Geology of the Van Buren and Lavaca Quadrangles, Arkansas and Oklahoma

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GEOLOGICAL SURVEY PROFESSIONAL PAPER 657-A

Prepared in cooperation with the
Arkansas Geological Commission

U. S. DEPARTMENT OF THE INTERIOR
March 3, 1849

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By BOYD R. HALEY *and* THOMAS A. HENDRICKS

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GEOLOGY OF THE ARKANSAS VALLEY COAL FIELD—PART 2

GEOLOGY OF THE VAN BUREN AND LAVACA QUADRANGLES, ARKANSAS AND OKLAHOMA

By BOYD R. HALEY and THOMAS A. HENDRICKS

ABSTRACT

Van Buren and Lavaca quadrangles cover an area of about 488 square miles in east-central Oklahoma and west-central Arkansas. Rocks of Middle Pennsylvanian age and unconsolidated alluvial deposits of Quaternary age are exposed at the surface, and rocks of Ordovician to Middle Pennsylvanian age have been penetrated by wells drilled in the area.

The rocks have been folded into east-trending broad, gentle folds whose limbs have been broken by north- or south-dipping normal faults. Displacement across the faults is generally less than 1,500 feet but may be as much as 2,500 feet across the fault that separates the Arkansas Valley section from the Ozark Plateaus province. Folding and faulting started on a major scale during the deposition of the Atoka Formation and continued until after deposition of the youngest Pennsylvanian beds. The structural relief in the report area, as measured on the base of the Hartshorne Sandstone, may be as much as 4,450 feet.

The Atoka, McAlester, and Savanna Formations contain coal beds. The Lower Hartshorne coal bed, near the base of the McAlester Formation, and the Charleston coal bed, near the base of the Savanna Formation, have been the most economically important.

Natural gas has been found in rocks of Silurian, Devonian, Mississippian, and Pennsylvanian age. Most of the gas is in rocks of Pennsylvanian age, in the Atoka Formation. The gas in Pennsylvanian rocks is lithologically entrapped, and structure appears to have had little influence on the location or extent of gas accumulation.

Building stone and road metal have been obtained from the Atoka, Hartshorne, McAlester, and Savanna Formations. Gravel and sand are obtained from the alluvial deposits, and the shale in the McAlester Formation has been quarried for brick and tile.

INTRODUCTION

This report is one of a series of geological reports being prepared by the U.S. Geological Survey in cooperation with the Arkansas Geological Commission. It has been prepared (1) to provide geologic and structure maps of the quadrangles on a modern topographic base; (2) to relate the structure and stratigraphy of the rocks exposed at the surface to that of the subsurface rocks; (3) to show the extent and thickness of known coal beds, and to present estimates of coal resources where data permit; (4) to provide geologic data and the authors' interpretations of these data relevant to the accumulation of natural gas; and (5) to provide information about the availability of building stone, gravel, sand, and clay.

This report together with added lithologic descriptions of rocks penetrated by selected wells and shallow holes is also published, under separate cover, as Arkansas Geological Commission Information Circular 20–I.

The Van Buren quadrangle (lat 35°15′ and 35°30′ N., long 94°15′ and 94°30′ W.) has an area of about 244 square miles, of which about 60 square miles is in Le Flore and Sequoyah Counties, Okla., and about 184 square miles is in Sebastian and Crawford Counties, Ark. The Lavaca quadrangle (lat 35°15′ and 35°30′ N., long 94°00′ and 94°15′ W.) adjoins the Van Buren quadrangle on the east. It has an area of about 244 square miles in Sebastian, Franklin, and Crawford Counties, Ark. (fig. 1).

Generalized geologic reports pertaining in part to the Van Buren and Lavaca quadrangles have been made by Winslow (1888), Smith (1914), Croneis (1930), and Haley (1960) for the Arkansas part, and by Drake (1897), Taff and Adams (1900), Taff (1905), Snider (1914), Smith (1914), and Shannon and others (1926) for the Oklahoma part.

Detailed geologic reports pertaining in part to the two quadrangles have been made by Collier (1907) and Hendricks and Parks (1937, 1950) for the Arkansas part, and by Knechtel (1949) for the Oklahoma part.

The stratigraphic boundaries of the post-Atoka rocks established by Hendricks and Parks (1950, p. 69) are used in this report. The stratigraphic nomenclature of these rocks as reported in Hendricks and Parks (1950) was modified by Merewether and Haley (1961), who adopted Miser's (1954) terminology of McAlester

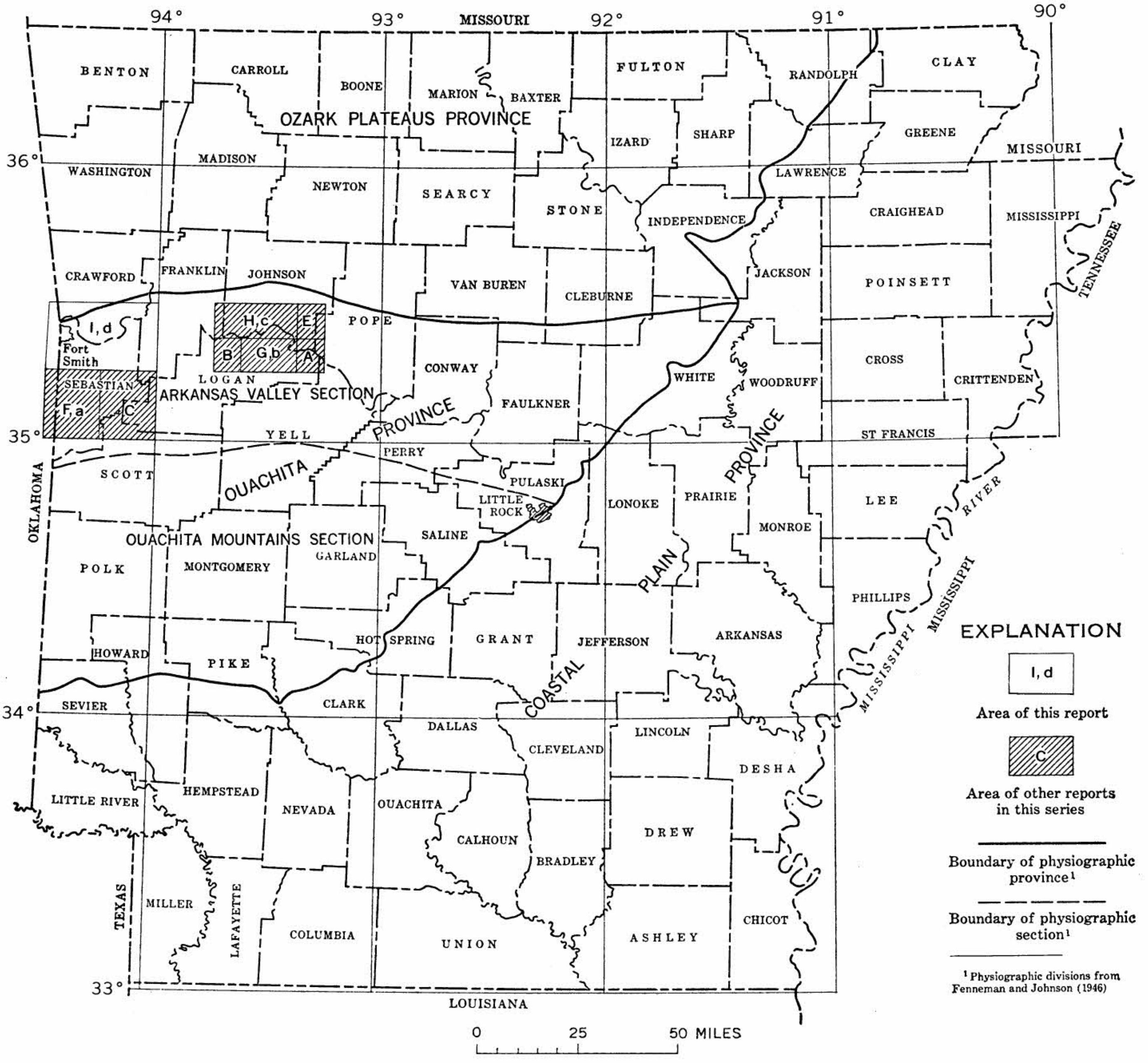

FIGURE 1.—Location of report area (I, d) and areas of other published reports: A, Delaware quadrangle (Merewether and Haley, 1961); B, Paris quadrangle (Haley, 1961); C, Barber quadrangle (Haley, 1966); E, Knoxville quadrangle (Merewether, 1967); F and a, Greenwood quadrangle (Haley and Hendricks, 1968); G and b, Scranton and New Blaine quadrangles (Haley, 1968); and H and c, Coal Hill, Hartman, and Clarksville quadrangles (Merewether and Haley, 1969).

Formation, Savanna Formation, and Boggy Formation, and Oakes' (1953) classification of the Krebs Group, which includes the Hartshorne Sandstone and the McAlester, Savanna, and Boggy Formations. Haley (1961) moved the base of the Boggy Formation stratigraphically upward, thereby conforming to the definition established by Miser (1954). The stratigraphic nomenclature and boundaries of Atoka and pre-Atoka rocks used in this report conform, in general, to those used elsewhere in Arkansas. This nomenclature is compared with that used in nearby areas in figure 2.

The authors express thanks to the Arkansas Geological Commission for providing rock samples from 23 wells drilled in the area, and to Gulf Oil Corp. for providing copies of the electrical logs and loaning the rock samples from the shallow holes drilled in the area. Members of the U.S. Geological Survey who examined and logged rock samples from 26 wells in the area are acknowledged in table 3.

STRATIGRAPHY

Rocks of Middle Pennsylvanian age and sediments of Quaternary age are exposed in the mapped area and are shown on plate 1. Rocks of Early Ordovician to Middle Pennsylvanian age have been penetrated by wells drilled in the area, and the general lithology of these rocks is shown graphically on plates 2 and 3. Detailed descriptions of eight of the lithologic sections shown on plate 2 and of all sections shown on plate 3 are included in Arkansas Geological Commission Information Circular 20–I. The lithology of rocks penetrated in wells 57, 73, and 137 shown on plate 2 was described by Sheldon (1954, p. 48–52, 53–56, and 163–167).

ORDOVICIAN SYSTEM

EVERTON FORMATION, ST. PETER SANDSTONE, AND JOACHIM DOLOMITE UNDIVIDED

In northern Arkansas, the Everton Formation, predominantly dolomite with some sandstone, is unconformably overlain by the St. Peter Sandstone. The St. Peter, predominantly sandstone with a minor amount of dolomite, is conformably overlain by the Joachim Dolomite. The Joachim, dolomite with some sandstone, is unconformably overlain by younger rocks of Ordovician, Silurian, Devonian, or Mississippian age. These younger rocks unconformably overlie the St. Peter where the Joachim is missing, or the Everton where the Joachim and St. Peter are missing.

In the area of this report, the rocks assigned to the Everton, St. Peter, and Joachim Formations undivided are known to have been penetrated by eight wells drilled for gas. The rock samples from five of these wells have been examined and logged by geologists of the U.S. Geological Survey.

Well 134 (pl. 1; table 3) penetrated 108 feet of sandstone that resembles the St. Peter Sandstone; apparently the Joachim is missing in this well. Well 136 penetrated 110 feet of dolomite and sandstone that resemble Joachim underlain by St. Peter, or alternatively, this 110 feet of rock could be the Everton Formation with the Joachim and St. Peter missing. Well 102 penetrated 85 feet of intercalated dolomite, sandstone, shale, and limestone that could not be identified by lithology. The sequence is in fault contact with rocks of Mississippian age; thus its stratigraphic position is indeterminate. Well 57 penetrated 93 feet of sandstone and dolomite that is either St. Peter or St. Peter and Everton; in either case, the Joachim is absent. Well 23 penetrated 212 feet of sandstone, dolomite, shale, and limestone that is thought to be St. Peter and Everton with the Joachim absent.

The above correlations are uncertain because (1) the distance from the wells to the outcrop area of the formations is long; (2) unconformities exist between these formations and between these and overlying formations; (3) detailed field mapping of facies changes needed to identify these formations in many of the outcrop areas has not been done; and (4) the logged wells are not deep enough to penetrate an identifiable formation older than the Everton, which would aid in distinguishing the overlying three units.

The Everton, St. Peter, and Joachim undivided in the five wells logged consists of sandstone, dolomite, shale, and limestone. The sandstone is white to light gray and is composed of fine to coarse rounded and frosted grains; most is dolomitic, and some is limy. The dolomite is very light to medium gray and dense to very finely crystalline; most is finely to medium sandy, some is limy, and some contains very finely crystalline pyrite. The limestone is medium gray, dense to granular, dolomitic in part, and finely to medium sandy in part. The shale is medium to dark gray and greenish gray; some is slightly dolomitic.

PLATTIN LIMESTONE

In northern Arkansas, the Plattin unconformably overlies the Joachim Dolomite or older rocks and is unconformably overlain by the Kimmswick Limestone, the Fernvale Limestone, or rocks of Mississippian age. The Plattin Limestone is known to have been partly or entirely penetrated by 10 wells drilled for natural gas in the Van Buren and Lavaca quadrangles. The rock samples from five of these wells have been examined and logged (table 3). The younger Kimmswick Limestone has not been identified in the logged wells; if present, it is included in the Plattin in this report. The Plattin is 60–74 feet thick in the logged wells; electrical log correlations of other wells indicate that it may be as thin as 50 feet. In well 136, the rocks that overlie the Everton, St. Peter, and Joachim interval and underlie the Penters Chert are very thin (76 ft) because of either normal faulting or pre-Penters erosion. Dolomitic greenish-gray shale at a depth of 8,185–8,195 feet in this well resembles the Cason Shale, which suggests that limy dolomite and dolomitic dark-gray limestone in the underlying interval, 8,195–8, 222 feet, represent the Plattin and the Fernvale Limestones. The Plattin in well 134 is 70 feet thick and is light- to medium-gray granular to finely crystalline limestone containing fine crystals of dolomite and widely scattered fragments of light-brownish-gray dense chert. A unit 21 feet thick in well 62 probably represents the upper part of the Plattin. It consists of very light to light-gray dense to very finely crystalline dolomite

<table>
<tr><th colspan="6">This report</th><th colspan="4">Northwestern Arkansas</th><th colspan="5">Northeast and east-central Oklahoma</th><th colspan="4">East-central Oklahoma (Knechtel, 1949)</th><th colspan="3">West-central Arkansas (Hendricks and Parks, 1950)</th></tr>
<tr><td rowspan="17">CARBONIFEROUS</td><td rowspan="11">PENNSYLVANIAN</td><td rowspan="5">Des Moines Series</td><td rowspan="5">Krebs Group</td><td colspan="2"></td><td rowspan="11">PENNSYLVANIAN</td><td rowspan="5"></td><td rowspan="5" colspan="2"></td><td rowspan="11">PENNSYLVANIAN</td><td rowspan="5">Des Moines Series</td><td rowspan="5">Krebs Group</td><td colspan="2">Boggy Formation</td><td rowspan="6">PENNSYLVANIAN</td><td rowspan="6">Des Moines Series</td><td colspan="2">Boggy Formation</td><td rowspan="6">CARBONIFEROUS</td><td rowspan="6">PENNSYLVANIAN</td><td>Boggy Shale</td></tr>
<tr><td colspan="2">Savanna Formation</td><td colspan="2">Savanna Formation</td><td colspan="2">Savanna Formation</td><td>Savanna Sandstone</td></tr>
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<tr><td>Lower member</td><td>Lower member</td></tr>
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<tr><td rowspan="5">Morrow Series</td><td colspan="2" rowspan="3">Bloyd Formation</td><td>Kessler Limestone Member equivalent</td><td rowspan="5">Morrow Series</td><td rowspan="3">Bloyd Formation</td><td>Kessler Limestone Member</td><td rowspan="5">Morrow Series</td><td colspan="2" rowspan="3">Bloyd Formation</td><td>Kessler Member</td><td rowspan="11" colspan="7"></td></tr>
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<tr><td>Brentwood Limestone Member equivalent</td><td>Brentwood Limestone Member</td><td>Brentwood Member</td></tr>
<tr><td colspan="2" rowspan="2">Hale Formation</td><td>Prairie Grove Member</td><td rowspan="2">Hale Formation</td><td>Prairie Grove Member</td><td colspan="2" rowspan="2">Hale Formation</td><td>Prairie Grove Member</td></tr>
<tr><td>Cane Hill Member</td><td>Cane Hill Member</td><td>Cane Hill Member</td></tr>
<tr><td rowspan="6">MISSISSIPPIAN</td><td rowspan="6">Upper</td><td colspan="3">Pitkin Limestone</td><td rowspan="6">MISSISSIPPIAN</td><td rowspan="6">Upper</td><td colspan="2">Pitkin Limestone</td><td rowspan="6">MISSISSIPPIAN</td><td rowspan="6">Upper</td><td colspan="3">Pitkin Limestone</td></tr>
<tr><td colspan="2" rowspan="2">Fayetteville Shale</td><td>Wedington(?) Sandstone Member</td><td rowspan="2">Fayetteville Shale</td><td>Wedington Sandstone Member</td><td colspan="3" rowspan="2">Fayetteville Shale</td></tr>
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<tr><td colspan="3" rowspan="3">Moorefield Formation</td><td>Batesville Sandstone</td><td>Hindsville Limestone Member</td><td colspan="3">Hindsville Limestone</td></tr>
<tr><td colspan="2">Ruddell Shale</td><td colspan="3" rowspan="2">Moorefield Formation</td></tr>
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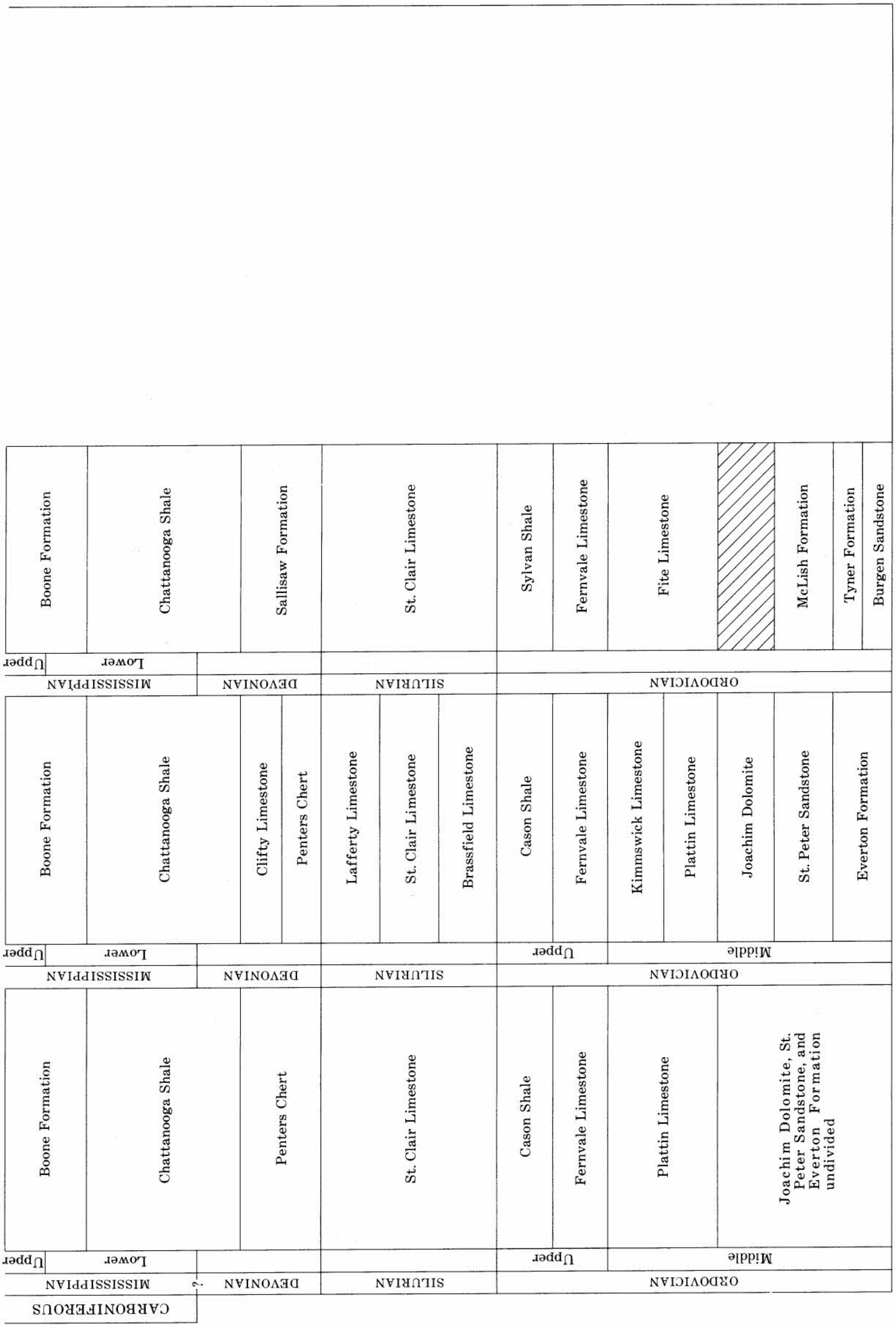


FIGURE 2.—Stratigraphic nomenclature of rocks in or near Van Buren and Lavaca quadrangles, Arkansas and Oklahoma.

containing very finely to finely crystalline pyrite. The Plattin is 60 feet thick where penetrated by well 57 and consists of medium- to dark-gray granular to finely crystalline limestone that is silty in part and finely sandy and dolomitic in the lower 5 feet. The Plattin is 74 feet thick where penetrated by well 23 and consists of very light to light-gray slightly dolomitic dense to granular limestone containing widely scattered fragments of very light gray and brownish-light-gray, smoky dense chert. A few thin beds of medium-gray granular limestone are near the base.

FERNVALE LIMESTONE

In northern Arkansas, the Fernvale Limestone unconformably overlies the Kimmswick or older formations and is unconformably overlain by the Cason Shale or younger rocks. In the area of this report it is underlain by the Plattin and overlain by the Cason Shale. It has been penetrated by 11 wells; samples from five of these wells were logged (table 3). It is 15–30 feet thick in logged wells and, according to electrical log correlation, ranges between these two thicknesses in other wells. In well 34 the Fernvale is 15 feet thick and is a light- to medium-gray finely to medium-crystalline limestone. In well 23 it is 16 feet thick and is a light-gray dense limestone. Well 62 penetrated 22 feet of white to very light gray very finely crystalline dolomite and dark-gray shale that is thought to represent the Fernvale. In well 57 the Fernvale is 30 feet thick and consists of medium-gray medium-crystalline limestone, medium-gray silty, clayey, and slightly dolomitic finely to medium-crystalline limestone, and thin layers of dark-gray shale.

CASON SHALE

In northern Arkansas the Cason unconformably overlies the Fernvale or the Kimmswick and is unconformably overlain by the St. Clair Limestone or by younger rocks of Devonian or Mississippian age. In the area of this report, the Cason is underlain by the Fernvale Limestone and overlain by the St. Clair Limestone.

The Cason is known to have been penetrated by 11 wells drilled in the Van Buren and Lavaca quadrangles. The rock samples from five of these have been examined and logged (table 3). In these wells, the Cason is 2–35 feet thick and is a medium- to dark-gray or greenish-gray shale that is slightly dolomitic in some places.

SILURIAN SYSTEM, ST. CLAIR LIMESTONE

The St. Clair Limestone of this report includes rocks equivalent to the Brassfield Limestone, St. Clair Limestone, and Lafferty Limestone of northern Arkansas and to the St. Clair Limestone of eastern Oklahoma.

The St. Clair of this report overlies the Cason Shale and is overlain by the Penters Chert. The nature of the lower and upper contacts is not known in this area, but in northern Arkansas the contacts are unconformities.

The St. Clair is 66–245 feet thick in the nine wells whose rock samples have been examined, and it may be as thick as 275 feet in well 127 according to the electrical log. In four of the logged wells the St. Clair is mostly very light to light-gray granular to finely crystalline limestone that is slightly dolomitic to dolomitic. Fine to coarse crystals of pink calcite are present in some parts, and white to very light gray translucent chert is common in the upper part. In wells 96, 58, and 23 the limestone contains units, as much as 25 feet thick, of very light gray limy granular dolomite. In well 62, white to very light gray granular dolomite comprises most of the lower 90 feet of the St. Clair. That part (110 ft thick) of the St. Clair penetrated by well 158 is 80 percent dolomite and 20 perent limestone; the part (76 ft thick) of the St. Clair in well 136 is 70 percent dolomite and 30 percent shale.

Frezon and Glick (1959, p. 177) believed that pre-Devonian erosion could account for the thinning of the Silurian rocks in northwestern Arkansas but considered the available data inconclusive. In the Van Buren–Lavaca quadrangles, the authors could not find conclusive evidence to confirm or disprove pre-Penters erosion. Thickness changes of intraformational units in the St. Clair (fig. 3) suggest, however, that several periods of erosion may have occurred during St. Clair time. This hypothesis is extremely tentative because it is based, for the most part, on correlations of electrical logs from a few wells drilled through predominantly carbonate rocks. Carbonate rock sequences do not lend themselves readily to subdivision on electrical logs because the curves show limited variation and few distinctive characteristics.

DEVONIAN SYSTEM, PENTERS CHERT

The Penters Chert in northern Arkansas unconformably overlies rocks ranging in age from Silurian to Ordovician and is unconformably overlain by the Chattanooga Shale or the Boone Formation. In the area of this report, the Penters overlies the St. Clair and is overlain by the Chattanooga.

The Penters ranges in thickness from 43 to 93 feet in the 14 logged wells (table 3), but it may be as thin as 27 feet in well 85 according to electrical log correlation. The Penters is predominantly white to very light gray translucent smoky or milky dense chert, but it contains some dark-gray to black dense chert and, in its

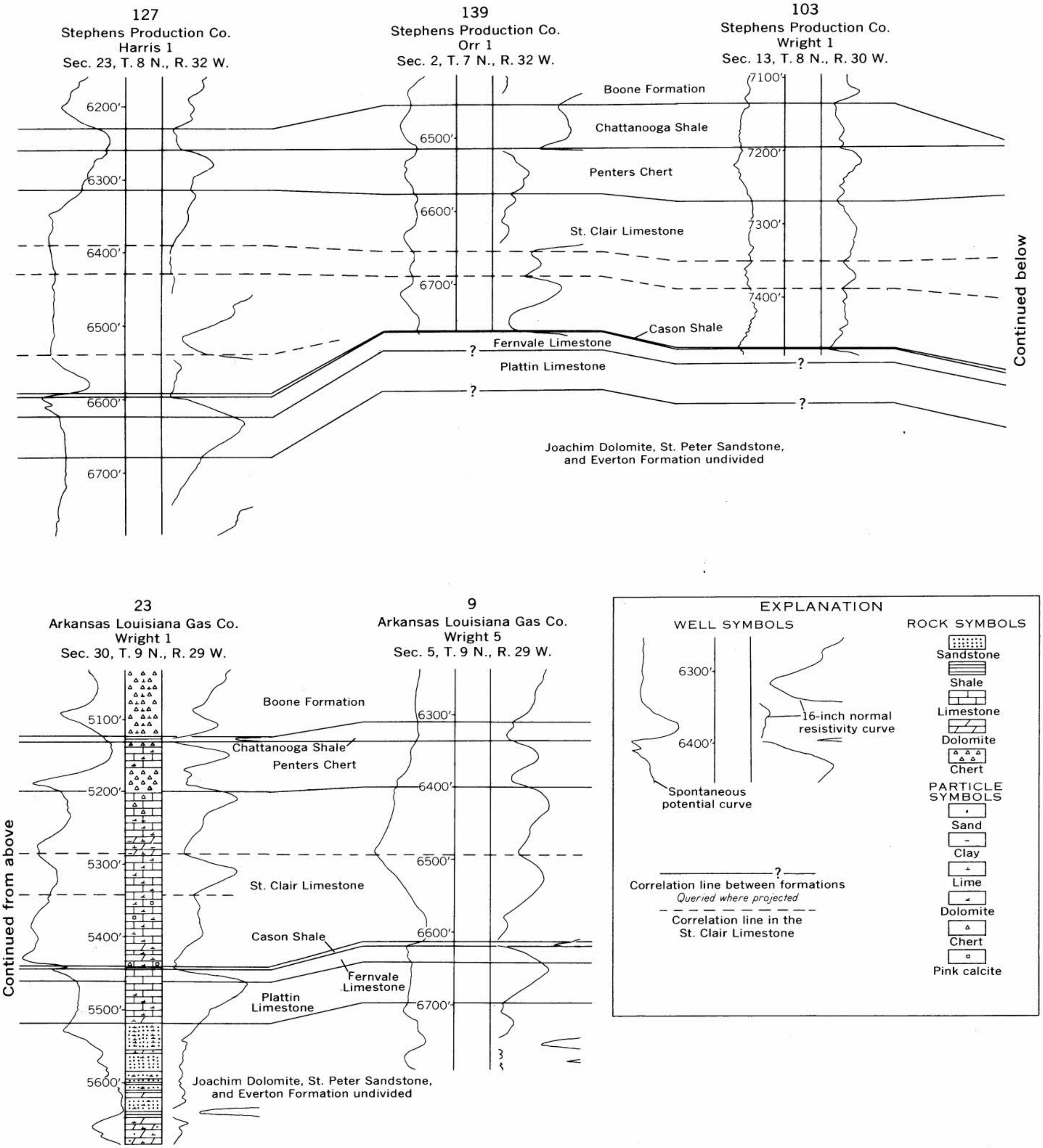


FIGURE 3.—Correlation of rocks between the Everton and Boone Formations, Van Buren and Lavaca quadrangles.

uppermost part, very fine to medium-grained sandstone and quartz sand. Some parts of the Penters are limy; other parts are dolomitic. Very light gray limy granular to very fine crystalline dolomite is present. Some of the dolomite contains white translucent to milky chert. Very light gray dolomitic granular to very finely crystalline limestone containing white to very light gray translucent to milky dense chert is present.

