, very finely sandy; and shale, dark-gray.
16	3096-3112	Shale, dark-gray to grayish-black, very finely micaceous.
2	3112-3114	Sandstone, light-gray, very fine grained, silty, well-cemented.
1	3114-3115	Shale, dark-gray, very finely micaceous.
6	3115-3121	Sandstone, as above.
2	3121-3123	Shale, as above.
2	3123-3125	Sandstone, as above.

Thickness in feet	Interval in feet	Description
		Upper part of Atoka Formation
15	3125-3140	Shale, as above.
33	3140-3173	Shale, dark-gray to grayish-black, very finely micaceous.
9	3173-3182	Sandstone, light-gray, very fine to fine-grained, slightly argillaceous. Top of unit is top of zone s.
2	3182-3184	Shale, dark-gray, very finely micaceous.
3	3184-3187	Sandstone, light-gray, very fine grained, silty, well-cemented.
3	3187-3190	Shale, as above.
4	3190-3194	Sandstone, as above.
3	3194-3197	Shale, as above.
3	3197-3200	Sandstone, light-gray, very fine to fine-grained, silty.
6	3200-3206	Shale, as above.
64	3206-3270	Sandstone, very light gray, fine-grained, scattered subangular to subrounded medium sand grains, drills free.
6	3270-3276	Sandstone, very light gray, fine- to medium-grained, scattered subrounded coarse sand grains. Base of unit is base of zone s.
18	3276-3294	Shale, dark-gray, very finely micaceous; and siltstone, medium-gray, very finely micaceous.
31	3294-3325	Siltstone, medium-gray, very finely sandy, almost a very silty very fine grained sandstone, very finely micaceous.
4	3325-3329	Shale, as above.
11	3329-3340	Siltstone, medium-gray, very finely sandy, very finely micaceous.
4	3340-3344	Shale, as above.
10	3344-3354	Siltstone, as above.
6	3354-3360	Shale, as above.
15	3360-3375	Siltstone, medium-gray, very finely micaceous.
2	3375-3377	Shale, as above.
9	3377-3386	Siltstone, as above.
10	3386-3396	Shale, as above.
4	3396-3400	Siltstone, as above.
	3400	Total depth.

Section 5

Gulf Oil Corp. No. 1 W. H. Tackett

Sec. 2, T. 8 N., R. 22 W., Johnson County, Ark. Elevation: 690 ft.; total depth: 7,525 ft. Rock samples examined and logged by Boyd R. Haley. Lower part of Hartshorne Sandstone, Atoka Formation, Bloyd Shale and Prairie Grove Member of Hale Formation undifferentiated, and upper part of Cane Hill Member of Hale Formation.

Thickness in feet	Interval in feet	Description
		Pennsylvanian System
		Hartshorne Sandstone
30	0- 30	(No sample.)
10	30- 40	Sandstone, light-gray, very fine grained, silty.
10	40- 50	Sandstone, light-gray, fine-grained, scattered angular medium sand grains.
10	50- 60	Sandstone, light-gray, fine-grained.
10	60- 70	Sandstone, light-gray, fine-grained, scattered angular medium sand grains, finely to medium micaceous.
10	70- 80	(No sample.)
10	80- 90	Sandstone, light- to medium-gray, fine-grained, scattered rounded medium sand grains, finely to medium micaceous.
10	90- 100	Sandstone, light-gray, fine- to medium-grained, abundant angular to rounded coarse to very coarse sand grains.
10	100- 110	Sandstone, light-gray, very fine to fine-grained, abundant rounded medium sand grains.
30	110- 140	Sandstone, light-gray, very fine grained, very silty, finely micaceous; base of unit is base of Hartshorne Sandstone.
		Atoka Formation
20	140- 160	Siltstone, dark-gray, finely micaceous.
15	160- 175	Siltstone, medium- to dark-gray, very finely sandy, finely micaceous.
30	175- 205	Shale, dark-gray, silty, finely micaceous.
55	205- 260	Shale, dark-gray, finely micaceous.
45	260- 305	Shale, dark-gray, silty, finely micaceous.
95	305- 400	Shale, dark-gray to grayish-black, finely micaceous.
26	400- 426	Siltstone, medium- to dark-gray, very finely sandy, finely micaceous.
4	426- 430	Sandstone, medium-gray, very fine grained, very silty, finely micaceous, very slightly limy. Top of unit is top of zone c.
24	430- 454	Sandstone, light- to medium-gray, very fine to fine-grained, silty, finely micaceous, slightly limy.
10	454- 464	Sandstone, medium-gray, very fine grained, silty, finely micaceous.
2	464- 466	Siltstone, medium-gray, finely micaceous.
5	466- 471	Sandstone, as above.
2	471-473	Siltstone, as above.
5	473- 478	Sandstone, as above.
2	478- 480	Siltstone, as above.
20	480- 500	Sandstone, light-gray, very fine to fine-grained, subrounded medium sand grains, slightly silty, finely micaceous.
3	500- 503	Shale, dark-gray, silty.
11	503- 514	Sandstone, as above.
2	514- 516	Shale, as above.
4	516- 520	Sandstone, as above.
2	520- 522	Shale, as above.
