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Geology of Northern Adair County, Oklahoma

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GEOLOGY OF NORTHERN ADAIR COUNTY, OKLAHOMA

GEORGE G. HUFFMAN, JACKSON M. LANGTON,* AND JAMES M. HANCOCK, JR.†

ABSTRACT

Northern Adair County, Oklahoma, lies on the south flank of the Ozark uplift. Sedimentary strata dip gently southward and southeastward and are interrupted by a series of northeastward-trending normal faults. Named faults include the Baron graben, South Christie graben (new), and the West Christie faults (new). Numerous small unnamed faults and minor folds are present.

Sedimentary strata range in age from Early Ordovician (Cotter Dolomite) to Early Pennsylvanian (Hale Formation). Terrace deposits and alluvium of Quaternary age are well developed along major drainage lines. Ordovician Cotter Dolomite is succeeded by the Burgen Sandstone, Tyner Shale, and Fite and Fernvale Limestones. These are truncated by pre-Chattanooga erosion and overlain by the Sylamore and Noel Members of the Chattanooga Formation. Succeeding Osagean Series includes the St. Joe Group, Reeds Spring Formation, and Keokuk Chert. Upper St. Joe (Pierson equivalent) is characterized by biohermal development. Late Mississippian Moorefield, Hindsville, Fayetteville, and Pitkin Formations occur in scattered outliers lying upon the post-Keokuk surface. Some of the outliers are capped by the Hale Formation of Early Pennsylvanian (Morrowan) age.

Oil and gas in commercial quantities are not believed to be present. Abundant water, building stone, and road materials are the principal economic products available.

INTRODUCTION

Location and description of area. — The area of investigation comprises approximately 260 square miles in northern Adair County, Oklahoma. It includes Tps. 17-19 N., Rs. 24-26 E. (fig. 1). It is bounded on the west by Cherokee County, Oklahoma; on the north by Delaware County, Oklahoma; and on the east by Benton and Washington Counties, Arkansas. The southern boundary is the south line of T. 17 N., Adair County.

The southern edge of the area lies 6 miles north of Stilwell, Oklahoma; the western edge is 9 miles east of Tahlequah, Oklahoma.

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Purpose and methods of investigation. — The primary purpose of this investigation was the detailed areal mapping of northern Adair County. This completes the geologic mapping of Adair County, a project begun in 1951 by graduate students working under the direction of the senior author. The results of earlier investigations in Adair County were included in a report by Huffman (1958). The present work complements recent mapping by Starke (1961) in northeastern Cherokee County.

The field work was begun in the summer of 1962 and continued upon a part-time basis during the academic year of 1962-1963. Field checking was finished in August 1964. The northern one-half of the area was mapped by J. M. Hancock, Jr.; the southern one-half by J. M. Langton.

Mapping was done on a base map prepared from aerial photographs at a scale of 3.2 inches per mile. Formational contacts, faults, and other data were recorded on this base. The final map (pl. I) was drafted from a photographic reduction at the scale of 2 inches per mile and was then photographically reduced to the present scale of 1.5 inches per mile.

During the course of the work, several representative stratigraphic sections were measured and described. Fossils were collected from several lithic units, and photographs of typical exposures were taken.

After the geologic mapping had been completed, a local vertical-magnetic-intensity survey was made by J. A. E. Norden, J. M. Langton, and J. M. Hancock, Jr., to explore the configuration of the sur-

Figure 1. Map of Oklahoma showing location of northern Adair County.

face of the Precambrian basement rock and to note its relationship to surface faulting in the area. The results of this survey were published in *Oklahoma Geology Notes* (1963).

Previous investigations. — The earliest geologic work in northeastern Oklahoma was done by Drake (1897). He assigned the older rocks in the area to the Silurian System and mapped the boundary between the Lower Carboniferous (Mississippian) and the Coal Measures (Pennsylvanian).

Topographic coverage was provided in 1904 (Siloam Springs and Tahlequah quadrangles) by the U. S. Geological Survey following topographic work from 1896 to 1899. Taff (1905) mapped the geology of the Tahlequah quadrangle, which includes a portion of northern Adair County.

The next major contribution was by Snider (1915). His map and text covered the geology of most of northeastern Oklahoma. In 1930, Cram discussed the geology of Cherokee and Adair Counties, prepared a generalized geologic map of the area, and described measured sections along the Illinois River in northern Adair County.

Laudon in his classic paper, *Stratigraphy of the Osage Subseries of Northeastern Oklahoma* (1939), described a measured section of Osage rocks along Barren Fork.*

In 1951, Montgomery remapped the pre-Chattanooga units along the Illinois River, and Graves (1952) measured and described some pre-Chattanooga sections along the Illinois River and its tributaries. "Post-Boone" outliers in northern Adair County were mapped by Slocum (1955).

Geological mapping and description of the rocks in the adjoining area to the south were completed by Huffman (1958), and the area to the west in Cherokee County was mapped by Starke (1961).

Geography. — Northern Adair County has a mild, uniform climate of the humid, subtropical to continental type. Average rainfall is 42.46 inches per year. Summer temperature averages 82.6 degrees fahrenheit; winter temperature averages 40.5 degrees fahrenheit. The first killing frost occurs in late October and the last in early April, giving an average annual growing season of 200 days.

The largest town in the area is Westville with a population of

* The location given by Laudon (sec. 25, T. 15 N., R. 25 E.) is incorrect. Most probably the section described by him is that along the south side of Barren Fork in sec. 36, T. 17 N., R. 25 E.

727. Watts is second in size with a population of 300. Small communities include Addielee, Baron, Ballard, Chance, Chewey, Christie, and Proctor; each consists essentially of a general store surrounded by a few houses. Rural areas are sparsely populated.

U. S. Highway 59 runs from north to south across the east side of the area, connecting Watts, Westville, and Baron and extending southward to Stilwell. An east-west, black-topped road extends from U. S. Highway 59 westward through Chance and Chewey. U. S. Highway 62 crosses the southern part of the area from east to west, passing through Westville, Christie, and Proctor. State Highway 10 cuts across the northwest corner of the area.

Secondary roads are not surfaced. In the western part of the area, where deep dissection has occurred, secondary roads parallel the stream valleys. In the eastern part of the area on the upland surface floored by Osagean cherts, secondary roads are good and typically follow section lines.

One railroad, the Kansas City Southern, traverses the area from north to south connecting Watts, Westville, and Baron with the county seat, Stilwell, which lies just south of this area.

Northern Adair County occupies a portion of the Ozark Plateau Province (Curtis and Ham, 1957). The topography is rugged. The uplands are flat and are supported by the resistant cherts of the Keokuk and Reeds Spring Formations. Conspicuous outliers of post-Keokuk rocks rise above the upland surface in the eastern part of the area. Westward the upland area is deeply dissected by narrow, V-shaped valleys along which pre-Osagean strata are exposed.

The drainage pattern is a combination of the dendritic and rectangular types. Dendritic drainage characterizes the surface carved on Osagean cherts. The rectangular aspect reflects the control of drainage lines by two prominent sets of joints and faults which trend northeastward and northwestward, essentially at right angles.

Maximum elevation, as shown by the topographic map, is between 1,400 and 1,450 feet. The highest points in the area are the crests of West Alberry Mountain and Baptist Mission Mountain (formerly called Bushyhead Mountain). The lowest elevation of between 750 and 800 feet occurs where Barren Fork crosses the western boundary. Maximum relief is between 600 and 700 feet.

The area is drained by the Illinois River and its tributaries. The principal tributary is Barren Fork; the second largest is Ballard

Creek. Major tributaries of Barren Fork include Tyner Creek and Courthouse Creek.

Principal industries are ranching and dairy farming. Other industries include growing of strawberries and beans, raising of poultry, and small-scale lumbering. The two main businesses are the Baron Canning Company and the Akin Lumber Company. Watts was formerly a thriving railroad town. Charcoal is manufactured in Baron by the Alabama Charcoal Company.

STRATIGRAPHY

Stratigraphic Summary

Rocks exposed at the surface (fig. 2) range in age from Early Ordovician (Cotter Dolomite) to Early Pennsylvanian (Hale Sandstone). These are overlain in places by terrace and alluvial deposits of Quaternary age.

The Cotter Dolomite is exposed only in the NW¼ sec. 8, T. 19 N., R. 25 E. There it is overlain unconformably by the Burgen Sandstone of Middle Ordovician age. The Burgen is succeeded conformably by the Tyner Formation, which thins rapidly northward to zero by truncation. The overlying Fite is known in two exposures, along the north side of U. S. Highway 62, SW¼ NE¼ sec. 9, T. 17 N., R. 24 E., and along a small creek, SE¼ NW¼ sec. 16, T. 17 N., R. 24 E. The Fernvale has been recognized only in sec. 16, T. 17 N., R. 24 E. Succeeding beds of Late Ordovician, Silurian, and Devonian ages, present in areas to the south and west, are missing through regional pre-Chattanooga unconformity.

Late Devonian Chattanooga Formation, represented principally by the black Noel Shale Member and only locally by the basal Sylamore Sandstone Member, rests with unconformity upon the truncated Ordovician strata.

The Noel Shale is succeeded by the St. Joe, Reeds Spring, and Keokuk limestones and cherts of Kinderhookian and Osagean age. The Keokuk floors the upland area and is the surface rock over approximately 235 square miles.

Late Mississippian Moorefield, Hindsville, Fayetteville, and Pitkin Formations are thin and are present only in outliers which rise above the Keokuk surface or are preserved on downthrown fault blocks. Most of the post-Keokuk outliers are in the eastern part of the area.