DEVONIAN AND MISSISSIPPIAN SYSTEMS, CHATTANOOGA SHALE

The Chattanooga in northern Arkansas unconformably overlies the Penters and is unconformably overlain by the Boone Formation. In the area of this report the Chattanooga overlies the Penters Chert and is overlain by the Boone Formation or, in those areas where the Boone-type rocks are absent, by the Moorefield Formation.

The Chattanooga is known to range in thickness from 9 to 121 feet in the two quadrangles (fig. 4). In the Lavaca quadrangle, the Chattanooga thickens southward by about the same amount that the overlying Boone Formation thins; this relationship is less consistent in the Van Buren quadrangle (fig. 4). The formation is a dark-gray to grayish-black sooty-appearing shale that contains very finely to coarsely crystalline pyrite and, locally, very thin layers of medium-gray siltstone.

MISSISSIPPIAN SYSTEM

The Mississippian System of this report comprises, in ascending order, the Boone Formation, Moorefield Formation, Fayetteville Shale, and Pitkin Limestone. The Mississippian rocks range in thickness from 290 to 604 feet and are thickest in the central part of the area (fig. 5*C*). The thickness of the Chattanooga Shale and younger Mississippian rocks is shown in figure 5*D*. In northwestern Arkansas and northeastern Oklahoma, the Boone is mostly limestone and chert; the Moorefield is shale, silty shale, siltstone, limy siltstone, and silty limestone; the Fayetteville is mostly nonsilty shale; and the Pitkin is mostly limestone.

A study of thickness maps (figs. 4, 5) shows that the Boone and, to a lesser extent, the Fayetteville Formations (fig. 4*B*, *D*,) are thin where the intervening Moorefield (fig. 4*C*) is thick, and that the combined thickness of the three formations (fig. 5*B*) varies in proportion to the thickness of the post-Chattanooga Mississippian rocks (fig. 5*C*).

The compensating thickening and thinning of the Moorefield in relation to the adjacent units can be explained by the following sequence of events: (1) Boone deposition; (2) post-Boone–pre-Moorefield erosion; (3) Moorefield deposition; (4) post-Moorefield–pre-Fayetteville erosion; and (5) Fayetteville deposition. Post-Boone–pre-Moorefield erosion would explain the absence of limestone and chert of the Boone in many parts of western Arkansas and eastern Oklahoma, but apparently any such erosion did not remove all the shale of the underlying Chattanooga at any place. In the area of this report the Chattanooga is thickest where the Boone is thin or absent (fig. 4*A*, *B*). In parts of northern Arkansas the Chattanooga is absent, but in these areas the Boone is present.

It seems more logical to the authors of this report to account for thickness changes in the Moorefield by relating them to facies changes in the Boone from limestone and chert to silty limestone, limy siltstone, siltstone, and silty shale, and in the Fayetteville from nonsilty shale to shale, silty shale, and siltstone. Thus in some areas of this report, the silty, noncherty rocks in the lowermost part of the Moorefield are thought to be equivalent to a part or all of the cherty rocks of the Boone in other areas. Likewise, the silty rocks in the upper part of the Moorefield in some areas are thought to be equivalent to the nonsilty shale in the lower part of the Fayetteville in other areas.

BOONE FORMATION

In northern Arkansas the Boone Formation unconformably overlies the Chattanooga and is unconformably overlain by the Moorefield Formation. In the area of this report the Boone unconformably overlies the Chattanooga, but it appears to be conformably overlain by the Moorefield.

The Boone ranges in measured thickness from a featheredge to 240 feet in the area of this report. It is absent in the southern part and is thickest in the northwestern, central, and northeastern parts (fig. 4*B*). The Boone is predominantly white to light-gray translucent to milky dense to granular chert. Beds of light- to medium-gray dense to finely crystalline limestone and cherty limestone are common. Chert is the identifying characteristic of the Boone Formation. If the rocks directly overlying the Chattanooga do not contain chert, they are identified as Moorefield even though they may be continuous with the Boone in other nearby areas.

MOOREFIELD FORMATION

The Moorefield Formation of this report overlies the Boone or, where cherty Boone-type rocks are absent, the Chattanooga. It ranges in measured thickness from 20 to 344 feet and is thickest in the south-central and north-central parts (fig. 4*C*). The Moorefield consists of dark-gray to grayish-black mostly silty shale, siltstone, limy siltstone, and silty limestone. Lack of chert in the Moorefield generally differentiates it from the Boone.

The presence of siltstone differentiates it from the overlying Fayetteville. A cherty zone in the middle of the Moorefield (intervals 4,430–4,440 ft in well 57 and 6,225–6,230 ft in well 101) may represent a tongue of Boone-type rocks extending from the northwest into the area of these wells.

FAYETTEVILLE SHALE

The Fayetteville Shale overlies the Moorefield and is overlain by the Pitkin Limestone. It ranges in measured thickness from 12 to 96 feet and is thickest in the north-central part of the area (fig. *4D*). The Fayetteville is dark-gray to grayish-black nonsilty shale, some of which is slightly limy. Near the top of the Fayetteville is a sandy and silty zone, usually less than 20 feet thick, that may be equivalent to the Wedington Sandstone Member of northern Arkansas. This zone consists of siltstone, limy siltstone, very finely sandy siltstone, or very silty very fine grained sandstone. In this report, the base of the Fayetteville is placed at the top of the first siltstone below the Wedington(?). This arbitrarily selected lithologic boundary may place some rocks equivalent to the Fayetteville in the underlying Moorefield.

PITKIN LIMESTONE

The Pitkin overlies the Fayetteville and is overlain by the Cane Hill Member of the Hale Formation or, where the Cane Hill is absent, by the Prairie Grove Member of the Hale Formation. The Pitkin ranges in measured thickness from 52 to 210 feet and is thickest in the east-central part of the area (fig. *5A*). The Pitkin is mostly light- to medium-gray oolitic fossiliferous dense to medium-crystalline limestone but includes some dark-gray to grayish-black shale.

PENNSYLVANIAN SYSTEM

MORROW SERIES

The Morrow Series in this area consists of the Hale Formation, which is made up of the Cane Hill and Prairie Grove Members, and the overlying Bloyd Formation, which is made up of shale and of thin limestone units that may be equivalent to the Brentwood and Kessler Limestone Members of northern Arkansas. The Morrow Series ranges in measured thickness from 380 to 692 feet, and it is thickest in the eastern part of the area (fig. 6).

HALE FORMATION

The Hale Formation unconformably overlies the Pitkin Limestone and is conformably overlain by the Bloyd Formation. The Hale ranges in measured thickness from 97 feet to 412 feet and is thickest in the central and eastern parts of the report area (fig. *7C*). It is composed mainly of shale and limy sandstone, with some limestone and siltstone.

Cane Hill Member

The Cane Hill overlies the Pitkin and is overlain by the Prairie Grove Member. In northern Arkansas, Frezon and Glick (1959, p. 181) considered the lower contact of the Cane Hill to be an unconformity. In the western part of the Van Buren quadrangle, both the Cane Hill and the underlying Pitkin are thin, which could be explained by erosion during part of Cane Hill time. The nature of the contact is not evident in the Lavaca quadrangle (figs. *5A*, *7A*). The upper contact of the Cane Hill is considered to be unconformable in the area of this report for the following reasons: (1) In some parts of the area where the overlying Prairie Grove is thick the Cane Hill is thin; however, not by the same amount; and (2) in the Lavaca quadrangle, where the Cane Hill is thin or absent, the underlying Pitkin is not significantly thinner than elsewhere as might be expected if there had been no Cane Hill deposited; therefore, it is assumed that the Cane Hill was removed by channeling during or preceding the deposition of the Prairie Grove. Channeling of the Cane Hill is reported in northern Arkansas (Frezon and Glick, 1959, p. 184).

A thin shale between the Prairie Grove and the Pitkin in western Van Buren quadrangle possibly is not the Cane Hill but represents a soil formed by erosion before or during Prairie Grove time.

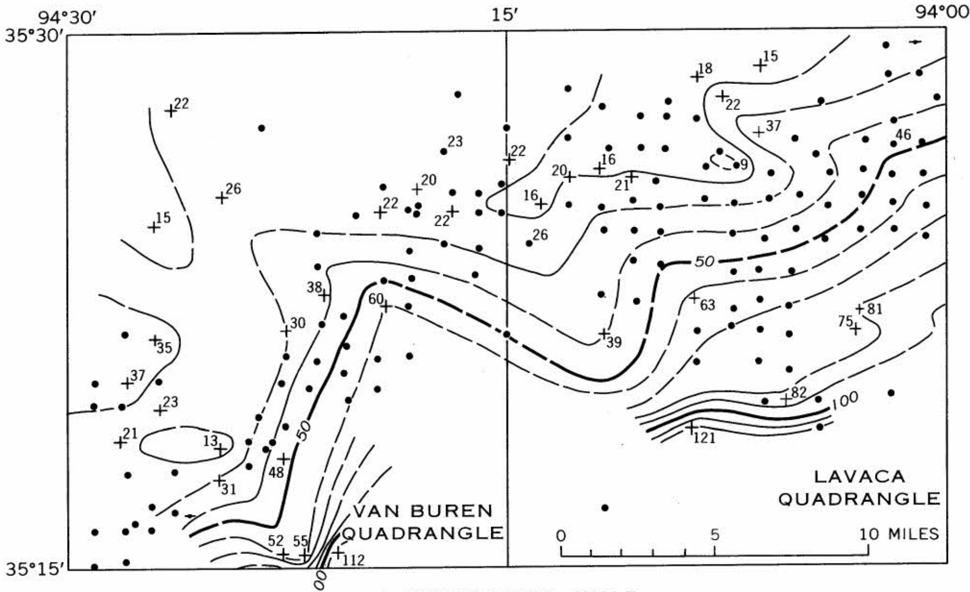
The measured thickness of the Cane Hill Member ranges from a featheredge to 66 feet and is greatest in the east-central part of the Lavaca quadrangle. The member consists of dark-gray shale, most of which is silty, some thin beds of siltstone, and a few thin beds of silty sandstone.

Prairie Grove Member

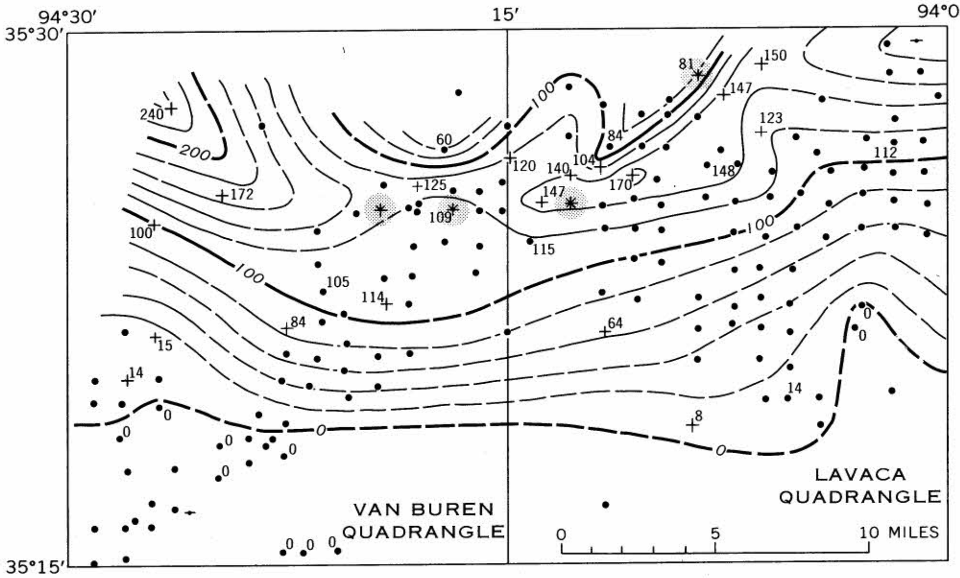
The Prairie Grove unconformably overlies the Cane Hill and is conformably overlain by the Bloyd Formation. It ranges in measured thickness from 74 to 391 feet and is thickest in the eastern part of the report area (fig. *7B*). The Prairie Grove consists mostly of light-gray limy fine- to medium-grained sandstone that grades laterally into light- to medium-gray fine- to medium-sandy limestone. Some medium-gray siltstone and dark-gray shale is present.

BLOYD FORMATION

The Bloyd overlies the Prairie Grove and is overlain by the Atoka Formation. It ranges in measured thickness from 237 feet to 439 feet and is thickest in the southwestern part of the report area (fig. *7D*). The Bloyd consists of dark-gray shale with medium-gray

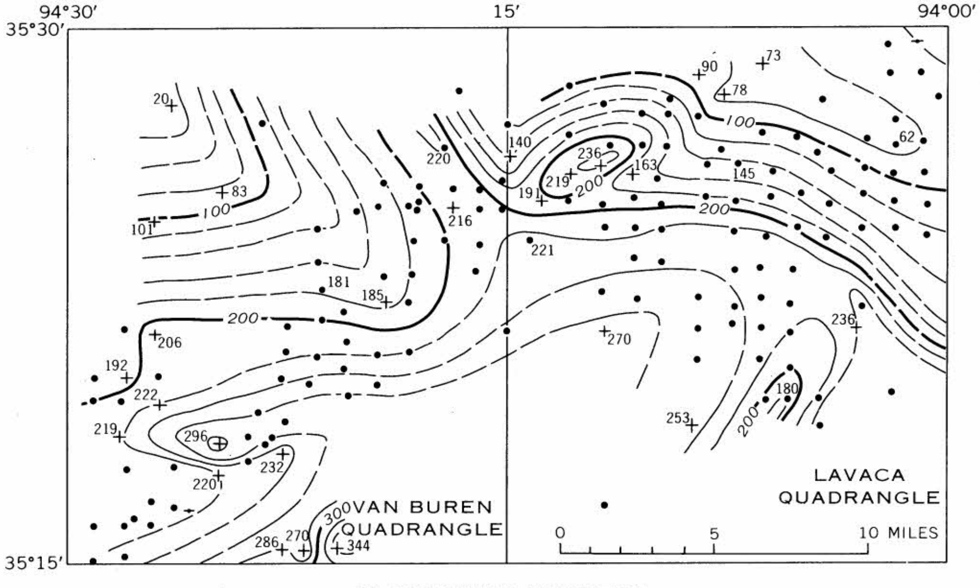


A. CHATTANOOGA SHALE

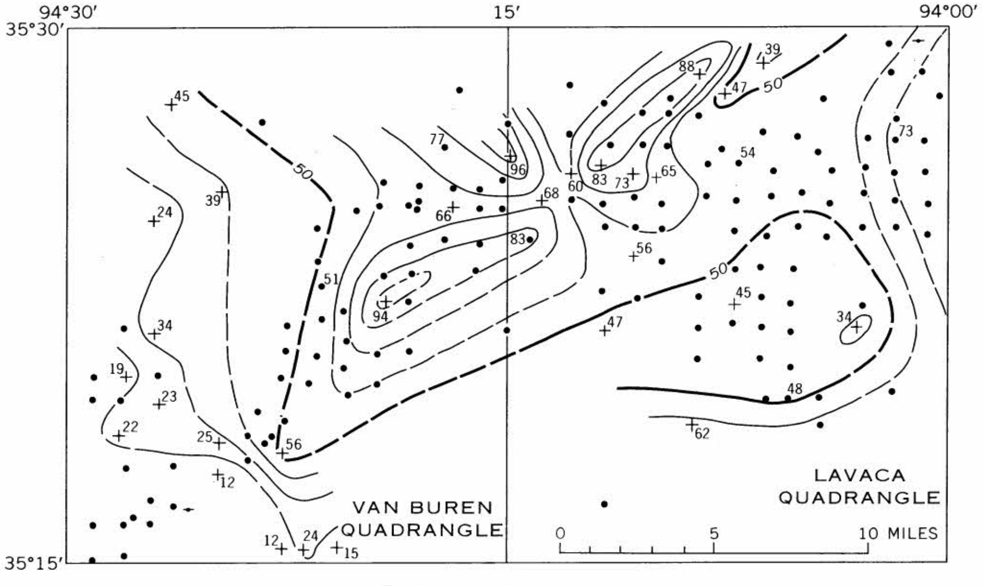


B. BOONE FORMATION

FIGURE 4.—Maps showing thickness of the Chattanooga Shale (Devonian and Mississippian) and the Boone formation, Moorefield Formation, and Fayetteville Shale (Mississippian). Thickness lines are dashed where projected; interval is 10 or 20 feet. Numbers indicate thickness of mapped unit, in feet. (See fig. 11 and table 3 for well number and location.) Stipple indicates possible reservoir area around well reported as producing or having a show of gas; diameter is arbitrarily shown as 1 mile to agree with well spacing.



C. MOOREFIELD FORMATION



D. FAYETTEVILLE SHALE

EXPLANATION

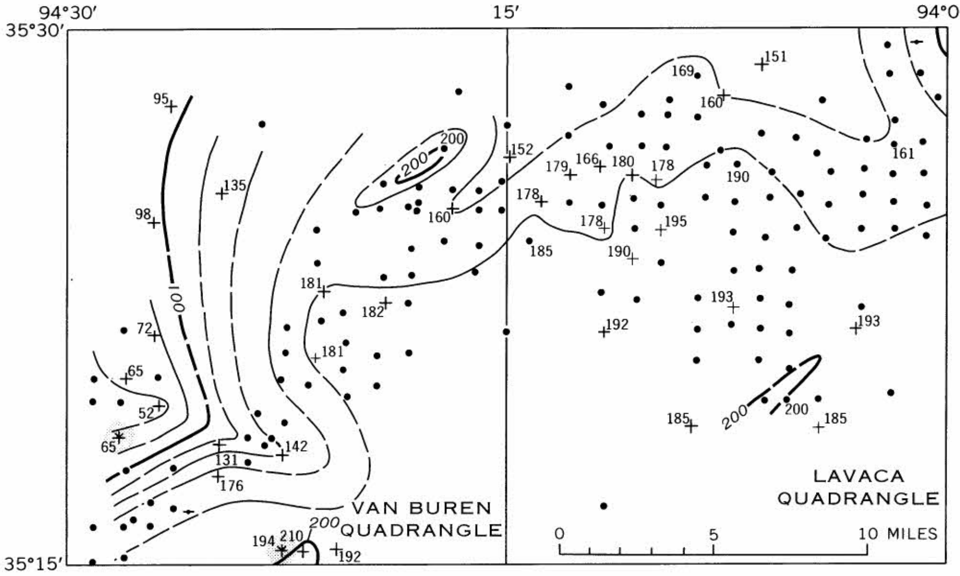
✳ Well producing gas

* Well with show of gas

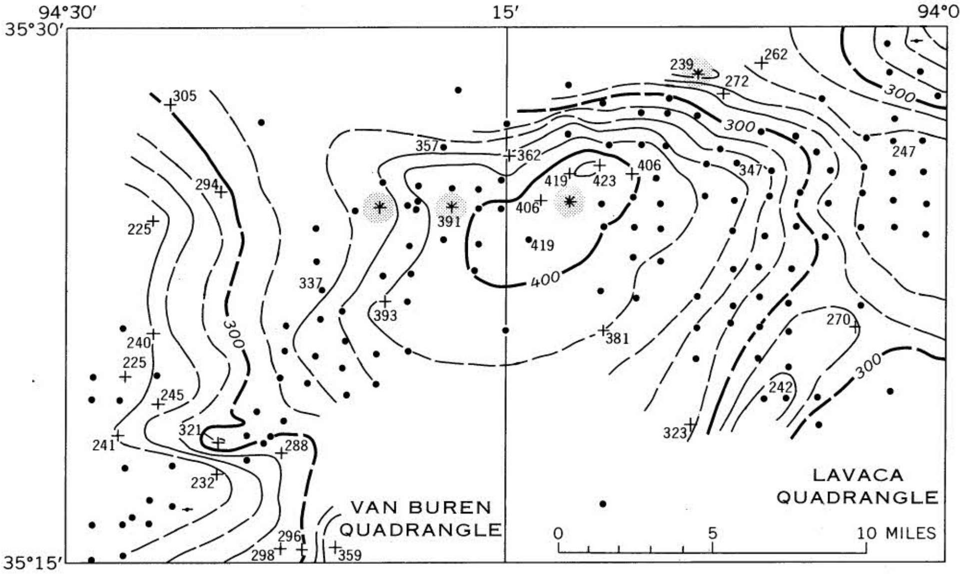
\+ Well with no show of gas

→ Well being drilled as of Sept. 30, 1966

• Well that did not penetrate the mapped unit or that has incomplete or unavailable records

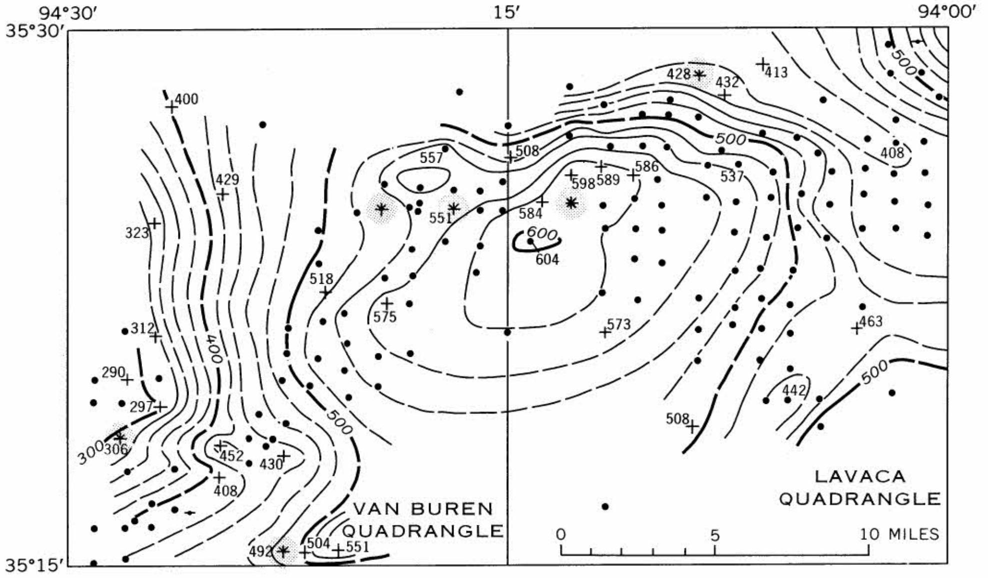


A. PITKIN LIMESTONE

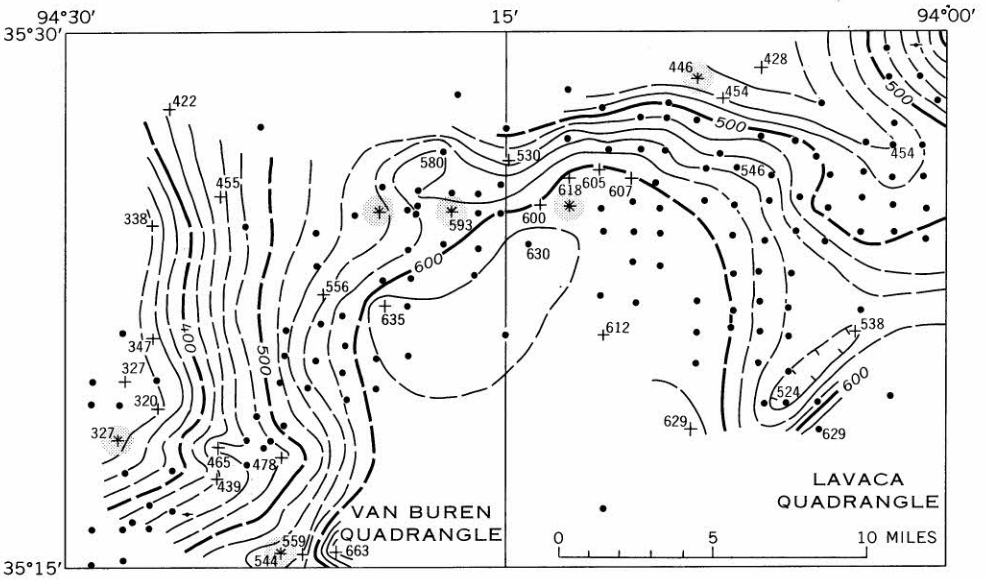


B. FAYETTEVILLE SHALE, MOOREFIELD FORMATION, AND BOONE FORMATION

Figure 5.—Maps showing thickness of the Pitkin Limestone (Mississippian), the combined thickness of the Fayetteville Shale, Moorefield and Boone Formations (Mississippian), the thickness of the post-Chattanooga Mississippian rocks, and the thickness of the Chattanooga Shale and Mississippian rocks. Thickness lines are dashed where projected; interval is 20 feet. Numbers indicate thickness of mapped unit, in feet. (See fig. 11 and table 3 for well number and location.) Stipple indicates possible reservoir area around well reported as producing or having a show of gas; diameter is arbitrarily shown as 1 mile to agree with well spacing.



C. POST-CHATTANOOGA MISSISSIPPIAN ROCKS



D. CHATTANOOGA SHALE AND MISSISSIPPIAN ROCKS

EXPLANATION

✱ Well producing gas	⇠ Well being drilled as of Sept. 30, 1966
✱ Well with show of gas	• Well that did not penetrate the mapped unit or that has incomplete or unavailable records
+ Well with no show of gas	

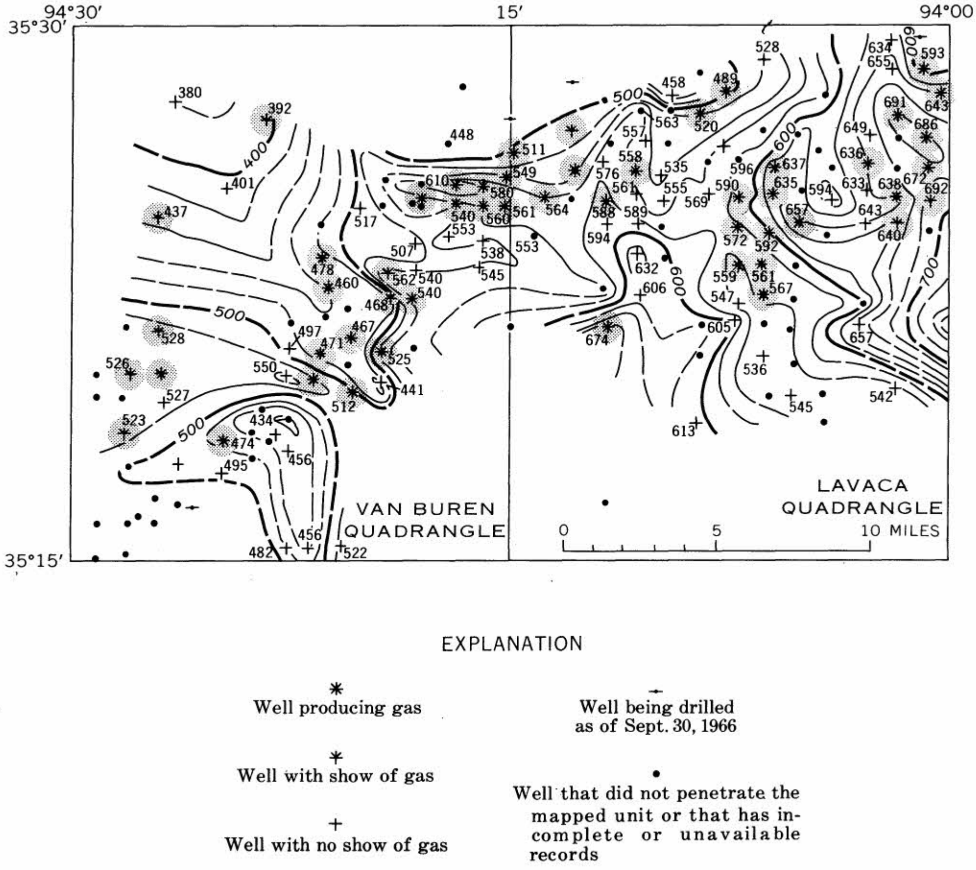


FIGURE 6.—Map showing thickness of Morrow rocks. Thickness lines are dashed where projected; interval is 20 feet. Numbers indicate thickness, in feet. (See fig. 11 and table 3 for well number and location.) Stipple indicates possible reservoir area around well reported as producing or having a show of gas; diameter is arbitrarily shown as 1 mile to agree with well spacing.

sandy limestone, and some medium-gray siltstone. The limestone in the upper part of the Bloyd grades laterally to the southwest into a fine- to medium-grained limy sandstone.

ATOKA SERIES

The Atoka Series consists of the Atoka Formation. In this report, the Atoka Formation has been divided into three lithologic parts which were further subdivided into zones on the basis of electrical log characteristics. The zones are numbered in nonconsecutive order from 1 near the top of the formation to 109 near the base (pls. 2, 4).

The Atoka Formation overlies the Bloyd and is unconformably overlain by the Hartshorne Sandstone. In northern Arkansas where the contact between the Atoka and the underlying Bloyd is exposed, it is unconformable. In the area of this report the contact relations cannot be determined with certainty, but the contact is probably unconformable. In this report, the base of the Atoka is placed at the base of the first sandstone (base of sandstone in zone 109 or zones 108 and 109, pls. 2, 4) above beds of Bloyd-type lithology (shale containing limestone, sandy limestone, and limy sandstone). Light-colored bentonitic(?) shale is in or just above the upper part of the sandstone in zone 109 or zones 108 and 109 (pl. 2, wells 158, 137, 72, 115, 50, 96, and 134). Frezon and Schultz (1961) described this as a marker bed in the lowermost Atoka. However, in parts of the Van Buren and Lavaca quadrangles and elsewhere in Arkansas, the base of the Atoka is difficult to identify because the limestone in the upper part of the Bloyd grades into sandstone, and more than one bed of bentonitic shale exists in the lowermost 700 feet of the Atoka.

The amount of erosion at the unconformity between the Atoka Formation and the overlying Hartshorne Sandstone is uncertain. In well 36 the Atoka sequence between the top of zone 1 and the base of the Hartshorne Sandstone is 185 feet thick; the same unit in well 38 (pl. 4, sec. *X–X′*), about 1 mile to the southwest, is only 110 feet thick; and in well 37, about 1 mile west of well 38 (pl. 4, sec *X–X′*), the unit is only 82 feet thick. A complementary thickening of the Hartshorne Sandstone occurs in wells 36 and 37; thus post-Atoka erosion removed as much as 103 feet of Atoka in the area of these wells. Atoka rocks are 223 feet thick above zone 1 in well 167 (pl. 4, sec. *Y–Y′*); thus, a comparison between wells 37 and 167 suggests that post-Atoka erosion removed as much as 141 feet of Atoka rocks. However, regional thickening of the rocks above zone 1 may account for the southward thickening between these two wells, and for as much as 101 feet of southward thickening between wells 37 and 143 (pl. 4, sec. *Y–Y′*).