24	522- 546	Sandstone, light-gray, very fine grained, silty, finely micaceous; crystals of calcite in samples from upper 8 feet (fracture filling?).
4	546- 550	Shale, as above.
15	550- 565	Sandstone, as above.
30	565- 595	Sandstone, medium-gray, very fine grained, very silty, finely micaceous.
20	595- 615	Siltstone, medium-gray, finely micaceous; scattered crystals of pyrite.
10	615- 625	Sandstone, light-gray, very fine grained, silty, finely micaceous.
10	625- 635	Sandstone, light- to medium-gray, fine-grained, scattered well-rounded medium sand grains, slightly silty.
5	635- 640	Sandstone, medium-gray, fine-grained, very silty, finely micaceous.
15	640- 655	Sandstone, light- to medium-gray, very fine to fine-grained, silty, finely micaceous.
5	655- 660	Sandstone, medium-gray, fine-grained, very silty, finely micaceous.
5	660- 665	Sandstone, medium- to dark-gray, very fine grained, very silty, finely micaceous.
2	665- 667	Shale, dark-gray.
6	667- 673	Sandstone, as above.
7	673- 680	Siltstone, dark-gray, very finely sandy, finely micaceous.
15	680- 695	Sandstone, medium-gray, very fine to fine-grained, silty, finely micaceous.

Thickness in feet	Interval in feet	Description
		Atoka Formation
45	695- 740	(No sample.)
65	740- 805	Sandstone, light-gray, very fine grained, silty, finely micaceous. Base of unit is base of zone c.
15	805- 820	Shale, dark-gray, finely micaceous.
60	820- 880	(No sample.)
20	880- 900	Shale, as above.
24	900- 924	(No sample.)
21	924- 945	Siltstone, medium- to dark-gray, very finely sandy, finely micaceous.
15	945- 960	Shale, dark-gray, silty, finely micaceous.
10	960- 970	(No sample.)
15	970- 985	Shale, dark-gray, very finely micaceous.
9	985- 994	Siltstone, medium-gray, very finely sandy, finely micaceous.
2	994- 996	Shale, as above.
6	996-1002	Siltstone, as above.
6	1002-1008	Shale, as above.
4	1008-1012	Siltstone, medium-gray, finely micaceous.
18	1012-1030	Shale, as above.
4	1030-1034	Siltstone, as above.
46	1034-1080	Shale, dark-gray, slightly silty, very finely to finely micaceous.
10	1080-1090	Shale, grayish-black.
8	1090-1098	Siltstone, as above.
11	1098-1109	Sandstone, medium-gray, very fine grained, very silty, finely micaceous.
17	1109-1126	Shale, dark-gray, silty, finely micaceous.
4	1126-1130	Siltstone, as above.
5	1130-1135	Sandstone, as above.
15	1135-1150	Shale, dark-gray, slightly silty, very finely micaceous.
8	1150-1158	Sandstone, light-gray, very fine grained, silty, finely micaceous.
7	1158-1165	Shale, as above.
35	1165-1200	Shale, dark-gray, very finely micaceous.
8	1200-1208	Siltstone, as above.
4	1208-1212	Shale, as above.
6	1212-1218	Siltstone, as above.
11	1218-1229	Shale, as above.
16	1229-1245	Siltstone, as above.
29	1245-1274	Shale, dark-gray, finely micaceous.
6	1274-1280	Siltstone, light- to medium-gray, finely micaceous.
30	1280-1310	(No sample.)
10	1310-1320	Siltstone, dark-gray, very finely micaceous.
2	1320-1322	Coal.
7	1322-1329	Shale, dark-gray; crystals of pyrite.
3	1329-1332	Coal.
16	1332-1348	Shale, dark-gray, very finely micaceous.
14	1348-1362	Sandstone, light-gray, very fine grained, silty.
7	1362-1369	Siltstone, medium-gray, very finely sandy.
14	1369-1383	Sandstone, light-gray, fine-grained, finely micaceous, very slightly limy.
15	1383-1398	Shale, as above.
3	1398-1401	Sandstone, light-gray, very fine to fine-grained, scattered rounded medium sand grains, finely micaceous.
13	1401-1414	Shale, as above.
4	1414-1418	Sandstone, medium-gray, very fine to fine-grained, silty, well-cemented.
22	1418-1440	Shale, as above.
10	1440-1450	(No sample.)
49	1450-1499	Shale, as above.
5	1499-1504	Sandstone, light-gray, very fine grained, very silty, finely micaceous.
11	1504-1515	Shale, as above.
8	1515-1523	Sandstone, light- to medium-gray, very fine to fine-grained, silty, well-cemented.
10	1523-1533	Shale, dark-gray, silty, finely micaceous.
5	1533-1538	Sandstone, as above.
4	1538-1542	Shale, as above.
5	1542-1547	Sandstone, as above.
2	1547-1549	Shale, as above.
2	1549-1551	Sandstone, as above.
7	1551-1558	Shale, as above.
7	1558-1565	Sandstone, light-gray, medium-grained, well-rounded grains, abundant rounded coarse sand grains.
15	1565-1580	Sandstone, light- to medium-gray, very fine grained, very silty, very finely micaceous.