Early Pennsylvanian Hale Sandstone lies with unconformity upon Mississippian strata and is preserved as the cap rock on several prominent outliers and in downthrown blocks along major fault zones.

System	Series	Formation	Rock	Thickness (feet)	Remarks
PENNSYLVANIAN	MORROWAN	HALE		0-53	Brown, massive-bedded, calcareous sandstone; caps outliers in eastern part of area.
MISSISSIPPIAN	CHESTERIAN	PITKIN		0-4	Blue-gray, nodular limestone limited to southeastern corner of area.
		FAYETTEVILLE		200±	Black, fissile shale with Wedington Sandstone Member (50') in upper part. Both shale and sandstone are unfossiliferous.
		HINDSVILLE		10-30	Gray, medium-crystalline, oölitic, fossiliferous limestone.
	MERAMECIAN	MOOREFIELD		0-45	Includes Ordnance Plant Siltstone, Lindsey Bridge Calcarenite, and argillaceous Bayou Manard Limestone.
	OSAGEAN	KEOKUK		50-70	White, mottled, massive-bedded, brecciated chert and gray cherty limestone. Forms surface rock over much of area.
		REEDS SPRING		100-200	Blue-gray to tan, thin-bedded chert alternating with thin beds of blue-gray limestone. Resistant cliff-forming unit.
	OSAGEAN / KINDERHOOKIAN	ST. JOE GROUP		0-58	Includes basal nodular limestone, green marly limestone, thin-bedded reefoid limestone facies.
DEVONIAN	BRADFORDIAN SENECAN	CHATTANOOGA		40-84	Black, fissile shale (Noel) with local development of Sylamore Sandstone at base.
ORDOVICIAN	CINCINNATIAN	FERNVALE		0-1.5	Gray, coarsely crystalline limestone.
	CHAMPLAINIAN	FITE		0-5	White, lithographic limestone.
		TYNER		0-46	Green waxy shales, brown shales, dolomite. Top eroded in northern Adair County.
		BURGEN		75±	White to yellow, iron-stained, fine- to medium-grained, calcareous, friable sandstone.
	CANADIAN	COTTER		11+	Buff to light-gray, fine-crystalline dolomite; only upper part exposed.

Figure 2. Generalized columnar section for northern Adair County.

Ordovician System

COTTER FORMATION

The Cotter Formation (named by Ulrich in 1911 for exposures near the town of Cotter in Baxter County, Arkansas) crops out only in a small anticlinal fold along the Illinois River in NW¼ sec. 8, T. 19 N., R. 25 E. It is believed to underlie the Burgen in subsurface throughout the area.

The Cotter Formation, as exposed in northern Adair County, is composed of light-gray, fine-grained, massive-bedded dolomite. A thickness of 11.4 feet is exposed above the water level (fig. 3).

The Cotter Dolomite rests unconformably upon the Spavinaw Granite in eastern Mayes County, Oklahoma, where its thickness is 125 feet (Gore, 1952). In subsurface it has a thickness of 270 feet (Ireland, 1944) and is separated from the basement rock by a maximum of 1,530 feet of Cambrian-Ordovician beds in parts of northeastern Oklahoma. It is overlain unconformably by the Burgen Sandstone in northern Adair County.

The Cotter Formation is sparingly fossiliferous and no recognizable fossils were collected by the writers. Ireland (1930, p. 16)

Figure 3. Burgen Sandstone (Ob) resting unconformably upon the Cotter Dolomite (Oc); Illinois River, NW¼ sec. 8, T. 19 N., R. 25 E.
(Photograph by J. M. Hancock, Jr.)

and Cram (1930, p. 11) listed the forms collected by earlier workers. Upon this basis, they assigned the Cotter to the Lower Ordovician, Canadian Series. The Cotter is believed to be equivalent to the upper part of the Arbuckle Group and is thought to be correlative to the West Spring Creek Formation (Huffman, 1958, p. 20).

BURGEN SANDSTONE

The Burgen Sandstone was named by Taff (1905, p. 2) for exposures in Tooley (Burgen) Hollow, a tributary of the Illinois River in Tps. 17, 18 N., R. 23 E., Cherokee County, Oklahoma. The Burgen crops out in northern Adair County along the Illinois River from sec. 30, T. 19 N., R. 24 E., to sec. 3, T. 19 N., R. 24 E., and in secs. 5-9, T. 19 N., R. 25 E.

Lithologically the Burgen is a white to gray, fine- to medium-grained sandstone. Upon weathering, it oxidizes to a yellow-brown color. It is typically soft and friable except in upper portions, where it is well cemented and resistant. It is slightly calcareous throughout but is more siliceous toward the top. Secondary enlargement of grains, pitting, etching, and frosting are characteristic. Maximum exposed thickness is 75 feet. It typically forms conspicuous cliffs along the Illinois River, and the uppermost beds form resistant ledges over which waterfalls are developed.

The Burgen rests unconformably upon the Cotter and, at places outside this area, fills sinks and caverns in the Cotter surface (Gore, 1952, p. 156-157). The Burgen is sparingly fossiliferous and only a few forms have been collected (Cram, 1930, p. 14). The age of the Burgen has long been a controversial subject, but recent studies by Starke (1961, p. 15) indicate that it correlates with the Oil Creek sandstone of the Arbuckle Mountains section. Subsurface studies by Disney and Cronenwett (1955) and by Schramm (1964) support this conclusion.

TYNER FORMATION

The Tyner Formation was named by Taff (1905, p. 2) for exposures along Tyner Creek near Proctor in western Adair County. As originally defined, the Tyner included all of the strata between the top of the Burgen Sandstone and the base of the Chattanooga Shale. Cram (1930, p. 20-22) removed the upper limestone sequence, assigned these beds to the Fite and Fernvale Formations, and restricted the Tyner to units below the Fite and above the Burgen.

The Tyner crops out along Tyner Creek in sec. 8, T. 17 N., R. 24 E., along Barren Fork in secs. 7-9, 11, 14, 17, T. 17 N., R. 24 E., and in secs. 19, 30, T. 19 N., R. 24 E. The exposures are discontinuous because of minor folding and cover by terrace and alluvial deposits. It is truncated northward by pre-Chattanooga erosion, the northernmost exposure being in sec. 19, T. 19 N., R. 24 E.

The Tyner Formation is composed of soft, green, waxy shales; hard, dolomitic sandstones which grade laterally into sandy dolomites; and tan to buff, thick-bedded, sandy, and locally cherty dolomite. Maximum development of the Tyner is along the Illinois River in eastern Cherokee County where 78.5 feet is exposed and approximately 100 feet is known to be present. The Tyner is incompletely exposed in Adair County where 45.7 feet was measured by Langton (1963, p. 11). The Tyner thins rapidly northward by truncation and only the basal 4 feet is present southwest of Chewey in sec. 30, T. 19 N., R. 24 E. (Hancock, 1963, p. 15).

Stratigraphically the Tyner rests conformably upon the Burgen Sandstone and is succeeded conformably by the Fite Limestone where the latter is present. Elsewhere the Tyner is succeeded unconformably by the Chattanooga Formation.

Cram (1930, p. 16-17) divided the Tyner into three parts: a lower dolomite and green shale, a middle green shale, and an upper cherty, dolomitic limestone.

Taff (1905, p. 2) collected a fauna from the upper part of the Tyner along the Illinois River consisting of *Camarocladia rugosa* Ulrich, *Hesperorthis tricenaria* (Conrad), *Liospira americana* Billings, *Lophospira* cf. *L. perangulata* (Hall), *Hormotoma gracilis* (Whitfield), *Leperditia* cf. *L. fabulites* (Conrad), and *Ceraurus pleurexanthemus* Greene. These are characteristic forms of Blackriveran and early Trentonian age.

The middle Tyner shales are barren of fossils. Dolomite ledges in the lower part of the Tyner (northeastern Cherokee County) yielded a fauna including *Clathrospira* cf. *C. subconica* (Hall), *Hormotoma* sp., *Maclurites* sp., *Pseudomaria nevadensis* (Walcott), *Raphistoma* cf. *R. denticulata* Ulrich, and *Trochonema* cf. *T. umbilicatum* Hall (Starke, 1961, p. 17).

Upon the basis of faunal evidence, the lower part of the Tyner is correlated with the Oil Creek Formation of the Arbuckle Mountains, which also contains *Pseudomaria nevadensis* (Walcott) (Decker and Merritt, 1931, p. 20), a typical Chazyan form. The upper part of the Tyner is believed to be equivalent to part of the Bromide of the Arbuckle Mountains, currently classed as Black-riveran and Trentonian. Schramm (1964, fig. 2) compared the middle part of the Tyner with the McLish Formation.

FITE LIMESTONE

The Fite Limestone, originally included in the upper part of the Tyner by Taff (1905, p. 2), was named by Cram (1930, p. 20) for exposures near the Fite ranch, sec. 11, T. 17 N., R. 22 E., Cherokee County, Oklahoma.

The Fite is exposed in two localities within the area of this report. It crops out in a hollow on the north side of U. S. Highway 62. SW¼ NE¼ sec. 9. T. 17 N., R. 24 E., and along a small creek in SE¼ NW¼ sec. 16, T. 17 N., R. 24 E. (fig. 4). It consists of light-gray, heavy-bedded, compact, lithographic limestone with an exposed thickness of approximately 4 feet. It lies with apparent conformity upon the upper Tyner dolomites and is succeeded unconformably by the Fernvale Limestone or the Chattanooga Formation.