The Atoka is known to range in thickness from 4,375 to 6,755 feet, and it may be as much as 8,800 feet thick in the southeastern part of the report area (fig. 8).

In comparing the thickness of the Atoka (pl. 4; fig. 8) in relation to the structure of the Hartshorne Sandstone (top of the Atoka) (pl. 5), it is apparent that in most of the area the Atoka is thinner where folded into anticlines and thicker where folded into synclines, and that where the Atoka changes thicknesses all parts of the Atoka thicken or thin in proportion. Such a relationship suggests that the anticlines and synclines were developing during the deposition of the Atoka. It is also possible to conclude that displacement occurred along many, if not all, of the major faults shown on plate 5 during the deposition of most of the Atoka. Many of the major faults are in the area between thick and thin Atoka, and the thicker part of the Atoka is on the downthrown side.

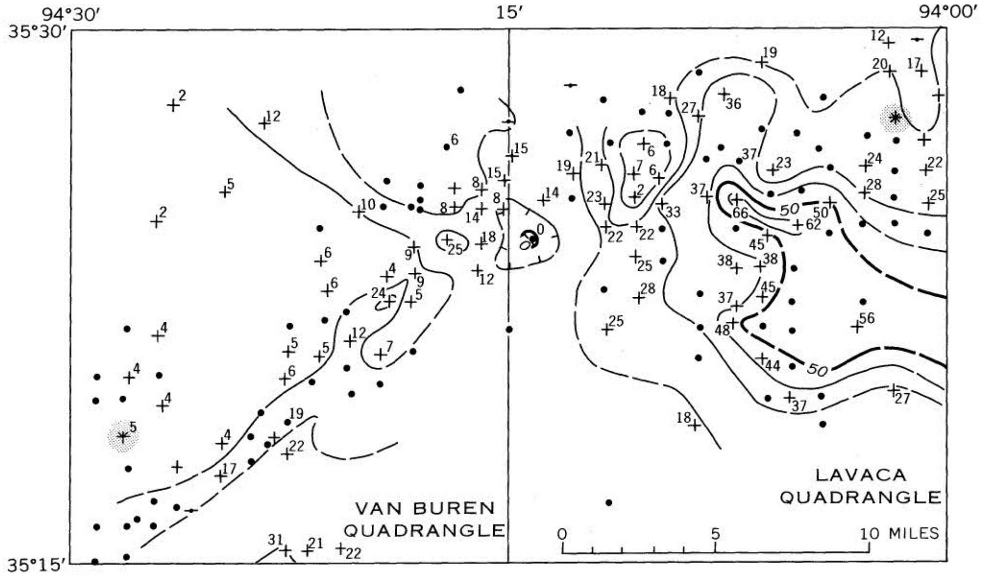
In this report, the Atoka is arbitrarily divided into three parts or groups of zones as shown in table 1. The thickness of each part is shown in figure 8. If the thickness changes reflect tectonic movements during deposition, then a study of the thickness maps of the three parts of the Atoka shows that, in most of Van Buren and in northern Lavaca quadrangles, the amount of flexing was greatest during deposition of the lower part of the Atoka and least during deposition of the upper part.

The thickness of the sandstone in some of the numbered zones (figs. 9, 10) seems to have been influenced by this flexing, particularly in zone 93 (fig. 9*D*). The thickness trends in zone 93 are about parallel to the thickness trends of the lower part of the Atoka (fig. 8*A*). The thickness trends in zones 98, 99, and 100 (fig. 10*A–C*) seem to be parallel to those in the lower part of the Atoka in some areas, but the thickness trends in zone 101 (fig. 10*D*) are not parallel in any area. The thickness trends of the sandstone in zones 58 and 67 (fig. 9*B*, *C*) are somewhat parallel to those of the middle part of the Atoka (fig. 8*B*) in a few areas. The thickness trends in zone 28 (fig. 9*A*) in some areas are parallel to those in the upper part of the Atoka (fig. 8*C*).

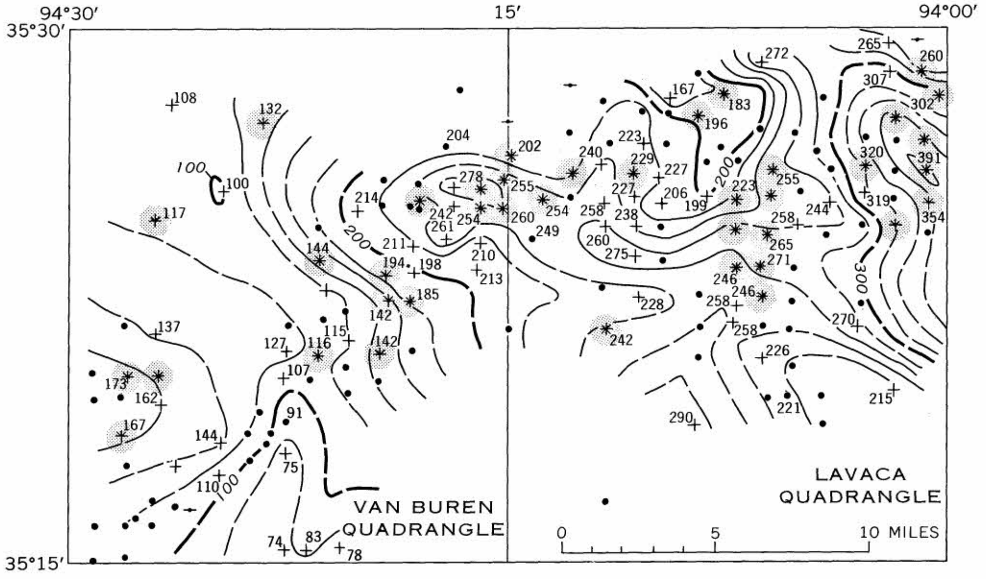
TABLE 1.—*Division of the Atoka Formation in Van Buren and Lavaca quadrangles, Arkansas and Oklahoma*

[The Hartshorne Sandstone overlies zone 1, and the Bloyd Formation underlies zone 109]

Zone number in this report	Part of Atoka in this report	Informal nomenclature used by local oil and gas industry	
1	Upper		
4			
6			
7			
10			
15			
18			Carpenter sand, Carpenter "A" sand
19			
24			
28		Alma series	Upper Alma sand
50			Middle Alma sand
53			
55			Lower Alma sand
57			
58	Middle		Lower Carpenter sand, Carpenter "B" sand
59			
60			
62			
63			
66			
67			Morris sand
71		Areci zone	
72			
73			
74			Areci sand
78			
79			
80			
82			
83	Lower		Bynum sand
84			
85			Lower Bynum sand
90			
92			Freiburg sand
93			Casey sand
95			Vernon sand
96			
97			
98		Cecil series	Dunn "A" sand, Sells sand
99			Ralph Barton sand, Dunn "B" sand, Jenkins sand
100			Dunn "C" sand, Dawson sand
101			Paul Barton sand, Lower Dawson sand
105			Cecil Spiro sand, Hamm sand
108			Patterson sand
109			Spiro sand, Kelly sand

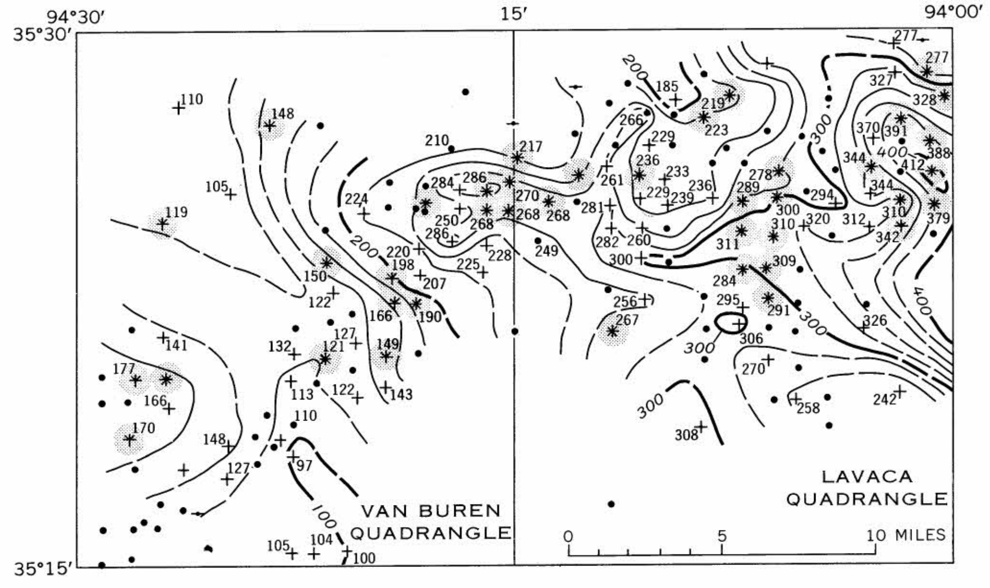


A. CANE HILL MEMBER OF HALE FORMATION

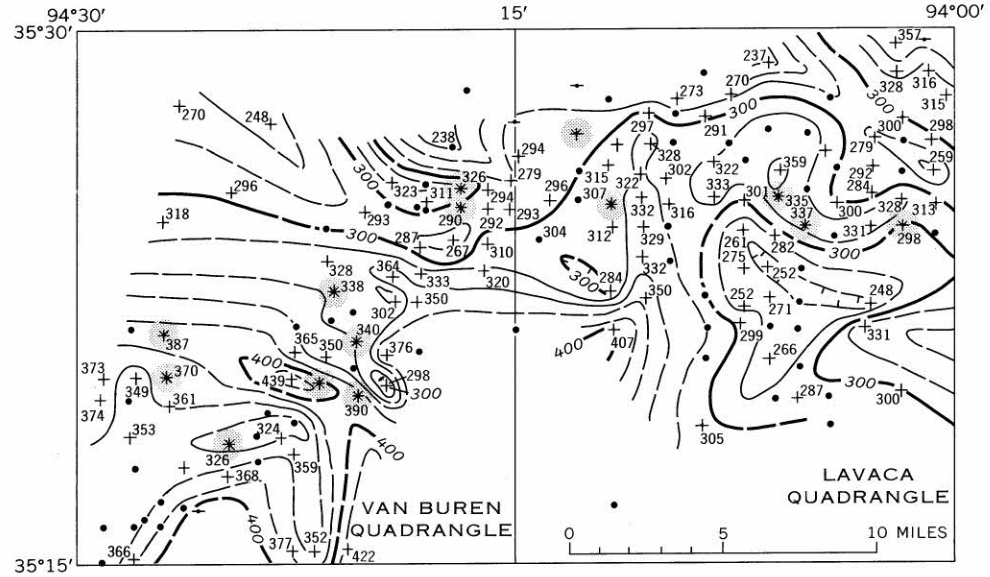


B. PRAIRIE GROVE MEMBER OF HALE FORMATION

FIGURE 7.—Maps showing thickness of the Cane Hill and Prairie Grove Members of the Hale Formation and the thicknesses of the Hale and the Bloyd Formations, all of Morrow age. Thickness lines are dashed where projected; interval is 10 or 20 feet. Numbers indicate thickness of mapped unit, in feet. (See fig. 11 and table 3 for well number and location.) Stipple indicates possible reservoir area around well reported as producing or having a show of gas; diameter is arbitrarily shown as 1 mile to agree with well spacing.



C. HALE FORMATION



D. BLOYD FORMATION

EXPLANATION

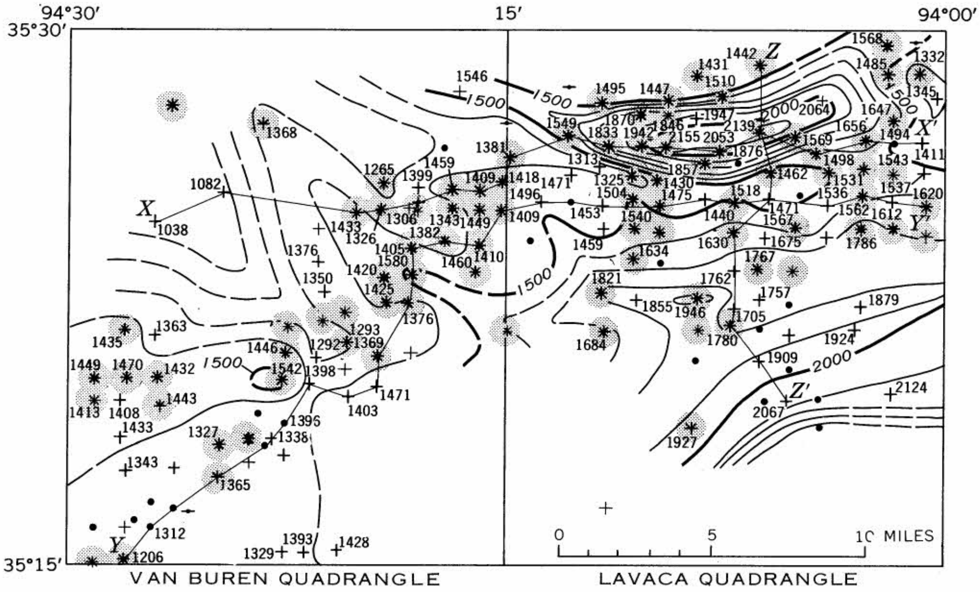
✱ Well producing gas

✳ Well with show of gas

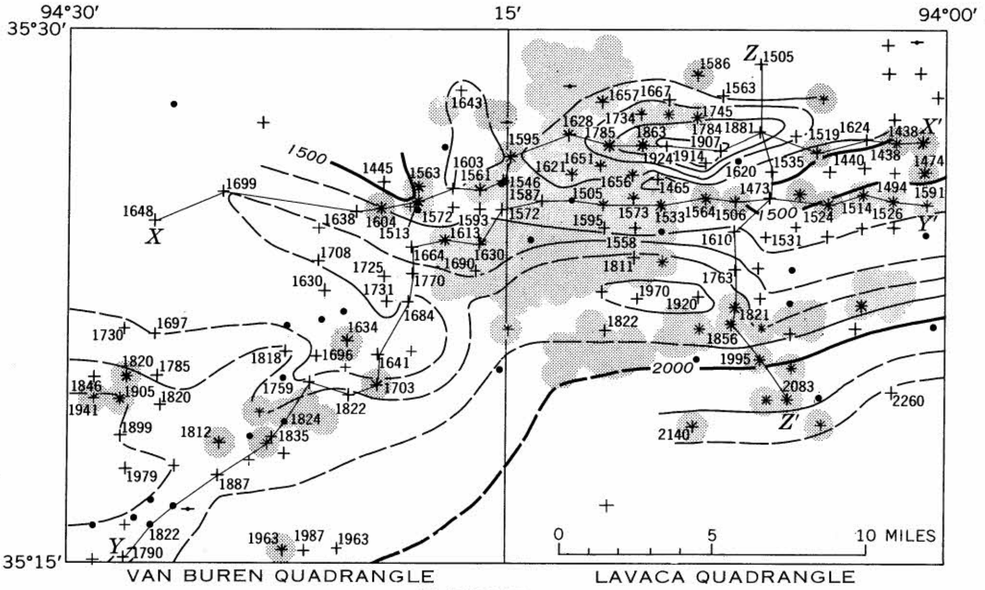
\+ Well with no show of gas

⊸ Well being drilled as of Sept. 30, 1966

● Well that did not penetrate the mapped unit or that has incomplete or unavailable records

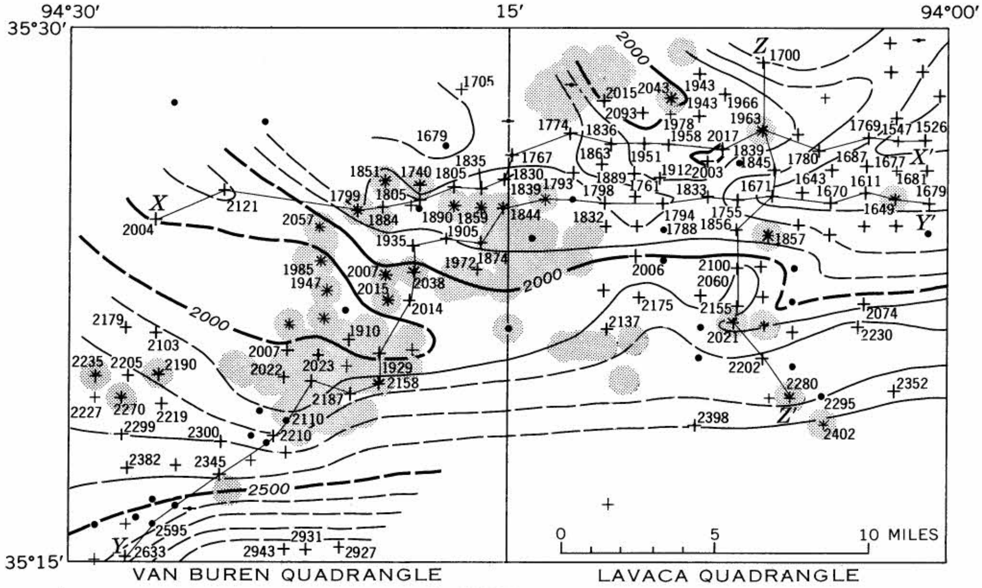


A. LOWER PART

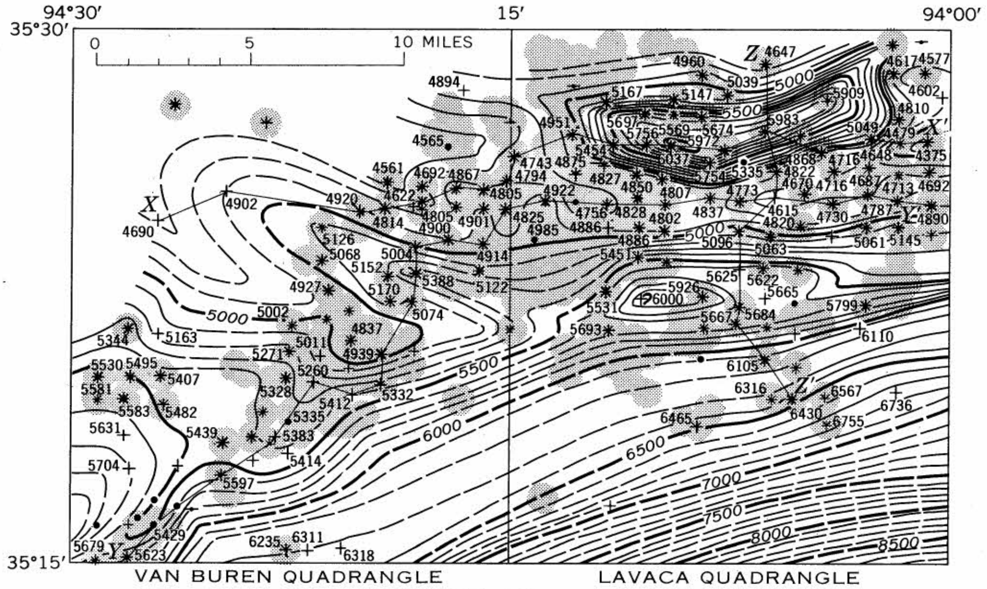


B. MIDDLE PART

FIGURE 8.—Maps showing thickness of the lower (from the base of the Atoka to the top of zone 83), middle (from the top of zone 83 to the top of zone 58), and upper (from the top of zone 58 to the top of the formation) parts of the Atoka Formation, and its total thickness. Thickness lines are dashed where projected; interval is 100 feet. Numbers indicate thickness of mapped unit, in feet. (See fig. 11 and table 3 for well number and location.) show of gas, including areas around wells not identified in this report and drilled before 1936; diameter is arbitrarily shown as 1 mile to agree with well spacing.



C. UPPER PART



D. TOTAL THICKNESS

EXPLANATION

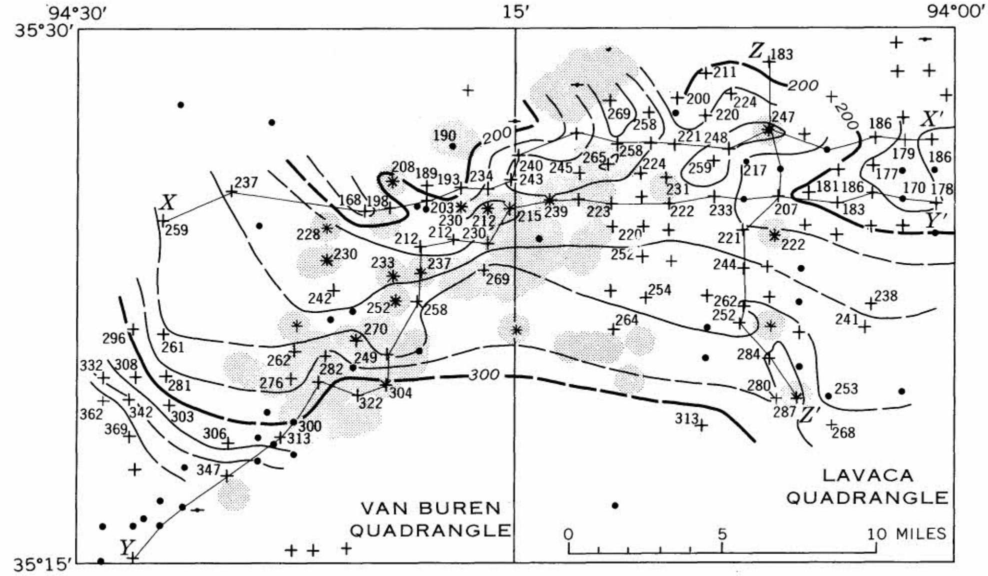
✳ Well producing gas

⊸ Well being drilled as of Sept. 30, 1966

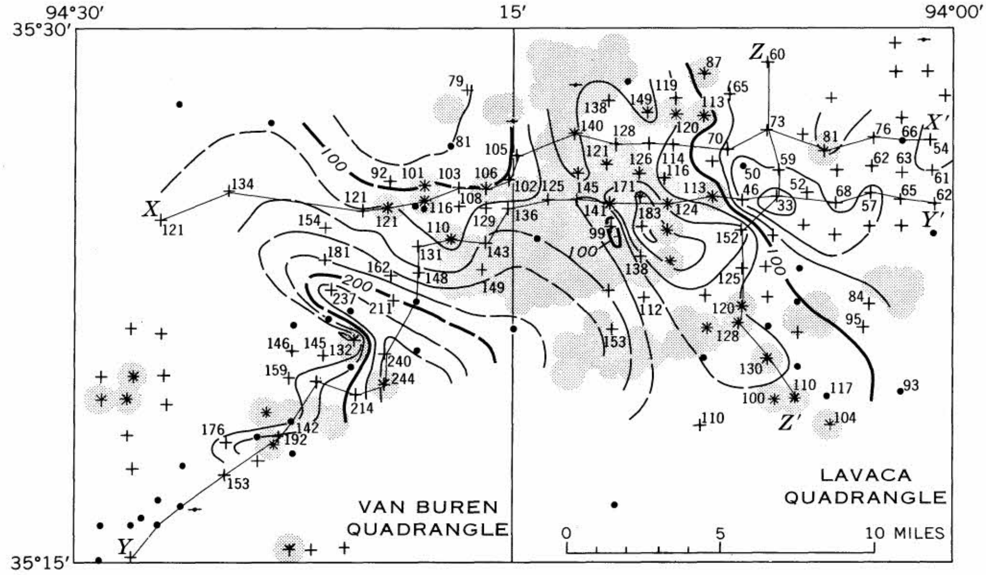
✳ Well with show of gas

● Well that did not penetrate the mapped unit or that has incomplete or unavailable records

+ Well with no show of gas

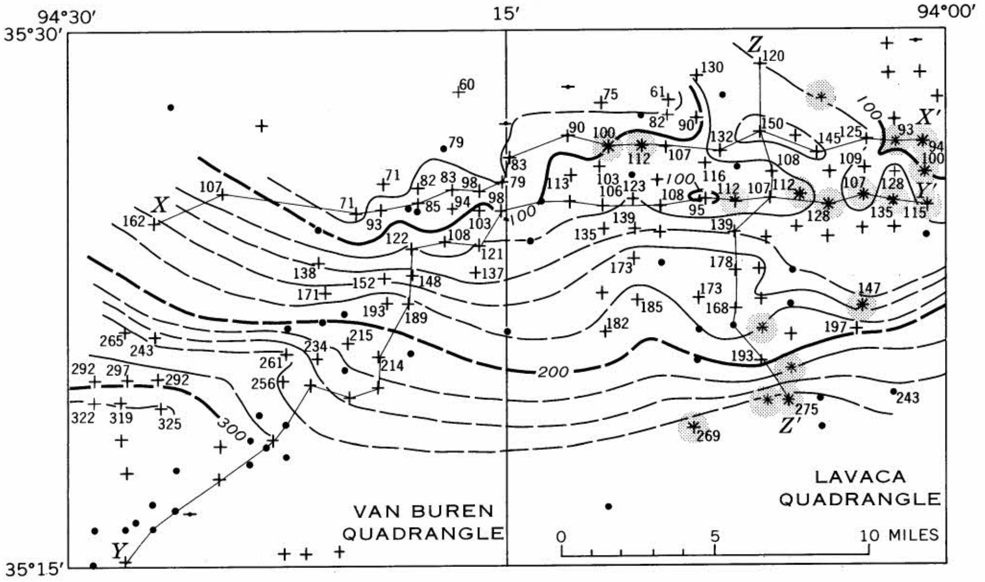


A. ZONE 28

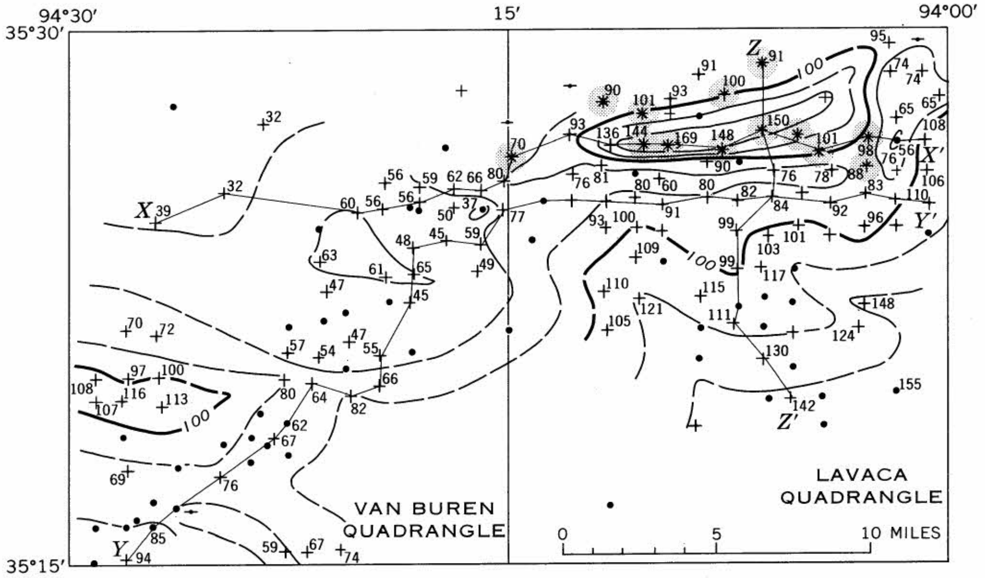


B. ZONE 58

FIGURE 9.—Maps showing thickness of the sandy parts of zones 28, 58, 67, and 93 in the Atoka Formation. Thickness lines are dashed where projected; interval is 20 feet. Numbers indicate thickness of mapped zone, in feet. (See fig. 11 and table 3 for well number and location.) Stipple indicates possible reservoir area around well reported as producing or having a show of gas, including areas around wells not identified in this report and drilled before 1936; diameter is arbitrarily shown as 1 mile to agree with well spacing.



