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GEOLOGY OF NORTHEASTERN CHEROKEE COUNTY, OKLAHOMA

by

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GEOLOGY OF NORTHEASTERN CHEROKEE COUNTY, OKLAHOMA

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ABSTRACT

Formations range in age from Lower Ordovician (Cotter dolomite) to Upper Mississippian (Hindsville limestone) and dip gently to the southwest. Pleistocene terrace gravels and alluvial deposits border the larger streams of the district. The stratigraphic sequence contains major unconformities; the three most important: (1) the post-Canadian, (2) pre-Chattanoogan, and (3) post-Osagean.

Several newly discovered outcrops were mapped, and previously unknown outliers of the Moorefield and Hindsville formations were studied and mapped. The St. Joe group was mapped separately from the overlying Reeds Spring and Keokuk formations. Fossils which permit more precise dating of the lower Tyner shales and dolomites were discovered.

The South Muskogee and Double Spring Creek faults were mapped several miles beyond the previously recognized termini. All known faults are upthrown to the southeast except the newly discovered Pumpkin Creek fault, which is upthrown to the northwest. The Pumpkin Creek fault is the north fault of the Pumpkin Creek graben, with the South Muskogee fault to the south.

INTRODUCTION

LOCATION AND DESCRIPTION OF AREA

The area under investigation comprises 216 square miles in northeastern Cherokee County, Oklahoma. It includes portions of Twps. 17 to 19 N., and Rs. 22 and 23 E. (fig 1). The area is 70 miles east of Tulsa, 45 miles northeast of Muskogee, and 20 miles northwest of Stilwell. Tahlequah is immediately beyond the extreme southwestern corner of the area.

SCOPE AND PURPOSE OF INVESTIGATION

Primary objectives of the study were: (1) mapping the areal extent of the established formations, (2) measurement and description of some typical stratigraphic sections, (3) collection and identification of representative faunas, and (4) re-evaluation of the Burgen, Tyner, and Fite formations and their correlatives in the Arbuckle region.

Methods of Investigation

Field study was done during the fall and early winter of 1959. A base map was prepared from aerial photographs at a scale of 3.2 inches to the mile. Geological information obtained in the field was recorded on acetate overlays with the aid of a stereoscope, and was later transferred to the base map which was in turn photographically reduced to its present scale of 1.5 inches per mile. As the region is heavily wooded, all outcrops mapped were carefully walked out.

Previous Investigations

The first geologic work in northeastern Oklahoma was that of Drake (1897), who discussed the general stratigraphy and structure of that area. The Tahlequah quadrangle was mapped by Taff (1903). The geology of Cherokee and Adair Counties was reviewed by Cram (1930). From 1930 to 1934 Cline studied the Osagean formations of this area in his work on the southern Ozark region. Laudon (1939) published a paper entitled "Stratigraphy of Osage subseries of northeastern Oklahoma." These publications included a description of several sections along the Illinois River in this area.

The rocks of the Illinois River Valley were remapped by Montgomery in 1951. The Spavinaw, Salina, and Spring Creek areas of Mayes, Cherokee, and Adair Counties were mapped by Gore (1952). Stratigraphic studies along the Illinois River were made by Graves (1952, unpublished report).

Geography

Northeastern Cherokee County has a mild, uniform climate with an average rainfall of 41.05 inches. Summer months are warm with an average temperature of 78 degrees, although a temperature of 100 degrees is not uncommon. The winter months are usually mild, a temperature of zero being exceptional. The average annual temperature is 66 degrees Fahrenheit.

Several small towns, each consisting essentially of a general store and a few homes, are found in this area. These include Scraper, Moody, Lowry, and Teresita.

Northeastern Cherokee County is traversed from west to east by black-topped Oklahoma Highway 51 and by U. S. Highway 62. These highways diverge west of Barren Fork; Highway 62 crosses