No fossils were collected from the Fite by the authors. Cram

Figure 4. Fite Limestone and overlying Fernvale Formation; north side of small creek, SE¼ NW¼ sec. 16, T. 17 N., R. 24 E.
(Photograph by G. G. Huffman)

upon the Sylamore where that unit is present. The Noel Member is relatively unfossiliferous and no attempt was made to collect a fauna or flora.

The Chattanooga (Noel) shale and its correlatives have been assigned to the Late Devonian and Early Mississippian. Presumably, the Devonian-Mississippian boundary is somewhere within the black shale sequence.

Mississippian System

ST. JOE GROUP

The St. Joe Group in northeastern Oklahoma comprises three fairly well-defined lithic units which are believed to correspond to the Compton, Northview, and Pierson Formations of southwestern Missouri. The term "St. Joe" was originally applied by Hopkins (1893, p. 10) to the basal "Boone" limestones near St. Joe, Arkansas. Taff (1905, p. 5) recognized the St. Joe equivalent in northeastern Oklahoma, and Huffman (1958) extended the three-fold subdivisions of the Missouri section into northeastern Oklahoma.

Figure 6. Lower part of the St. Joe Group (Compton equivalent); Lake Francis dam, NW cor. sec. 17, T. 19 N., R. 26 E.
(Photograph by G. G. Huffman)

Figure 7. Middle shaly part of the St. Joe Group (probable Northview equivalent); Lake Francis dam, NW cor. sec. 17, T. 19 N., R. 26 E.
(Photograph by G. G. Huffman)

Figure 8. Fluted weathering, top of exposure, St. Joe limestone; Lake Francis dam, NW cor. sec. 17, T. 19 N., R. 26 E.
(Photograph by G. G. Huffman)

Figure 9. Reef facies, upper part of St. Joe Group (Pierson equivalent); in bend of road northwest of Lake Francis, SE¼ sec. 7, T. 19 N., R. 26 E. *(Photograph by J. M. Langton)*

Figure 10. Closeup view of reef limestone, upper part of St. Joe Group; in bend of road northwest of Lake Francis, SE¼ sec. 7, T. 19 N., R. 26 E. *(Photograph by G. G. Huffman)*

The St. Joe limestone is present between the Noel Shale and the Reeds Spring Formation throughout most of the area. At places it is thin and locally it is absent. Over most of the area it is concealed by float from the overlying Reeds Spring and Keokuk Formations, and its lateral continuity is difficult to trace. Good exposures occur along a small stream in secs. 6, 7, 18, T. 19 N., R. 24 E.; along the Illinois River near Watts; along the shores of Lake Frances; along Ballard Creek south of Watts; along Tyner Creek northeast of Proctor; along Barren Fork and its tributaries from sec. 7, T. 17 N., R. 24 E., to sec. 11, T. 17 N., R. 24 E.; and southeast of Baron in sec. 36, T. 17 N., R. 25 E., and sec. 31, T. 17 N., R. 26 E. (figs. 6-13).

The lower part of the St. Joe (possible Compton equivalent) is a gray, medium-crystalline, nodular-weathering limestone ranging in thickness from 2.8 feet to 10.3 feet. It is best developed immediately below the dam which impounds Lake Frances (fig. 6). The middle part of the St. Joe (possible Northview equivalent) is a green shaly marlstone which weathers to form a distinctive recess below the overlying heavy-bedded limestone. This shaly zone ranges in thickness from a few inches to approximately 3 feet. It is typically developed at the dam near Watts where it displays its distinctive features (fig. 7). The problem of whether or not this shaly zone

Figure 11. Reef development in the St. Joe limestone; on road north of Illinois River, NW¼ sec. 18, T. 19 N., R. 26 E.
(Photograph by J. M. Hancock, Jr.)

corresponds to the Northview Formation of Missouri and parts of northeastern Oklahoma is as yet unsolved.

The upper part of the St. Joe is a gray, medium- to coarse-crystalline, heavy-bedded limestone which ranges in thickness from a few inches to more than 45 feet (figs. 9-11). It is characterized by numerous moundlike masses of fossiliferous limestone ranging from biomicrite to biosparrudite in texture (Hancock, p. 24; fig. 12 of this report). The flank facies tend to be thinner bedded than the

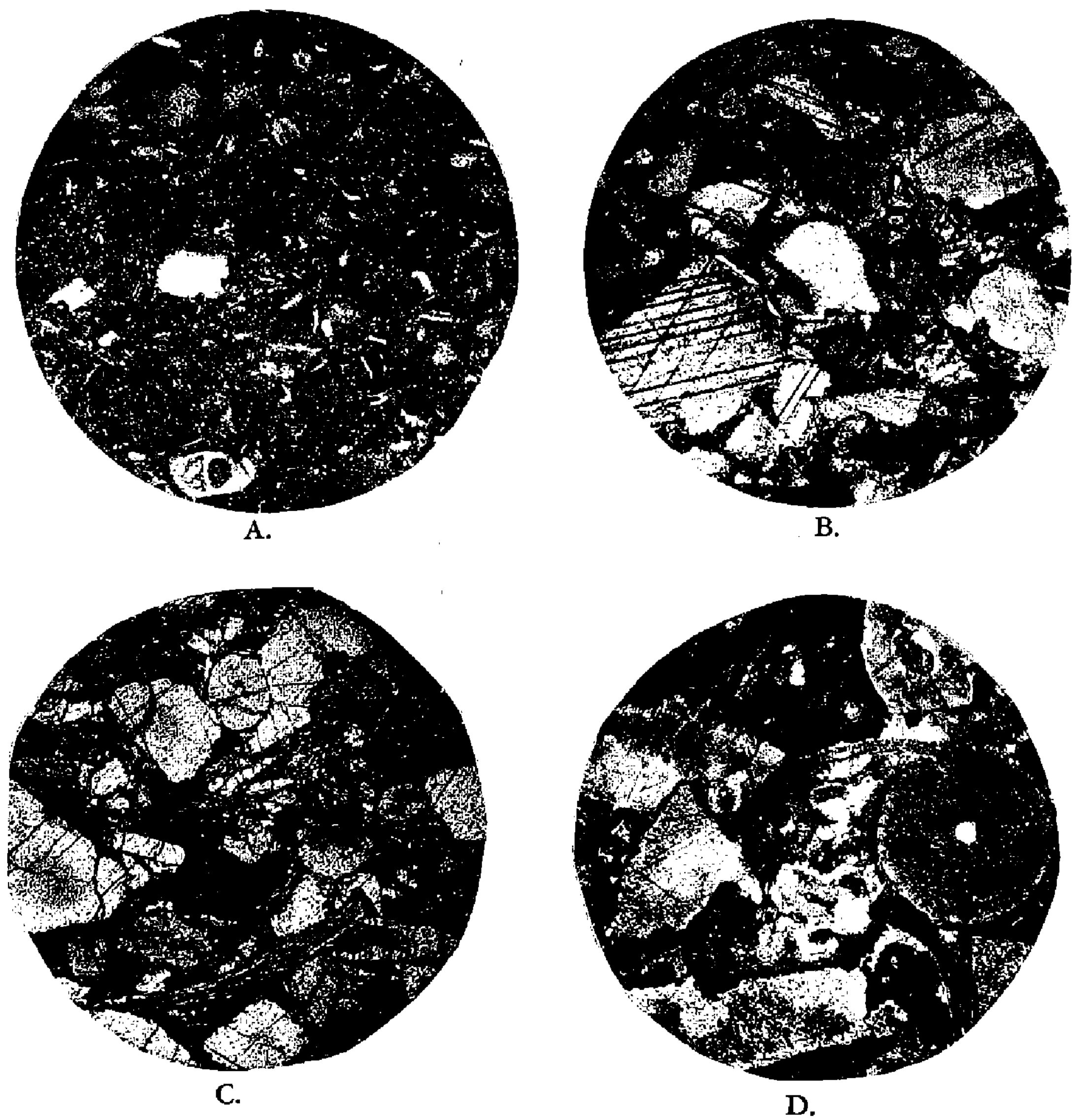

Figure 12. Photomicrographs of St. Joe reef-facies rocks from exposure shown in figure 11; NW¼ sec. 18, T. 19 N., R. 26 E. Magnification is x25.7.

A. Crinoidal biomicrite from base of section.
B. Crinoidal biosparite from 8 feet above base of section.
C. Crinoidal biosparite from 14 feet above base of section.
D. Crinoidal biosparrudite from 26 feet above base of section.

(Photographs by T. L. Rowland; from Hancock, 1963)

core area and to thin by convergence of the individual beds, giving a domal structure which is reflected in overlying units (fig. 13).

Diagnostic fossils from the upper part of the St. Joe have been listed by Laudon (1939, p. 327) and Starke (1961, p. 30). Some of the more abundant forms are *Athyris lamellosa* Leveille, *Brachythyris suborbicularis* (Hall), *"Chonetes" glenparkensis* Weller, *Cliothyridina prouti* (Swallow), *Marginatia fernglenensis* (Weller), *Leptaena analoga* Phillips, *Punctospirifer subellipticus* (McChesney), *Rhipidomella oweni* Hall and Clarke, *Rhynchopora rowleyi* Weller, *Spirifer grimesi* Hall, *Spirifer rowleyi* Weller, *Platyceras paralius* Weller and Weller, *Actinocrinites* sp., *Schizoblastus moorei* Cline, and *Phillipsia sampsoni* Vogdes (from Starke, 1961, p. 30).

The upper limestone unit of the St. Joe is tentatively assigned to the Pierson Formation and classed as basal Osagean, Fern Glen, in age. The lower units are believed to represent Compton and Northview equivalents of Kinderhookian age.

REEDS SPRING FORMATION

The term "Reeds Spring" was applied by Moore (1928, p.