C. ZONE 67



D. ZONE 93

EXPLANATION

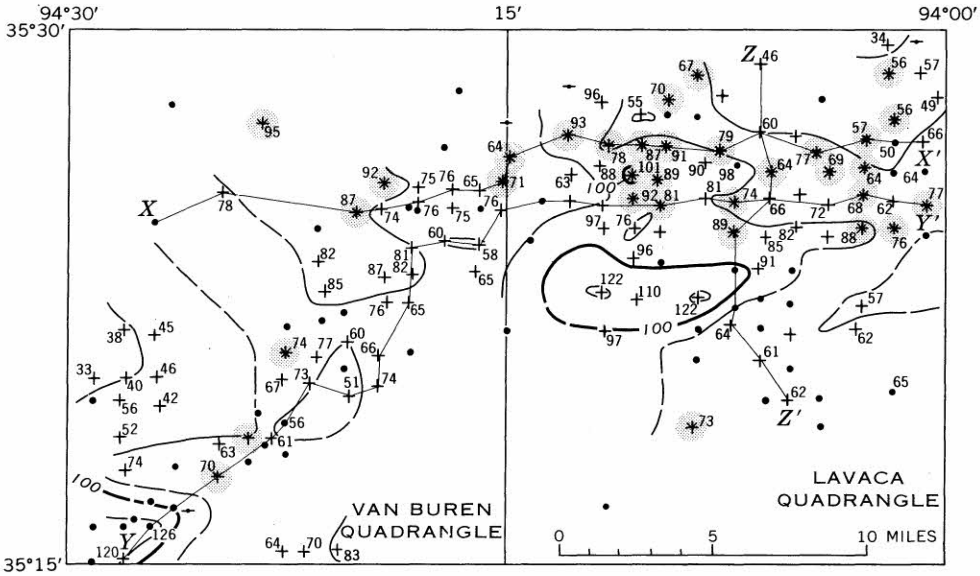
✱ Well producing gas

⁎ Well with show of gas

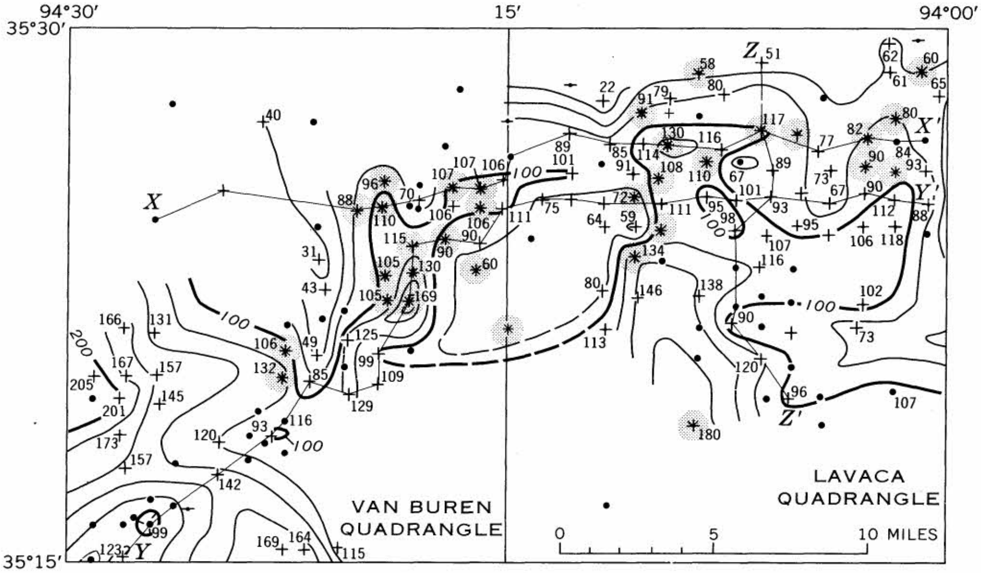
\+ Well with no show of gas

→ Well being drilled as of Sept. 30, 1966

• Well that did not penetrate the mapped unit or that has incomplete or unavailable records

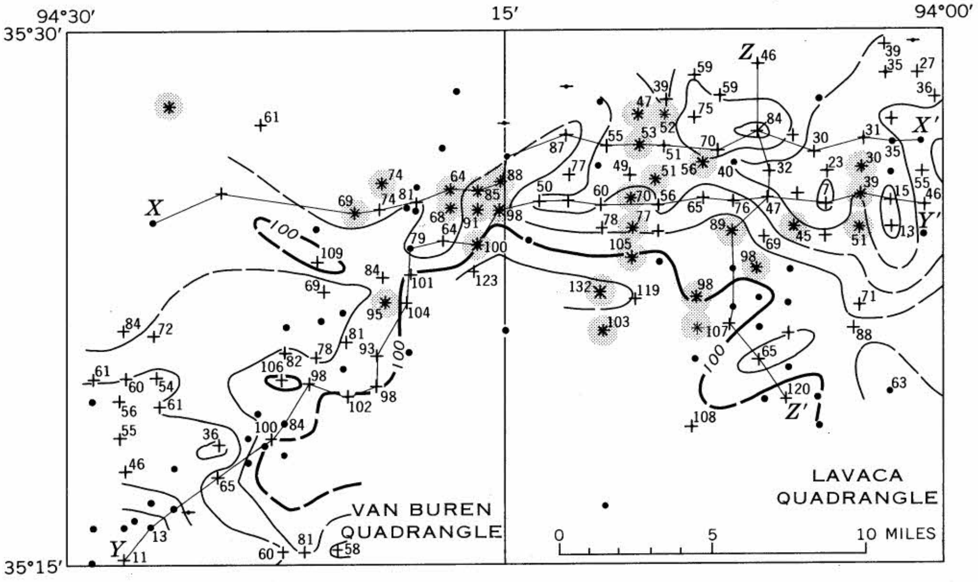


A. ZONE 98

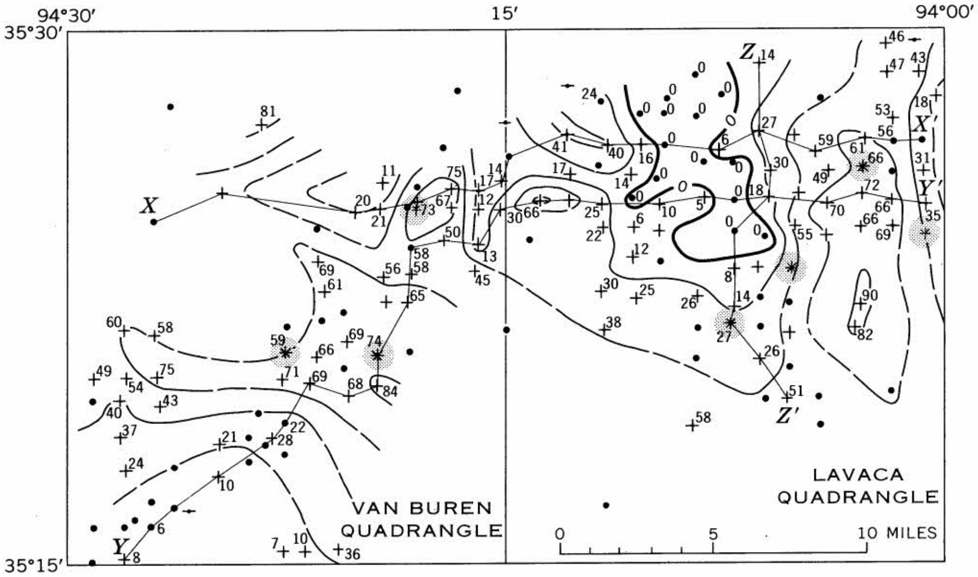


B. ZONE 99

Figure 10.—Maps showing thickness of the sandy parts of zones 98, 99, 100, and 101 in the Atoka Formation. Thickness lines are dashed where projected; interval is 20 feet. Numbers indicate thickness of mapped zone, in feet. (See fig. 11 and table 3 for well number and location.) Stipple indicates possible reservoir area around well reported as producing or having a show of gas; diameter is arbitrarily shown as 1 mile to agree with well spacing.



C. ZONE 100



D. ZONE 101

EXPLANATION

✱
Well producing gas

✱
Well with show of gas

+
Well with no show of gas

→
Well being drilled as of Sept. 30, 1966

●
Well that did not penetrate the mapped unit or that has incomplete or unavailable records

Electrical log correlations, some of which are shown on plate 4, and electrical log and lithological log correlations, some of which are shown on plate 2, suggest that many zones thicken because of the addition of sandstone and siltstone above the shale at the base of the zones. (See zones 18, 28, 50, 93, and 105, pl. 4.)

In the report area the Atoka is about 55 percent shale, much of which is silty, 20 percent light- to dark-gray siltstone, and 25 percent very light to medium-gray sandstone. A few thin beds of bentonitic (?) shale, limestone, and coal are interspersed in these clastic beds. The shale is mostly dark gray, but it is also commonly grayish black. Where exposed, the shale is fissile bedded. Well-preserved plant fossils are present above the coal bed in the W½NE¼SE¼ sec. 3, T. 9 N., R. 32 W., and in the SW¼NE¼ sec. 32, T. 10 N., R. 30 W. The siltstone, where exposed, is thin to thick bedded, foreset bedded in part, lenticular bedded in part, and commonly ripple marked; fossil plant fragments are common and marine fossils are sparse. The exposed sandstone is thin bedded, very fine grained, and ripple marked where a sandstone unit (two or more beds of sandstone) is thin, and it is thick to massive bedded and fine to coarse grained where a sandstone unit is thick. Where a sandstone unit is thin, the sandstone generally is gradational with the underlying siltstone; and where a unit is thick, the sandstone may overlie siltstone or shale with a channel-type contact. The top of thin or thick sandstone units is flat and generally is overlain by nonsilty dark-gray or grayish-black shale which in many places contains plant fossils or a coaly zone just above the sandstone. Fragments of plant fossils are common in the sandstone; marine fossils are common only at water level on the north side of Lee Creek in the NW. cor. sec. 6, T. 9 N., R. 32 W., and in a streambed just north of the report area near the center of NW¼NE¼SW¼SW¼ sec. 33, T. 10 N., R. 32 W.

DES MOINES SERIES, KREBS GROUP

The Krebs Group consists of, in ascending order, the Hartshorne Sandstone, McAlester Formation, Savanna Formation, and Boggy Formation. The Boggy Formation and most of the Savanna Formation have been removed from the area of this report by erosion.

HARTSHORNE SANDSTONE

The Hartshorne Sandstone of this report is the first laterally continuous sandstone unit below the Lower Hartshorne coal bed and is the lower sandstone member of the Hartshorne Sandstone of Oklahoma (fig. 2). It overlies the Atoka Formation unconformably and is conformably overlain by the McAlester Formation.

The thickness of the Hartshorne ranges from 15 feet in shallow hole 271 to 229 feet in well 134.

The Hartshorne is mostly very light to light-gray very fine to fine grained sandstone but contains a few gray siltstone beds and lenses and thin layers of dark-gray shale. In the southwestern part of the Lavaca quadrangle, the formation consists of two sandstone units separated by a unit, about 50 feet thick, of dark-gray silty shale and dark-gray shale.

The bedding is thin to massive and is regular, irregular, lenticular, foreset, or convolute. Fragments of plant fossils are common.

The formation is well exposed in the quarries in secs. 5 and 6, T. 8 N., R. 29 W., and sec. 17, T. 9 N., R. 31 W., and along Mill Creek in sec. 32, T. 9 N., R. 29 W.

M'ALESTER FORMATION

The McAlester conformably overlies the Hartshorne and is overlain by the Savanna Formation with a contact that, according to Hendricks and Parks (1950, p. 76), represents a minor unconformity. Haley (1961, p. 7) reported that the McAlester and Savanna in the vicinity of Paris, Ark. (about 18 miles east of the report area), have an interfingering relationship. Merewether and Haley (1969) stated that the formations interfinger in the vicinity of Clarksville, Ark. (about 30 miles east of the report area). In the southeastern part of Van Buren quadrangle (pl. 1) where the basal sandstone of the Savanna is in channels cut in shale of the McAlester, the contact appears unconformable, but the lateral extent of the channels could not be determined because of alluvial cover. In northwestern Lavaca quadrangle, a study of the lithologic logs of the shallow holes seems to indicate that the two formations interfinger.

The McAlester is about 715, 700, and 705 feet thick in wells 33, 35, and 36, respectively, in northwestern Lavaca quadrangle, and is estimated to be as much as 950 feet thick in the southeastern part of the Lavaca quadrangle (pl. 6).

The McAlester Formation is mostly shale with a minor amount of siltstone and sandstone. The shale is dark gray, nonsilty, and fissile bedded for the most part. A persistent zone of dark-gray to grayish-black shale (25–60 ft. thick) is present about 100 feet above the base of the formation. Pyrite and ironstone concretions are common in all the shale. Scattered plant and invertebrate fossils and phosphate pellets are present (pl. 3). The siltstone is light to medium gray and clayey in part. It is generally thin, irregularly bedded, and ripple marked. Mica and plant fragments are common. The sandstone is light to medium gray, very fine grained, very silty, and clayey. Bedding ranges from thin to thick and is regular to irregular or convolute. The lower

Hartshorne coal bed is present near the base of the formation everywhere in the two quadrangles.

SAVANNA FORMATION

The Savanna Formation has been partly or totally removed by erosion from the report area. The remaining Savanna is about 500 feet thick in northwestern Lavaca quadrangle and about 1,100 feet thick in southeastern Lavaca quadrangle (pls. 3, 6).

The Savanna is mostly shale with some siltstone and a minor amount of sandstone. Thin coal beds are common in the lower 140 feet. Rocks in the Savanna weather light greenish brown, in contrast to the rocks in the McAlester, Hartshorne, and Atoka, which generally weather gray. The shale is mostly dark gray, micaceous, and slightly silty to silty. Some of the shale is light to medium gray and, from the appearance of the rock samples from shallow holes, is nonbedded; thus it could be either claystone or underclay. Ironstone concretions are common in the shale, and pyrite is present in some places. The siltstone is light to medium gray, micaceous, and very finely sandy in part and shows common sediment-flow features. The sandstone is light to medium gray, very fine grained, very silty, and generally clayey. Sediment-flow features are so prevalent that they aid in differentiating the sandstone of the Savanna from the sandstone of the underlying formations. Excellent examples of sediment-flow features are exposed in the quarry and road junction in the SW¼ sec. 9, T. 7 N., R. 31 W., in the quarry in the SE¼NW¼ sec. 17, T. 7 N., R. 31 W., and in the quarry in the NW¼ sec. 16, T. 7 N., R. 31 W. The channeloid character of some of the sandstone in the Savanna is well exemplified in the NE¼ sec. 19, the NW¼ sec. 20, the SW¼NW¼ sec. 3, and the NE¼ sec. 2 in T. 7 N., R. 31 W.; the SE¼ sec. 13, T. 7 N., R. 29 W.; and in the adjoining corners of secs. 19, 20, 29, and 30, T. 7 N., R. 28 W.

The Charleston coal bed is near the base of the formation, and the Paris coal bed is in the upper part of the formation. Marine fossils are present in an iron-rich limestone above the Paris coal bed. Plant fossils are common in the shale, and fragments of plant fossils are common in all rock types.

QUATERNARY SYSTEM

TERRACE DEPOSITS

Alluvial material is present in terrace deposits at two levels along many streams and in discontinuous terrace deposits at a single level along the Arkansas River. The upper terrace, common to both the smaller streams and the Arkansas River, is 30–40 feet above the present drainage levels. The lower terrace, recognizable along local streams only, is generally less than 10 feet above the present drainage levels. The alluvial material deposited by the Arkansas River contains abundant pebbles and cobbles of chert that help to distinguish it from terrace deposits of local origin. Some chert pebbles contain fusulinids. These pebbles must have been transported from north-central Oklahoma by the Arkansas River. Stream-terrace deposits in secs. 2, 3, 10, and 11, T. 9 N., R. 32 W., contain widely scattered pebbles and cobbles of chert that probably were transported by Lee Creek from an outcrop of the Boone Formation about 18 miles north of the report area. The upper terrace deposits may be Pleistocene in age (Hendricks and Parks, 1950, p. 78, pl. 13; and Miser, 1954.)

ALLUVIUM

Alluvial material is present along the Arkansas River and along most local streams. The alluvium along the river generally is less clayey and contains coarser grains of quartz than the alluvium along the local streams.

STRUCTURE

Van Buren and Lavaca quadrangles are in the northern part of the Arkansas Valley section of the Ouachita province and in the extreme southern part of the Ozark Plateaus province (fig. 1). The rocks have been broadly folded and broken by north- or south-dipping normal faults. (pls 5, 6). The Arkansas Valley section is separated from the Ozark Plateaus province by a southward-dipping normal-fault system across which the displacement may be as much as 2,500 feet. The elevation of the base of the Hartshorne Sandstone ranges from about 1,450 feet below sea level in the southeastern Lavaca quadrangle to an estimated 3,000 feet above sea level in northwestern Van Buren quadrangle, a structural relief of about 4,450 feet.

FOLDS

Folds in the report area consist of eastward-trending anticlines and synclines whose limbs have been broken in many places by normal faults. The limbs of the folds dip less than 10° except near fault zones, where they may dip as much as 25°. Hendricks and Parks (1950) based their report on the Fort Smith district on geologic information gathered prior to 1934 and thus did not have advantage of the wealth of information that can be obtained from the records of wells and shallow holes drilled since that time. This new information plus field mapping by Haley (1960, 1961) has shown that the rocks in the northern two-thirds of the Van Buren and Lavaca quadrangles are faulted to a far greater extent than Hendricks and Parks realized. Consequently, many of the folds shown on plate 13 of their report either do not exist or cannot be identified with certainty. Those folds that can be identified are shown wherever possible on plates 1, 5, and 6.

Central, Bloomer, and Charleston synclines are the only synclines that are not bounded on both sides by normal faults, and the Biswell Hill anticline is the only anticline that is not bounded on both sides by normal faults (pls. 5, 6). The rest of the synclines are essentially grabens, and the anticlines are horsts. How much of the folding is the result of drag induced by the faulting is unknown, but it seems likely that folding and tilting did occur during the faulting. If the structural sections shown on plate 6 are reconstructed to remove the displacement across all faults that cut the top of the Atoka Formation, the result is structural relief of about 2,100 feet in section *A–A′* and *B–B′* between the top of the Atoka on the crest of the Cecil anticline and the top of the Atoka in the trough of the Bloomer syncline. This amount of structural relief at the top of the Atoka must represent post-Atoka folding and faulting of the rocks in the area.

If at the end of Atoka time the top of the Atoka Formation in the report area was about level, then the base of the Atoka had a measurable structural relief of at least 2,380 feet and an estimated structural relief of as much as 4,500 feet (based on fig. 8*D*). This structural relief on the base of the Atoka can be attributed to folding or faulting, or to a combination of folding and faulting, all of which occurred during Atoka time.

FAULTS

Faults in the report area are normal and dip either north or south at angles of 33°–63°; however, the dip of most of the faults is 40°–50°. Maximum displacement across the faults ranges from 10 feet to 2,500 feet. Where faults with opposing dips intersect, some of the south-dipping faults terminate downward against north-dipping faults, whereas all the north-dipping faults apparently are terminated by south-dipping faults; in either case the throughgoing faults everywhere have larger displacements than any of the opposite-dipping intersecting faults.

Fault planes known to have been penetrated by wells have been projected to the surface, even though a few may not reach that far. The extensive alluvial cover, particularly along the Arkansas River, obscures the bedrock, and therefore the surface traces of only a few faults could be verified.

In this publication the reported amount of displacement across a particular part of a fault is determined by the stratigraphic displacement. The amount of movement along the fault will everywhere be larger because the fault planes are inclined rather than vertical.

Six wells in the report area cut faults that have a greater stratigraphic displacement in rocks below the Hartshorne than at the base of the Hartshorne Sandstone. Well 13 cut two faults with measured displacement totaling 1,277 feet at depth and decreasing to about 650 feet at the base of the Hartshorne; in other wells, displacements decrease upward from 310 to 200 feet in well 22, 1,487 to 800 feet in well 57, and 595 to 150 feet in well 87. Well 38 cut a fault with 420 feet of displacement that decreases to 200 feet in younger rocks in well 39 and about 150 feet at the base of the Hartshorne. Many other wells—including wells 10, 22, 23, 34, 35, 36, 37, 39, 65, 88, 102, and 103—cut faults estimated to have a greater displacement in rocks below the Hartshorne than at the base of the Hartshorne. All these wells, except well 57, are in areas where the Atoka thickens.

The amount of displacement at different places along the Mill Creek fault can be determined from the following table, in which the wells are listed from east to west.

No. of well	Displacement (ft.)	Depth (ft.)
5	598	3, 975
6	635	800
18	656	4, 505
19	645	774
20	615	2, 668
21	598	500
22	747	2, 896
24	405	970
54	468	3, 152

The amount of displacement along the Mill Creek fault increases from well 54 eastward, and (except for well 22) the difference in magnitude cannot be associated with the age of rock cut by the fault (compare well 5 with 6 and well 18 with 19). Well 22 is the only well in this group that cuts the fault in the area of thickening of the Atoka (fig. 8*D*). The displacement across the fault in this well decreases upward to about 450 feet at the base of the Hartshorne.

The increasing displacement of faults at depth and the relation of thicker Atoka on the downthrown side of the faults indicate that faulting occurred in the area during the deposition of the Atoka.

The lower part of the Atoka (fig. 8*A*) is, in general, thicker in the synclines than on the anticlines, indicating that faulting, or possibly folding, was occurring by the time that zone 83 was deposited. The similarity of the thickness trends shown in figure 9*D* to the thickness trends in the lower part of the Atoka suggests that sand deposition in zone 93 was affected by the faulting and is greater in the areas of the synclines. In some areas, the similarity of the thickness trends of the sandstone in zones 99 and 100 (fig. 10*B*, *C*) to the thickness trends in the lower part of the Atoka suggests that faulting affected some sand deposition in these zones. Thickness trends indicate that deposition of zone 101 (fig. 10*D*) and of Morrow rocks (figs. 6, 7) was not affected by contemporaneous faulting. Thus faulting in the report area may have started after zone 101 was deposited and before zone 100 was deposited and continued at least through the time of deposition of the youngest part of the Savanna Formation that is present.

ECONOMIC GEOLOGY

COAL

Coal beds are present in the Atoka, McAlester, and Savanna Formations. The Lower Hartshorne, Charleston, and Paris coal beds have been mined in some areas. The outcrops of known coal beds are shown on plate 1; the extent, known thickness, and mined areas of known coal beds are shown on plate 5. All coal in the report area is classified as low-volatile bituminous (Haley, 1960, pl. 62) on the basis of percentage of dry mineral-matter-free fixed carbon, in accordance with the specifications of the American Society for Testing and Materials (1964). Estimated original reserves are tabulated in table 2 in accordance with standards and procedures established by Averitt (1961, p. 14–26).

COAL BEDS IN THE ATOKA FORMATION

All coal beds in the Atoka are thin—6 inches or less—and of poor quality. The extent of the coal beds is unknown.

COAL BEDS IN THE McALESTER FORMATION

The Lower Hartshorne coal bed near the base of of the McAlester Formation is the thickest, most extensive, and most economically important coal bed in the report area. Its known thickness ranges from 8 to 72 inches. It is under less than 1,000 feet of overburden except in the southeast corner of the Lavaca quadrangle. The thickness, amount of overburden, mined areas, and reserve categories of the coal in the Lower Hartshorne are shown on plate 5.

TABLE 2.—*Estimated original reserves of coal in the Arkansas part of Van Buren and Lavaca quadrangles, Arkansas and Oklahoma*

Overburden (ft)	Reserves, in millions of short tons, in beds of thickness stated											
	Measured and indicated reserves				Inferred reserves				Total reserves, all categories			
	Thickness of coal (inches)			Total	Thickness of coal (inches)			Total	Thickness of coal (inches)			Total
	14–28	28–42	42+		14–28	28–42	42+		14–28	28–42	42+	
LOWER HARTSHORNE COAL BED												
Crawford County												
0–1, 000	0. 148	0. 910	0. 114	1. 172	13. 478	8. 614	0. 721	22. 813	13. 626	9. 524	0. 835	23. 905
Franklin County												
0–1, 000	0. 841			0. 841	4. 194			4. 194	5. 035			5. 035
1, 000–2, 000					. 848			. 848	. 848			. 848
Total	. 841			. 841	5. 042			5. 042	5. 883			5. 883
Sebastian County												
0–1, 000	1. 686	2. 731	3. 207	7. 624	14. 983	15. 338	3. 114	33. 435	16. 669	18. 069	6. 321	41. 059
1, 000–2, 000					. 638			. 638	. 638			. 638
Total	1. 686	2. 731	3. 207	7. 624	15. 621	15. 338	3. 114	34. 073	17. 307	18. 069	6. 321	41. 697
All counties												
0–1, 000	2. 675	3. 641	3. 321	9. 637	32. 655	23. 952	3. 835	60. 442	35. 330	27. 593	7. 156	70. 079
1, 000–2, 000					1. 486			1. 486	1. 486			1. 486
Total	2. 675	3. 641	3. 321	9. 637	34. 141	23. 952	3. 835	61. 928	36. 816	27. 593	7. 156	71. 565
CHARLESTON COAL BED												
Franklin County												
0–1, 000	0. 477			0. 477	1. 980			1. 980	2. 457			2. 457

TABLE 2.—*Estimated original reserves of coal in the Arkansas part of Van Buren and Lavaca quadrangles, Arkansas and Oklahoma*—Continued

Overburden (ft)	Reserves, in millions of short tons, in beds of thickness stated											
	Measured and indicated reserves				Inferred reserves				Total reserves, all categories			
	Thickness of coal (inches)			Total	Thickness of coal (inches)			Total	Thickness of coal (inches)			Total
	14–28	28–42	42+		14–28	28–42	42+		14–28	28–42	42+	
CHARLESTON COAL BED—Continued **Sebastian County**												
0–1,000	0.174			0.174	0.545			0.545	0.719			0.719
PARIS COAL BED **Franklin County**												
0–1,000	0.138			0.138	0.277			0.277	0.415			0.415
ALL COAL BEDS, ALL COUNTIES												
0–1,000	3.464	3.641	3.321	10.426	35.457	23.952	3.835	63.244	38.921	27.593	7.156	73.670
1,000–2,000					1.486			1.486	1.486			1.486
Total	3.464	3.641	3.321	10.426	36.943	23.952	3.835	64.730	40.407	27.593	7.156	75.156

An estimated 71,565,000 short tons of coal in the Lower Hartshorne was present in the Arkansas part of the report area prior to mining. The amount of coal that has been mined and lost in mining is unknown but is estimated to be 723,000 short tons; thus about 70,800,000 short tons of Lower Hartshorne coal is estimated to remain. The amount of coal present in the Oklahoma part is unknown, but approximately 2,880 acres are underlain by the Lower Hartshorne coal bed. If the coal averages 24 inches in thickness, about 10,370,000 short tons of coal was present before the start of mining. The Lower Hartshorne coal in the Oklahoma part of the area was briefly described by Trumbull (1957).

COAL BEDS IN THE SAVANNA FORMATION

Many coal beds are present in the Savanna Formation, particularly in its lower part (pls. 3, 5), but only the Charleston and the Paris are sufficiently thick and extensive to be of economic importance. The Charleston is near the base of the formation and is not known to be more than 24 inches thick. The coal bed that is mined in the southeastern part of the report area as the Charleston coal is one of at least three coal beds in or just above the basal sandstone of the Savanna. The coal bed mined as Charleston coal probably is a single continuous bed, but, as most of the coal beds in the Savanna are lenticular and of local extent, the coal possibly is in discontinuous lenses at about the same stratigraphic position.

The outcrop and all known surface measured thicknesses of the Charleston coal bed are shown on plates 1 and 5, and the known mined areas are shown on plate 5.

The amount of coal in the Charleston bed mined and lost in mining is unknown, but it is probably less than 100,000 tons; more than 3,000,000 short tons of Charleston coal probably remain. This estimate pertains to the southern part of the Lavaca quadrangle. Coal is present in the northwestern part of the Lavaca quadrangle, but reserves cannot be estimated because there the thickness of coal is unknown. Additional coal may be present in west-central Van Buren quadrangle.

The Paris coal bed, in the upper part of the Savanna Formation, is present only in the southeastern part of the Lavaca quadrangle. (See pls. 1, 5.) It has been removed by erosion elsewhere. The Paris coal is not known to be more than 18 inches thick.

So far as is known, the Paris coal has not been mined in the report area, but it has been rather extensively mined in the area immediately to the southeast.

OIL AND GAS

Oil has not been discovered in the report area, but blebs and streaks of solid hydrocarbons have been noted in the rock samples of the Everton, St. Peter, and Joachim Formations undivided in wells 57 and 134, the St. Clair Limestone in wells 57, 63, and 158, and the Penters Chert in well 136. This suggests that liquid hydrocarbons were once present in these pre-Carboniferous rocks and have been devolatilized by heat and pressure.

Natural gas has been reported as a show from limestone in the Plattin Limestone, as being produced from limestone and dolomite in the St. Clair Limestone, as being produced from chert in the Penters Chert and the Boone Formation, as a show from limestone in the Pitkin Limestone and from siltstone in the Cane Hill

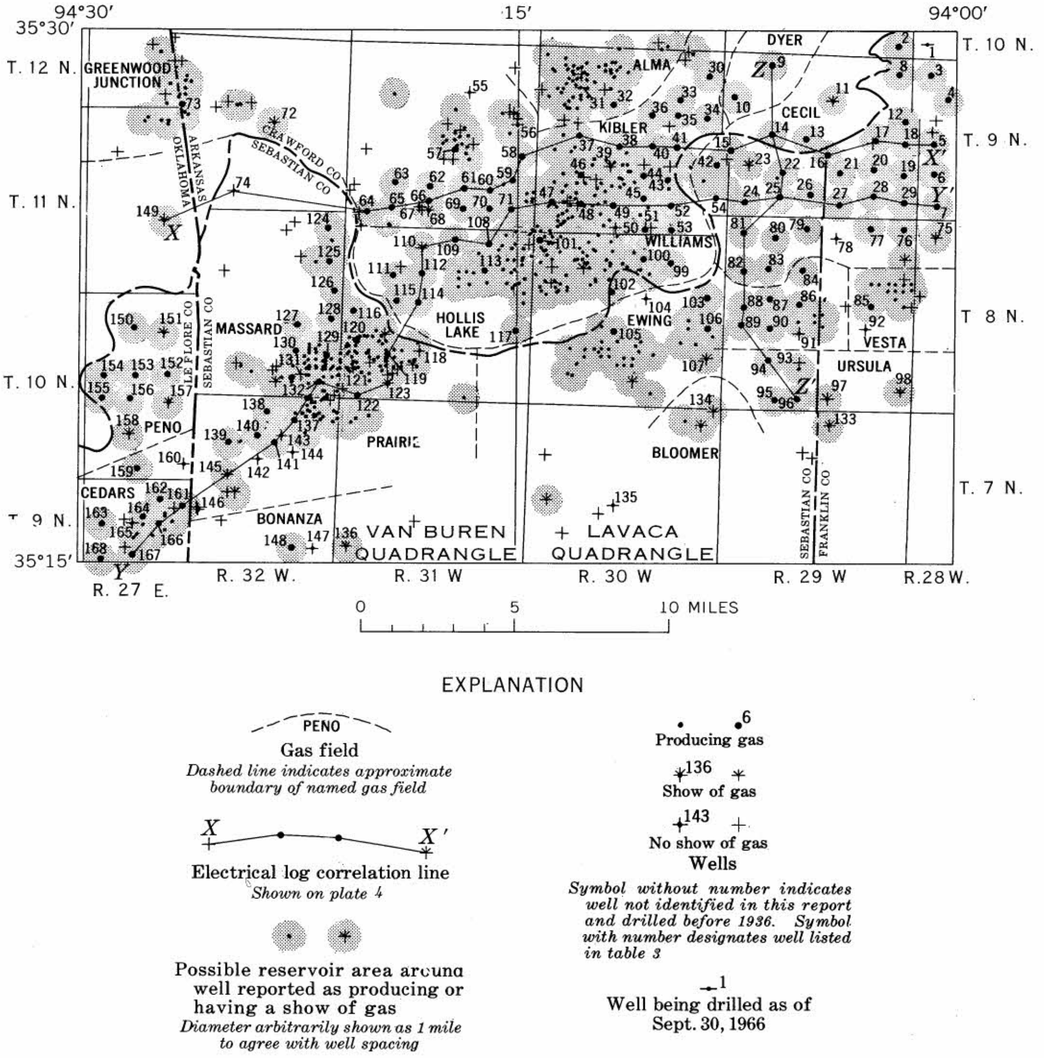


FIGURE 11.—Location of wells drilled in the Van Buren and Lavaca quadrangles.