Thickness in feet	Interval in feet	Description
		Atoka Formation
10	1580-1590	(No sample.)
10	1590-1600	Shale, dark-gray, slightly silty, finely micaceous.
6	1600-1606	Sandstone, as above.
104	1606-1710	Shale, dark-gray to grayish-black, very finely micaceous; abundant crystals of pyrite.
10	1710-1720	(No sample.)
7	1720-1727	Sandstone, light- to medium-gray, very fine to fine-grained, abundant rounded medium sand grains, silty, finely to medium micaceous.
2	1727-1729	Shale, dark-gray.
9	1729-1738	Sandstone, as above.
4	1738-1742	Shale, as above.
8	1742-1750	Sandstone, light-gray, fine- to medium-grained, slightly silty, finely micaceous.
11	1750-1761	Shale, dark-gray, silty, finely micaceous.
8	1761-1769	Sandstone, light- to medium-gray, fine-grained, abundant rounded medium sand grains, silty, finely micaceous.
3	1769-1772	Shale, as above.
6	1772-1778	Sandstone, as above.
3	1778-1781	Shale, as above.
7	1781-1788	Sandstone, as above.
7	1788-1795	Sandstone, light- to medium-gray, very fine to fine-grained, very silty, finely micaceous.
55	1795-1850	Shale, dark-gray to grayish-black, finely micaceous.
24	1850-1874	Shale, dark-gray, slightly silty, very finely micaceous.
24	1874-1898	Shale, dark-gray to grayish-black, very finely micaceous.
2	1898-1900	Limestone, dark-gray, very silty; crinoids.
5	1900-1905	Shale, as above.
2	1905-1907	Limestone, as above.
3	1907-1910	Shale, as above.
1	1910-1911	Limestone, as above.
36	1911-1947	Shale, as above; except crystals of pyrite in sample 1920-1930.
33	1947-1980	Shale, dark-gray, very finely micaceous.
20	1980-2000	(No sample.)
28	2000-2028	Shale, as above.
20	2028-2048	Shale, grayish-black, very finely micaceous; abundant crystals of pyrite.
7	2048-2055	Sandstone, very light gray, very fine to fine-grained, slightly silty, well-cemented.
6	2055-2061	Shale, dark-gray, very finely micaceous.
9	2061-2070	Sandstone, light-gray, very fine grained, slightly silty.
10	2070-2080	(No sample.)
9	2080-2089	Sandstone, as above.
9	2089-2098	Shale, as above.
4	2098-2102	Sandstone, very light gray, very fine to fine-grained, slightly silty, finely micaceous.
84	2102-2186	Shale, dark-gray to grayish-black, very finely micaceous; crystals of pyrite in samples 2130-2170.
3	2186-2189	Sandstone, medium-gray, very fine grained, very silty, very finely micaceous.
31	2189-2220	Shale, dark-gray to grayish-black, very finely micaceous.
20	2220-2240	(No sample.)
90	2240-2330	Shale, as above; except crystals of pyrite in sample 2300-2310.
8	2330-2338	Sandstone, light-gray, very fine to fine-grained, slightly silty, finely micaceous.
12	2338-2350	Shale, dark-gray, silty, finely micaceous.
6	2350-2356	Sandstone, light-gray, fine-grained, scattered rounded medium sand grains, silty.
8	2356-2364	Shale, dark-gray, very finely micaceous.
7	2364-2371	Sandstone, light-gray, fine-grained, abundant rounded medium sand grains, scattered rounded coarse sand grains, slightly silty.
2	2371-2373	Shale, as above.
5	2373-2378	Sandstone, light-gray, very fine to fine-grained, finely micaceous.
2	2378-2380	Shale, as above.
5	2380-2385	Sandstone, as above.
15	2385-2400	Shale, as above.
820	2400-3220	(No sample.)
10	3220-3230	Shale, dark-gray, silty, finely micaceous.
40	3230-3270	(No. sample.)
10	3270-3280	Sandstone, light-gray, very fine grained, slightly silty, finely micaceous; sand is almost silt size (less than 0.062 mm in diameter). Top of unit is top of zone s.
10	3280-3290	(No sample.)
5	3290-3295	Shale, dark-gray, very finely micaceous.
6	3295-3301	Sandstone, light-gray, very fine grained, silty.
5	3301-3306	Shale, as above.
4	3306-3310	Sandstone, light-gray, very fine to fine-grained, silty, finely micaceous, well-cemented.

Thickness in feet	Interval in feet	Description
		Atoka Formation
67	3310-3377	(No sample.) Lower part of this interval probably includes base of zone s.
3	3377-3380	Shale, dark-gray, silty, finely micaceous.
24	3380-3404	Shale, dark-gray to grayish-black, very finely micaceous.
26	3404-3430	Siltstone, medium-gray, very finely sandy, finely micaceous.
22	3430-3452	Shale, dark-gray, silty, very finely micaceous.
8	3452-3460	Sandstone, light- to medium-gray, very fine grained, very silty, finely micaceous.
2	3460-3462	Shale, as above.
19	3462-3481	Sandstone, medium-gray, very fine grained, very silty, finely micaceous.