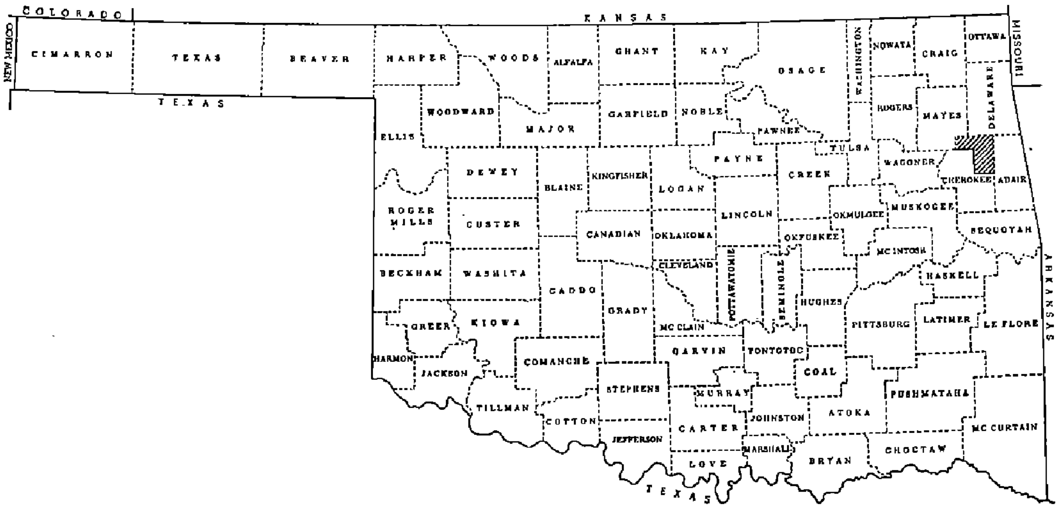

FIGURE 1. Index map showing location of northeast Cherokee County area (shaded).

Barren Fork and extends southeastward to Stilwell; whereas Highway 51 continues eastward to Westville. State Highway 10 traverses the area from southwest to northeast, connecting Highways 51 and 62 with Highway 33 to the north. State Highway 10 is blacktopped south of Eagle Bluff (sec. 13, T. 18 N., R. 22 E.).

The principal industry in northeastern Cherokee County is ranching. Flood plains of the Illinois River and its numerous tributaries afford excellent grazing land. Although this district was once agricultural, farming has almost ceased, the exception being the growing of strawberries for the cannery at Tahlequah. Lumbering is conducted on a small, local scale.

PHYSIOGRAPHY

The Ozark uplift, occupying 40,000 square miles in Missouri, Arkansas, and Oklahoma, includes this region and the surface has a gentle slope toward the southwest. The Springfield Structural Plain encompasses the entire area (Huffman, 1958, p. 10-11).

The topography is rugged and is typical of that of the Springfield Plain. The uplands are flat and are underlain by resistant cherts and limestone of the "Boone" group, so that resultant drainage valleys are narrow and deep (V-shaped), with characteristic dendritic patterns.

The region, with the exception of the northwestern one-fourth is drained by the Illinois River and its tributary, Barren Fork. The northwestern one-fourth lies within the watershed of Spring Creek and Double Spring Creek, tributaries of Grand River. Both the

Illinois and Grand River basins are components of the drainage basin of the Arkansas River.

The maximum elevation within the area is approximately 1,200 feet. The highest elevations are on Lowry Prairie (secs. 19, 20, T. 19 N., R. 23 E.) and on the Keokuk-capped hills in secs. 21 and 22, T. 18 N., R. 23 E. Minimum elevation of 700 feet is on the Illinois River directly east of Tahlequah, and on Spring Creek at the mouth of Bryant Hollow.

The surface of the Springfield Plateau slopes to the southwest, west, and south. The Illinois River has dissected this plateau and relief of 200 to 300 feet is present.

ACKNOWLEDGMENTS

Dr. G. G. Huffman directed the field and laboratory work. Dr. R. W. Harris and Ralph Disney were consulted concerning the Burgen-Tyner-Fite correlation problem. The Oklahoma Geological Survey defrayed some field expenses and furnished aerial photographs, publications, and maps. The report was read and criticized by Dr. W. D. Pitt. Mr. Tom R. Norris of Tahlequah accompanied the writer into the field on several occasions.

STRATIGRAPHY

General Statement

The rocks exposed at the surface range in age from Early Ordovician (Cotter dolomite) to Late Mississippian (Hindsville limestone). Locally terrace gravels and alluvium of Pleistocene and Recent age form a thin veneer.

The Cotter dolomite is exposed in small outcrops in secs. 10, 11, 25, and 36, T. 19 N., R. 21 E. It is succeeded unconformably by the Burgen sandstone, which is in turn overlain by the Tyner formation. Middle Ordovician Fite limestone rests conformably upon the Tyner, as exhibited in an exposure along a road cut on Highway 10 in sec. 35, T. 18 N., R. 22 E. Here the Fernvale, of Late Ordovician age, succeeds the Fite unconformably.

Silurian and Devonian units are absent due to pre-Chattanooga erosion, and the Chattanooga formation of Late Devonian and Early Mississippian age rests unconformably upon Fernvale and older units.

The remainder of the Mississippian system is represented in ascending order by the St. Joe, Reeds Spring, and Keokuk formations of Osagean age, the Moorefield formation of probable Meramecian age, and the Hindsville limestone, which is assigned to the Chester.

Ordovician System

Cotter Formation

History of Nomenclature. Ulrich (Purdue and Miser, 1916, p. 5) in 1912 applied the term "Cotter" to rocks exposed adjacent to the town of Cotter, in the Eureka Springs-Harrison quadrangle, Baxter County, Arkansas. He proposed dropping the mistakenly applied term of Jefferson City (Winslow, 1894, p. 331), which had been used previously.