Member of the Hale Formation, and as being produced from sandstone in the Prairie Grove Member of the Hale Formation and in the Bloyd and Atoka Formations. The Atoka Formation has yielded the most gas, and the Prairie Grove Member is the next most productive. Information on the occurences in wells drilled as of September 30, 1966, is in table 3. The distribution of gas found in all wells is shown in figure 11.

The reservoir rock for the gas in the Prairie Grove Member of the Hale Formation and in the Bloyd Formation is limy sandstone, and the amount of gas is inversely proportional to the amount of lime cement. Probably this lithologic control of the porosity and permeability is responsible for the scattered distribution of producing wells and groups of producing wells (figs. 6, 7). The accumulation of the gas in the Prairie Grove and in the Bloyd is apparently unrelated to the thickness of these rock units or to the thickness of the total Morrow (figs. 6, 7). However, most of the Morrow gas wells are in those areas where the lower part of the overlying Atoka is thin (compare fig. 6 with fig. 8*A*). Such a relationship can be explained by the migration of gas that originated in the Morrow to the top of the structures formed in Morrow reservoir rocks during the deposition and faulting of the lower part of the Atoka Formation. In areas where the Atoka is thicker (wells 10 and 24, for example), the gas may not have migrated because of lithologic barriers such as abundance of lime cement, or possibly because the early Atoka faults broke the continuity of the reservoir rocks before the gas had an opportunity to migrate to a higher part of the structure.

Commercial quantities of gas have been produced from 12 zones in the Atoka, and shows of gas have been reported from eight other zones in the Atoka Formation (table 3). The reported interval of gas production and gas shows is shown for each well on plate 4. The distribution of gas in certain zones is shown in figure 9. Zones 28 and 58 have been the most productive to date (fig. 9*A*, *B*). Gas production from these zones began in 1904 when the Massard Prairie gas field was discovered. Later, production began from the Kibler gas field in 1915, the Williams gas field in 1918, the Alma gas field in 1922, the Lavaca part of the Ewing gas field in 1928, and the Vesta gas field in 1932. Declining production indicates that much of the gas has been drained from these zones in the above fields.

The reservoir rock for the gas in the Atoka Formation is sandstone, which in the better producing reservoirs is nonlimy, well sorted, coarser than very fine grained, and quartzose. Clay, silt, and very fine grained sand in the sandstone inhibit the production of gas by reducing permeability and porosity. Most gas in the Atoka Formation appears to be entrapped by variations in porosity because there is not any discernible relationship between the distribution of the gas and (1) the thickness of the rock unit containing the gas, (2) the thickness of the rock unit or units above the gas reservoir, and (3) its present-day structural position (compare pl. 5 and figs. 8–11).

Maximum porosity values were calculated by William L. Pugh, consultant petroleum engineer, Denver, Colo., from available electrical logs of wells drilled through zones 58, 67, 93, 98, 99, 100, and 101. These values are plotted (pl. 7) relative to the thickness of the sandstone in their respective zones. The information shown on plate 7 and in figures 9 and 10 is summarized below.

Zone No.	Range of measured thickness (feet)	Minimum thickness of commercial production (feet)	Range of thickness of calculated 10 percent or less maximum porosity (feet)
58	33–244	100	54–136
67	60–325	88	72–146
93	32–169	70	37–150
98	33–126	56	34–126
99	22–205	60	22–169
100	7–132	30	7–106
101	0–90	27	11–75

Some wells drilled prior to 1936 in zone 58 produce gas from areas where the sandstone may be as thin as 84 feet (pl. 7*A*).

Equal porosity lines based on the data on plate 7 of this report can be positioned to show either a southward or an eastward alinement for nearly all zones. An example of each alinement for zone 98 is shown in figure 12. The southward alinement of porosity as shown in figure 12*A* would result from (1) winnowing of the sediments by the southward-flowing streams, (2) little, if any, winnowing along an eastward-trending shoreline of the Atoka Sea, and (3) a direct relationship between higher porosity and thicker sediments. The eastward alinement shown in figure 12*B* would result from (1) a minor amount of winnowing by the southward-flowing streams, (2) a major amount of winnowing along the eastward-trending shoreline of the Atoka Sea, and (3) little if any relationship between higher porosity and thicker sediments.

Which of the porosity alinements shown for zone 98 is more nearly correct in the report area cannot be determined from the available porosity, thickness, and lithologic data, but an eastward alinement is more in harmony with the lithologic characteristics and assumed depositional environment of the Atoka Formation.

Bartlett (1966, p. 144, fig. 8) reported a southward alinement of producing wells in the area east of Lavaca quadrangle. He attributed this alined production to the presence of southward-elongated areas of high porosity in the Dunn "A" sand (zone 98).

BUILDING STONE

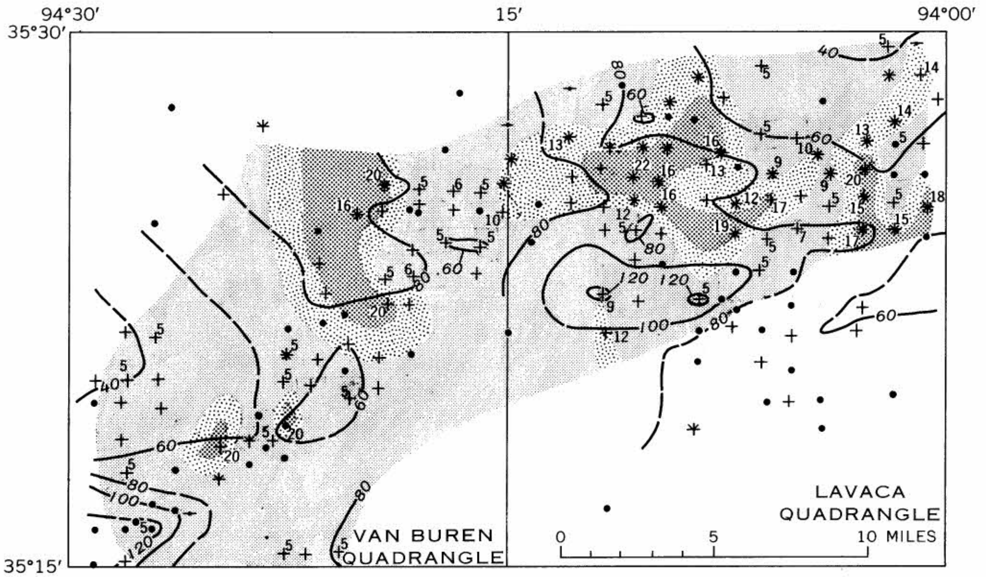
Blocks and slabs of sandstone from the Atoka and McAlester Formations have been used as building stone on many buildings in the report area, and slabs of sandstone from the McAlester Formation have been used as flagstone in the city of Fort Smith. The Hartshorne Sandstone has been the source of excellent quality building stone in Arkansas. Sandstone with even foreset beds as much as 50 feet long and 2–8 inches thick is being quarried in the area east of the Lavaca quadrangle, and some stone has been quarried from the Hartshorne in northeastern Lavaca quadrangle. However, in most of the area of this report the sandstone beds in the Hartshorne are too thick, thin, irregular, or lenticular to be used as sources of building stone. Shale in the McAlester Formation has been used in making brick and tile in the vicinity of Fort Smith.

ROAD METAL

Shale, shale and siltstone, and sandstone in the Atoka, Hartshorne, McAlester, and Savanna Formations have been quarried in these quadrangles for road metal and for riprap along the Arkansas River. The gravel, sand, silt, and clay in the uppermost Arkansas River terrace deposits have been extensively used as road metal.

GRAVEL, SAND, AND CLAY

Gravel, sand, and clay is present in the river and stream terraces and alluvium. Most of the gravel and sand has been obtained from the river terraces and alluvium, but some has been dredged from the channel of the Arkansas River.



A. MAXIMUM POROSITY VALUES CONTOURED TO SHOW NORTH–SOUTH POROSITY TREND

EXPLANATION

▩ Area of maximum porosity value of 15 percent or more

▨ Area of maximum porosity value from 10 to 15 percent

▧ Area of maximum porosity value of 10 percent or less

—— — — Thickness line
Dashed where projected. Interval 20 feet

✱ Well producing gas

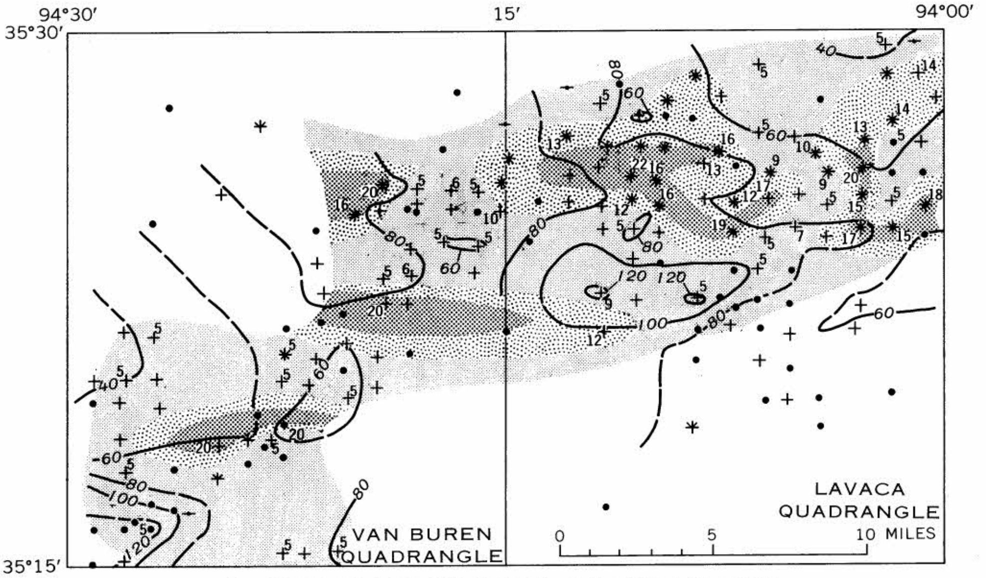
✱ Well with show of gas

+ Well with no show of gas

Well being drilled as of Sept. 30, 1966

● Well that did not penetrate zone or that has unavailable or incomplete records

22 Maximum porosity, in percent, as determined from electrical logs
5 denotes 5 percent or less porosity



B. MAXIMUM POROSITY VALUES CONTOURED TO SHOW EAST–WEST POROSITY TREND

FIGURE 12.—Possible maximum-porosity trends in the sandstone part of zone 98 of the Atoka Formation in Van Buren and Lavaca quadrangles, Arkansas and Oklahoma.

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TABLE 3.—*Descriptions of selected wells drilled in Van Buren and Lavaca quadrangles, Arkansas and Oklahoma, as of September 30, 1966*

Well No. (pls. 1, 5; fig. 11)	Company name	Lease name	Location (EL, east line; NL, north line; SL, south line; WL, west line)	Date (Completion date, unless otherwise noted)	Reported ground elevation (ft)	Bottom of well		Producing zone				Reported production (cu ft per day)	Remarks (est., estimated)
						Depth (ft)	Stratigraphic unit	Formation	Zone No.	Member	Reported depth (ft)		
						Arkansas							
1	Stephens Production Co.	R. McKinney 1.	150 ft SW. of center, sec. 31, T. 10 N., R. 28W.	Being drilled.									
2	Arkansas Western Gas Co.	H. Jackson 1	400 ft S., 400 ft E. of center, sec. 36, T. 10N., R. 29W.	July 1966	444	5, 529	Pitkin Ls	Atoka Fm	85		3, 539–3, 546	2,500,000	Fault with an est. displacement of 435 ft cut at est. depth of 2,000 ft.
3	Stephens Inc	J.S. Snodgras 1.	120 ft S., 270 ft E. of center, sec. 6, T. 9N., R. 28W.	July 1964	[1]420	4, 807	Pitkin Ls	do Hale Fm	95 99 120	 Prairie Grove.	3,351 3,601–3,609 {4,453–4,465 4,491–4,499}	Show of gas 2,820,000. 1,460,000.	Fault with 630 ft of displacement cut at est. depth of 2,500 ft.
4	do	D. L. Dean 1	1,650 ft. from NL, 75 ft. from WL, sec. 8, T. 9N., R. 28W.	May 1964	[1]380	4, 837	Cane Hill Mbr. of Hale Fm.	do	120	Prairie Grove.	4, 677–4, 736	4,550,000	Fault with 300 ft of displacement cut at est. depth of 1,800 ft.
5	Arkansas Louisiana Gas Co. and Arkansas Oklahoma Gas Co.	H. L. Evans 1.	50 ft S., 500 ft W. of center, sec. 19, T. 9N., R. 28W.	April 1953	804. 98	4, 506	do	Atoka Fm Hale Fm	67 120	 Prairie Grove.	2, 266–2, 286 4, 285–4, 365	6,908,000 8,500,000.	Fault with 598 ft of displacement cut at depth of 3,975 ft.
6	do	L. B. Crawford 1.	150 ft N., 250 ft E. of center, sec. 30, T. 9N., R. 28W.	June 1952	576	4, 844	Pitkin Ls	Atoka Fm Hale Fm	67 120	 Prairie Grove.	1, 781–1, 808 4, 516–4, 607	5,800,000 2,300,000.	Fault with 635 ft of displacement cut at depth of 800 ft. Rock samples examined and logged by S. E. Frezon.
7	Arkansas Louisiana Gas Co.	L. Posey 1	475 ft from NL, 375 ft from WL, SE¼, sec. 31, T. 9N., R. 28W.	Sept. 1959	778	5, 690	do	Atoka Fm Hale Fm	67 98 120	 Prairie Grove.	2, 460–2, 468 4, 296–4, 323 5, 393–5, 417	Show of gas 1,400,000. Show of gas.	
8	Arkansas Western Gas Co.	H. Jackson 1	400 ft S., 400 ft. E of center sec. 1, T. 9N., R. 29 W.	June 1965	375	5, 139	do	Atoka Fm	98		3, 766–3, 782	40,000,000	Fault with 572 ft of displacement cut at est. depth of 2,500 ft.
9	Arkansas Louisiana Gas Co.	C. Wright 5	500 ft N. of center sec. 5, T. 9N., R. 29 W.	Sept. 1963	384	6, 957	Everton Fm	do	93		4, 571–4, 588	850,000	Fault with 122 ft of displacement cut at depth of 5,347 ft.
10	do	J. Porter 1	550 ft N., 750 ft W. of center sec. 7, T. 9N., R. 29 W.	July 1965	378	5, 903	St. Clair Ls	do Hale Fm	93 116	 Prairie Grove.	3, 970–3, 976 5, 244–5, 260	Show of gas 5,900,000.	Faults with 540 ft and 550 ft of displacement cut at depths of 1,170 ft and 2,580 ft, respectively.
11	Arkansas Western Gas Co.	G. Vinsant 1	200 ft S., 200 ft W. of center sec. 10, T. 9N., R. 29 W.	Dec. 1961	380	6, 037	Atoka Fm	Atoka Fm	67		3, 275	Show of gas	
12	Arkansas Louisiana Gas Co.	Tom and Frank Alexander 1.	800 ft from SL, 2,500 ft from EL, sec. 13, T. 9N., R. 29 W.	Apr. 1963	[1]380	5, 151	Cane Hill Mbr. of Hale Fm.	do Hale Fm	98 99 120	 Prairie Grove.	3, 952–3, 970 4, 016–4, 023 4, 952–4, 993	}2,000,000 4,200,000.	
13	Arkansas Western Gas Co.	P. Alexander 1.	1,000 ft S., 250 ft E. of center sec. 16, T. 9N., R. 29 W.	Sept. 1965	389	5, 535.	Pitkin Ls	Atoka Fm	93 99		4, 288–4, 296 4, 638–4, 642	1,500,000 Show of gas.	Faults with 836 ft and 441 ft of displacement cut at depths of 4,115 ft and 4,720 ft, respectively.
14	do	A. Morse 1	730 ft from NL, 390 ft from WL, NW¼SE¼ sec. 17, T. 9N., R. 29W.	Mar. 1964	380	7, 320	St. Clair Ls	do Bloyd (?) Fm	28 93 99		1, 881–1, 889 5, 423 5, 987 6, 731–6, 743	2,480,000 Show of gas. Show of gas. 1,940,000.	Fault with 512 ft of displacement cut at depth of 6,660 ft.
15	Arkansas Louisiana Gas Co.	C. Wright and F.A. Humphreys Unit 1.	500 ft from SL, 200 ft from WL, sec. 19, T. 9N., R. 29 W.	Oct. 1962	380	7, 501	Fayetteville Sh	Atoka Fm	93 98		5, 675 5, 700 6, 136–6, 160	275,000 45,000,000.	
16	do	C. Hiatt 1	300 ft from SL, 200 ft from WL, sec. 22, T. 9N., R. 29W.	Oct. 1963	[1]440	5, 229	St. Peter Ss	do	58 93 98		1, 507 3, 577–3, 582 3, 942–3, 959	Show of gas 900,000 (shut-in). 9,500,000.	Faults with 425 ft and 524 ft of displacement cut at depths of 850 ft and 4,856 ft respectively.
17	do	F. Holden 1	267 ft N., 557 ft E. of center sec. 23, T. 9N., R. 29W.	Nov. 1960	402	5, 340	Cane Hill Mbr. of Hale Fm.	do	93 98 99		3, 787–3, 809 4, 142–4, 155 4, 251–4, 256	650,000 }2,000,000.	
18	do	L. D. Morris 1.	330 ft S., 330 ft E. of center sec. 24, T. 9N., R. 29W.	Feb. 1952	776	5, 008	Penters Chert	do	67? ?			}75,000,000	Fault with 656 ft of displacement cut at depth of 4,505 ft. Rock samples examined and logged by E. E. Glick.
19	do	G. Hamm et al 1.	600 ft from NL, 50 ft from WL, SE¼, sec. 25, T. 9N., R. 29W.	Feb. 1954	569	4, 670	Prairie Grove Mbr. of Hale Fm.	do Hale (?) Fm	99 116?	 Prairie Grove.	3, 583–3, 589 4, 511–4, 670	1,800,000 9,000,000.	Fault with 645 ft of displacement cut at depth of 774 ft.

See footnotes at end of table, p. A41.

TABLE 3.—*Descriptions of selected wells drilled in Van Buren and Lavaca quadrangles, Arkansas and Oklahoma, as of September 30, 1966*—Continued

Well No. (pls. 1, 5; fig. 11)	Company name	Lease name	Location (EL, east line; NL, north line; SL, south line; WL, west line)	Date (Completion date, unless otherwise noted)	Reported ground elevation (ft)	Bottom of well		Producing zone				Reported production (cu ft per day)	Remarks (est., estimated)
						Depth (ft)	Stratigraphic unit	Formation	Zone No.	Member	Reported depth (ft)		
Arkansas—Continued													
20	Arkansas Louisiana Gas Co.	S. A. Tankersley 1.	Center SW¼SW¼NE¼ sec. 26, T. 9N., 29W.	Oct. 1952	[2] 736.88	4,895	Pitkin Ls	Atoka Fm	93		3,208	Show of gas	Fault with 615 ft of displacement cut at depth of 2,668 ft. Rock samples examined and logged by S. E. Frezon.
									98		3,514–3,540	74,000,000.	
									99		3,610–3,656		
									100		3,714–3,738		
									101		3,806–3,828		
								Hale Fm	120	Prairie Grove.	4,594–4,630 4,654–4,682	1,400,000.	
21	do	N. Shannon 1.	300 ft from NL, 100 ft from EL, SW¼, sec. 27, T. 9N., R. 29W.	Oct. 1952	772.5	4,790	Cane Hill Mbr. of Hale Fm.	Atoka Fm	98		3,595–3,609	3,500,000	Fault with 598 ft of displacement cut at est. depth of 500 ft.
22	do	F. Martin 1	1,980 ft N., 1,980 ft W. of SE cor. sec. 29, T. 9N., R. 29W.	Oct. 1964	400	4,592	Pitkin Ls	do	98		3,328–3,340	18,750,000	Faults with 310 ft and 747 ft of displacement cut at depths of 1,287 ft and 2,896 ft, respectively.
								Bloyd Fm			4,032–4,049	1,750,000.	
								Hale Fm	120	Prairie Grove.	4,405–4,503	10,250,000.	
23	do	C. Wright 1	600 ft N., 150 ft E. of center sec. 30, T. 9N., R. 29W.	Sept. 1959	380	5,735	Everton Fm		?			Slight show of gas.	Faults with 1,200 ft and 120 ft of displacement cut at depths of 3,668 ft and 4,417 ft, respectively. Rock samples examined and logged by B. R. Haley.
24	do	Arbuckle Heirs 1.	600 ft S., 100 ft E. of center sec. 31, T. 9N., R. 29 W.	May 1964	466	5,051	Cane Hill Mbr. of Hale Fm.	Atoka Fm	67		2,105–2,130	Show of gas	Fault with 405 ft of displacement cut at depth of 970 ft.
									98		3,856–3,879	4,000,000.	
								Hale Fm	116	Prairie Grove.	4,819–4,847	29,000,000.	
									120		4,910–4,931		
25	do	D. M., Eubanks 1.	430 ft N., and 330 ft E. of center, sec. 32, T. 9 N., R. 29 W.	Mar. 1962	[1] 460	4,800	Prairie Grove Mbr. of Hale Fm.	Bloyd Fm			4,301–4,324	3,325,000	
								Hale Fm	120	Prairie Grove.	4,636–4,705	5,300,000.	
26	Stephens Investment Co.	A. J. Stephens 1.	1,150 ft from SL, 330 ft from WL, NE¼ sec. 33, T. 9N., R. 29 W.	Feb. 1957	[1] 470	4,895	Pitkin Ls	Atoka Fm	67		1,898–1,960	,3,400,000	
27	Arkansas Louisiana Gas Co.	R. Rebsamen 1.	615 ft from NL, 75 ft from EL, SW¼, sec. 34, T. 9N., R. 29W.	May 1959	819	5,475	do	do	67		2,436–2,472	3,125,000	
28	do	W. T. McDonald et al 1.	1,100 ft. N., 220 ft E. of center sec. 35, T. 9N., R. 29 W.	Apr. 1960	530	5,080	Cane Hill Mbr. of Hale Fm.	do	67		2,014–2,057	1,300,000	
									98		3,781–3,793	750,000.	
									100		3,963–3,982		
29	do	S. Stubblefield 1.	50 ft from NL, 100 ft from WL, SE¼, sec. 36, T. 9N., R. 29W.	Aug. 1955	777	5,365	do	do	18		651	Slight show of gas.	
									55		1,526	Show of gas.	
									67		2,353–2,364	1,800,000.	
								Hale Fm	120	Prairie Grove.	5,278–5,320	2,100,000.	
30	J. M. Huber Corp.	J. B. King B–1.	750 ft from SL, 2,365 ft from WL, sec. 1, T. 9N., R. 30 W.	May 1966	386	6,517	Penters Chert	Atoka Fm	58		3,155	Show of gas	Fault with 540 ft of displacement cut at depth of 6,096 ft.
									98		5,526–5,528	580,000.	
									99		5,619–5,640	Show of gas.	
								Boone Fm			6,378–5,390	Show of gas.	
31	Arkansas Louisiana Gas Co.	W. R. Alexander 2	1,000 ft N., 500 ft W. of center sec. 8, T. 9N., R. 30 W.	Being drilled.									
32	Ambassador Oil Corp.	F. E. Shearer Unit 1.	990 ft N., 2,310 ft E. of SW. cor. sec. 9, T. 9N., R. 30 W.	Jan. 1962	397	6,266	Prairie Grove Mbr. of Hale	Atoka Fm	74		4,246–4,256	Show of gas	Faults with 190 ft and 88 ft of displacement cut at depths of 5,745 ft and 5,912 ft, respectively. Well abandoned as dry in July 1964.
									85		5,037–5,045	Show of gas.	
									93		5,275–5,316	698,877.	
33	Gulf Oil Corp	H. A. Rich 1	900 ft from NL, 150 ft from WL, NE¼ sec. 11, T. 9 N., R. 30W.	June 1965	391	7,000	do	do	18		2,125–2,145	11,880,000	
									98		5,826–5,851	5,275,000.	
34	do	McVey 1	920 ft S. of NW. cor. NE¼ sec. 13, T. 9N., R. 30W.	Jan. 1965	378	5,685	Pitkin Ls	do	58		2,490–2,510	4,806.000	Faults with 615 ft and 872 ft of displacement cut at depths of 755 ft and 4,830 ft, respectively.
								Hale Fm	116	Prairie Grove.	5,601–5,622	4,750,000.	
35	do	Thicksten 1	750 ft from NL, 200 ft from EL, NW¼ sec. 14, T. 9N., R. 30W.	Dec. 1963	386	5,540	Bloyd Fm	Atoka Fm	58		2,574–2,641	5,000,000	Faults with 680 ft and 664 ft of displacement cut at depths of 2,308 ft and 4,930 ft, respectively.
									100		5,056–5,078	13,000,000.	
36	do	D. Byars 1	707 ft from NL, 1,933 ft from EL, sec. 15, T. 9N., R. 30W.	Nov. 1964	385	6,000	Cane Hill Mbr of Hale Fm.	do	58		3,387	Show of gas	Faults with 770 ft and 639 ft of displacement cut at depths of 3,755 ft and 4,644 ft, respectively.
									93		4,652–4,680	1,600,000.	
									99		5,010–5,022	3,200,000.	
									100		5,126–5,143	3,920,000.	

37	Ambassador Oil Corp.	Kreuger 1	633 ft from SL, 1,975 ft from WL, sec. 17, T. 9N., R. 30W.	June 1961	395	5,918	Boone Fm	do Bloyd Fm	58 98		2,393–2,445 4,978–4,988 5,629–5,632	Show of gas 600,000. Show of gas.	Faults with 348 ft and 590 ft of displacement cut at depths of 2,058 ft and 5,683 ft, respectively. Rock samples from 4,830 to 4,910 ft and from 5,400 to 5,910 ft examined and logged by B. R. Haley.
38	Anadarko Production Co.	Hamer Unit 1	1,000 ft SE. of NW. cor. NE¼ sec. 21, T. 9N., R. 30W.	Sept. 1965	370	6,900	Chattanoga Sh	Atoka Fm	67 98 109		3,240–3,246 5,499–5,504 6,098–6,102	6,800,000 Show of gas. 4,300,000.	Fault with 420 ft of displacement cut at depth of 6,630 ft.
39	Stephens Production Co.	M. A. Hanna 1.	800 ft from SL, 400 ft from EL, SW¼ sec. 21, T. 9N., R. 30W.	Apr. 1960	410	6,061	Fernvale Ls	do	58		2,409	Show of gas	Faults with 200 ft and 543 ft of displacement at depths of 3,992 ft and 4,603 ft, respectively.
40	Gulf Oil Corp	Denman 1	700 ft from NL, 1,940 ft from EL, sec. 22, T. 9N., R. 30W.	Oct. 1963	389	7,020	Pitkin Ls	do	67 93 98 100		3,428–3,440 5,344–5,392 5,792–5,822 5,984–6,000	2,640,000 2,560,000. 3,645,000. 1,400,000.	
41	do	C. Meodors 1	800 ft from NL, 2,340 ft from WL, sec. 23, T. 9N., R. 30W.	July, 1963	388	6,486	Atoka Fm	do	93 98 99		5,635–5,660 6,106–6,134 6,208–6,236	2,630,000. 6,665,000. 11,300,000.	
42	Arkansas Louisiana Gas Co.	C. Wright 3	400 ft N. of center sec. 25. T. 9N., R. 30W.	July 1962	380	6,378	Prairie Grove Mbr of Hale Fm.	do	99 100		5,402–5,415 5,518–5,527	990,000	Fault with 530 ft of displacement cut at depth of 4,595 ft.
43	Stephens Production Co.	B. Wofford 1	1,000 ft from NL, 1,100 ft from WL, sec. 26, T. 9N., R. 30W.	May 1963	[1] 380	5,626	Moorefield Fm	do	98 99 100		4,206–4,222 4,284–4,298 4,409–4,425	12,500,000 1,550,000. 5,000,000.	Faults with 260 ft, 85 ft, 65 ft, and 85 ft of displacement cut at depths of 2,545 ft, 2,813 ft, 3,428 ft, and 4,046 ft, respectively.
44	do	P. Laster 1	600 ft from NL, 600 ft from EL, NW¼ sec. 27, T. 9N., R. 30W.	Aug 1958	418	5,997	St. Clair Ls	do Hale Fm	58 98 120	 Prairie Grove.	2,371 and 2,427 4,196–4,216 5,154–5,174	Show of gas 2,278,000. 2,470,000.	Faults with 296 ft and 300 ft of displacement cut at depths of 2,922 ft and 4,108 ft, respectively.
45	do	Eva and Tom Blakely 1.	700 ft from SL, 150 ft from EL, SW¼, sec. 27, T. 9N., R. 30W.	May 1961	389	5,537	Pitkin Ls	Atoka Fm	58 98 99 100		1,894 4,369–4,392 4,396–4,402 4,522–4,536	Show of gas 34,000,000. 8,800,000.	Fault with 200 ft of displacement cut at depth of 1,508 ft.
46	do	L. S. Steward 1.	1,770 ft N., 200 ft W. of center, sec. 29, T. 9N., R. 30W.	Mar. 1965	[1] 440	6,037	Boone Fm	do Hale Fm	58 120	 Prairie Grove.	2,355 5,420–5,435	Show of gas 5,300,000.	Faults with 75 ft and 370 ft of displacement cut at depths of 1,467 ft and 5,306 ft, respectively.
47	do	L. Hatchett 1	300 ft from NL, 300 ft from WL, NE¼, sec. 31, T. 9N., R. 30W.	Dec. 1961	[1] 440	6,086	St. Clair Ls	Atoka Fm Hale Fm	28 120	 Prairie Grove.	1,472–1,492 5,244–5,254	750,000 4,800,000.	Faults with 140 ft, 320 ft, and 67 ft of displacement cut at depths of 2,815 ft, 4,187 ft, and 4,460 ft, respectively.
48	do	D. L. Fontaine 1.	150 ft from NL, 150 ft from EL, NW¼ sec. 32, T. 9N., R. 30W.	June 1962	[3] 431	6,161	St. Clair (?) Ls	Boone (?) Fm Penters (?) Chert.			5,755–5,777 5,922–5,954	2,450,000 7,500,000.	Electrical log not available to authors.
49	do	M. Turner et al 1.	500 ft from NL, 100 ft from WL, NE¼, sec. 33, T. 9N., R. 30W.	Aug. 1957	456	5,475	Pitkin Ls	Atoka Fm Bloyd Fm	58		2,007 4,850–4,870	Show of gas 5,280,000.	Faults with 55 ft and 50 ft of displacement cut at depths of 4,475 ft and 4,314 ft respectively.
50	do	J. F. Alexander 1	830 ft from SL, 540 ft from WL, SE¼, sec. 33, T. 9N., R. 30W.	Sept. 1961	[1] 380	5,923	Fayetteville Sh					Dry	Fault with 140 ft of displacement cut at depth of 1,642 ft.
51	do	J. D. Gooch 1	950 ft from SL, 300 ft from WL, SE¼, sec. 34, T. 9N., R. 30W.	Nov. 1961	[1] 380	5,658	Cane Hill Mbr of Hale Fm.	Atoka Fm	100		4,630–4,654	25,500,000	
52	do	E. Gregory	150 ft from NL, 900 ft from EL, NW¼, sec. 35, T. 9N., R. 30W.	Sept. 1959	383	5,662	Fayetteville Sh	do	58 98		2,066–2,120 4,310–4,344	900,000 1,750,000.	Faults with 75 ft and 90 ft of displacement cut at depths of 2,205 ft and 5,154 ft, respectively.
53	do	J. D. Gooch 2	800 ft from SL, 600 ft from EL, SW¼, sec. 35, T. 9N., R. 30W.	July 1966	[1] 440	5,694	Cane Hill (?) Mbr. of Hale (?) Fm.	do	58 99?		1,892–2,076 4,590–4,600	1,759,000 9,800,000.	Electrical log not available to authors.
54	Arkansas Louisiana Gas Co.	C. Wright 2	2,600 ft from NL, 2,200 ft from EL, sec. 36, T. 9N., R. 30W.	Aug. 1960	[1] 380	5,105	Pitkin Ls	do	58		2,051–2,082	450,000	Faults with 468 ft and 40 ft of displacement cut at depths of 3,152 ft and 3,408 ft, respectively.
55	do	F. N. Preston 1.	380 ft from NL, 330 ft from EL, SE¼, sec. 10, T. 9N., R. 31W.	Nov. 1960	560	4,169	Atoka Fm					Dry	Rock samples examined and logged by B. R. Haley.
56	Skelly Oil Co	S. Greig 1	600 ft SW. of center, sec.13, T. 9N., R. 31W.	Being completed.	492	5,087							

See footnotes at end of table, p. A41.