2	3481-3483	Shale, dark-gray, very finely micaceous.
7	3483-3490	Siltstone, medium-gray, very finely sandy, finely micaceous.
2	3490-3492	Shale, as above.
8	3492-3500	Siltstone, as above.
24	3500-3524	Shale, as above.
12	3524-3536	Siltstone, medium-gray, very finely sandy, finely micaceous; silt is almost very fine sand grain size (more than 0.062 mm in diameter).
9	3536-3545	Shale, dark-gray, silty, very finely micaceous.
35	3545-3580	Siltstone, medium-gray, very finely sandy, finely micaceous.
15	3580-3595	Shale, dark-gray, silty, finely micaceous.
35	3595-3630	Shale, dark-gray, very finely micaceous.
100	3630-3730	Shale, dark-gray to grayish-black, very finely micaceous.
65	3730-3795	Shale, grayish-black; crystals of pyrite in samples 3740-3760.
7	3795-3802	Sandstone, medium-gray, very fine grained, very silty, very finely micaceous.
5	3802-3807	Shale, dark-gray, very finely micaceous.
10	3807-3817	Sandstone, as above.
8	3817-3825	Shale, as above.
13	3825-3838	Sandstone, light-gray, fine-grained; drills free.
12	3838-3850	Sandstone, light-gray, very fine to fine-grained; drills free.
12	3850-3862	Sandstone, light-gray, very fine grained.
3	3862-3865	Shale, as above.
5	3865-3870	Siltstone, medium-gray, very finely sandy, finely micaceous.
3	3870-3873	Shale, as above.
7	3873-3880	Siltstone, as above.
4	3880-3884	Shale, as above.
9	3884-3893	Sandstone, medium-gray, very fine grained, very silty, finely micaceous, well-cemented.
2	3893-3895	Shale, as above.
5	3895-3900	Sandstone, as above.
6	3900-3906	Shale, as above.
12	3906-3918	Sandstone, as above.
2	3918-3920	Shale, as above.
5	3920-3925	Sandstone, as above.
3	3925-3928	Shale, as above.
7	3928-3935	Sandstone, as above.
2	3935-3937	Shale, as above.
10	3937-3947	Sandstone, medium-gray, very fine grained, very silty, finely micaceous, well-cemented; sand is almost silt size (less than 0.062 mm in diameter).
4	3947-3951	Shale, as above.
23	3951-3974	Sandstone, as above.
6	3974-3980	Shale, as above.
5	3980-3985	Sandstone, as above.
9	3985-3994	Shale, as above.
6	3994-4000	Sandstone, as above.
8	4000-4008	Shale, as above.
4	4008-4012	Sandstone, as above.
6	4012-4018	Shale, as above.
2	4018-4020	Siltstone, medium-gray, very finely micaceous.
2	4020-4022	Shale, as above.
4	4022-4026	Siltstone, as above.
12	4026-4038	Shale, as above.
8	4038-4046	Sandstone, light- to medium-gray, fine-grained, scattered rounded medium sand grains, slightly silty, finely micaceous.
6	4046-4052	Siltstone, as above.
43	4052-4095	Shale, as above.
65	4095-4160	Siltstone, light- to medium-gray, very finely sandy, very finely micaceous.
4	4160-4164	Shale, as above.
12	4164-4176	Sandstone, light-gray, very fine to fine-grained, finely micaceous; drills free.

Thickness in feet	Interval in feet	Description
		Atoka Formation
2	4176-4178	Shale, as above.
6	4178-4184	Sandstone, light- to medium-gray, very fine grained, very silty, very finely micaceous; sand is almost silt size (less than 0.062 mm in diameter).
2	4184-4186	Shale, as above.
4	4186-4190	Sandstone, as above.
2	4190-4192	Shale, as above.
8	4192-4200	Sandstone, as above.
4	4200-4204	Shale, as above.
5	4204-4209	Sandstone, as above.
2	4209-4211	Shale, as above.
7	4211-4218	Sandstone, as above.
62	4218-4280	Shale, dark-gray, very finely micaceous; in beds 2 to 3 feet thick; and light- to medium-gray very fine grained very silty very finely micaceous sandstone; sand is almost silt size (less than 0.062 mm in diameter); in beds 3 to 6 feet thick.
10	4280-4290	Sandstone, light- to medium-gray, very fine grained, very silty, very finely micaceous; sand is almost silt size (less than 0.062 mm in diameter).
20	4290-4310	Siltstone, medium-gray, very finely micaceous.
56	4310-4366	Siltstone, medium-gray, very finely sandy, very finely micaceous.
14	4366-4380	Shale, dark-gray, very silty, very finely micaceous.
11	4380-4391	Siltstone, medium-gray, very finely micaceous.
2	4391-4393	Shale, dark-gray, silty, very finely micaceous.
3	4393-4396	Siltstone, as above.
2	4396-4398	Shale, as above.
8	4398-4406	Siltstone, as above.
2	4406-4408	Shale, as above.
3	4408-4411	Siltstone, as above.
24	4411-4435	Shale, as above.
11	4435-4446	Siltstone, as above.
4	4446-4450	Shale, as above.
5	4450-4455	Siltstone, as above.