In northeastern Oklahoma the terms "Turkey Mountain" and "Siliceous lime" (White, 1926, p. 12-13) were used until Ireland (1944) correlated an outcrop at Spavinaw with the "Swan Creek" zone of the Cotter formation.

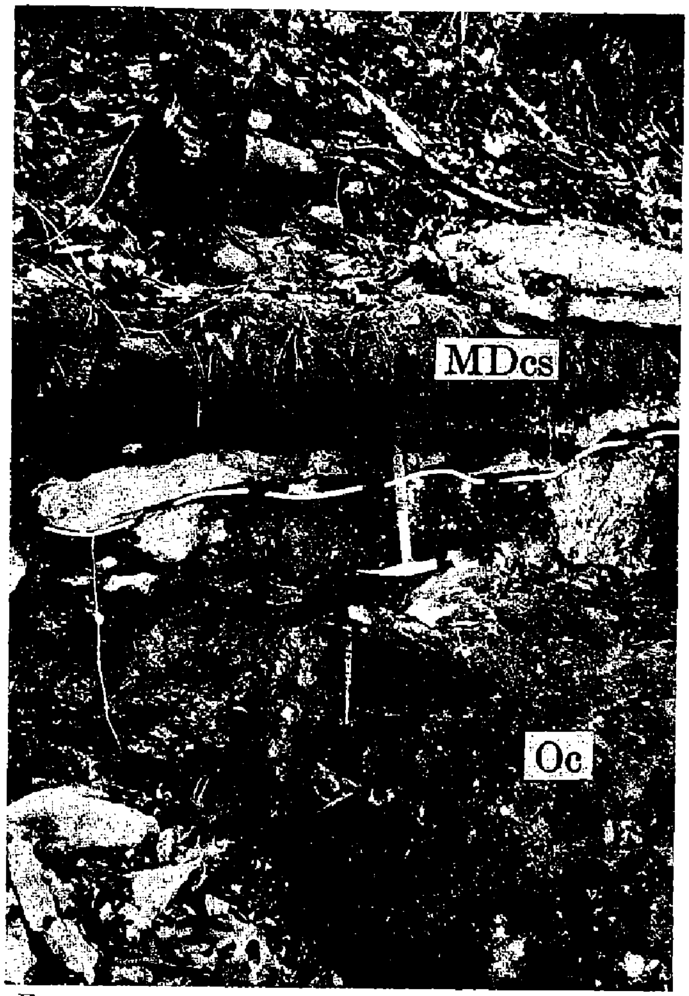

FIGURE 2. Cotter dolomite conglomerate (Oc) unconformably overlain by the Sylamore sandstone (MDcs): South side of Spring Creek, NW¼ sec. 36, T. 19 N., R. 20 E.

Distribution. The Cotter formation crops out in two small anticlinal folds within the area. The first and most extensive one is in sec. 11, T. 19 N., R. 21 E., and the other is on Spring Creek in secs. 25 and 36, T. 19 N., R. 21 E. Outside the area the Cotter is exposed near Flint (secs. 23 and 26, T. 20 N., R. 24 E.) and along the Illinois River (secs. 5, 6, 7, and 8, T. 19 N., R. 25 E.) (Huffman, 1958, p. 19). Near Spavinaw a unit lithologically similar to those within the area, is well exposed.

Character and Thickness. The Cotter formation is composed essentially of dolomite, and minor amounts of sandstone, shale, and chert. Three distinct units may be recognized within the area: (1) a thin layer of light-green clayey shale (sec. 25, T. 19 N., R. 12 E.) of limited lateral extent, (2) a fine-grained, light-gray dolomite with angular fragments of dark-gray dolomite and chert, well-rounded sand grains, and sub-rounded pebbles and cobbles of light-green clayey shale (fig. 2), and (3) a lower, massive, light-gray to buff dolomite exhibiting light to dark gray-banded, vitreous, in part oolitic, chert. The chert is fragmentary, nodular, or irregularly massive. Chert breccia is present locally. Crystals of pyrite, dolomite, calcite, and quartz are present in cavities of the chert. Other cavities contain small amounts of asphaltic residue.

In sec. 11, T. 19 N., R. 21 E., cave fillings to a depth of approximately 20 feet occur within the Cotter dolomite. The fillings are of massive, irregularly bedded quartzitic sandstone of Burgen (?) age. Fillings occur on the south side of Spring Creek, sec. 36, T. 19 N., R. 21 E., the largest measuring 30 feet in diameter and extending downward into the Cotter for a distance of seven feet.

The thickness of the Cotter dolomite in the subsurface of northeastern Oklahoma ranges from zero to 270 feet (Ireland, 1944). A maximum of 125 feet was measured by Gore (1952, p. 152) near Spavinaw. The actual thickness of the Cotter in this area will not be known until extensive drilling and subsurface correlation supplies the information.