TABLE 3.—*Descriptions of selected wells drilled in Van Buren and Lavaca quadrangles, Arkansas and Oklahoma, as of September 30, 1966*—Continued

Well No. (pls. 1, 5; fig. 11)	Company name	Lease name	Location (EL, east line; NL, north line; SL, south line; WL, west line)	Date (Completion date, unless otherwise noted)	Reported ground elevation (ft)	Bottom of well		Producing zone				Reported production (cu ft per day)	Remarks (est., estimated)
						Depth (ft)	Stratigraphic unit	Formation	Zone No.	Member	Reported depth (ft)		
							Arkansas—Continued						
57	Industrial Oil and gas Co.	Brownlee 1	Center SE¼ NW¼, sec. 22, T. 9N., R. 31W.	June 1942	492	5,087	St. Peter Ss	?	?		?	?	Faults with 362 ft, 468 ft, 190 ft, and 467 ft of displacement cut at depths of 1,652 ft, 2,840 ft, 3,116 ft, and 3,230 ft, respectively. Rock samples examined and logged by E. E. Glick.
58	Gulf Oil Corp	Titsworth 1	750 ft from NL, 150 ft from WL, SE¼, sec. 24, T. 9N., R. 31W.	Feb. 1963	492	6,370	St. Clair Ls	Atoka Fm	93		4,514–4,544	3,500,000	Fault with 287 ft of displacement cut at depth of 4,873 ft Rock samples were examined and logged by B. R. Haley.
									98		4,777–4,792		
								Hale Fm	116	Prairie Grove.	5,439–5,452	1,000,000.	
									120		5,529–5,542		
59	Ambassador Oil Corp.	N.E. Brinegar Unit 1.	Center SW¼SE¼NW¼ sec. 25, T. 9N., R. 31W.	Dec. 1961	463	5,840	Pitkin Ls	Atoka Fm	98		4,668–4,686	7,950,000	
									100		4,860–4,872	5,200,000.	
								Hale Fm	116	Prairie Grove.	5,614–5,622	379,000.	
									120		5,743–5,774		
60	do	Bailey Unit 1	Center SW¼NW¼SE¼ sec. 26, T. 9N., R. 31W.	Mar. 1962	461	5,840	do	Atoka Fm	58		2,286	Show of gas	
									99		4,700–4,725	13,500,000.	
									99		4,794–4,799	1,900,000	
									100		4,825–4,827		
									105		4,978–5,060		
								Hale Fm	116	Prairie Grove.	5,588–5,614	1,600,000.	
									120		5,712–5,740		
61	do	Biggerstaff 1	1,000 ft SE of center sec. 27, T. 9N., R. 31w.	Apr. 1964	468	5,892	Cane Hill Mbr. of Hale Fm.	Atoka Fm	99		4,794–4,821	3,200,000	
									100		4,912–4,952	18,800,000.	
								Bloyd Fm			5,323–5,326	24,000,000.	
62	Shell Oil Co	Vinsett 1	660 ft from NL, 662 ft from WL, SE¼ sec. 28, T. 9N., R. 31W.	Dec. 1964	472	5,756	Plattin Ls	Atoka Fm	50		1,765	Show of gas	Faults with 260 ft and 500 ft of displacement cut at depths of 4,670 ft and 5,176 ft, respectively. Rock samples from 4,800 to 4,920 ft and 5,100 to 5,756 ft examined and logged by B. R. Haley.
									58		2,260–2,295	2,600,000.	
63	do	Vinsett A-1	200 ft S., 200 ft W. of center sec. 29, T. 9N., R. 31W.	Nov. 1965	405	5,297	Prairie Grove Mbr. of Hale Fm.	do	28		1,766	Show of gas	Faults with 275 ft and 160 ft of displacement cut at depths of 2,850 ft and 3,068 ft, respectively.
									28		1,790–1,804	240,000.	
									98		4,258–4,282	8,600,000.	
									99		4,340–4,359		
									100		4,445–4,460	6,250,000.	
64	Steve Gose	Van Zandt Unit 1.	2,590 ft from NL, 1,980 ft from EL, sec. 31, T. 9N., R. 31W.	Apr. 1964	397	6,375	Cane Hill Mbr. of Hale Fm.	do	18		1,647	Show of gas	
									98		5,238–5,253	3,000,000.	
									99		5,306–5,332		
									100		5,456–5,464	2,750,000.	
65	Shell Oil Co	Whiteside 1	750 ft from SL, 1,980 ft from WL, NW¼ sec. 32, T. 9N., R. 31W.	May 1965	402	5,900	St. Clair Ls	do	58		2,402–2,450	5,620,000	Fault with 814 ft of displacement cut at depth of 5,510 ft.
									99		4,802–4,830	3,330,000.	
								Boone Fm			5,532–5,548	Show of gas.	
66	do	Edwards 1	660 ft from NL, 2,130 ft from EL, sec. 33, T. 9N., R. 31W.	May 1966	500	5,570	Prairie Grove Mbr. of Hale Fm.	Atoka Fm	58		2,268–2,290	4,650,000	
								Hale Fm	116	Prairie Grove.	5,393–5,431	11,100,000.	
67	Arkansas Oklahoma Gas Co.	E. L. McDaniel 1.	300 ft E., 400 ft S. of center, NW¼ sec. 33, T.9N., R.31W.	Dec. 1952	436.3	3,142	Atoka Fm					Dry	Electrical log was not run.
68	J. A. Chapman	Chambless Unit 1.	Center SW¼ SW¼ NE¼, sec. 33, T.9N., R.31W.	July 1959	[1]460	5,676	Prairie Grove(?) Mbr. of Hale(?) Fm.	Atoka(?) Fm	101?		4,839	Show of gas	Electrical log not available to authors.
								Hale(?) Fm	116?	Prairie Grove.	5,544–5,582	Show of gas.	
69	Ambassador Oil Corp.	Neidecker Unit 1.	1,000 ft NE. of center, sec. 34, T.9N., R.31W.	Mar. 1963	490	6,508	Penters Chert	Atoka Fm	28		1,729–1,804	1,350,000	Rock samples from 4,400 to 4,770 ft, 5,180 to 5,400 ft, and 5,800 to 6,508 ft examined and logged by B. R. Haley.
									100		4,954–4,982	8,900,000.	
									109		5,314–5,318	970,000.	
								Bloyd Fm			5,338–5,362		
								Boone Fm			6,336–6,388	Show of gas.	
70	do	S. Greig 1	1,140 ft N., 330 ft E. of center, sec. 35, T.9N., R.31W.	Aug. 1960	451	5,709	Pitkin Ls	Atoka Fm	28		1,699–1,727	971,000	Fault with 230 ft of displacement cut at depth of 4,527 ft.
									99		4,558–4,578	2,610,000.	
									100		4,684–4,698	4,566,000.	
								Hale Fm	120	Prairie Grove.	5,584–5,614		

71	do	H. J. Morris Unit 1.	1,000 NW. of center, sec. 36, T.9N., R.31W.	Dec. 1960	447	5,534	do	Atoka Fm Hale Fm	28 55 100 116 120	 Prairie Grove.	1,505 2,070 4,514–4,523 5,308–5,346 5,449–5,463	Show of gas Show of gas. 2,282,000. 1,448,000. Show of gas.	Fault with 235 ft of displacement cut at depth of 3,244 ft.
72	Floyd E. Sagely	J. S. Richmond 1.	200 ft from NL, 600 ft from WL, SW¼ SE¼, sec. 15, T.9N., R.32W.	Dec. 1961	422	2,340	do	Atoka Fm	83 98 116	 Prairie Grove.	560 1,400 2,200	Show of gas Show of gas. Show of gas.	Fault with an est. 400 ft of displacement cut at an est. depth of 350 ft. Rock samples examined and logged by B. R. Haley.
73	Citizens Gas Co.	T. I. Greenstreet 1.	Center SW¼ NE¼ sec. 18, T.9N., R.32W.	Nov. 1927	806	2,380	Penters Chert	do	100?		1,215–1,235	610,000	Electrical log was not run. Rock samples examined and logged by S. E. Frezon.
74	G. C. Parker	J. B. Harwood 1.	Center SE¼ SE¼ NW¼, sec. 33, T.9N., R.32W.	May 1966	402	6,742	St. Clair Ls					Dry	Fault with 510 ft of displacement cut at depth of 4,955 ft.
75	Stephens Inc	A. Triplett 1	3,110 ft from NL, 2,000 ft from EL, sec. 6, T.8N., R.28W.	Oct. 1959	[1] 620	6,252	?	Atoka Fm	101?		4,773	Show of gas	Electrical log was not run.
76	Stephens Investment Co.	C. Hiatt 1	2,000 ft from NL, 350 ft from WL, NE¼ sec. 1, T. 8N., R. 29W.	Dec. 1956	675	5,801	Cane Hill Mbr. of Hale Fm.	do Bloyd Fm Hale Fm	98 120	 Prairie Grove.	4,625–4,632 5,354–5,370 5,676–5,696	500,000 Show of gas. Show of gas.	
77	Stephens Inc	Bush Estate 1	2,140 ft from NL, 330 ft from WL, NE¼ sec. 2, T. 8N., R. 29W.	Mar. 1961	[1] 680	5,648	Prairie Grove Mbr. of Hale Fm.	Atoka Fm	98 100		4,481–4,502 4,701–4,714	2,850,000 680,000.	
78	do	L. Spencer 1	465 ft S., 200 ft W. of center sec. 3, T. 8N., R. 29W.	May 1959	[1] 520	5,985	?					Dry	Electrical log was not run.
79	Stephens Production Co.	H. Tate 1	2,150 ft from NL, 100 ft from EL, NE¼ sec. 4, T. 8N., R. 29W.	Mar. 1958	620	5,536	Cane Hill Mbr. of Hale Fm.	Atoka Fm Bloyd Fm	100		4,484–4,506 5,034–5,036	3,500,000 4,750,000.	
80	Stephens Inc	N. Williams 1	3,700 ft from NL, 200 ft from WL, NE¼, sec. 5, T. 8N., R. 29W.	Aug. 1961	[1] 520	5,610	Pitkin Ls	Atoka Fm Hale Fm	28 120	 Prairie Grove.	1,307–1,320 5,402–5,440	496,000 5,900,000.	Fault with 205 ft of displacement cut at an est. depth of 2,300 ft.
81	Arkansas Louisiana Gas Co.	J. B. Hobbs 1	2,977 ft from NL, 125 ft from WL, NE¼ sec. 6, T. 8N., R. 29W.	Apr. 1962	440	5,495	Cane Hill Mbr. of Hale Fm.	Atoka Fm Hale Fm	98 100 116 120	 Prairie Grove.	4,295–4,314 4,499–4,517 5,282–5,328 5,362–5,409	3,050,000 3,350,000.	Fault with 235 ft of displacement cut at an est. depth of 625 ft.
82	Stephens Production Co.	L. Khilling 1	200 ft N., 500 ft E. of center sec. 7, T. 8N., R. 29W.	Sept. 1964	[1] 400	6,271	Pitkin Ls	do	116 120	Prairie Grove.	5,946–5,969 6,030–6,040	13,750,000	Fault with 332 ft of displacement cut at depth of 5,253 ft.
83	do	G. Gattis 1	466 ft N., 466 ft S. of center sec. 8, T. 8N., R. 29W.	Feb. 1964	[1] 390	6,495	do	Atoka Fm Hale Fm	100 120	 Prairie Grove.	5,371–5,404 6,259–6,314	22,500,000 8,000,000.	Fault with 50 ft of displacement cut at an est. depth of 2,100 ft.
84	do	I. W. Jones 1	500 ft N. 500 ft W. of center sec. 9, T. 8N., R. 29W.	Feb. 1966	[1] 410	6,405	Pitkin(?) Ls	Atoka(?) Fm	101? ?		5,200–5,208 5,728–5,786	1,200,000 9,200,000.	Electrical log not available to authors.
85	Gulf Oil Corp	T. C. Drake 1	742 ft S., 742 ft E. of center sec. 14, T. 8N., R. 29W.	Sept. 1961	437	6,850	St. Clair Ls	Atoka Fm	67		3,060–3,080	3,025,000	Faults with 50 ft and 250 ft of displacement cut at depths of 2,980 ft and 6,420 ft. Rock samples from 3,410 to 6,850 ft examined and logged by B. R. Haley
86	Stephens Production Co.	L. Keck 1	150 ft S., 950 ft W. of center sec. 16, T. 8N., R. 29W.	May 1966	[1] 460	7,635	?	Penters(?) Chert.			6,590–6,597	1,100,000	Electrical log not available to authors.
87	Gulf Oil Corp	A. E. Wilson 1	650 ft N., 330 ft W. of center sec. 17, T. 8N., R. 29W.	Nov. 1964	501	6,143	Pitkin Ls	Hale Fm	120	Prairie Grove.	5,884–5,928	4,300,000	Fault with 595 ft of displacement cut at depth of 5,065 ft.
88	Stephens Production Co.	W. W. Nixon 1	430 ft S., 200 ft E. of center sec. 18, T. 8N., R. 28W.	Feb. 1965	[1] 460	6,339	Boone Fm	Atoka Fm	58		2,687.5–2,723	1,300,000	Faults with 91 ft, 541 ft, and 122 ft of displacement cut at depths of 4,404 ft, 4,950 ft, and 5,190 ft, respectively.
89	Gulf Oil Corp	S. M. Lyons 1	1,050 ft N., 250 ft E. of center, sec. 19, T. 8N., R. 29W.	July 1965	415	6,350	Pitkin Ls	do	55 58 101		2,108–2,129 2,400–2,460 5,130–5,140	Show of gas 7,500,000. 1,270,000.	Faults with 200 ft, 161 ft, 279 ft, and 55 ft of displacement cut at depths of 505 ft, 2090 ft, 3,155, and 4,040 ft, respectively.
90	Stephens Production Co.	O. R. Moore 1	900 ft N., 100 ft w. of center sec. 20, T. 8N., R. 29W.	Apr. 1966	[1] 500	7,256	?	do Hale Fm.?	28? 67? ?		2,420 2,999–3,011 6,170–6,178	Show of gas 5,800,000. 5,200,000.	Electrical log not available to authors.
91	do	J. Montgomery 1.	200 ft N., 880 ft w. of center, sec. 21, T. 8N., R. 29W.	Apr. 1966	[1] 470	7,381	?					Dry	Electrical log not available to authors.
92	do	J. W. Tate 1	900 ft N., 200 ft w. of center, sec. 23, T. 8N., R. 28W.	Jan. 1966	[1] 480	8,331	Everton Fm					Dry	Fault with 125 ft of displacement cut at depth of 5,109 ft.
93	do	E. Metcalf 1	400 ft S., 500 ft w. of center, sec. 28, T. 8N., R. 29W.	May 1966	[1] 420	4,078	Atoka Fm	Atoka Fm	67?		3,769–3,791	3,100,000	Electrical log not available to authors.

See footnotes at end of table, p. A41.

TABLE 3.—*Descriptions of selected wells drilled in Van Buren and Lavaca quadrangles, Arkansas and Oklahoma, as of September 30, 1966*—Continued

Well No. (pls. 1, 5; fig. 11)	Company name	Lease name	Location (EL, east line; NL, north line; SL, south line; WL, west line)	Date (Completion date, unless otherwise noted)	Reported ground elevation (ft)	Bottom of well		Producing zone			Reported depth (ft)	Reported production (cu ft per day)	Remarks (est., estimated)
						Depth (ft)	Stratigraphic unit	Formation	Zone No.	Member			
						Arkansas—Continued							
94	J. M. Huber Corp.	McFerrin 1	1,050 ft N. of center sec. 29, T. 8N., R. 29W.	Mar. 1966	416	7,244	Hale Fm	do	58		2,822–2,878	683,000	
95	do	Pope 1	659 ft S., 675 ft E. of center, sec. 32, T. 8N., R. 29W.	Aug. 1965	484	3,975	Atoka Fm	do	58 67		2,792–2,933 3,543–3,622	1,510,000 1,720,000.	
96	do	Nixon 1	3,050 ft from NL, 1,930 ft from WL, sec. 33, T. 8N., R. 29W.	Oct. 1962	430	8,337	St. Clair Ls	do	28 58 67		1,945 2,876–2,945 3,768–3,910	Show of gas 5,600,000. 12,300,000.	Fault with 80 ft of displacement cut at depth of 1,010 ft. Rock samples examined and logged by B.R. Haley.
97	do	Hiatt 1	442 ft S., 917 ft W. of center, sec. 34, T. 8N., R. 28W.	May 1965	427	4,255	Atoka Fm	do	?		?	Show of gas	
98	Steve Gose–Oil and Gas Producer.	Lambert 1	660 ft N., 673 ft E. of center, sec. 36, T. 8N., R. 29W.	Sept. 1965	487	8,066	Pitkin Ls	Hale Fm	116	Prairie Grove.	7,896	Show of gas	Fault with 160 ft of displacement cut at depth of 5,934 ft.
99	Stephens Production Co.	E. J. Ingram 1	900 ft from SL, 150 ft from EL, SW¼ sec. 2, T. 8N., 30W.	Feb. 1965	[1]380	8,020	?	Atoka Fm	58?		2,621–2,658	1,700,000	Electrical log not available to authors.
100	do	W. Gooch Unit 1.	1,300 ft from SL, 250 ft from WL, SE¼ sec. 3, T. 8N., R. 30W.	Feb. 1964	[1]400	6,597	Boone Fm	do	99 100		5,110–5,128 5,250–5,272	3,150,000 9,800,000.	Faults with 320 ft and 200 ft of displacement cut at depths of 4,094 ft and 5,415 ft, respectively.
101	Industrial Oil and Gas Co.	G. W. Williams 3.	1,200 ft S., 1300 ft W. NE. cor., NW¼ sec. 6, T. 8N., R. 30W.	July 1941	[1]400	6,578	St. Clair Ls	?	?		?	25,000	Electrical log was not run. Rock samples were examined and logged by R. J. Lantz.
102	R. T. Smith	Robbins-Fine 1.	950 ft from SL, 2,789 ft from WL, sec. 9, T. 8N, R. 30W.	Sept. 1962	380	7,288	Penters Chert	Atoka Fm	100		5,980–6,014	3,700,000	Fault with 587 ft of displacement cut at depth of 7,197 ft. Rock samples from 5,000 to 7,288 ft examined and logged by B.R. Haley.
103	Stephens Production Co.	F. Wright 1	500 ft N., 150 ft W. of center, sec. 13, T. 8N., R. 30 W.	Mar. 1964	[1]380	7,475	Fernvale Ls	do	100		6,152–6,165	7,500,000	Fault with 565 ft of displacement cut at depth of 7,078 ft.
104	do	U. R. Ray 1	2,975 ft from SL, 2,790 ft from WL, sec. 15, T. 8N., R. 30W.	Dec. 1965	[1]380	7,528	Cane Hill Mbr. of Hale Fm.					Dry	
105	do	C. Cross	2,407 ft from SL, 2,746 ft from EL, sec. 21, T. 8N., R. 30W.	July 1965	[1]390	7,905	Everton Fm	Atoka Fm Hale Fm	100 116	 Prairie Grove.	5,607–5,637 6,532–6,546	2,150,000 2,380,000.	Fault with 373 ft of displacement cut at depth of 1,260 ft.
106	do	I. Ingraham 1	800 ft N., 150 ft W. of center sec. 24, T. 8N., R. 30W.	Mar. 1965	[1]380	6,167	Cane Hill (?) Mbr. of Hale Fm.?	Atoka(?) Fm	58? 100?		2,535–2,565 5,070–5,083	495,000 12,600,000.	Electrical log not available to authors.
107	do	J. S. Durham 1.	850 ft N., 250 ft W. of center sec. 25, T. 8N., R. 30W.	Dec. 1965	[1]390	7,672	Fernvale(?) Ls	St. Clair(?) Ls			7,556–7,568	Show of gas	Electrical log not available to authors.
108	Gulf Oil Corp	R. S. Parks 1	400 ft. N., 400 ft E. of center sec. 2, T. 8N., R. 31W.	Sept. 1961	424	5,800	Pitkin Ls	Atoka Fm	100		4,782–4,787	2,400,000	
109	do	Daugherty 1	800 ft from SL, 200 ft from EL, NW¼ sec. 3, T. 8N., R. 31W.	Aug. 1963	444	5,878	Cane Hill Mbr. of Hale Fm.	do	58 99		2,392–2,424 4,801–4,848	2,260,000 1,150,000.	
110	G. C. Parker	W. Williams 1	660 ft S., 500 ft W. of center sec. 4. T. 8N., R. 31W.	Sept. 1964	427	6,159	Pitkin Ls	do	99		5,081–5,098	Show of gas	
111	do	Myers A–1	Center NW¼NW¼SE¼ sec. 8, T. 8N., R. 31W.	Oct. 1965	399	6,273	do	do Hale Fm	28 99 116	 Prairie Grove.	1,688–1,707 5,172–5,182 6,016–6,084	2,000,000 3,900,000. Show of gas.	
112	G. C. Parker and J. A. Chapman.	Myers 1	2,380 ft from NL, 2,510 ft from WL, sec. 9, T. 8N., R. 31W.	July 1958	400	6,478	do	Atoka Fm	28 99		1,800 5,305–5,340	Show of gas 1,400,000.	
113	G. C. Parker	Tibbetts 1	900 ft N., 120 ft W. of center sec. 11, T. 8N., R. 31W.	June 1964	427	6,693	do	do	99 109		4,942–4,950 5,364–5,382	4,950,000 4,200,000.	Fault with 98 ft of diplacement cut at depth of 3,908 ft.
114	J. M. Huber Corp.	Lincoln 1	Center SE¼NW¼ sec. 16, T. 8N., R. 31W.	Mar. 1961	414	5,727	do	do Hale Fm	99 109 116	 Prairie Grove.	4,554–4,588 5,054–5,084 5,510–5,616	4,550,000 385,000.	Fault with 392 ft of displacement cut at depth of 2,486 ft.

115	R. T. Smith and Landa Oil Co.	Crawford County Levee 1.	1,870 ft from NL, 1,870 ft from EL, sec. 17, T. 8N., R. 31W.	Aug. 1962	400	6,225	Penters Chert	Atoka Fm. Hale Fm.	28 99 100 116	 Prairie Grove.	1,744-1,762 4,624-4,632 4,738-4,750 5,500	820,000. 6,600,000. Show of gas.	Faults with 375 ft and 75 ft of displacement cut at depths of 4,437 ft and 4,872 ft, respectively. Rock samples from 4,400 to 4,800 ft and 4,970 to 6,220 ft examined and logged by B. R. Haley.
116	Stephens Production Co.	T. M. Horan 1.	500 ft from NL, 977 ft from EL, NW¼ sec 19, T. 8N., R. 31W.	Mar. 1958	410	5,625	Hale(?) Fm.	Atoka(?) Fm. Bloyd(?) Fm.	109?		5,150-5,166 5,200-5,216	4,000,000.	Electrical log not available to authors.
117	Steve Gose–Oil and Gas Producer.	Gilbert Unit 1.	839 ft from NL, 285 ft from WL, NE¼ sec. 24, T. 8N., R. 31W.	Nov. 1965	395	6,406	Pitkin(?) Ls.	Atoka Fm.	28? 99?		1,670-1,672 5,067-5,082	1,200,000. 3,500,000.	Electrical log not available to authors.
118	do.	L.L. Paddock 1.	640 ft N., 150 ft W. of center sec. 28, T. 8N., R. 31W.	Mar. 1964	410	6,532	?					Dry.	Electrical log was not run.
119	do.	Goebel Estate 1.	200 ft from NL, 300 ft from EL, SW¼ sec. 29, T. 8N., R. 31W.	June 1957	420	5,566	Pitkin Ls.	Atoka Fm. Hale Fm.	101 116	 Prairie Grove.	4,773-4,822 5,428-5,510	6,000,000. Show of gas.	
120	do.	B. Williams 1.	575 ft from NL, 260 ft from EL, NW¼, sec. 30, T. 8N., R.31W.	July 1963	447	6,361	do.	Atoka Fm. Bloyd Fm. Penters(?) Chert. St. Clair(?) Ls.	58 109		2,000 4,904-4,976 5,896-5,988 6,116-6,238	Show of gas. 20,000,000. 2,200,000. 10,000,000.	Fault with 55 ft of displacement cut at depth of 2,035 ft. Electrical log from 5,417 to 6,361 ft not available to authors.
121	W. R. Stephens Investment Co.	M. F. F. Allen 1.	200 ft from SL, 850 from EL, SW¼ sec. 30, T. 8N., R. 31W.	Jan. 1957	485	5,514	?	Hale(?) Fm.		Prairie Grove(?).	5,392-5,443	27,000,000.	Electrical log not available to authors.
122	Stephens Production Co.	D. A. Pigg 1.	876 ft from SL, 200 ft from EL, SW¼ sec. 31, T. 8N., R. 31W.	Feb. 1961	417	5,874	Cane Hill Mbr. of Hale Fm.	Bloyd Fm.			5,413-5,425	16,500,000.	Fault with 276 ft of displacement cut at depth of 3,433 ft.
123	do.	P. M. Finton 1.	300 ft N., 100 ft W. of center sec. 32, T. 8N., R. 31W.	June 1960	545	5,894	Prairie Grove Mbr. of Hale Fm.	Atoka Fm.	28 58		1,698 2,760	Show of gas. Show of gas.	Faults with 210 ft and 300 ft. of displacement cut at depths of 1,404 ft and 3,624 ft, respectively.
124	do.	W. W. Ward 1.	200 ft from NL, 240 ft from EL, SW¼ sec. 1, T. 8N., R. 32W	Feb. 1962	[1]400	6,716	?	do.	28		2,435-2,462	1,750,000.	Electrical log from 3,782 to 6,716 ft was not run.
125	Athletic Mining and Smelting Co.	C. P. Wilson 1.	292 ft from NL, 90 ft from WL, SE¼ sec. 12, T. 8N., R. 32W.	June 1961	404	6,044	Pitkin Ls.	do. Hale Fm.	28 116	 Prairie Grove.	2,009-2,023 5,880-5,936	3,150,000. 250,000.	Faults with 40 ft and 198 ft of displacement cut at depths of 1,725 ft and 4,130 ft, respectively.
126	Stephens Production Co.	Free Ferry Estate 1.	75 ft S., 1,200 ft E. of center sec. 13, T. 8N., R. 32W.	Mar. 1963	[1]400	6,494	St. Clair Ls.	Atoka Fm. Bloyd Fm.	57		2,350-2,420 5,345-5,354	2,000,000. 540,000.	Fault with 70 ft of displacement cut at depth of 2,782 ft.
127	do.	S. Harris 1.	800 ft S., 600 ft E. of center sec. 23, T. 8N., R. 32W.	Mar. 1964	417	6,969	Everton Fm.	Atoka Fm. Atoka(?) Fm. Bloyd(?) Fm. St. Clair Ls.	28? 109? ?		1,680-1,740 5,409-5,450 6,342-6,348	75,000. 250,000. Show of gas.	Electrical log to depth of 6,019 ft not available to authors. Well depleted and abandoned in Feb. 1966.
128	do.	C. Young 1.	275 ft N., 950 ft E. of center sec. 24, T. 8N., R. 32W.	July 1962	505	6,386	Fernvale(?) Ls.	Atoka(?) Fm. Bloyd(?) Fm. St. Clair(?) Ls.	57? 109?		2,334-2,478 5,380-5,394 6,281-6,297	2,100,000. 500,000. 3,400,000.	Electrical log not available to authors.
129	do.	R. Sengel 1.	450 ft from NL., 475 ft from WL, SE¼, sec. 25 T. 8N., R.32W.	Oct. 1958	443	5,585	Fayetteville Sh.	Hale Fm.	116	Prairie Grove.	5,330-5,352	15,000,000.	Faults with 205 ft and 75 ft of displacement cut at depths of 3,404 ft and 4,383 ft, respectively.
130	do.	Hardscrabble Country Club 1.	150 ft N., 600 ft E. of center, sec. 26, T. 8N., R. 32W.	June 1959	440	5,891	Pitkin Ls.	Atoka Fm.	98 99 101		4,991-4,994 5,052-5,058 5,312-5,394	2,500,000.	Faults with 90 ft and 158 ft of displacement cut at depths of 2,510 ft and 5,376 ft, respectively.
131	do.	Municipal Airport 2.	700 ft from SL., 50 ft from EL, NW¼, sec. 35, T. 8N., R. 32W.	Feb. 1960	460	6,201	do.	do.	99		5,102-5,114	1,500,000.	
132	Arkansas Oklahoma Gas Co.	Municipal Airport 1.	50 ft S., 600 ft W. of center, sec. 36, T. 8N., R. 32W.	Oct. 1953	440	5,802	Prairie Grove? Mbr. of Hale? Fm.	Bloyd Fm.			5,343-5,346	400,000.	Electrical log from 0 ft to 3,043 ft and from 5,406 ft to 5,802 ft was not run.
133	Shamrock Oil and Gas Corp.	B. Berry 1.	2,550 ft from NL, 2,056 ft from WL, sec. 3, T. 7N., R.29W.	Jan 1966	430	4,402	Atoka Fm.	Atoka Fm.	10 58		1,252 3,141	Show of gas. Show of gas.	
134	Western Natural Gas Co.	W. B. Bergkump 1.	2,578 ft from NL, 1,978 ft from WL, sec. 1, T. 7N., R. 30W.	Mar. 1954	420	8,325	St. Peter Ss.	do.	67 98 99		3,650-3,814 5,920-5,941 5,986-6,012	Show of gas. Show of gas.	Fault with 160 ft of displacement cut at depth of 3,215 ft. Rock samples examined and logged by E. E. Glick.
135	Ozark Natural Gas Co.	S. Girard 1.	1,000 N., 660 ft E. SW. cor. NW¼NE¼ sec. 21, T. 7N., R. 30W.	Dec. 1937	[1]780	5,940	Atoka Fm.					Dry.	Electrical log was not run. Rock samples examined and logged by S. E. Frezon.
136	Shell Oil Co.	Western Coal and Mining Co. 4.	Center, NE¼SW¼, sec. 30, T. 7N., R. 31W.	July 1963	484	8,336	St. Peter Ss.	St. Clair Ls.			8,206-8,236	Show of gas.	Rock samples from 7,940 to 8,330 ft examined and logged by B. R. Haley.