4	4455-4459	Shale, as above.
6	4459-4465	Siltstone, as above.
2	4465-4467	Shale, as above.
5	4467-4472	Siltstone, as above.
3	4472-4475	Shale, as above.
5	4475-4480	Siltstone, as above.
21	4480-4501	Shale, as above.
119	4501-4620	Shale, dark-gray to grayish-black, very finely micaceous.
4	4620-4624	Siltstone, as above.
47	4624-4671	Shale, as above.
25	4671-4696	Siltstone, medium-gray, very finely micaceous; silt is almost very fine sand size (more than 0.062 mm in diameter).
10	4696-4706	Shale, dark-gray, very finely micaceous.
3	4706-4709	Siltstone, as above.
1	4709-4710	Shale, dark-gray to grayish-black, very finely micaceous.
4	4710-4714	Siltstone, as above.
2	4714-4716	Shale, as above.
6	4716-4722	Siltstone, as above.
6	4722-4728	Shale, as above.
2	4728-4730	Siltstone, as above.
1	4730-4731	Shale, as above.
6	4731-4737	Siltstone, as above.
3	4737-4740	Shale, as above.
5	4740-4745	Siltstone, as above.
2	4745-4747	Shale, as above.
5	4747-4752	Siltstone, as above.
5	4752-4757	Shale, as above.
4	4757-4761	Siltstone, as above.
6	4761-4767	Sandstone, light- to medium-gray, very fine grained, silty.
19	4767-4786	Sandstone, medium-gray, very fine grained, very silty; well-cemented; sand is almost silt size (less than 0.062 mm in diameter).
11	4786-4797	Shale, dark-gray, silty, very finely micaceous.
15	4797-4812	Sandstone, as above.
11	4812-4823	Siltstone, dark-gray, very finely micaceous.
46	4823-4869	Shale, dark-gray to grayish-black, very finely micaceous.

Thickness in feet	Interval in feet	Description
		Atoka Formation
13	4869-4882	Siltstone, light-gray, well-cemented; silt is almost very fine sand size (more than 0.062 mm in diameter).
23	4882-4905	Sandstone, light-gray, very fine grained, very silty; well-cemented; sand is almost silt size (less than 0.062 mm in diameter).
10	4905-4915	Shale, dark-gray, slightly silty, very finely micaceous.
59	4915-4974	Siltstone, light- to medium-gray, very finely sandy, very finely micaceous.
3	4974-4977	Shale, grayish-black, very finely micaceous.
6	4977-4983	Siltstone, medium-gray, very finely micaceous.
36	4983-5019	Shale, dark-gray to grayish-black.
10	5019-5029	Siltstone, medium-gray, very finely micaceous, well-cemented.
3	5029-5032	Shale, as above.
6	5032-5038	Siltstone, as above.
2	5038-5040	Shale, as above.
7	5040-5047	Siltstone, as above.
9	5047-5056	Shale, as above.
8	5056-5064	Siltstone, as above.
2	5064-5066	Shale, as above.
3	5066-5069	Siltstone, as above.
1	5069-5070	Shale, as above.
7	5070-5077	Siltstone, as above.
6	5077-5083	Shale, as above.
10	5083-5093	Siltstone, as above.
1	5093-5094	Shale, as above.
10	5094-5104	Siltstone, as above.
4	5104-5108	Shale, as above.
7	5108-5115	Siltstone, as above.
4	5115-5119	Shale, as above.
7	5119-5126	Sandstone, light- to medium-gray, very fine grained, very silty, well-cemented; sand is almost silt size (less than 0.062 mm in diameter).
1	5126-5127	Shale, as above.
9	5127-5136	Sandstone, as above.
2	5136-5138	Shale, as above.
10	5138-5148	Sandstone, as above.
2	5148-5150	Shale, as above.
20	5150-5170	(No sample.)
5	5170-5175	Shale, dark-gray to grayish-black, very finely micaceous.
10	5175-5185	Siltstone, medium-gray, very finely micaceous.
3	5185-5188	Shale, as above.
9	5188-5197	Siltstone, as above.
2	5197-5199	Shale, as above.
7	5199-5206	Siltstone, as above.
4	5206-5210	Shale, as above.
11	5210-5221	Sandstone, light- to medium-gray, very fine grained, very silty, very finely micaceous.
5	5221-5226	Shale, dark-gray, very finely micaceous.
4	5226-5230	Sandstone, as above.
2	5230-5232	Shale, as above.
3	5232-5235	Sandstone, as above.
3	5235-5238	Shale, as above.
3	5238-5241	Sandstone, as above.
16	5241-5257	Siltstone, medium- to dark-gray, very finely micaceous.
23	5257-5280	Shale, dark-gray, silty, very finely micaceous.
6	5280-5286	Siltstone, as above.
3	5286-5289	Shale, dark-gray, very finely micaceous.
16	5289-5305	Siltstone, as above.
7	5305-5312	Shale, as above.
9	5312-5321	Siltstone, as above.
2	5321-5323	Shale, as above.
8	5323-5331	Siltstone, as above.
2	5331-5333	Shale, as above.
6	5333-5339	Siltstone, as above.
3	5339-5342	Shale, as above.