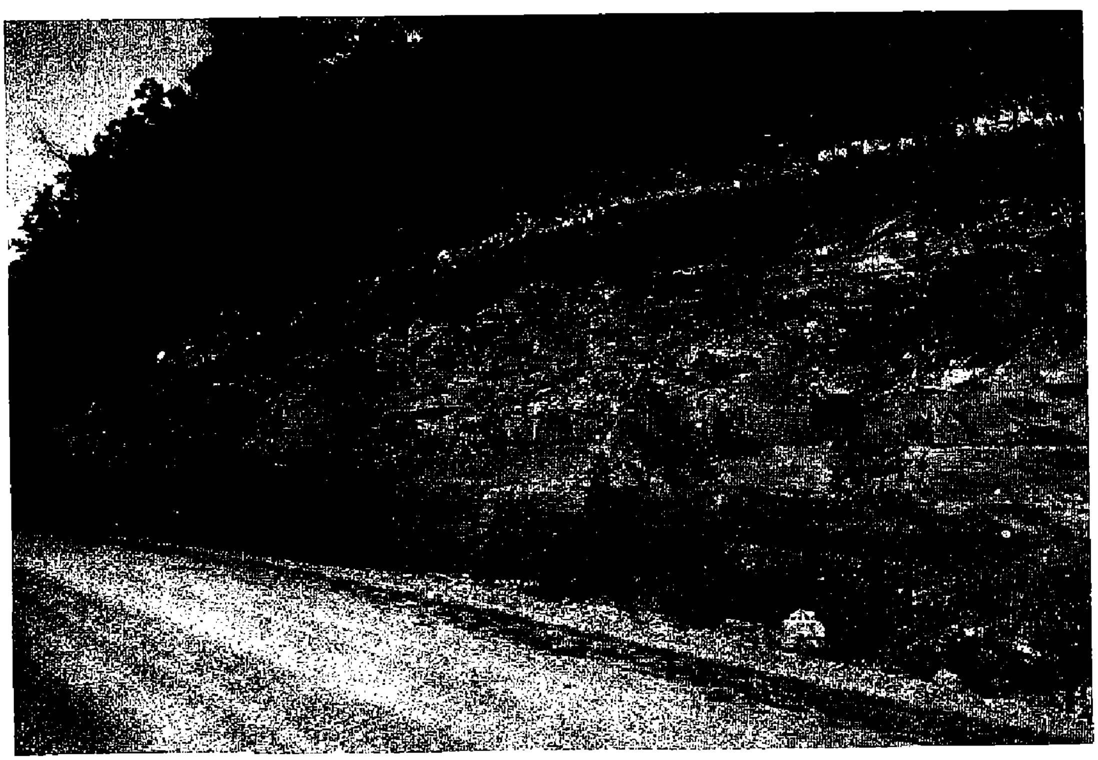

Figure 13. Reef facies of the St. Joe Group (Msj) overlain by Reeds Spring chert (Mrs); sec. 21, T. 18 N., R. 24 E.
(Photograph by G. G. Huffman)

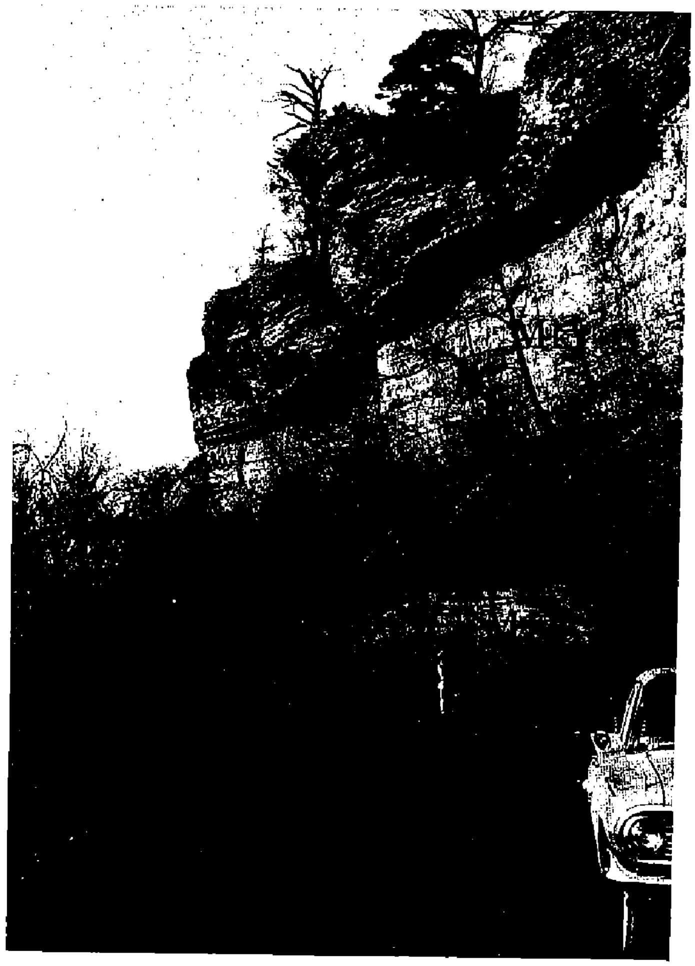

Figure 14. Reeds Spring Formation (Mkr) and the Chattanooga shale (MDc); in bluff along the road east of a bend in the Illinois River, SW¼ sec. 16, T. 19 N., R. 24 E. (St. Joe limestone is present but concealed).
(Photograph by J. M. Hancock, Jr.)

190) to exposures near Reeds Spring in southwestern Missouri. It was given formational rank by Cline (1934, p. 1141).

The Reeds Spring Formation is widespread throughout the area and occurs along the lower part of the bluffs where erosion has cut through the overlying Keokuk chert. Separation of the Reeds Spring and Keokuk Formations for mapping purposes is difficult because the contact is at most places covered by chert rubble.

The Reeds Spring Formation consists of dark, blue-gray, thin-bedded, fine-grained limestone interbedded with thin layers of gray to blue-gray chert. Thickness of individual beds ranges from a few inches to nearly 1 foot. The formation is resistant to erosion and forms nearly vertical to overhanging cliffs. Thickness ranges from 100 to 150 feet in the Illinois River area. It lies unconformably upon the St. Joe limestone and is succeeded unconformably by the Keokuk chert (figs. 14, 15).

Fossils are extremely rare in the Reeds Spring of northeastern Oklahoma and no identifiable forms were collected in northern Adair County. The unit is abundantly fossiliferous at the type locality in southwestern Missouri, where Cline (1934, p. 1144-1145) collected an extensive fauna. Cline (1934, p. 1144-1145) and Laudon (1939, p. 328) listed forms collected by Cline from northeastern Oklahoma. These include *Marginatia fernglenensis* (Weller), *Favosites valmeyerensis* (Weller), *Schizophoria poststriatula* (Weller), *Spirifer carinatus* Rowley, and *Unispirifer vernonensis* (Swallow).

Upon the basis of fauna, the Reeds Spring has been assigned to the Osagean and correlated with the upper part of the Fern Glen Formation.

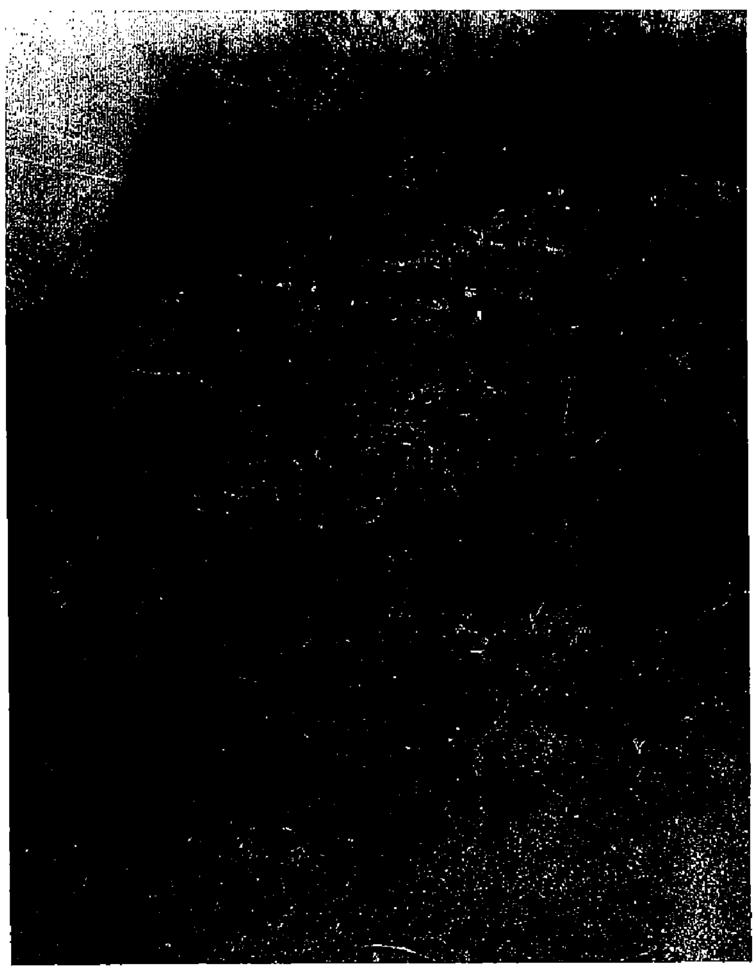

Figure 15. Chattanooga (MDc), St. Joe (Msj), and Reeds Spring (Mkr); along U. S. Highway 62, W½ sec. 11, T. 17 N., R. 24 E.
(Photograph by G. G. Huffman)

KEOKUK FORMATION

The Keokuk Limestone was named by Owen (1852, p. 91) from exposures near Keokuk, Iowa. Snider (1915) recognized fossils of Keokuk age in northeastern Oklahoma and Girty (1915, p. 5) noted that the Boone of Arkansas ranges from Fern Glen to Keokuk in age. Moore (1928, p. 207) extended the term "Keokuk" into southwestern Missouri and Laudon (1939, p. 329) applied the term to beds above the Reeds Spring in northeastern Oklahoma.