See footnotes at end of table, p. A41.

TABLE 3.—*Descriptions of selected wells drilled in Van Buren and Lavaca quadrangles, Arkansas and Oklahoma, as of September 30, 1966*—Continued

Well No. (pls. 1, 5; fig. 11)	Company name	Lease name	Location (EL, east line; NL, north line; SL, south line; WL, west line)	Date (Completion date, unless otherwise noted)	Reported ground elevation (ft)	Bottom of well		Producing zone			Reported depth (ft)	Reported production (cu ft per day)	Remarks (est., estimated)
						Depth (ft)	Stratigraphic unit	Formation	Zone No.	Member			
						Arkansas—Continued							
137	Arkansas-Oklahoma Gas Co.	G. Bieker 1	Center, NW¼SE¼ sec. 2, T. 7N., R. 32W.	Dec. 1951	491	5,810	Pitkin Ls	?	?		?	24,000,000	Rock samples examined and logged by E. E. Glick.
138	Stephens Production Co.	R. Orr 1	2,498 ft from NL, 1,320 ft from EL, sec. 3, T. 7N., R. 32W.	Apr. 1956	495	6,315	Pitkin (?) Ls	Atoka (?) Fm	58?		2,420–2,480	275,000	Electrical log was not run.
139	do	Buell Ranch 3.	600 ft from SL, 100 ft from EL, NW¼, sec. 9, T. 7N., R. 32W.	Feb. 1963	[1] 490	6,770	Fernvale Ls	do	78		3,858	Show of gas	Faults with 110 ft and 123 ft of displacement cut at depths of 3,276 ft and 4,906 ft, respectively.
									109		5,486–5,523	16,000,000.	
								Bloyd Fm			5,536–5,582		
140	Arkansas Oklahoma Gas Co.	Buell Ranch 2.	670 ft from NL, 550 ft from EL, NW¼ sec. 10, T. 7N., R. 32W.	Jan 1953	497	5,740	Bloyd (?) Fm	Atoka (?) Fm.	98?		5,100	Show of gas	Electrical log not available to authors.
									109?		5,608–5,656	4,000,000.	
								Bloyd (?) Fm.					
141	Athletic Mining and Smelting Co.	W. W. Ayers 5.	1,994 ft from NL, 180 ft from EL, sec. 10, T. 7N., R. 32W.	Nov. 1947	[1] 505	2,440	Atoka Fm.	Atoka Fm.	58?		?	160,000	Electrical log was not run.
142	Stephens Production Co.	Buell Ranch 2.	600 ft from SL, 200 ft from EL, SW¼ sec. 10, T. 7N., R. 32W.	June 1957	480	6,145	Pitkin(?)Ls					Dry	Electrical log was not run.
143	Arkansas Oklahoma Gas Co.	W. W. Ayers 1.	630 ft S., 1,200 E. of NW. cor. sec. 11, T. 7N., R. 32W.	Aug. 1952	501	5,474	Pitkin Ls					Dry	
144	Athletic Mining and Smelting Co.	W. W. Ayers 6.	1,992 ft from SL, 1,992 ft from EL, sec. 11, T. 7N., R. 32W.	Jan. 1949	[1] 480	6,385	Penters Chert					Dry	Elecrrical log was not run. Rock samples from 5,410 to 6,385 ft. examined and logged by R. J. Lantz.
145	Stephens Production Co.	C. Stephens 1.	600 ft N., 100 ft E. of center sec. 16, T. 7N., R.32W.	Dec. 1963	[1] 645	7,160	St. Clair Ls	Atoka Fm	98		5,551	Show of gas	Fault with 80 ft of displacement cut at depth of 5,293 ft.
146	Tenneco Oil Co.	T. J. McBride Unit 1.	2,970 ft from NL, 2,310 ft from EL, sec. 20, T. 7N., R. 32W.	Being drilled.									
147	Shell Oil Co.	Missouri Improvement Unit 1.	1,497 ft from SL, 1,650 ft from WL, sec. 25, T. 7N., R. 32W.	Sept. 1965	503	7,971	St. Clair Ls					Dry	
148	do	Bull Unit 1	1,602 ft from SL, 1,805 ft from EL, sec. 26, T.7N., R. 32W.	Mar. 1964	526	8,265	St. Peter Ss	Atoka Fm	58		3,775	Show of gas	
								Pitkin Ls			7,411–7,450	Show of gas.	
								Penters Chert St. Clair Ls			7,918–8,002	8,800,000.	
								Plattin Ls			8,178–8,190	Show of gas.	
						Oklahoma							
149	E. L. Cox	Cates 1	1,650 ft from NL, 2,555 ft from WL, sec. 21, T. 10N., 27E.	Spudded June 1966.	[2] 429	5,925	Penters Chert	Hale Fm	116	Prairie Grove.	5,476–5,502 5,543–5,547	Show of gas	Fault with 610 ft of displacement cut at depth of 5,255 ft.
150	Sun Oil Co.	Arkansas Valley Farms 1.	Center NW¼NW¼NE¼ sec. 8, T. 10N., R. 27E.	Spudded Feb. 1966.	416	6,000	Bloyd Fm	Atoka Fm	109		5,884–5,924	3,000,000	Fault with 250 ft of displacement cut at depth of 1,541 ft.
151	do	Arkansas Valley Farms "B"-1.	Center N½, sec. 9, T. 10N., R. 27E.	Spudded June 1966.	[2] 420	6,665	St. Clair Ls	Bloyd Fm			5,620–5,660	Show of gas	
152	do	Forsgren Bros. 1.	Center NW¼SE¼ sec. 16, T. 10N., R. 27E.	Spudded Feb. 1966.	414	6,489	Pitkin Ls	Atoka Fm	6		Show of gas		
									109		5,964–6,004	1,020,000	
								Bloyd Fm					
								Hale Fm	116	Prairie Grove.	6,354–6,390	4,600,000.	
153	do	B. E. Cobb 1.	Center NW¼NE¼ sec. 17, T. 10N., R. 27E.	Spudded Aug. 1965.	[2] 431	6,975	St. Clair Ls	Atoka Fm	58		3,016–3,030	1,044,000	Fault with 355 ft of displacement cut at depth of 5,152 ft.
									109		5,890–5,942	2,225,000.	
								Hale Fm	116	Prairie Grove.	6,294–6,383	Show of gas.	
								Penters Chert			6,842–6,855	Show of gas.	
154	do	R. A. Wilson 1.	Center NW¼SE¼ sec. 18, T. 10N., R. 27E.	Spudded Mar. 1966.	418.8	6,751	Prairie Grove Mbr. of Hale Fm.	Atoka Fm	7		1,704–1,720	Show of gas	Faults with 210 ft and 105 ft of displacement cut at depths at 4,457 ft and 5,175 ft, respectively.
									109		6,318–6,336	250,000.	

155	do	F. Watkins 1	Center NE¼SW¼NE¼ sec. 19, T. 10N., R. 27 E.	Spudded Apr. 1966.	424	6,726	do	do	58		3,636	Show of gas	Fault with 535 ft of displacement cut at depth of 6,113 ft.
											4,874–4,884	Show of gas.	
									109		6,237–6,252	3,300,000.	
156	do	Murray "A"–1.	Center SE¼NW¼ sec. 20, T. 10N., R. 27 E.	Spudded Feb. 1966.	416	6,696	Bloyd Fm	do	6		1,467	Show of gas.	
									58		3,272–3,278	500,000.	
157	do	Arkansas Valley Farms "A"–1.	Center NE¼NW¼SE½ sec. 21, T. 10N., R. 27 E.	Spudded Apr. 1966.	409	7,233	Plattin Ls	do	109		5,985	Show of gas	Fault with 137 ft of displacement cut at depth of 4,872 ft.
158	do	H. V. Murray 1.	Center NE¼NE¼SW¼ sec. 29, T. 10N., R. 27 E.	Spudded Jan. 1964.	418	7,260	St. Clair Ls	Hale Fm	116	Prairie Grove. Cane Hill.	6,700–6,795	Show of gas	Fault with 185 ft of displacement cut at depth of 5,607 ft. Rock samples examined and logged by B. R. Haley.
								Pitkin Ls					
								St. Clair Ls			7,162–7,163	Show of gas.	
159	Monsanto Co	Hickman 1	1,405 ft from SL, 1,235 ft from WL, sec. 32, T. 10N., R. 27 E.	Spudded July 1966.	[3] 433	6,350	Bloyd Fm	Bloyd Fm			6,274–6,290	4,070,000	
160	Stephens Production Co.	H. L. Swink 1	Center NE¼NW¼SW¼ sec. 34, T. 10N., R. 27 E.	Spudded Mar. 1962.	[2] 510	6,906	?					Dry	Electrical log not available to authors.
161	do	Trimble 1	Center NE¼SW¼SW¼ sec. 3, T. 9N., R. 27 E.	Spudded Jan. 1966.	[2] 499	6,405	Pitkin(?) Ls	?	?		5,778–5,856	14,500,000	Electrical log not available to authors.
162	Le Flore County Gas and Electric Co.	M. McWaters 1.	1,907 ft from SL, 2,410 ft from WL, sec. 4, T. 9N., R. 27 E.	Spudded Sept. 1961.	434	6,398	?	?	?		5,868–5,915	24,500,000	Electrical log not available to authors.
163	do	Richison R-1	Center SW¼SW¼NE¼ sec. 7, T. 9N., R. 27 E.	Spudded July 1956.	[1] 420	6,588	?	?	?		6,512–6,549	1,000,000	Electrical log not available to authors.
164	do	V. Karl–Cedars 7.	Center SE¼NE¼NE¼ sec. 8, T. 9N., R. 27 E.	Spudded May 1947.	[1] 440	6,502	?	?	?		?	?	Electrical log not available to authors.
165	do	Karl 2	Center SW¼SW¼NE¼ sec. 8, T. 9N., R. 27 E.	Spudded ? 1957.	[1] 420	6,475	?					Dry	Electrical log not available to authors.
166	do	Kilgore 1	Center SE¼SE¼NW¼ sec. 9, T. 9N., R. 27 E.	Spudded ? 1957.	414	6,297	Bloyd Fm	?	?		?	Gas	
167	do	Hoover 1	Center SW¼SW¼NE¼ sec. 17, T. 9N., R. 27 E.	Spudded Mar. 1955.	473	6,590	Prairie Grove Mbr. of Hale Fm.	Atoka Fm	109		6,135–6,192	1,250,000	
168	do	Parnell 1	Center NW¼NW¼SE¼ sec. 18, T. 9N., R. 27 E.	Spudded Sept. 1954.	[1] 460	6,444	Bloyd Fm	do	109		6,206–6,308	10,000,000	
								Bloyd Fm					

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[1] Estimated from plate 1. [2] Derrick floor. [3] Estimated from kelly bushing.

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UNITED STATES DEPARTMENT OF THE INTERIOR
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PREPARED IN COOPERATION WITH THE
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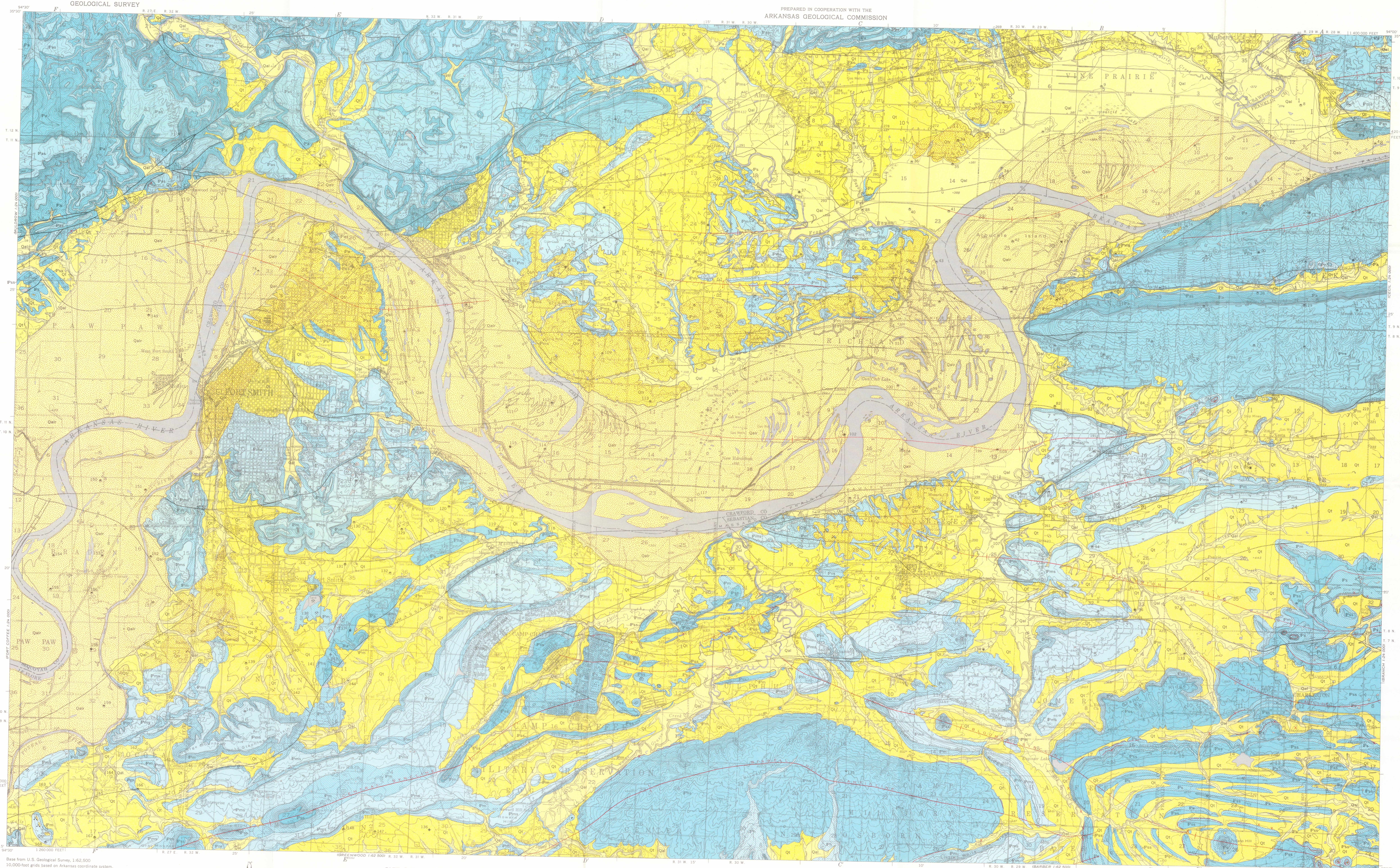
PROFESSIONAL PAPER 657-A
PLATE 1



Base from U.S. Geological Survey, 1:62,500
10,000-foot grids based on Arkansas coordinate system, north zone

GEOLOGIC MAP OF VAN BUREN AND LAVACA QUADRANGLES, ARKANSAS AND OKLAHOMA

SCALE 1:48 000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1971—G69393

Geology by T. A. Hendricks, 1934,
and B. R. Haley, 1960–61

EXPLANATION

QUATERNARY

Qal / Qalr

Alluvium

Deposits along stream channels. In some places includes parts of lowermost terrace
Qal, *alluvium along small streams or reworked alluvium along Arkansas River*
Qalr, *alluvium along Arkansas River*

Qt / Qtr

Terrace deposits

Alluvial deposits on two terrace levels
Qt, *along small streams*
Qtr, *along Arkansas River*

UNCONFORMITY

CARBONIFEROUS — PENNSYLVANIAN

Des Moines Series

ℙs / ℙss

Savanna Formation

Alternating units of predominant shale or predominant sandstone
ℙs, *shale, siltstone and thin beds of silty sandstone*
ℙss, *sandstone, silty sandstone, or interbedded sandstone, siltstone, and shale*

ℙm / ℙms

McAlester Formation

Alternating units of predominant shale or predominant sandstone
ℙm, *shale, siltstone, and thin beds of sandstone and silty sandstone*
ℙms, *sandstone, silty sandstone, or interbedded sandstone, siltstone, and shale*

ℙh / ℙhs

Hartshorne Sandstone

Alternating units of predominant shale or predominant sandstone
ℙh, *shale and siltstone*
ℙhs, *sandstone, silty sandstone, or interbedded sandstone, siltstone, and shale*

Atoka Series

ℙa / ℙas

Atoka Formation

Alternating units of predominant shale or predominant sandstone
ℙa, *shale, siltstone, and thin beds of sandstone and silty sandstone*
ℙas, *sandstone, silty sandstone, interbedded sandstone, siltstone, and shale*

Contact
Dashed where approximately located

Fault, showing dip
Dashed where approximately located; dotted where concealed. U, *upthrown side;* D, *downthrown side*

Anticline
Showing trace of axial plane. Dotted where concealed

Syncline
Showing trace of axial plane. Dotted where concealed

Inclined   Horizontal
Strike and dip of beds
Symbols in areas of alluvial deposits were measured on bedrock exposures too small to be shown on this map

Coal bed
Dashed where approximately located

Exposure of coal

Surface opening on coal bed

Mine shaft to coal bed

262
Shallow hole
Drilled by Gulf Oil Corp.

Quarry

Gravel pit

A —— A′
Structural section shown on plate 6

WELL SYMBOLS

Number designates well listed in table 3 in text and pertains to wells drilled since 1936

3
Gas producing

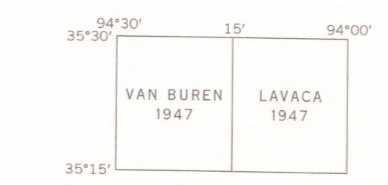
23
Reported show of gas

118
No reported show of gas

1
Being drilled as of Sept. 30, 1966

92
Electrical log was available, as of Sept. 30, 1966, to the authors of this report

144
Rock samples were examined and logged by a geologist of the U.S. Geological Survey



INDEX SHOWING LOCATION OF QUADRANGLES

UNITED STATES DEPARTMENT OF THE INTERIOR
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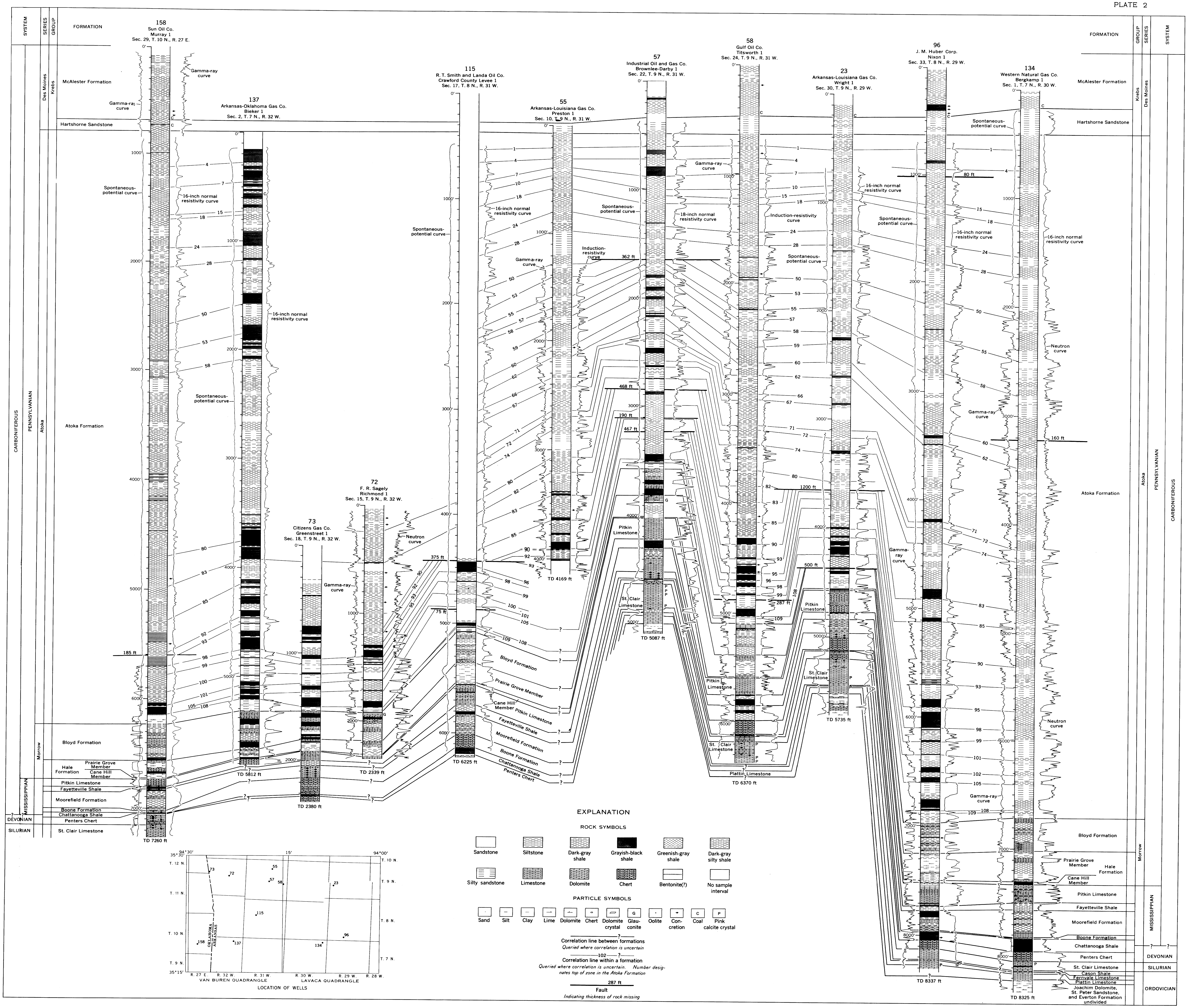
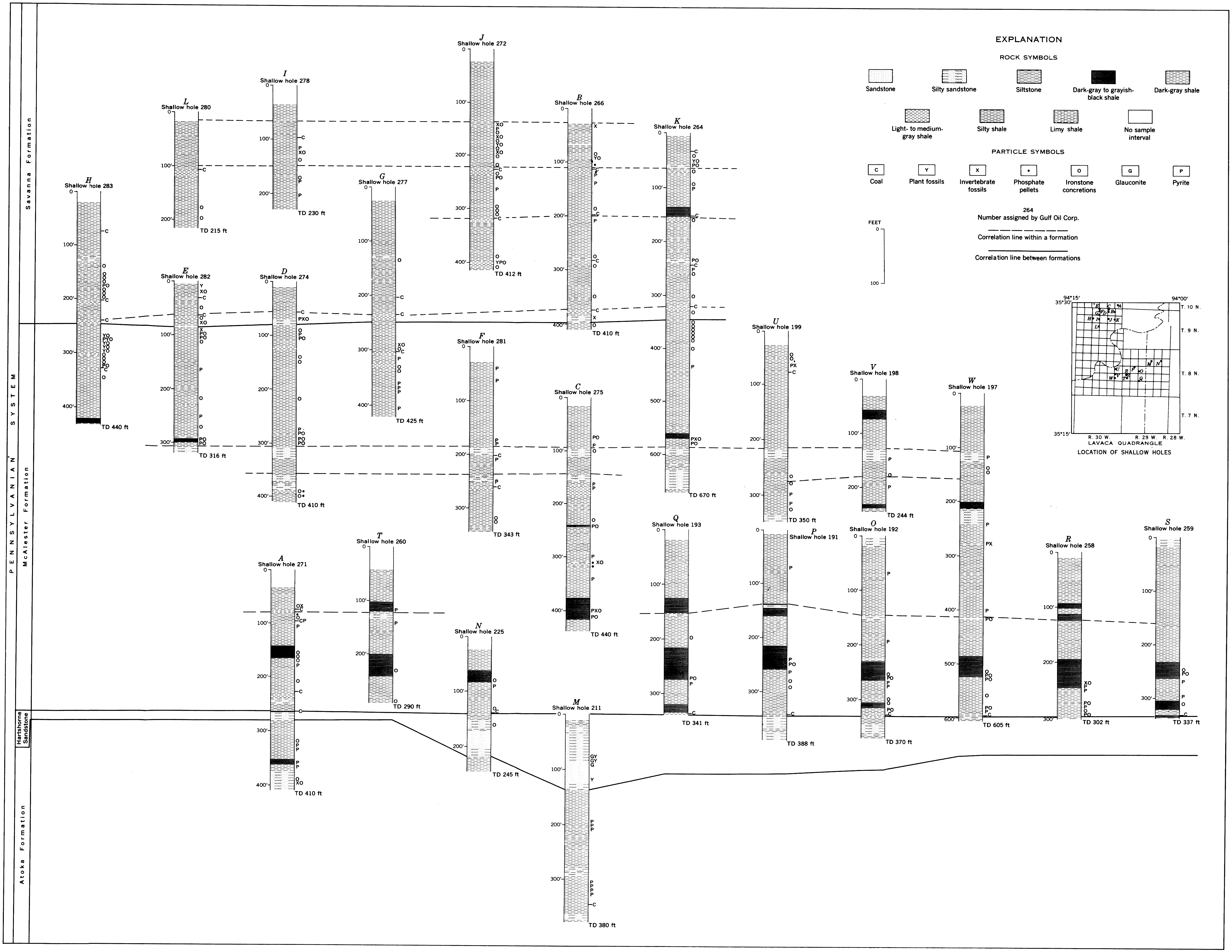
PROFESSIONAL PAPER 657-A
PLATE 2



STRATIGRAPHIC SECTIONS IN VAN BUREN AND LAVACA QUADRANGLES, ARKANSAS AND OKLAHOMA

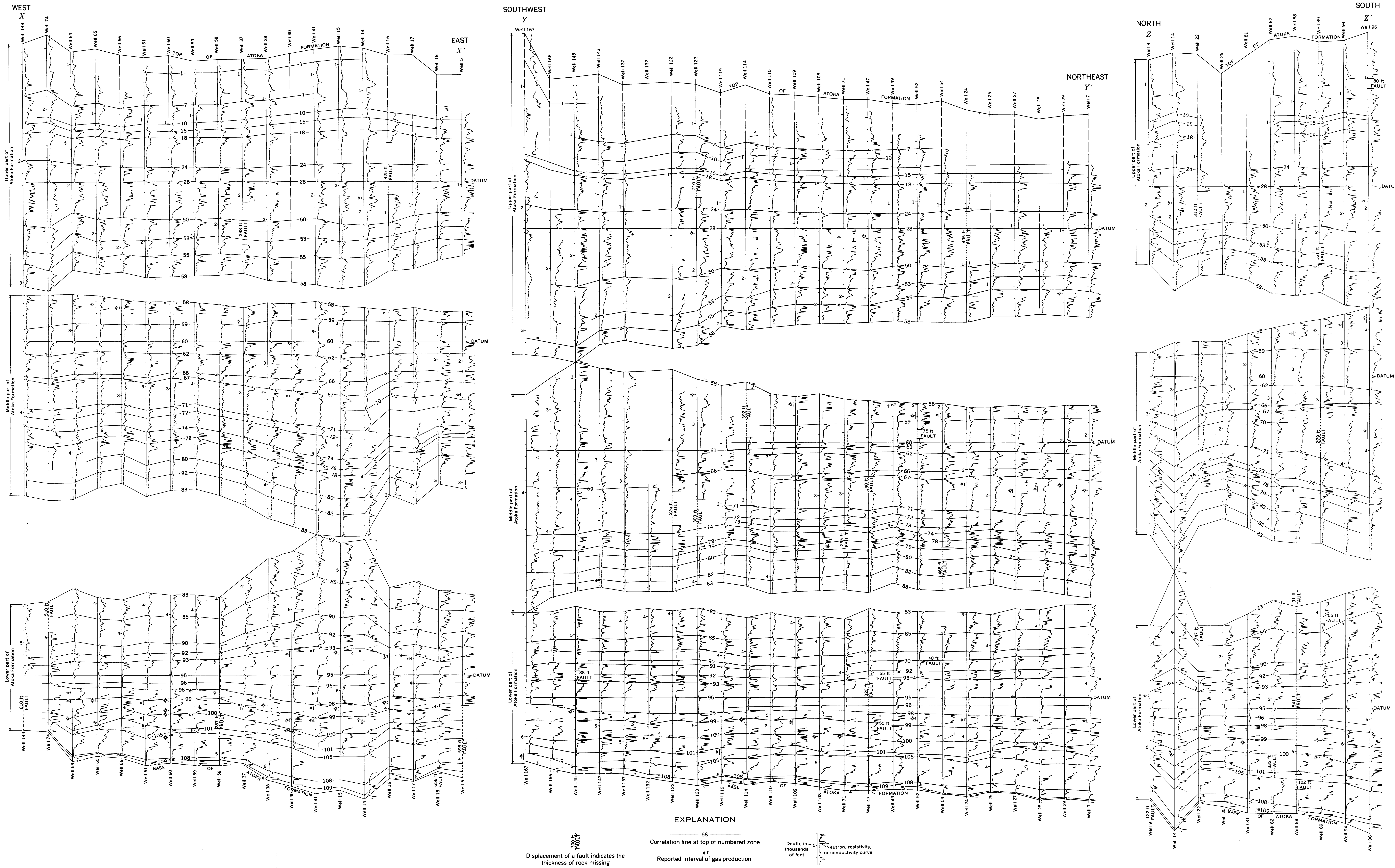


LITHOLOGIC SECTIONS OF POST-ATOKA ROCKS IN LAVACA QUADRANGLE, ARKANSAS

414-469 O - 71 Plate 3 (In pocket)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PROFESSIONAL PAPER 657-A
PLATE 4



EXPLANATION

300 ft FAULT
Displacement of a fault indicates the thickness of rock missing

——— 58 ———
Correlation line at top of numbered zone

✲[
Reported interval of gas production

✲[
Reported interval of show of gas

Depth, in thousands of feet — 5
Neutron, resistivity, or conductivity curve

Datum planes are at top of the indicated zones. Sections are pulled apart at zones 58 and 83. Well numbers correspond to those listed in table 3 in text. Lines of sections are shown on fig. 8.