Stratigraphic Relationships. The Cotter rests unconformably upon the Spavinaw granite (Huffman, 1958, p. 19) and contains reworked pebbles of the granite. Near Flint (sec. 26, T. 20 N., R. 24 E.) both the Burgen and Sylamore rest unconformably upon the Cotter (Montgomery, 1951, p. 138). A well drilled southwest of Flint encountered the Cotter directly beneath the Tyner formation (personal communication from M. R. Shaffer of Tulsa, Oklahoma). In the area the Cotter-Spavinaw contact is not exposed. The Chattanooga formation lies unconformably upon the Cotter dolomite in the Spring Creek area.

Paleontology. No fossils were collected because of the relatively unfossiliferous nature of the Cotter dolomite and the small extent of its outcrop within the area. Ireland (1930, p. 16) reported *Archinacella, Ecculiomphalus, Eotomaria, Liospira, Liospira (?)* sp., *Maclurites, Orospira bigranosa,* and *Turritoma milaniformis.*

Age and Correlation. The Cotter dolomite is considered Early Ordovician (Canadian) in age (Huffman, 1958, p. 20), and is believed to be equivalent to the Cotter dolomite of Arkansas and to the West Spring Creek formation of the Arbuckle group in south-central Oklahoma.

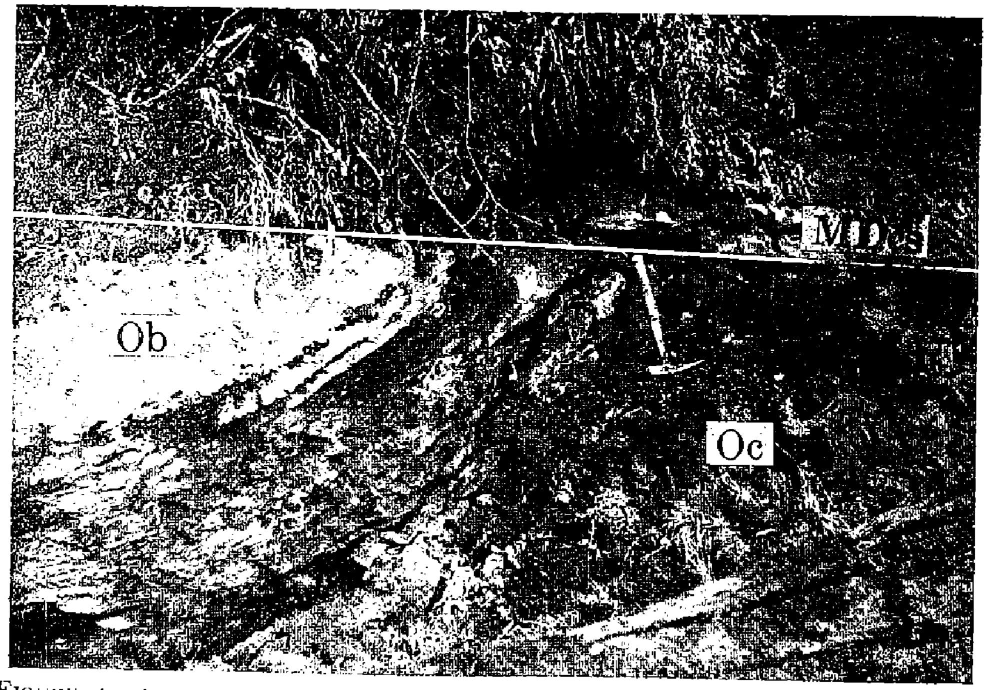

FIGURE 3. Lens of Burgen sandstone (Ob) filling depression in the Cotter dolomite (Oc). Reworked Cotter dolomite and shale underlie the filling. Sylamore sandstone (MDcs) lies unconformably upon the Burgen and Cotter. South side of Spring Creek, NW¼ sec. 36, T. 19 N., R. 20 E.

BURGEN SANDSTONE

History of Nomenclature. The Burgen sandstone was named by Taff (1905, p. 2) from exposures in Tooley (Burgen) Hollow, a tributary of the Illinois River in sec. 5, T. 17 N., R. 23 E., to sec. 36, T. 17 N., R. 22 E. The Burgen is exposed along a fault block bounded by northeast-trending faults in sec. 9, T. 17 N., R. 23 E., and sec. 14, T. 18 N., R. 22 E. It again is exposed in an anticlinal fold in sec. 1, T. 18 N., R. 23 E. and in secs. 26, 35, and 36, T. 19 N., R. 23 E. Outside the area it crops out near Chewey (Montgomery, 1951, p. 141).

Along Spring Creek (secs. 25 and 36, T. 19 N., R. 21 E.) and Bryant Hollow (secs. 10 and 11, T. 19 N., R. 21 E.) the Burgen is preserved as cave fillings in the Cotter dolomite. Gore (1952, p. 156, 157) described similar fillings along Spavinaw Creek. St. Peter sandstone fillings in the Everton limestone of the Harrison quadrangle, Arkansas, have been described by Purdue and Miser (1916, p. 7).