13	5342-5355	Sandstone, light-gray, very fine grained, silty, very finely micaceous.
3	5355-5358	Shale, as above.
3	5358-5361	Siltstone, medium-gray, very finely micaceous.
8	5361-5369	Shale, grayish-black.

Thickness in feet	Interval in feet	Description
		Atoka Formation
17	5369-5386	Sandstone, light-gray, very fine grained, very silty, very finely micaceous.
6	5386-5392	Shale, as above.
8	5392-5400	Siltstone, medium-gray, very finely micaceous; silt is almost very fine sand size (more than 0.062 mm in diameter).
3	5400-5403	Shale, as above.
9	5403-5412	Siltstone, dark-gray, very finely micaceous; crystals of pyrite.
8	5412-5420	Shale, as above.
4	5420-5424	Siltstone, as above.
6	5424-5430	Shale, as above.
15	5430-5445	Siltstone, medium-gray, very finely sandy, very finely micaceous; silt is almost very fine sand size (more than 0.062 mm in diameter).
3	5445-5448	Shale, as above.
5	5448-5453	Siltstone, as above.
3	5453-5456	Shale, as above.
4	5456-5460	Siltstone, as above.
9	5460-5469	Shale, grayish-black, very finely micaceous.
3	5469-5472	Siltstone, medium-gray, very finely micaceous.
18	5472-5490	Shale, as above.
3	5490-5493	Siltstone, as above.
17	5493-5510	Shale, as above.
10	5510-5520	Siltstone, medium- to dark-gray, very finely micaceous.
2	5520-5522	Shale, dark-gray, silty, very finely micaceous.
6	5522-5528	Siltstone, as above.
1	5528-5529	Shale, as above.
7	5529-5536	Siltstone, as above.
1	5536-5537	Shale, as above.
5	5537-5542	Siltstone, as above.
16	5542-5558	Shale, as above.
10	5558-5568	Siltstone, as above.
4	5568-5572	Shale, as above.
7	5572-5579	Siltstone, as above.
84	5579-5663	Shale, grayish-black.
6	5663-5669	Siltstone, as above.
2	5669-5671	Shale, dark-gray to grayish-black.
9	5671-5680	Siltstone, as above.
10	5680-5690	Shale, as above.
70	5690-5760	Shale, grayish-black.
20	5760-5780	(No sample.)
8	5780-5788	Shale, as above.
2	5788-5790	Shale, light-gray; flaky; abundant fine crystals of dolomite.
13	5790-5803	Siltstone, light- to medium-gray, very finely micaceous.
17	5803-5820	Shale, dark-gray, silty, very finely micaceous; crystals of pyrite.
10	5820-5830	Shale, dark-gray, very finely micaceous.
20	5830-5850	(No sample.)
3	5850-5853	Shale, grayish-black.
8	5853-5861	Sandstone, light- to medium-gray, medium-grained, abundant subangular to subrounded coarse sand grains.
2	5861-5863	Shale, as above.
9	5863-5872	Sandstone, light- to medium-gray, very fine to fine-grained, silty, well-cemented.
6	5872-5878	Shale, as above.
24	5878-5902	Sandstone, light- to medium-gray, very fine grained, very silty, well-cemented.
2	5902-5904	Shale, as above.
6	5904-5910	Sandstone, light-gray, very fine to fine-grained, silty.
4	5910-5914	Shale, as above.
6	5914-5920	Sandstone, light-gray, fine-grained, abundant rounded medium sand grains, limy; crinoids.
10	5920-5930	Sandstone, light-gray, very fine grained, well-cemented.
14	5930-5944	Sandstone, light-gray, very fine grained, silty, well-cemented.
5	5944-5949	Shale, dark-gray.
5	5949-5954	Siltstone, light-gray, very finely sandy, slightly limy.
28	5954-5982	Sandstone, light- to medium-gray, very fine grained, slightly silty, very slightly limy, well-cemented.
10	5982-5992	Siltstone, medium-gray, very finely sandy, very finely micaceous.
8	5992-6000	Sandstone, light- to medium-gray, very fine grained, silty.
10	6000-6010	(No sample.)

Thickness in feet	Interval in feet	Description
		Atoka Formation
8	6010-6018	Siltstone, dark-gray, finely micaceous.
4	6018-6022	Shale, grayish-black.
6	6022-6028	Siltstone, as above.
21	6028-6049	Shale, as above.
12	6049-6061	Sandstone, light- to medium-gray, very fine grained, very silty, well-cemented.
14	6061-6075	Shale, dark-gray to grayish-black.
20	6075-6095	Siltstone, medium- to dark-gray, very finely micaceous.
55	6095-6150	Shale, grayish-black.
10	6150-6160	Sandstone, light-gray, very fine to fine-grained; drills free.
8	6160-6168	Sandstone, light-gray, very fine grained; drills free.
2	6168-6170	Shale, as above.
5	6170-6175	Sandstone, as above.
1	6175-6176	Shale, as above.
5	6176-6181	Sandstone, medium- to dark-gray, very fine grained, very silty, well-cemented; crystals of pyrite.
2	6181-6183	Shale, as above.
4	6183-6187	Sandstone, as above.