The Keokuk Formation forms the surface rock in approximately 90 percent of northern Adair County. Its top is extensively eroded and the true depositional thickness is unknown.

The Keokuk consists of massive, white to buff, gray-mottled, fossiliferous chert. Irregular stringers and masses of blue-gray, dense, finely crystalline limestone are present locally. The formation is characterized by its brittleness and brecciated character. It weathers tripolitic and locally is iron stained.

Thickness ranges from 50 to 70 feet, the upper portion having been removed by erosion over most of the area. The unit rests unconformably upon the Reeds Spring and is succeeded in scattered outliers by Moorefield and Hindsville, which rest upon the post-Keokuk surface with unconformity.

Keokuk cherts are highly fossiliferous, the forms preserved mainly as molds and casts. The fauna consists largely of corals, bryozoans, and brachiopods. Some of the more abundant forms are *Amplexizaphrentis, Neozaphrentis, Auloprotonia? crawfordsvillensis* (Weller), *Spirifer keokuk* Hall, *Spirifer logani* Hall, *Spirifer mortonanus* Miller, *Spirifer montgomeryensis* Weller, *Tetracamera subtrigona* (Meek and Worthen), *Torynifera pseudolineata* Hall, and *Werriea (Orthotetes) keokuk* (Hall).

The Keokuk Formation of northeastern Oklahoma and northern Adair County is correlated with the type Keokuk Formation of Iowa.

MOOREFIELD FORMATION

The term "Moorefield" was proposed by Adams (1904, p. 26) for beds between the Boone Chert and the Batesville Sandstone at Moorefield, Arkansas. Gordon (1944, p. 1629) restricted the term "Moorefield" to the lower limestone portion of this sequence and applied the term "Ruddell" to the overlying shales formerly referred to as the Moorefield Shale.

Huffman (1958, p. 49) divided the Moorefield of northeastern Oklahoma into four facies of member rank: the lower, glauconitic limestone or Tahlequah Member; the argillaceous Bayou Manard Limestone Member; the chert-pebble calcarenite, or Lindsey Bridge Member; and the Ordnance Plant Siltstone and Shale Member.

The Moorefield Formation is thin and poorly preserved in northern Adair County, being present at the bases of isolated outliers in the eastern portion and in the Baron graben. Three of the four members, Bayou Manard, Lindsey Bridge, and Ordnance Plant, have been identified.

Bayou Manard Member. — The Bayou Manard Member crops out on the northern end of Walkingstick Mountain, secs. 28, 33, T. 17 N., R. 25 E.; at the base of Snake Mountain, sec. 27, T. 17 N., R. 26 E.; near Baron in secs. 25, 26, 35, T. 17 N., R. 25 E.; on the east side of West Alberry Mountain, secs. 5, 8, 9, T. 17 N., R. 26 E.; on the southwest side of Baptist Mission Mountain, sec. 24, T. 18 N., R. 25 E.

The Bayou Manard Member consists of gray to black, thin-bedded, silty limestone which emits a strong bituminous odor when freshly broken. Nodular chert is present locally. Thickness ranges from 0 to 30 feet. It rests unconformably upon Keokuk chert (fig. 16).

Fossils characteristic of the Bayou Manard Member include *Auloprotonia aulacophora* Muir-Wood and Cooper, *Leiorhynchus carboniferum* Girty, *Moorefieldella eurekensis* (Walcott), *Ovatia elongata* Muir-Wood and Cooper, *Orbiculoidea newberryi* (Girty), *Spirifer arkansanus* Girty, *Aviculopecten batesvillensis* (Weller), and *Shansiella* sp.

Lindsey Bridge Member. — The Lindsey Bridge Member is limited in distribution to the east side of Walkingstick Mountain in sec. 33, T. 17 N., R. 25 E., and to sec. 26, T. 17 N., R. 25 E., along Barren Fork. There it consists of approximately 6 feet of gray, medium-crystalline, slightly cross-bedded calcarenite containing angular fragments of white, tan, and blue-gray chert.

The fauna includes *Camarotoechia purduei* Girty, *Composita subquadrata* (Hall), *Diaphragmus cestriensis* (Worthen), *Flexaria arkansana* (Girty), *Kozlowskia adairensis* (Drake), *Leiorhynchus carboniferum* Girty, *Moorefieldella eurekensis* (Walcott), *Ovatia elongata* Muir-Wood and Cooper, and *Spirifer* aff. *S. increbescens* Hall.

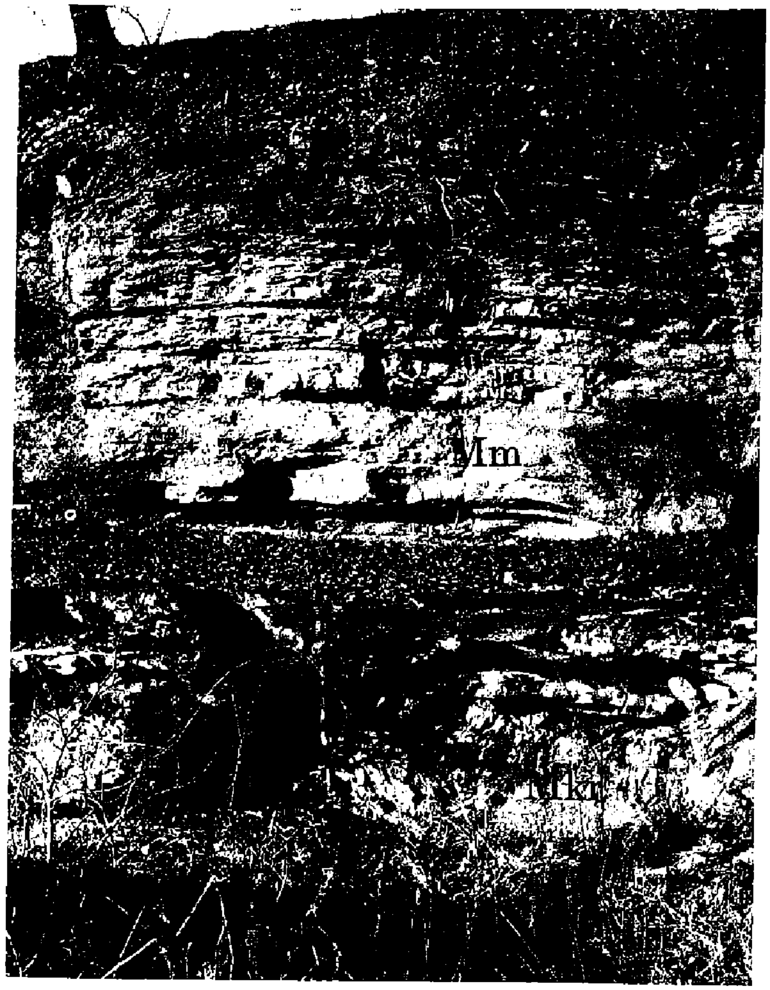

Figure 16. Moorefield Limestone (Mm) resting unconformably upon Keokuk chert (Mkr); in ravine south of Baron, SW¼ sec. 25, T. 17 N., R. 25 E.
(Photograph by G. G. Huffman)

Ordnance Plant Member. — The Ordnance Plant Member is limited to one exposure along Barren Fork, sec. 26, T. 17 N., R. 25 E. Elsewhere in the area it has been removed by pre-Hindsville erosion.

Along Barren Fork south of Baron, the Ordnance Plant Member includes a maximum of 9 feet of yellow-green, platy siltstone of which only the lower beds are well exposed. It is characterized by an abundance of *Leiorhynchus carboniferum* Girty, *Aviculopecten batesvillensis* (Weller), *Camarotoechia purduei* Girty, and *Echinoconchus alternatus* (Norwood and Pratten).

The Bayou Manard and Lindsey Bridge Members are considered equivalent to the Moorefield of Arkansas (restricted) and the Ordnance Plant Member is correlated with the Ruddell Shale of Arkansas. These beds correlate with the Ahloso and Delaware Creek

Members of the Caney Shale of the northern Arbuckles and are classed as Meramecian in age.

HINDSVILLE FORMATION

The Hindsville Limestone was named by Purdue and Miser (1916, p. 12) for exposures near Hindsville, Arkansas, where it was considered a basal calcareous facies or member of the Bateville Formation. The Hindsville was given formational rank in Oklahoma by Reed, Schoff, and Branson (1955, p. 57). The term "Hindsville" replaces the "Grand River" (preoccupied) of Brant (1941, p. 31) for rocks of early Chesterian age in Oklahoma.

The Hindsville is limited in distribution to a few small outliers in the eastern and southern parts of the area. These include: the South Christie graben, secs. 25, 26, 35, T. 17 N., R. 24 E.; Walkingstick Mountain, secs. 28, 32, 33, T. 17 N., R. 25 E.; in the Baron graben in secs. 25, 26, 34, 35, T. 17 N., R. 25 E.; at the base of Snake Mountain, sec. 27, T. 17 N., R. 26 E.; on Alberry Mountains, secs. 4, 5, 8, 9, T. 17 N., R. 26 E.; Baptist Mission Mountain, secs. 13, 24, T. 18 N., R. 25 E., and secs. 18, 19, T. 18 N., R. 26 E.; on

Figure 17. Hindsville Limestone (Mh) resting unconformably upon Keokuk chert (Mkr); NE¼ sec. 6, T. 18 N., R. 26 E.
(Photograph by G. G. Huffman)

Bates Mountain, secs. 16, 21, T. 18 N., R. 26 E., and in sec. 6, T. 18 N., R. 26 E. (fig. 17).