From the evidence discovered in the area and supporting evidence in other areas, the Burgen sandstone was deposited in sinks and depressions in the irregular Cotter surface. These fillings formed lenses, plugs, and irregular masses (fig. 3). In some of the lenses, bedding is even and readily apparent. Some of the fillings, with deeper penetration into the Cotter, display irregular cross-bedding which was possibly caused by sliding and shifting of the sand within the depression or sink prior to lithification.

Along Spring Creek local exposures of shale and reworked dolomite were observed beneath small lenses of Burgen sandstone (fig. 3).

Character and Thickness. Although it is predominantly sandstone, the Burgen formation contains minor amounts of shale and thin dolomitic limestone. The sandstone is white to gray or yellow, and is relatively soft and loosely cemented except in upper beds, which are well cemented. These beds form conspicuous cliffs along the Illinois River in sec. 31, T. 18 N., R. 23 E. The Burgen sandstone typically forms ledges for waterfalls, as at McSpaddin Falls, Cedar Hollow, and Tooley Hollow (figs. 4 and 5). The Sylamore member of the Chattanooga formation forms similar waterfall ledges on Waterfall Creek (sec. 15, T. 19 N., R. 23 E.) and should not be mistaken for the Burgen.

The Burgen is a medium- to fine-grained sandstone, with angular to well-rounded grains showing secondary enlargement. It should not be confused with the Sylamore sandstone, which is coarser and darker. Frosting, pitting, and etching are common on Burgen sandstone grains. Cementing material is silica with varying amounts of iron oxide. Magnetite and zircon are present in traces (Huffman, 1958, p. 20). Thin beds of green shale are common in upper portions and are fissile, sandy, or dolomitic.

A zone of cephalopods noted by Cram (1930, p. 9, 10) at McSpaddin Falls (measured section number 20) is believed to correspond to that at Rock Branch (sec. 7, T. 19 N., R. 25 E.). By means of this zone, one can reconstruct a complete section of the Burgen and arrive at an exposed total thickness of 112.5 feet.

The Burgen attains a thickness exceeding 100 feet in sec. 1, T. 17 N., R. 22 E., and a water well near McSpaddin Falls is reported to have penetrated 136 feet into the Burgen without reaching its base (Graves, 1952).

Stratigraphic Relationships. The Burgen formation rests unconformably upon the Cotter dolomite. Along Bryant Hollow and Spring Creek the Burgen fills sinks and depressions in the Cotter.

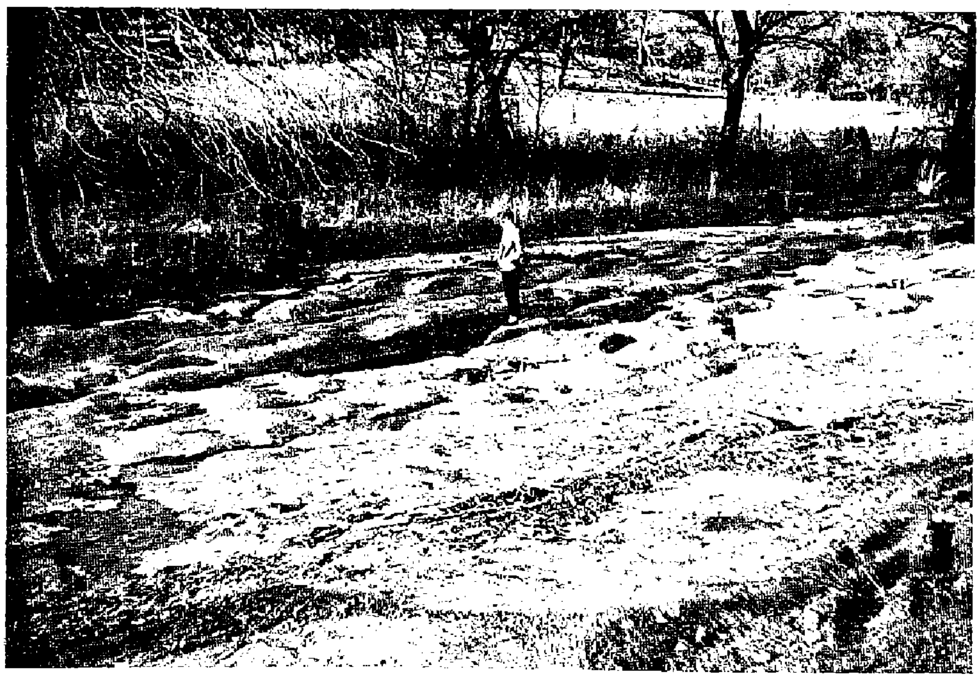

FIGURE 4. Burgen sandstone at the type locality in Tooley (Burgen) Hollow. North center sec. 5, T. 17 N., R. 23 E.