38	6187-6225	Shale, grayish-black; crystals of pyrite.
17	6225-6242	Siltstone, dark-gray, very finely micaceous, clayey.
18	6242-6260	Shale, as above.
10	6260-6270	(No sample.)
2	6270-6272	Shale, as above.
6	6272-6278	Sandstone, light-gray, very fine grained, silty, well-cemented.
2	6278-6280	Shale, as above.
20	6280-6300	(No sample.)
6	6300-6306	Siltstone, light- to medium-gray, finely micaceous.
3	6306-6309	Shale, dark-gray, silty, very finely micaceous.
7	6309-6316	Siltstone, as above.
9	6316-6325	Shale, as above.
6	6325-6331	Siltstone, as above.
10	6331-6341	Shale, as above.
22	6341-6363	Siltstone, medium- to dark-gray, finely micaceous.
24	6363-6387	Shale, dark-gray, silty, very finely micaceous; crystals of pyrite in sample 6370-6380.
25	6387-6412	Shale, dark-gray, very silty, very finely micaceous.
43	6412-6455	Shale grayish-black, very finely micaceous.
6	6455-6461	Siltstone, light-gray, well-cemented.
12	6461-6473	Shale, dark-gray, silty, very finely micaceous.
8	6473-6481	Siltstone, light-gray, very finley micaceous.
9	6481-6490	Shale, as above.
37	6490-6527	Shale, grayish-black.
10	6527-6537	Siltstone, light- to medium-gray, finely micaceous.
1	6537-6538	Shale, as above.
4	6538-6542	Siltstone, as above.
1	6542-6543	Shale, as above.
5	6543-6548	Siltstone, as above.
7	6548-6555	Shale, dark-gray to grayish-black, very finely micaceous.
8	6555-6563	Siltstone, medium- to dark-gray, very finely micaceous.
3	6563-6566	Shale, as above.
6	6566-6572	Siltstone, as above.
3	6572-6575	Shale, as above.
6	6575-6581	Siltstone, as above.
3	6581-6584	Shale, as above.
6	6584-6590	Siltstone, as above.
10	6590-6600	Shale, as above.
7	6600-6607	Siltstone, as above.
38	6607-6645	Shale, grayish-black.
7	6645-6652	Siltstone, light- to medium-gray, finely micaceous.
2	6652-6654	Shale, as above.
2	6654-6656	Siltstone, as above.
2	6656-6658	Shale, as above.
4	6658-6662	Siltstone, as above.
2	6662-6664	Shale, as above.
7	6664-6671	Sandstone, light-gray, fine-grained, abundant subrounded medium sand grains; drills free.
7	6671-6678	Shale, grayish-black.

Thickness in feet	Interval in feet	Description
		Atoka Formation
7	6678-6685	Sandstone, light- to medium-gray, fine-grained, scattered rounded medium sand grains, finely micaceous.
56	6685-6741	Shale, as above.
1	6741-6742	Shale, very light gray, slightly very finely sandy; crystals of dolomite; flaky.
8	6742-6750	Sandstone, light-gray, fine-grained, scattered rounded medium sand grains; porous.
30	6750-6780	Sandstone, very light to light-gray, very fine to fine-grained, slightly limy; porous.
26	6780-6806	Shale, grayish-black.
14	6806-6820	Sandstone, light-gray, fine-grained, abundant rounded medium sand grains, scattered subrounded coarse sand grains, limy; porous; crystals of pyrite.
5	6820-6825	Sandstone, medium- to dark-gray, fine- to medium-grained, abundant subrounded coarse to very coarse sand grains, silty, limy; crinoids.
5	6825-6830	Sandstone, grayish-white, fine- to medium-grained, abundant coarse to very coarse sand grains, slightly limy.
10	6830-6840	Sandstone, grayish-white, medium- to coarse-grained, abundant subrounded very coarse sand grains; very porous.
3	6840-6843	Sandstone, grayish-white, medium-grained, abundant subrounded coarse sand grains.
3	6843-6846	Shale, as above.
4	6846-6850	Sandstone, very light gray, medium-grained, abundant subrounded coarse sand grains.
7	6850-6857	Sandstone, grayish-white, fine- to medium-grained; porous.
3	6857-6860	Sandstone, grayish-white, meduim- to coarse-grained, abundant subrounded coarse to very coarse sand grains, slightly limy; porous.
15	6860-6875	Sandstone, grayish-white, fine- to medium-grained, scattered subrounded coarse to very coarse sand grains; porous.
2	6875-6877	Shale, as above.
6	6877-6883	Sandstone, grayish-white, fine- to medium-grained; porous.
2	6883-6885	Shale, as above.
5	6885-6890	Sandstone, as above; base of unit is base of the Atoka Formation.
		Bloyd Shale and Prairie Grove Member of Hale Formation, undifferentiated
21	6890-6911	Shale, grayish-black; drills splintery.
5	6911-6916	Sandstone, light-gray, fine- to medium-grained, very limy.
9	6916-6925	Limestone, medium-gray, granular, finely to medium sandy; crystals of pyrite; crinoids.
5	6925-6930	Limestone, medium-gray, granular, finely to medium sandy; crystals of pyrite; crinoids. rounded medium sand grains; crystals of pyrite; crinoids, bryozoans, brachiopods.