The Hindsville is gray, medium-crystalline, fossiliferous, thick-bedded, oölitic, locally shaly limestone. It weathers to a soft, gray, crumbly limestone which yields abundant fossils. Thickness ranges from 10 to approximately 30 feet. It rests unconformably upon the Moorefield and Keokuk Formations, and, where in contact with the Keokuk chert, a basal conglomerate is locally present.

The unit is highly fossiliferous. Typical forms include *Agassizocrinus, Brachythyris ozarkensis* (Snider), *Camarotoechia purduei* Girty, *Composita subquadrata* (Hall), *Diaphragmus cestriensis* (Worthen), *Beecheria arkansana* (Weller), *Flexaria arkansana* (Girty), *Inflatia inflata* (McChesney), *Kozlowskia adairensis* (Drake), *Ovatia elongata* Muir-Wood and Cooper, *Spirifer increbescens* Hall, and *Spirifer leidyi* Norwood and Pratten.

The Hindsville Formation is classed as early Chesterian and is correlated with the Hindsville-Batesville sequence of Arkansas.

FAYETTEVILLE FORMATION

The Fayetteville Formation was named by Simonds (1891) for exposures near Fayetteville, Washington County, Arkansas. In extreme eastern Oklahoma and in Arkansas, the Wedington Sandstone Member (named by Adams, 1904) occurs in the upper part of the Fayetteville Formation.

The Fayetteville is present in the South Christie graben, secs. 25, 26, 35, T. 17 N., R. 24 E.; in the Baron graben, secs. 24, 25, 26, 34, 35, T. 17 N., R. 25 E.; on Walkingstick Mountain, secs. 32, 33, T. 17 N., R. 25 E.; on Snake Mountain, sec. 27, T. 17 N., R. 26 E.; on Alberry Mountains, secs. 4, 5, 8, 9, T. 17 N., R. 26 E.; on Baptist Mission Mountain, secs. 13, 24, T. 18 N., R. 25 E., and secs. 18, 19, T. 18 N., R. 26 E.; and on Bates Mountain, sec. 21, T. 18 N., R. 26 E.

Thickness of the Fayetteville ranges from 125 to 200 feet, reaching a maximum of 200 feet on Baptist Mission Mountain in secs. 13, 24, T. 18 N., R. 25 E. (figs. 18, 19). There the lower 150 feet consists of black, fissile, unfossiliferous shale. The upper 50 feet is occupied mainly by the Wedington Member, a brown to buff, thin-bedded, iron-stained sandstone. The Wedington Sandstone Member is a tongue which enters Oklahoma from the east and thins

Figure 18. Fayetteville Shale; roadcut two miles north of Westville along U. S. Highway 59, SE¼ sec. 24, T. 18 N., R. 25 E.
(Photograph by G. G. Huffman)

Figure 19. Small-scale faulting in the Fayetteville Shale (Mf); roadcut along U. S. Highway 59, SE¼ sec. 24, T. 18 N., R. 25 E. Note thin bed of Wedington Sandstone (Mfw) near upper right.
(Photograph by G. G. Huffman)

a small hill in sec. 35, T. 17 N., R. 24 E. It is preserved in the South Christie graben, sec. 35, T. 17 N., R. 24 E., and in Baron graben, sec. 35, T. 17 N., R. 25 E.

The unit is characteristically a massive, medium-grained, cross-bedded, calcareous sandstone which weathers with pitted and fluted surface. It is resistant and forms a cliff capping "post-Boone" outliers. At places it grades both laterally and vertically into a gray-brown, fine- to medium-crystalline, crinoidal limestone. It attains a thickness of 52.5 feet on Baptist Mission Mountain, where it reaches its maximum development in the area (figs. 20, 21).

The Hale unconformably overlies the Pitkin and older formations. It is the youngest rock exposed in northern Adair County. Southward and westward it is succeeded conformably by the Bloyd Formation. It is classed as Early Pennsylvanian in age (Morrowan Series) and is correlated with the Primrose Sandstone of the Ardmore basin. No fossils were collected from the Hale in this area, and the reader is referred to Huffman (1958, p. 78-79) for a faunal listing.

Quaternary System

TERRACE DEPOSITS AND ALLUVIUM

Extensive deposits of alluvium and terrace materials occur along all of the major drainage lines, especially Barren Fork and the Illinois River. The terrace deposits are composed of well-rounded chert gravels and reach a maximum thickness of 40 feet. Several of the smaller towns, such as Chewey, Proctor, and Baron, are located on the terrace.

The contact of the terrace and the adjoining bedrock is characteristically masked by varying thicknesses of colluvium which make the exact contact difficult to locate. Locally the terrace deposits are marked by "pimple mounds," small, rounded, hemispherical mounds of uncertain origin.

STRUCTURE

General Regional Structure

Northern Adair County lies in the Ozark Plateau on the southwestern end of the Ozark uplift. The rocks dip gently southward and are interrupted by gentle folds and faults which trend northeastward parallel to the axis of the Ozark uplift. The streams are well adjusted to the structure and parallel the northeastward-trending faults and a northwestward-trending set of joints.

Structural features in northern Adair County are part of a major structural pattern which prevails throughout the Oklahoma Ozark area. Pre-Chattanooga units were tilted southward and truncated by erosion prior to deposition of the Chattanooga Formation. Post-Keokuk uplift and subsequent erosion produced a surface of considerable relief, upon which the Moorefield and younger beds were deposited. Southward tilting in pre-Hale time is shown by the northward truncation of the Pitkin Limestone, which is present only in the southeastern corner of the area. Post-Hale beds were removed by erosion.

The principal northeastward-trending faults and folds underwent their deformation in Middle Pennsylvanian (Desmoinesian) time. The faults extend into the basement rock, and many of these are believed to represent Pennsylvanian movement along earlier lines of fracture in the Precambrian basement. Isostatic adjustment between the Arkoma basin to the south and the more positive Ozark uplift created a set of stresses which resulted in normal faulting. Associated folds are a combination of drag against the faults and differential compaction and adjustment over basement-rock structures.

Local Structures

Baron graben. — The Baron graben is bounded on the northwest and southeast by normal gravity faults. These enter the area in secs. 34, 35, T. 17 N., R. 25 E., and continue northeastward for at least 3 miles. Drainage trends and microfaulting suggest a northeastward extension of the northwest fault into sec. 7, T. 17 N., R. 26 E.; the southeastern fault intersects the northwestern in sec. 24, T. 17 N., R. 25 E. Moorefield, Hindsville, Fayetteville, and Hale Formations are downdropped between the two faults with Keokuk chert on either side. Immediately south of the area, in sec. 2, T. 16

N., R. 25 E., dips on the Hale Formation reach 75 degrees along the east side of the graben. Calculated stratigraphic throw is 150 feet.

South Christie graben (new). — The South Christie graben was recognized by Langton (1963, p. 48). The gravity faults which bound the graben enter the area in sec. 34, T. 17 N., R. 24 E., and strike northeastward, disappearing beneath the alluvium of a small stream in sec. 25, T. 17 N.. R. 24 E. Hindsville, Fayetteville, and Hale Formations are wedged between the two faults with Reeds Spring and Keokuk on both sides. Estimated stratigraphic throw is 180 feet.

West Christie gravity faults (new). — Two small gravity faults were mapped and described by Langton (1963, p. 49) west of the small town of Christie. The easternmost fault passes through secs. 23, 14, 12, T. 17 N., R. 24 E., bringing the Tyner, Chattanooga, and St. Joe to rest against the Keokuk-Reeds Spring with an estimated displacement of 70 feet. The westernmost fault trends northeastward through secs. 2, 11, T. 17 N., R. 24 E., bringing the Chattanooga and St. Joe against the Keokuk-Reeds Spring along a small stream.

Proctor dome (new). — The Proctor dome is an elliptical uplift near Proctor, in sec. 8, T. 17 N., R. 24 E. This gentle anticlinal uplift brings the Tyner Formation to the surface. A magnetic survey (Norden and Langton, 1963) indicated a magnetic "high" in the area, suggesting that the basement rock is relatively shallow.

Courthouse Creek fracture zone. — The northeastward trend of Courthouse Creek (from sec. 13, T. 17 N., R. 24 E., to sec. 13, T. 18 N., R. 25 E.) and the presence of minor displacement along this trend suggest that a major fracture zone extends the full length of Courthouse Creek.

Miscellaneous faults and folds. — A minor fault in sec. 6, T. 18 N., R. 26 E., brings the Hindsville Limestone down against the Keokuk chert. This fault is in line with the Courthouse Creek fracture zone and may be an extension of that feature.

A minor uplift along Barren Fork, in secs. 25, 36, T. 17 N., R. 25 E., and in sec. 31, T. 17 N., R. 26 E., brings the Chattanooga Formation to the surface.

The Cotter Dolomite is brought to the surface along the Illinois River, in sec. 8, T. 19 N., R. 25 E. The small fold has a northeastward trend and its axis extends through secs. 5, 8, 7, T. 19 N., R. 25 E.

A small northeastward-trending anticline brings the Burgen Sandstone to the surface in secs. 9, 17, T. 19 N., R. 25 E.