ELECTRICAL LOG CORRELATION OF THE ATOKA FORMATION IN VAN BUREN AND LAVACA QUADRANGLES, ARKANSAS AND OKLAHOMA

414-469 O - 71 Plate 4 (In pocket)

UNITED STATES DEPARTMENT OF THE INTERIOR
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ARKANSAS GEOLOGICAL COMMISSION

PROFESSIONAL PAPER 657-A
PLATE 5

EXPLANATION

Symbols in red indicate data on contoured horizon

Structure contours
Drawn on base of Hartshorne Sandstone. Dashed where datum is eroded. Contour interval 100 feet

Anticline
Showing trace of axial plane

Syncline
Showing trace of axial plane

Traces of normal fault
Dashed on downthrown block. U, *upthrown side;* D, *downthrown side*

Surface trace of contact between Hartshorne Sandstone (IPh) and Atoka Formation (IPa)

Structural section shown on plate 6

Paris coal bed

Unnamed coal bed in Savanna Formation

Charleston coal bed

Unnamed coal bed in McAlester Formation

Lower Hartshorne coal bed

Unnamed coal bed in Atoka Formation

Exposure of coal
Number is thickness of coal, in inches

Surface opening on coal bed
Number is thickness of coal, in inches

Drill hole or mine locality
Number is thickness of coal, in inches

Mine shaft to coal bed

Mined area in Lower Hartshorne coal bed, except where labeled otherwise

Lower Hartshorne coal-bed thickness line
Number is thickness of coal, in inches

Boundary in Lower Hartshorne coal between measured and indicated reserves and inferred reserves of coal
Squares within area of measured and indicated reserves of coal

Shallow hole
Drilled by Gulf Oil Corp.

WELL SYMBOLS

Number designates well listed in table 3 in text and pertains to wells drilled since 1936

Gas producing

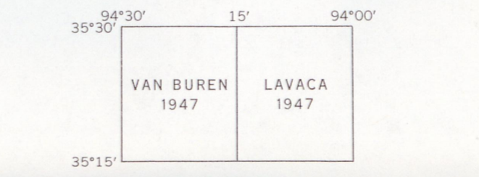
Reported show of gas

No reported show of gas

Being drilled as of Sept. 30, 1966

Electrical log was available, as of Sept. 30, 1966, to the authors of this report

Rock samples were examined and logged by a geologist of the U.S. Geological Survey



INDEX SHOWING LOCATION OF QUADRANGLES

Base from U.S. Geological Survey, 1:62,500
10,000-foot grids based on Arkansas coordinate system, north zone

APPROXIMATE MEAN DECLINATION, 1971

STRUCTURE-CONTOUR AND COAL-BED MAP OF VAN BUREN AND LAVACA QUADRANGLES, ARKANSAS AND OKLAHOMA

SCALE 1:48 000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1971—G69393

Geology by T. A. Hendricks, 1934,
and B. R. Haley, 1960–61

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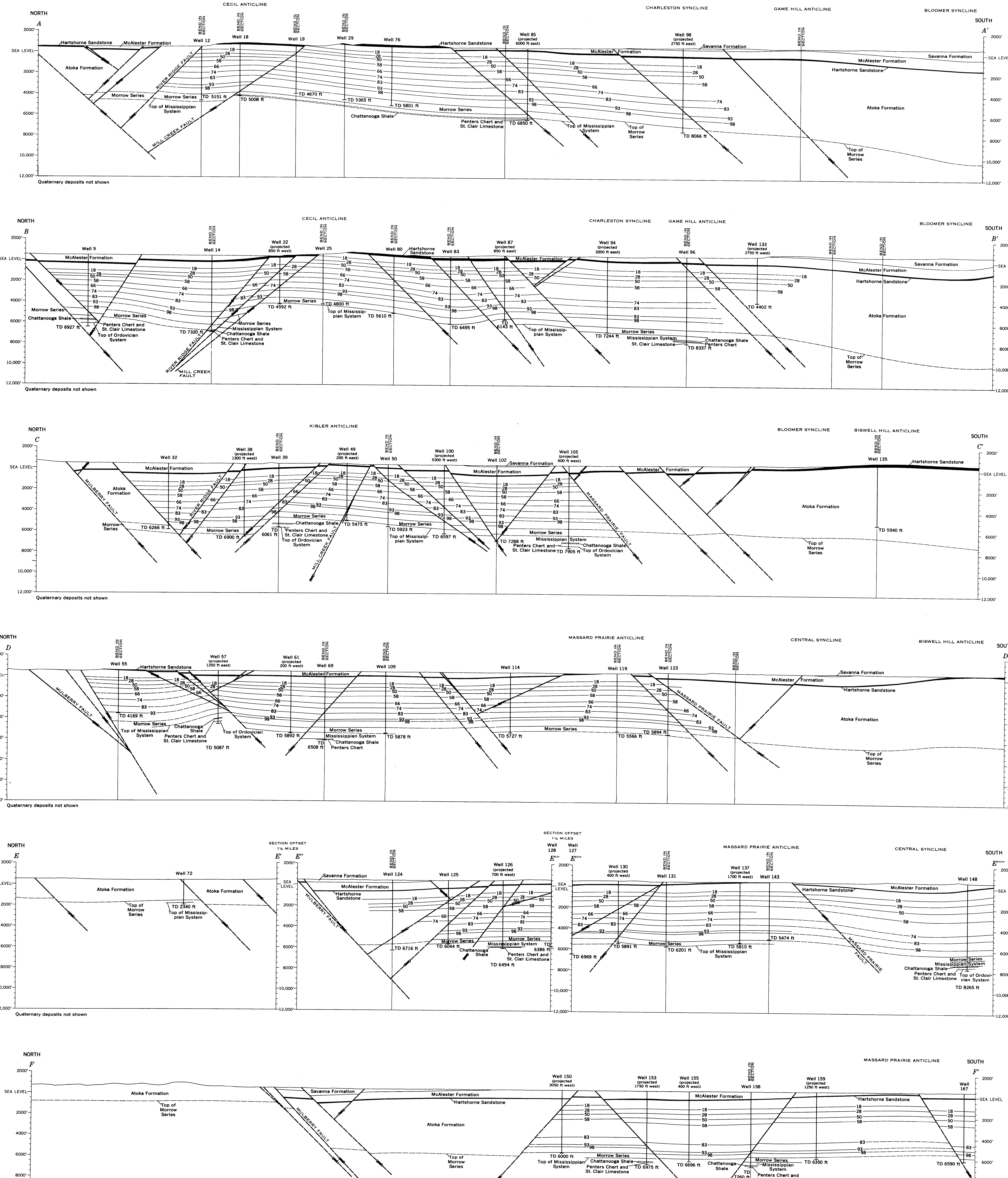


STRUCTURAL SECTIONS IN VAN BUREN AND LAVACA QUADRANGLES, ARKANSAS AND OKLAHOMA

Locations of sections shown on plates 1 and 5
Numbers in sections designate tops of numbered zones in the Atoka Formation

SCALE 1:48 000

1 ½ 0 1 2 3 MILES

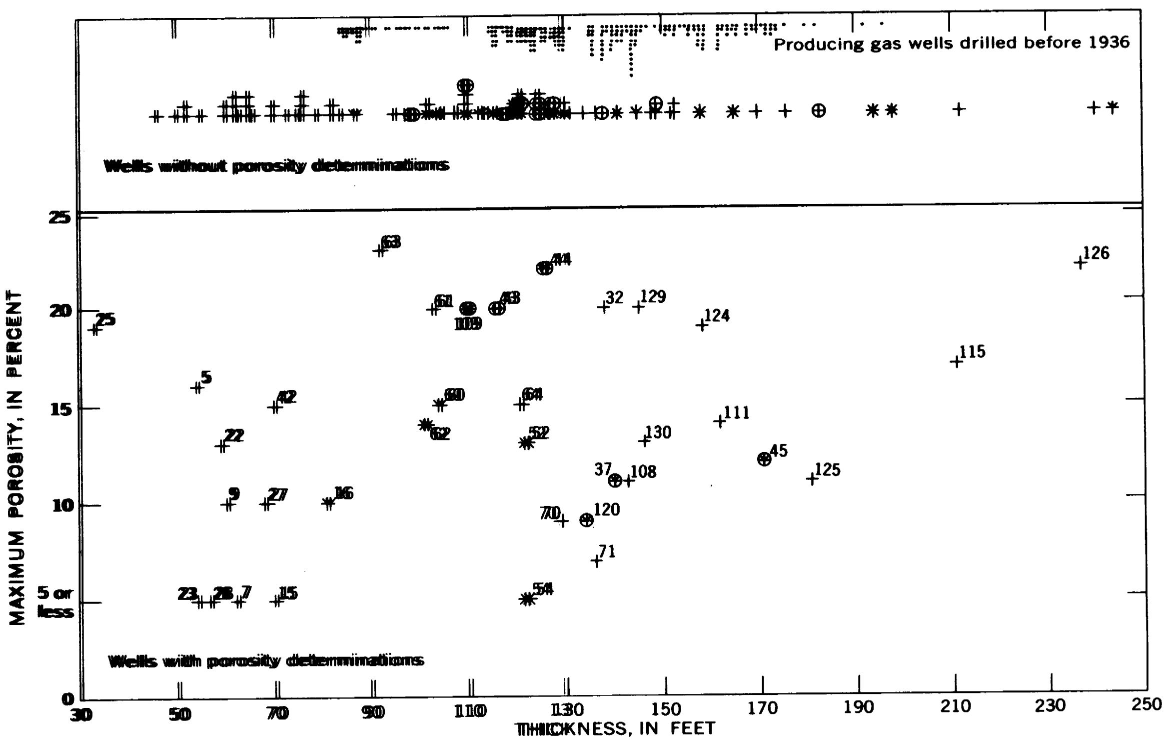
1 .5 0 1 2 3 KILOMETERS

DATUM IS MEAN SEA LEVEL

414-469 O - 71 Plate 6 (In pocket)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PROFESSIONAL PAPER 657-A
PLATE 7



A. ZONE 58

EXPLANATION

54
Well number in this report

✱
Well producing gas

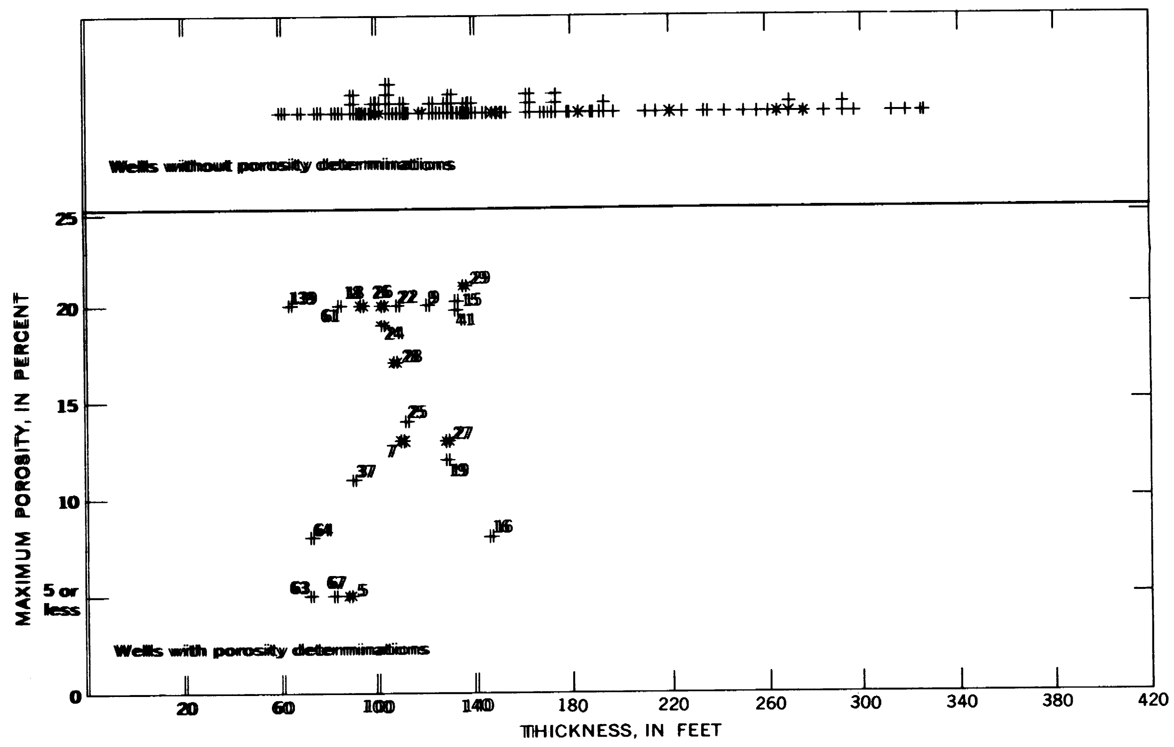
*
Well with show of gas

\+
Well with no show of gas

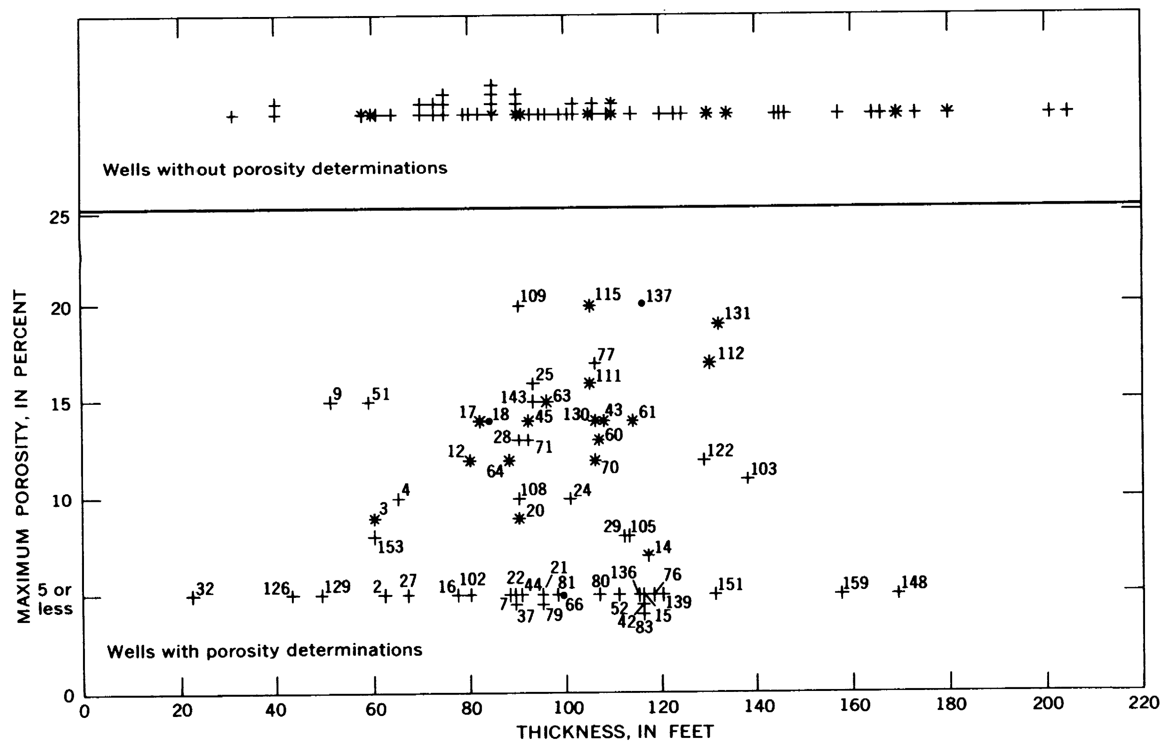
•
Well with unknown gas potential

○
Well in which gas may have been depleted by nearby production

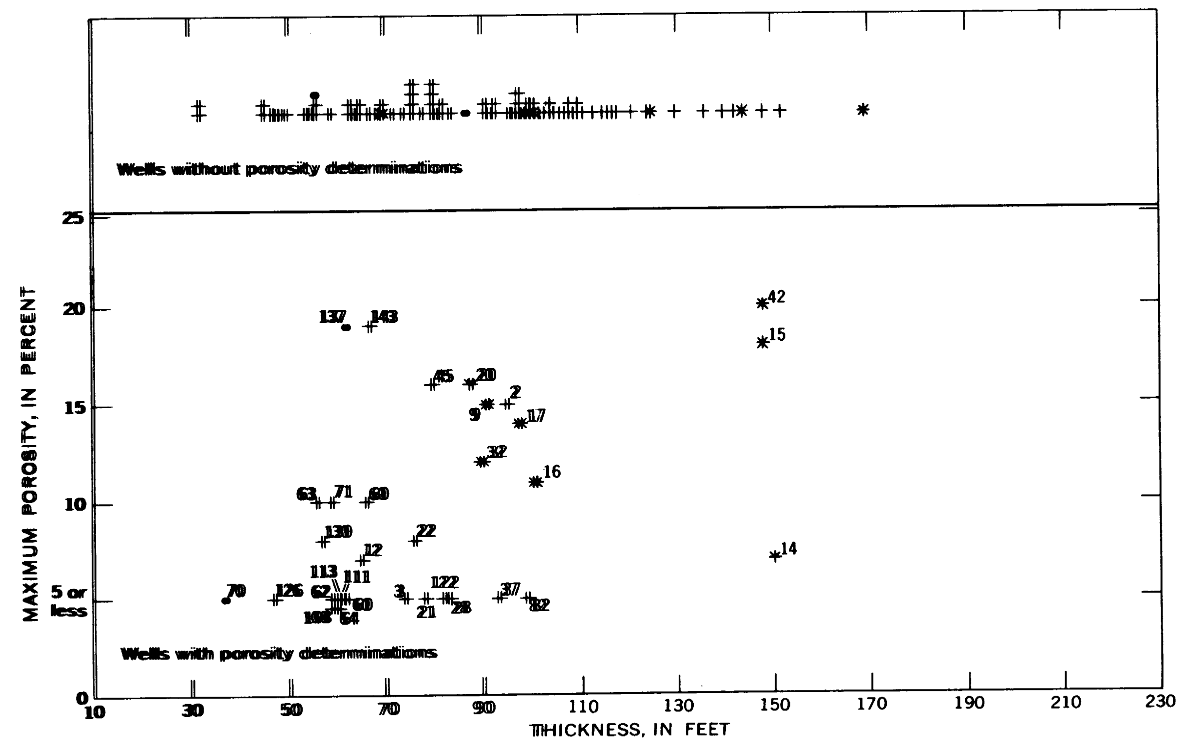
Porosity was calculated from electric logs by William L. Pugh, consultant petroleum engineer, Denver, Colo.



B. ZONE 67



E. ZONE 99



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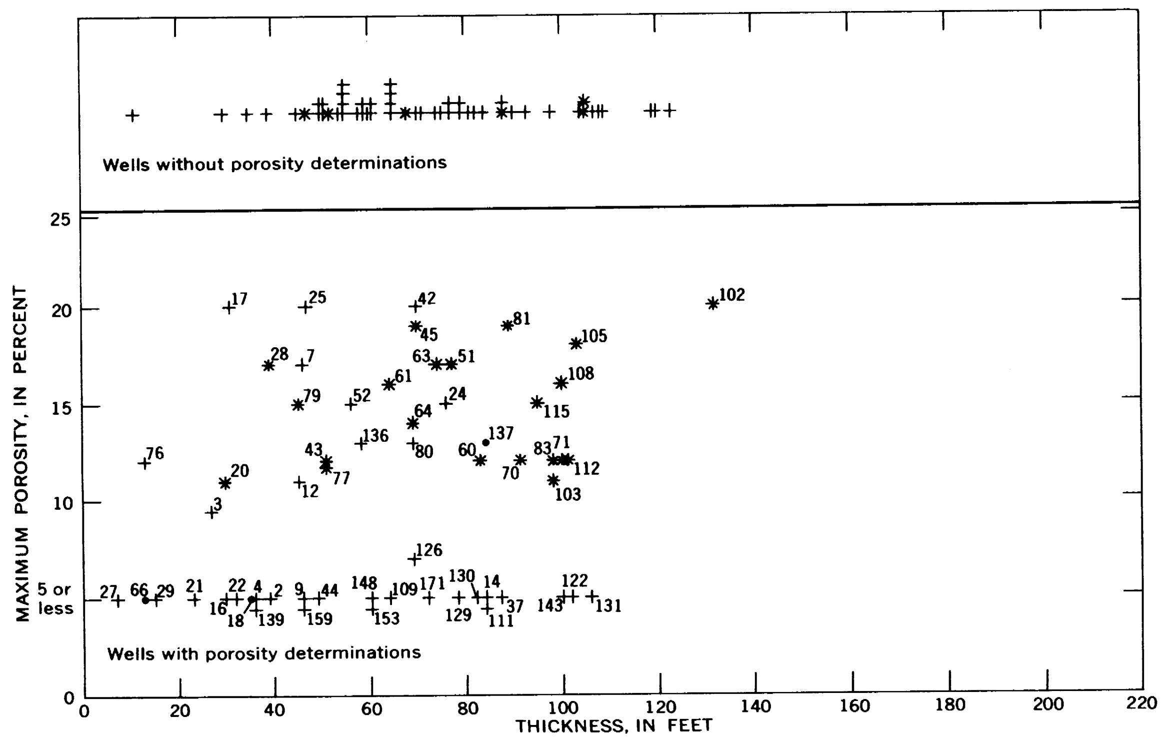
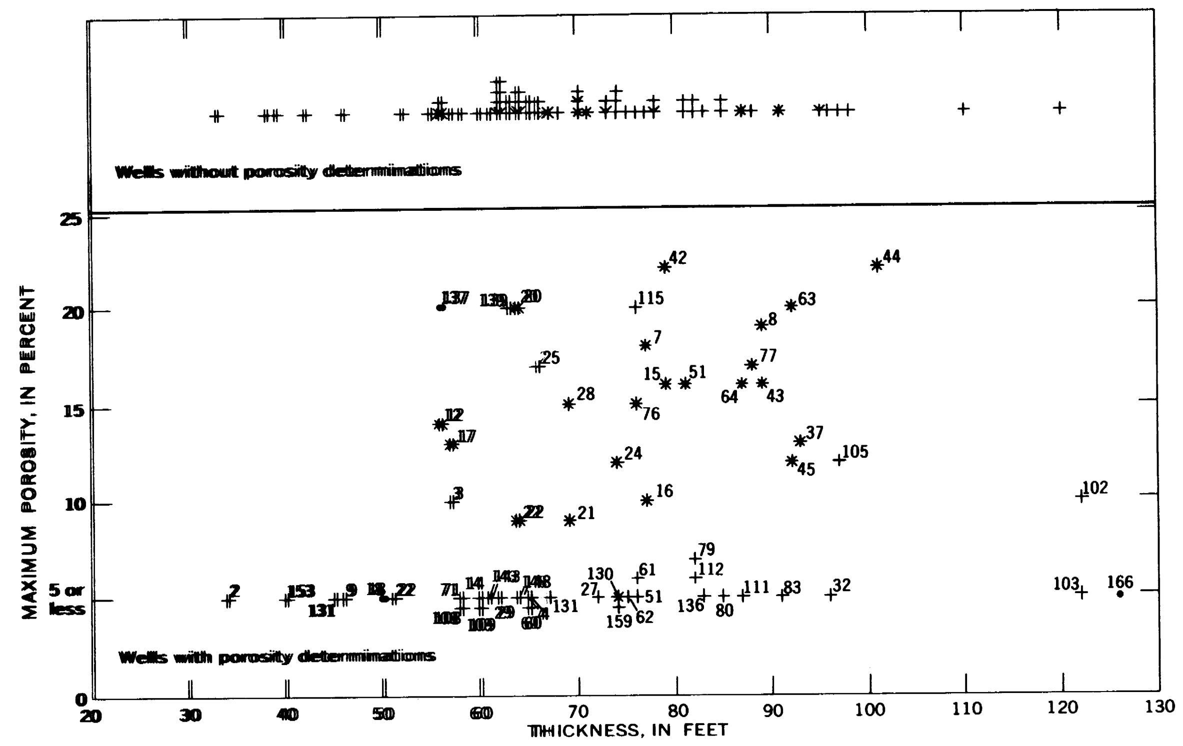
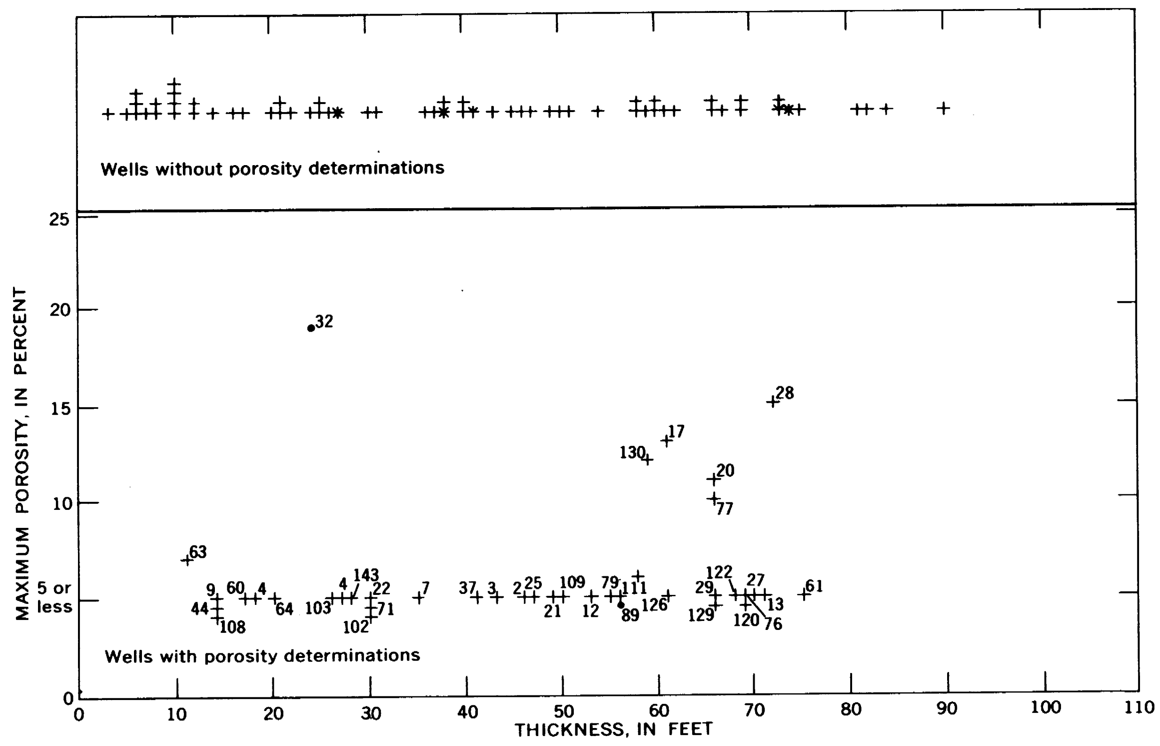


F. ZONE 100



D. ZONE 98



G. ZONE 101

GRAPHS SHOWING THICKNESS, MAXIMUM POROSITY, AND GAS CONTENT OF THE SANDSTONE PART OF SELECTED ZONES IN THE ATOKA FORMATION IN VAN BUREN AND LAVACA QUADRANGLES, ARKANSAS AND OKLAHOMA

414-469 O - 71 Plate 7 (In pocket)