9	6930-6939	Limestone, medium-gray, granular, finely to medium sandy, scattered rounded very coarse sand grains; ovoid fine to medium grayish-black oolitodis; crystals of pyrite; crinoids, bryozoans, brachiopods, spines.
3	6939-6942	Shale, grayish-black.
8	6942-6950	Sandstone, light- to medium-gray, fine- to medium-grained, very limy; crinoids, bryozoans, brachiopods.
4	6950-6954	Sandstone, brownish-gray, fine- to medium-grained, scattered rounded very coarse sand grains, limy; crinoids.
5	6954-6959	Shale, dark-gray, very finely micaceous; fragments of very finely micaceous slightly silty dark brownish-gray shale.
6	6959-6965	Sandstone, light- to medium-gray, fine- to medium-grained, limy; crystals of pyrite; crinoids, brachiopods.
16	6965-6981	Shale, dark-gray, slightly silty, very finely micaceous; crinoids.
6	6981-6987	Shale, dark-gray, very finely micaceous; fragments of very finely micaceous dark brownish-gray shale.
32	6987-7019	Shale, dark-gray, silty, very finely micaecous.
2	7019-7021	Shale, dark-gray, very finely micaceous; fragments of very finely micaceous dark brownish-gray shale.
24	7021-7045	Shale, dark-gray, very finely micaceous.
5	7045-7050	Limestone, medium-gray, granular, very finely to finely sandy.
2	7050-7052	Shale, grayish-black.
8	7052-7060	Sandstone, light-gray, very fine to fine-grained, silty, slightly limy; porous.
15	7060-7075	Shale, as above.
5	7075-7080	Sandstone, light- to medium-gray, fine-grained, very limy; crinoids.
15	7080-7095	Sandstone, grayish-white to very light gray, fine-grained, slightly limy; porous.
15	7095-7110	Sandstone, light-gray, fine- to medium-grained, scattered rounded coarse sand grains; porous.
10	7110-7120	Sandstone, brownish-gray, very fine to fine-grained, scattered rounded medium sand grains, finely micaceous, well-cemented.
10	7120-7130	Sandstone, light- to medium-gray, fine-grained, scattered rounded medium sand grains, well-cemented.

Thickness in feet	Interval in feet	Description
		Bloyd Shale and Prairie Grove Member of Hale Formation, Undifferentiated
34	7130-7164	Sandstone, light- to medium-gray, very fine to fine-grained, scattered rounded medium sand grains, slightly silty, finely to medium micaceous, well-cemented.
6	7164-7170	Sandstone, brownish-gray, very fine to fine-grained, scattered rounded medium sand grains, slightly silty, well-cemented.
5	7170-7175	Sandstone, very light to light-gray, very fine to fine-grained, scattered rounded medium sand grains, well-cemented.
4	7175-7179	Sandstone, light- to medium-gray, very fine to fine-grained, silty, very coarsely micaceous, well-cemented.
5	7179-7184	Siltstone, dark-gray, very finely micaceous, well-cemented.
48	7184-7232	Shale, as above.
20	7232-7252	Sandstone, light- to medium-gray, very fine grained, very silty, very slightly limy.
2	7252-7254	Shale, as above.
8	7254-7262	Sandstone, brownish-gray, very fine grained, very silty, very slightly limy.
3	7262-7265	Shale, as above.
15	7265-7280	Sandstone, very light to light-gray, very fine grained, silty, slightly limy.
8	7280-7288	Sandstone, light-gray, very fine grained, slightly silty, well-cemented.
2	7288-7290	Shale, as above.
10	7290-7300	Sandstone, light-gray, very fine grained; well-cemented.
31	7300-7331	Shale, grayish-black; drills splintery.
10	7331-7341	Limestone, medium-gray, granular, finely to medium sandy; crinoids.
9	7341-7350	Sandstone, light- to medium-gray, fine- to medium-grained, scattered rounded coarse sand grains, very limy.
4	7350-7354	Shale, grayish-black.
7	7354-7361	Sandstone, medium-gray, medium-grained, abundant rounded coarse to very coarse sand grains, limy; crystals of pyrite; crinoids.
3	7361-7364	Shale, as above.
6	7364-7370	Sandstone, light-gray, fine- to medium-grained, well-cemented.
10	7370-7380	Sandstone, light- to medium-gray, very fine to fine-grained, silty, well-cemented.
10	7380-7390	Shale, as above.
6	7390-7396	Sandstone, very light to light-gray, very fine grained, silty; base of unit is base of Bloyd Shale and Prairie Grove Member of Hale Formation, undifferentiated.
		Upper part of Cane Hill Member of Hale Formation
37	7396-7433	Shale, as above.
21	7433-7454	Sandstone, medium- to dark-gray, very fine grained, very silty, well-cemented.
27	7454-7481	Shale, as above.
19	7481-7500	Sandstone, medium- to dark-gray, very fine grained, very silty, well-cemented.
10	7500-7510	Siltstone, dark-gray; very finely sandy.
2	7510-7512	Shale, as above.
13	7512-7525	Siltstone, as above.
	7525	Total depth.