Differential compaction of beds overlying bioherms in the St. Joe forms small domal uplifts, the presence of which has been detected by magnetic-intensity surveys.

ECONOMIC GEOLOGY

The prospects for oil and gas in the Ozark uplift were summarized by Cram (1930), Ireland (1930), and Huffman (1958). Although minor shows of oil and gas have been detected in water wells, the prospects for major production are believed unfavorable. Potential structures, source rocks, and reservoir rocks are all present, but the shallow depth, the abundant jointing and fracturing, and the fact that most of the reservoir rocks crop out at the surface lead one to believe that commercial production is unlikely. A well drilled by Adair Oil and Gas Company several years ago in sec. 32, T. 19 N., R. 25 E., reached the granite basement at 1,395 feet and found no shows of oil and gas.

Northern Adair County has abundant water supplies, both in surface streams and in underground sources. Numerous springs occur throughout the area at the contact of the Mississippian chert and limestone section and the underlying Chattanooga (Noel) Shale. The fractured nature of the Mississippian cherts and limestones precludes natural filtration and any water from these springs should be analyzed for purity. The Burgen Sandstone is believed to carry abundant supplies of fresh water in subsurface. Shallow water supplies are found in the terrace gravels but the amount of available water there is small.

The area is endowed with abundant stone. The crinoidal reefs in the St. Joe offer a possible source of high-purity lime. Cobbles of Keokuk chert are used for facing homes and buildings. The Moorefield and Hindsville Limestones could be used for limestone aggregate, and the Hale and Wedington Sandstones offer possible sources of building stone.

Unlimited supplies of rounded chert gravels are available from terrace deposits along Barren Fork, Tyner Creek, Courthouse Creek, and Shell Branch and locally along the Illinois River. The black shales of the Chattanooga and Fayetteville could be used for inexpensive road material.

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APPENDIX

Measured Sections

1. ***Reeds Spring, St. Joe, and Chattanooga.*** **Along U. S. Highway 62, W½ sec. 11, T. 17 N., R. 24 E. (Langton, 1963, p. 70).**

	Thickness (feet)
Mississippian:	
Reeds Spring:	
Chert and limestone sequence measured only to top of bluff	39.5
St. Joe:	
Limestone, medium-crystalline, pyritic, light-gray; several broken crinoid stems	2.1
Chattanooga:	
Noel Member:	
Shale, black, fissile, pyritic; cone-in-cone structure common; base covered	41.25

2. ***Reeds Spring, St. Joe, Chattanooga, Fite, and Tyner.*** **On U. S. Highway 62, W½ NE¼ sec. 9, T. 17 N., R. 24 E. (Langton, 1963, p. 70).**

	Thickness (feet)
Mississippian:	
Reeds Spring:	
Chert and limestone sequence; not measured	
St. Joe:	
Limestone, crystalline; several broken crinoid stems; not measured	
Chattanooga:	
Noel Member:	
Shale, black, fissile, pyritic	48.0
Ordovician:	
Fite:	
Limestone, lithographic, light-gray; calcite specks and streaks	1.4
Tyner:	
Dolomite, sandy; buff to dark gray at bottom	0.5
Dolomite, gray, calcareous, dense, hard, massive	0.3
Sandstone fine-grained, buff to gray and green; medium- to well-rounded sand grains throughout; shaly toward bottom	10.5
Shale, dark-green, sandy; brittle and hard toward bottom	2.5
Sandstone, salt and pepper, white to buff; weathers brown	1.3

	Thickness (feet)
Shale, dark-green, sandy, soft	0.6
Shale, light-green, sandy, soft; mostly covered; hard toward base; weathers into minute pieces	21.0
Sandstone, yellow to brown; many interbedded layers of white, hard, sandstone; grades into overlying shale	2.2
Shale, soft, dark-green; base covered	6.7

3. ***Chattanooga and Tyner.*** **Along Tyner Creek north of U. S. Highway 62, E½ NE¼ sec. 8, T. 17 N., R. 24 E. (Langton, 1963, p. 72).**

	Thickness (feet)
Mississippian:	
Chattanooga:	
Noel Member:	
Shale, black, fissile, pyritic; sparsely covered	31.1
Sylamore Member:	
Sandstone, hard, coarse-grained, white to yellow, salt and pepper; frosted grains	3.4
Ordovician:	
Tyner:	
Covered interval	3.5
Sandstone, dolomitic, buff to white, medium-grained, moderately hard	4.6
Sandstone, green to white, shaly, medium- to fine-grained; frosted sand grains	1.75
Shale, soft, green; mostly covered to base	26.25

4. ***Fite, Fernvale, and Chattanooga.*** **Along small creek, SE¼ NW¼ sec. 16, T. 17 N., R. 24 E. Measured by G. G. Huffman, 1964.**

	Thickness (feet)
Mississippian-Devonian:	
Chattanooga (Noel):	
Shale, black, fissile, pyritic; poorly exposed between road and creek. Contact with Fernvale not exposed	4.0
Ordovician:	
Fernvale:	
Limestone, dark-gray, coarsely crystalline; fossiliferous, with *Lepidocyclus;* base has pebbles of underlying Fite Limestone	1.25
Fite:	
Limestone, light-gray, lithographic; with thin streaks of brown, silty dolomite; in two heavy ledges	2.75
Limestone, light-gray, lithographic; in one heavy ledge	1.3

	Thickness (feet)
Tyner:	
Dolomite, buff, fine-grained; with splotches of gray, lithographic limestone; in one heavy ledge (may be lower Fite)	1.3

Base of exposure in creek bed

5. ***Reeds Spring, St. Joe, and Chattanooga.*** **Along Barren Fork south of Baron, SW¼ sec. 25, T. 17 N., R. 25 E. (Langton, 1963, p. 73).**

	Thickness (feet)
Mississippian:	
Reeds Spring:	
Chert and limestone sequence; thickness estimated	75.0
St. Joe:	
Limestone, crystalline, light-gray; several broken crinoid stems	1.4
Chattanooga:	
Noel Member:	
Shale, clayey, light-gray; with some iron staining	0.2
Shale, black, fissile, pyritic; some cone-in-cone structure present; base covered	13.7

6. ***Hindsville, Moorefield, and Keokuk.*** **Along east flank of Baron graben, sec. 25, T. 17 N., R. 25 E. (Slocum, 1955, p. 31).**

	Thickness (feet)
Mississippian:	
Hindsville:	
Limestone, gray, crystalline, thin-bedded; forms bench around hillside	5.5
Covered	4.0
Limestone, gray, thin-bedded, fossiliferous, crystalline	5.0
Covered	2.0
Moorefield:	
Bayou Manard Member:	
Limestone, gray, finely crystalline; contains brown, nodular chert "stringers"; weathers gray	2.5
Limestone, gray, finely crystalline, thin-bedde dto platy; weathers brownish gray	1.0
Covered	0.5
Limestone, gray, finely crystalline, hard, unfossiliferous; nodular chert in lower 8 feet; weathers light gray	1.5
Limestone, black, finely crystalline, hard, massive-bedded, petroliferous; weathers gray	8.0
Covered	2.0

	Thickness (feet)
Limestone, dark-gray, thin-bedded, finely crystalline; weathers brownish gray	0.5
Covered	1.0
Limestone, gray, sublithographic, hard, massively bedded; thin, platy, unfossiliferous 2-inch bed near middle of sequence	5.0
Limestone gray, argillaceous, platy, petroliferous; weathers gray	1.5
Limestone, black, lithographic; bituminous odor; jointed brown chert nodules near bottom; weathers gray	3.5
Covered	2.5
Keokuk:	
Chert, gray to white, massive, iron-stained. Not measured	

7. ***Hindsville, Moorefield, and Keokuk.*** **Barren Fork, sec. 26, T. 17 N., R. 25 E. (Slocum, 1955, p. 40-41).**

	Thickness (feet)
Mississippian:	
Hindsville:	
Limestone, dark-gray, massive, crystalline, crinoidal, fossiliferous; weathers light gray	5.5
Moorefield:	
Ordnance Plant Member:	
Siltstone, brown; weathers brown; shaly weathering	0.8
Limestone, dark-gray, silty to finely crystalline, hard; fossiliferous, with abundant *Leiorhynchus carboniferum* and *Echinoconchus alternatus;* weathers brownish gray	1.0
Covered	1.0
Limestone, brown, silty; contains same fossils as siltstone below; weathers brown; rubbly weathered surface; may be slumped slightly	1.25
Siltstone, brown, calcareous; platy weathering; brown weathered surface; abundantly fossiliferous, with *Allorisma walkeri, Leiorhynchus carboniferum, Aviculopecten batesvillensis,* and *Spirifer increbescens*	4.5
Limestone, black, thin-bedded, lithographic, platy, unfossiliferous; weathers brown	0.5
Lindsey Bridge Member:	
Limestone, gray, medium-crystalline, thin-bedded; weathers gray; contains angular reddish-brown chert fragments; fossiliferous, with *Ovatia elongata, Spirifer increbescens,* and crinoids	2.2
Covered	2.0
Limestone, gray, massive-bedded; weathers brownish gray; rough crinoidal surface; contains angular chert fragments	2.0

	Thickness (feet)
Bayou Manard Member:	
Covered	2.0
Limestone, gray, massive, hard, finely crystalline; thin shaly partings between thicker limestone beds; contains weathered chert nodules and "stringers"; weathers light gray; fossiliferous, with *Ovatia elongata* and *Spirifer increbescens*	14.0
Covered (includes base of argillaceous member)	6.0
Keokuk:	
Chert, white to gray, iron-stained, highly fractured; not measured	