Along the Illinois River and its tributaries the Burgen is succeeded conformably by the Tyner formation. Along Spring Creek and Bryant Hollow, the Tyner formation has been truncated by pre-Chattanooga erosion and the Sylamore sandstone member of the Chattanooga formation rests upon the Burgen cave fillings. North of T. 19 N. (outside the map area), the Sylamore sandstone rests directly upon the Cotter.

Paleontology. No fossils were collected from the Burgen of this area, as it is sparingly fossiliferous. Cram (1930, p. 11) reported *Aparchites* (?), *Lophospira, Matheria,* a patelloid shell resembling *Palaeacmaea, Primitia, Psiloconcha,* and *Raphistomina,* from a locality near McSpaddin Falls (sec. 1, T. 17 N., R. 22 E.).

Age and Correlation. The Burgen formation was first correlated with the sandstone above the Yellville in the region of Yellville, Arkansas, by Taff (1905, p. 2). This sandstone was considered the equivalent of the St. Peter of the Mississippi Valley, which has been assigned to the Middle Ordovician. Giles (1930), and Croneis (1930, p. 27) agreed with this correlation. Ulrich (Cram, 1930, p. 12) suggested that the Burgen was much younger than the St. Peter and could be correlated with the sandstone at the base of the Bromide in the Arbuckle region. White (1926, p. 15) thought that the drillers' "True Wilcox" was below the Burgen, whereas Edson (1927, 1935)

FIGURE 5. Burgen sandstone on the Illinois River directly south of the mouth of Tooley (Burgen) Hollow. North center sec. 5, T. 17 N., R. 23 E.

correlated the Burgen with the "True Wilcox." Cram (1930, p. 12) correlated the Burgen with the basal sandstone of the Oil Creek formation of the Simpson group of the Arbuckle region. Decker and Merritt (1931, p. 34) recognized Tyner and Burgen lithologic types in the McLish of the Arbuckles. Disney and Cronenwett (1955) compared the Burgen with the sandstone of the Oil Creek. Huffman (1958, p. 22) suggested that the Burgen might be the Tulip Creek or "Third Bromide" equivalent.

The writer correlates the Burgen with the basal Oil Creek sand of the Arbuckle region on the basis of the Chazyan fauna collected from the overlying Tyner.

R. W. Harris (January, 1960, personal communication) collected a cephalopod fauna from the Burgen at Goat Bluff (south center sec. 31, T. 18 N., R. 23 E.) which was tentatively classed as lower Chazyan-Oil Creek by Flower.

TYNER FORMATION

History of Nomenclature. Taff (1905, p. 2) named the Tyner formation for outcrops near the town of Proctor along Tyner Creek, a tributary of of Barren Fork in northern Adair County. He included the units between the Burgen sandstone and the Chattanooga formation. Cram (1930, p. 20-22) restricted the term to units below the Fite and Fernvale and above the Burgen.

Distribution. The Tyner formation crops out at Camp Egan, SW¼ sec. 12, T. 17 N., R. 23 E.; along the Illinois River in sec. 26, T. 17 N., R. 22 E.; in Pumpkin Hollow in secs. 27, 34, 35, T. 18 N., R. 23 E.; and along the Illinois River Valley north of the mouth of Pumpkin Hollow in sec. 7, T. 17 N., R. 23 E. The outcrops along the Illinois River may be discontinuous locally due to minor folding. It is exposed along Waterfall Creek in secs. 15, 16, 22, 23, T. 19 N., R. 23 E. At Eagle Bluff, in secs. 13, 23, 24, T. 18 N., R. 22 E., an imposing section of Tyner may be observed in new road cuts.

Character and Thickness. The Tyner formation is composed of soft shale, sandstone, and compact dolomite. The shales are dominantly olive-green to dark blue-green, but range from yellow to mottled brown. Some are compact and sandy, and others are soft and earthy.

The sandstones are indurated, calcareous and dolomitic, and grade laterally into sandy dolomite or dolomite. Tyner dolomites are dominantly tan to buff, massive, sandy and compact, but locally grade to soft, thin-bedded earthy dolomites. Light-gray chert nodules, chert fragments, and crystalline quartz form a definite zone in the uppermost Tyner dolomite. Locally the dolomites and shales are calcareous.

The top of the Tyner is here established at the base of the lowermost bed of typical lithographic Fite limestone. Cram (1930, p. 16-17) divided the Tyner into three parts: (1) a lower Tyner dolomite and green shale, (2) middle Tyner green shale, and (3) upper Tyner cherty, dolomitic limestone. Huffman (1958, p. 23) stated that these units may be recognized throughout much of northeastern Oklahoma.

A maximum exposed thickness of 78.5 feet was measured at Eagle Bluff, where the contact with the Burgen is not exposed. The Burgen is exposed across the river, and an estimated thickness slightly exceeding 100 feet for the Tyner would not be far in error. At Eagle Bluff some of the upper part of the Tyner has been removed by pre-Chattanooga erosion. The amount removed is believed to be slight, however, as the upper cherty dolomite is present. This upper cherty zone is regarded as the top of the Tyner at the Loosier School House, measured section number 18, where the upper 38 feet is exposed. The Tyner thins north of T. 18 N., by truncation and overlap of the Chattanooga. The Chattanooga formation lies upon Burgen and Cotter north of T. 19 N. (outside the area).

Stratigraphic Relationships. The Tyner formation rests conformably upon the Burgen sandstone. Such contact is exposed in the SW¼ sec. 31, T. 18 N., R. 23 E., where it is lithologically abrupt; typical soft yellow-green Tyner shales rest upon massive, cliff-forming Burgen sandstone. The Tyner is overlain conformably by the Fite limestone and a transition zone of alternating limestone and dolomite is present.

Paleontology. The Tyner is sparingly fossiliferous and the writer was unable to discover fossils reported by Cram and Montgomery in the upper Tyner cherty dolomite. A small faunule was collected from lower Tyner dolomites, although the fossils were poorly preserved and only tentative identifications were possible. These include *Clathrospira* sp. cf. *C. subconica* Hall, fucoids, *Hormotoma* sp. (large), *Hormotoma gracilis* (Hall), weathered casts resembling *Maclurites* sp., *Pseudomaria (Pliomerops) nevadensis* (Walcott), *Raphistoma* sp. cf. *denticulatum* Ulrich, *Trochonema* sp. cf. *T. umbilicatum* Hall, and a small straight cephalopod.

Taff (1905, p. 2) collected a faunule from the upper part of the Tyner which Ulrich reported as including *Camarocladia rugosa* Ulrich, *Ceraurus pleurexanthemus* Greene, *Hesperorthis tricenaria* (Conrad), *Hormotoma gracilis* (Hall) *Leperditia* sp. cf. *L. fabulites, Liospira americana* Billings, *Lophospira* sp. cf. *L. perangulata, Psiloconcha inornata* Ulrich, *P. sinuata* Ulrich, *P.* sp. cf. *P. subovalis* Ulrich, *Rhytima* sp., and *Whiteavesia* sp.

Cram (1930, p. 18) collected a faunule containing *Ceraurus* sp., *Ctenodonta* sp., *Eurydictya* sp., *Hormotoma* sp. cf. *H. salteri, Leperditella* sp., *Pterygometopus* sp., *Rafinesquina* sp., and *Streptelasma* ?. Montgomery (1951, p. 152) collected a faunule from the upper cherty dolomite, but discovered no additional forms.

R. W. Harris (January 1960, personal communication) collected *Drepanodus arcuatus* Pander from the lower part of the Tyner at Eagle Bluff.

Age and Correlation. Precise age and correlation of the Tyner has led to much argument. Taff (1905, p. 2) assigned an age of

Early Trentonian or Blackriveran to the Tyner formation at Eagle Bluff, but indicated Lorraine age for fossils occurring in a sandstone on Tyner Creek, which he suggested is higher in the section than the dolomites at Eagle Bluff. This sandstone has been examined by the writer and is believed to be Sylamore containing re-worked fossils. The Sylamore was found, at another locality, to contain fossils of Richmondian age which had been re-worked and re-deposited by early Chattanooga seas.

Edson (1927, p. 975) correlated the Tyner with the "post-Wilcox" of the Midcontinent and the Bromide of the Arbuckles. Cram (1930, p. 19) stated that the upper part of the Tyner can be traced into the Bromide of the Arbuckles, and that the middle shale unit grades into "Wilcox" and other sandstones to the west. He placed the lower Tyner far down in the Simpson section.

Huffman (1958, p. 24) correlated the upper part of the Tyner formation with the upper part of the Bromide, and the middle part of the Tyner with the Marshall zone and possibly Tulip Creek. He further correlated the upper part of the Tyner, in part at least, with the Gratton-Witten sequence of Virginia, the Camp Nelson of Kentucky, the Plattin of Missouri, and the Platteville of Iowa.

A faunule collected from the lower part of the Tyner contains *Pseudomaria (Pliomerops) nevadensis* (Walcott), which is considered a definite Chazyan form (Cooper, 1956, p. 119). *P. nevadensis* is present in the Oil Creek of the Arbuckle region (Decker, 1931, p. 20), indicating that the lower part of the Tyner and the Oil Creek are correlative. Remaining faunal evidence suggests that the middle and upper parts of the Tyner are Blackriveran in age and equivalent to the McLish, Tulip Creek, Bromide sequence (Huffman and Starke, 1960b, p. 268-271). Available lithologic evidence and subsurface correlations support this probable Blackriveran age. No physical evidence of a hiatus was found within the Tyner section, but if one is present, as suggested by Cram (1930, p. 19) at the base of the middle part of the Tyner, then the McLish equivalent may be absent.