8. ***Hale, Fayetteville, Hindsville, and Keokuk.*** **North end of Walkingstick Mountain, sec. 33, T. 17 N., R. 25 E. (Slocum, 1955, p. 33).**

	Thickness (feet)
Pennsylvanian:	
Hale:	
Sandstone, brown, medium-grained, massive, unfossiliferous, noncalcareous; fluted surface; weathers reddish-brown; alternating dark and light bands, not thought to be lamination; provides large amount of float	33.5
Limestone, gray-green, granular; jasperoid particles; fossiliferous with abundant crinoid and small brachiopod fragments; rubbly	5.0
Mississippian:	
Fayetteville:	
Covered; mapped as Wedington Sandstone and Fayetteville Shale	123.0
Hindsville:	
Limestone, gray, crystalline, rather thin-bedded, crinoidal, limonitic; weathers brownish gray; forms bench around hillside; lies unconformably upon the Keokuk surface	11.0
Keokuk:	
Chert, buff, pitted, iron-stained; angular surface; not measured	

9. ***Fayetteville and Hindsville.*** **Southeast of Westville, south side sec. 5, T. 17 N., R. 26 E. (Slocum, 1955, p. 32).**

	Thickness (feet)
Mississippian:	
Fayetteville:	
Sandstone, brown to reddish-brown, thinly laminated, hard, very fine-grained; weathers to thin "slabs"; brown-weathered surface	25.0

	Thickness (feet)
Shale, black, fissile, carbonaceous, unfossiliferous, jointed, iron-stained; with black, lithographic, septarian limestone concretions	140.0
Hindsville:	
Limestone, dark-gray, crystalline, hard, crinoidal, thin-bedded, limonitic; weathers brownish gray; fossiliferous, with *Diaphragmus cestriensis, Composita subquadrata,* and *Fenestrellina* sp.; forms bench around hillside	28.0
Covered; not measured	

10. ***Reeds Spring, St. Joe bioherm, and Chattanooga.*** **W½ SE¼ sec. 21, T. 18 N., R. 24 E. (Langton, 1963, p. 77).**

	Thickness (feet)
Mississippian:	
Reeds Spring:	
Chert and limestone sequence; not measured	
St. Joe:	
Shale, green to black; iron-stained at top	0.2
Shale, reddish-brown, iron-stained; grades downward into reddish-brown clay	0.3
Shale, black, iron-stained; weathers into small pieces	0.1
Shale, dark-gray; almost a clay	0.1
Clay, red, iron-stained; strongly weathered	0.5
Limestone, gray, strongly pyritic, crinoidal; weathers light gray; few brachiopods present; central portion almost a coquina	13.1
Shale, marly, light gray-green; nodular weathering	1.7
Limestone, crinoidal, light-gray, crystalline, pyritic, relatively hard; few brachiopods present; base covered	3.3
Chattanooga:	
Noel Member:	
Shale, black, pyritic, fissile; base covered	17.75

11. ***Hale, Fayetteville, and Hindsville.*** **Baptist Mission Mountain, NE¼ sec. 24, T. 18 N., R. 25 E. (Hancock, 1963; Langton, 1963).**

	Thickness (feet)
Pennsylvanian:	
Hale:	
Sandstone, massive, white to brown, calcareous; weathers pitted and fluted	52.5
Mississippian:	
Fayetteville:	
Clay, white to gray, iron-stained	0.3
Sandstone, tan, laminated	10.5

	Thickness (feet)
Shale, brown, sandy, clayey	0.7
Sandstone, buff to tan; and shale, black, fissile; mostly covered	140.3
Shale, black, fissile, jointed, iron-stained; septarian concretions	31.0
Covered interval	21.9
Hindsville:	
Limestone, gray, medium-crystalline, highly fossiliferous. Not measured to base	10.0

12. ***Reeds Spring, St. Joe, Chattanooga, and Burgen.*** **East bank of Illinois River, SE¼ SW¼ sec. 16, T. 19 N., R. 24 E. (Hancock, 1963, p. 68).**

	Thickness (feet)
Mississippian:	
Reeds Spring:	
Chert and limestone sequence; estimated	40.0
St. Joe:	
Shale, green, soft, clayey, calcareous	1.0
Limestone, dense, gray, sparsely fossiliferous	0.2
Limestone, light-gray to green, shaly	0.4
Limestone, gray, crystalline; nodular weathering; weathers tan	6.0
Chattanooga:	
Noel:	
Covered	3.0
Shale, black, fissile, pyritic, iron-stained	65.8
Ordovician:	
Burgen:	
Sandstone, light-gray, fine-grained, highly porous, friable; trace zircon; trace black bituminous substance between grains; trace yellow stain	1.3
Covered interval	2.5
Sandstone, white to light-gray, fine-grained, angular, friable, highly porous; trace black bituminous substance between grains	1.0
Covered interval	3.0
Sandstone, white to light-gray, fine-grained, angular to subangular, friable, highly porous; trace black bituminous substance between grains; yellow calcareous stain; water bearing	6.5
Covered interval	12.8
Sandstone, white, very fine-grained to fine-grained, subangular, friable; trace zircon, magnetite, epidote, and calcareous yellow stain; porous	2.0
Sandstone, white, fine-grained, subangular, friable; minute	

	Thickness (feet)
calcite veins; trace zircon; trace black bituminous substance between grains	2.0
Covered interval	10.0
Sandstone, white to buff, fine-grained, angular, calcareous, friable; trace magnetite and zircon	1.0
Covered interval	0.5
Sandstone, buff, very fine-grained, angular; prominent calcite veins; trace zircon	1.7
Covered interval; probably calcareous siltstone	1.5
Sandstone, buff, very fine-grained, angular; minute calcite veins	1.25
Sandstone, buff, very fine-grained to silty, angular, calcareous; trace zircon	0.8
Sandstone, gray, very fine-grained to silty, calcareous, porous	0.75
Sandstone, white, fine-grained, massive, subangular, calcareous; trace zircon with bed of buff sandstone, having subrounded, medium grains in silty, calcareous matrix	11.0

13. *Reeds Spring, St. Joe, Chattanooga, Tyner, and Burgen.* **Hollow south of Illinois River, C SE¼ NW¼ sec. 30, T. 19 N., R. 24 E. (Hancock, 1963, p. 70).**

	Thickness (feet)
Mississippian:	
Reeds Spring:	
Chert and limestone sequence; estimated	15.0
St. Joe:	
Covered interval	3.7
Limestone, gray, crystalline, moderately fossiliferous	4.8
Limestone, dark-gray, dense, sparsely fossiliferous	10.3
Chattanooga:	
Noel:	
Shale, black, fissile, pyritic; mostly covered	83.8
Sylamore:	
Sandstone, salt and pepper, conglomeratic	0.3
Ordovician:	
Tyner:	
Shale, yellow-green, clayey	4.0
Burgen:	
Sandstone, buff to white to gray, fine- to medium-grained, calcareous; mostly covered	74.3

14. *Burgen and Cotter.* **East of mouth of Rock Branch, NW¼ sec. 8, T. 19 N., R. 25 E. (Hancock, 1963, p. 68).**

	Thickness (feet)
Ordovician:	
Burgen:	
Sandstone, white to yellow-brown, massive, friable; forms bluff	41.25
Sandstone, white, fine-grained, slightly friable	2.75
Cotter:	
Dolomite, light-gray, fine-grained, hard, massive	4.2
Dolomite; covered to river	7.25

15. *Reeds Spring and St. Joe.* **Roadcut at bend in road northwest of Lake Frances on south section line, SE¼ SE¼ sec. 7, T. 19 N., R. 26 E. (Hancock, 1963, p. 66).**

	Thickness (feet)
Mississippian:	
Reeds Spring:	
Chert and limestone sequence; estimated	3.0
St. Joe:	
Limestone, light-gray, massive, nodular weathering, highly crinoidal	42.1

16. *St. Joe.* **West of dam at Lake Frances, NW¼ NW¼ sec. 17, T. 19 N., R. 26 E. (Hancock, 1963, p. 67).**

	Thickness (feet)
Mississippian:	
St. Joe:	
Limestone, light-gray, nodular weathering, crystalline, moderately fossiliferous; upper surface fluted	1.75
Limestone, gray, nodular weathering, crystalline, thin-bedded, moderately fossiliferous	3.5
Marl, green, shaly; iron-stained concretions; moderately fossiliferous	1.75
Limestone, dark-gray, crystalline, nodular weathering, massive, moderately fossiliferous; pyritic nodules altered to limonite	9.8

17. *Reeds Spring and St. Joe.* North bank of Illinois River, NW¼ NW¼ sec. 18, T. 19 N., R. 26 E. (Hancock, 1963, p. 67).

	Thickness (feet)
Mississippian:	
Reeds Spring:	
Chert and limestone sequence; not measured	
St. Joe:	
Limestone, gray, massive, highly fossiliferous; nodular weathering; grades from crinoidal biomicrite at base to tightly packed, crinoidal biosparrudite at top	34.2
Covered to river	12.4

18. *Reads Spring, St. Joe, and Chattanooga.* Roadcut at bend in road at the southwest end of Lake Frances, C SW¼ sec. 20, T. 19 N., R. 26 E. (Hancock, 1963, p. 65).

	Thickness (feet)
Mississippian:	
Reeds Spring:	
Chert and limestone sequence; estimated	25.0
St. Joe:	
Shale, soft, dark-green, calcareous, pyritic	3.1
Limestone, gray, crystalline, slightly fossiliferous	2.8
Chattanooga:	
Noel:	
Shale black, iron-stained, conglomeratic, nodular, calcareous	2.0
Shale, black, fissile, pyritic	37.1