Harris supports the writer's correlation with the Oil Creek on the basis of the occurrence of *Drepanodus arcuatus* Pander, a definite Oil Creek fossil.

FIGURE 6. Fite (Ofi), Fernvale (Ofe), and Chattanooga (MDc) formations exposed at Sparrowhawk Mountain near the center of sec. 12, T. 17 N., R. 22 E.

FITE LIMESTONE

History of Nomenclature. Taff (1905, p. 2) included the Fite limestone with the Tyner formation, and these were not separated until 1930, when Cram (p. 20) applied the term "Fite" to limestones exposed near the Fite ranch (sec. 11, T. 17 N., R. 22 E.) northeast of Tahlequah.

Distribution. The Fite crops out along Barren Fork (sec. 27, T. 17 N., R. 23 E.); at Camp Egan (secs. 11, 12, 13, and 14, T. 17 N., R. 23 E.); along the Illinois River east of Tahlequah (sec. 26, T. 17 N., R. 22 E.); and along the Illinois River between the mouth of Pumpkin Hollow on the south and sec. 23, T. 18 N., R. 22 E., on the north. North of sec. 23 it is absent due to pre-Chattanooga truncation.

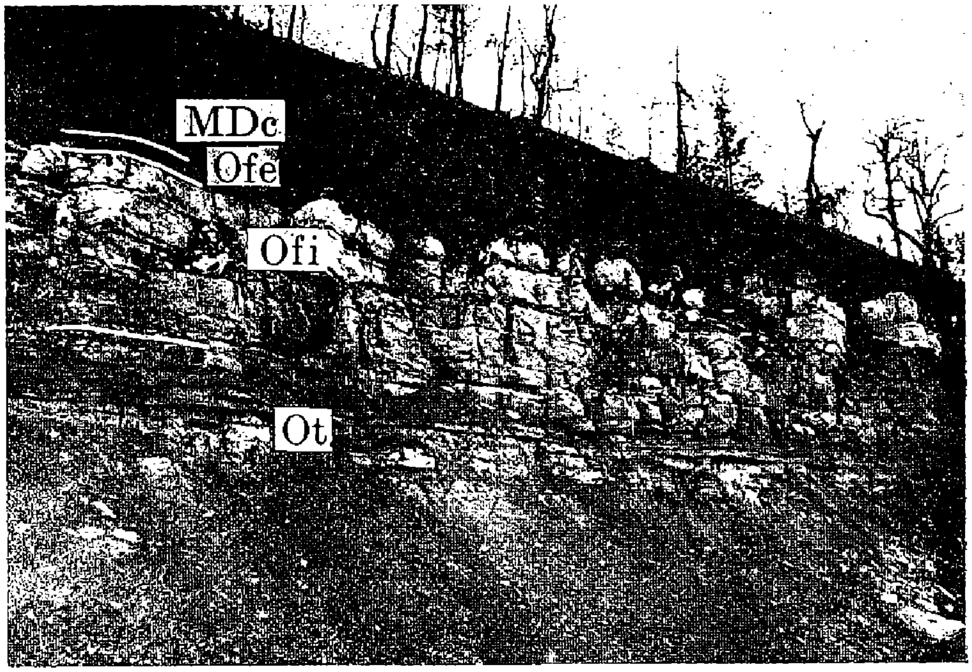

FIGURE 7. Tyner (Ot), Fite (Ofi), Fernvale (Ofe), and Chattanooga (MDc) formations at Loosier School House on State Highway 10. A thin weathered zone of Fernvale may be observed here. Center east line sec. 35, T. 18 N., R. 22 E.

Character and Thickness. The Fite is a light-gray, dense lithographic limestone with calcite crystals in specks and streaks, giving it a characteristc appearance on fresh surface. The lower part of the Fite contains beds of buff to gray, sandy dolomite alternating with beds of typical Fite lithology to form a transition zone.

Along Barren Fork the Fite is 10 feet thick at the south end of the bridge (sec. 27, T. 17 N., R. 23 E.) and 10 feet thick at Camp Egan. Along the Illinois River it is 17 feet thick at Sparrowhawk Mountain (fig. 6) and 18 feet thick at the Loosier School House (fig. 7). North of the Loosier School House section it is truncated by pre-Chattanooga erosion and is absent to the north.

Stratigraphic Relationships. The Fite limestone lies conformably upon the Tyner formation, and a transition zone of alternating Tyner-type dolomite and Fite-type limestone is present. The Fite is succeeded unconformably by the Fernvale limestone. An erosional surface representing a brief hiatus was noted at Camp Egan, where the contact is abrupt and where the Fernvale fills small cavities in the Fite.

Paleontology. Fossils are few and are extremely difficult to remove from the Fite limestone. No fossils were collected, although Cram and Ulrich (Cram, 1930, p. 21) collected a faunule at the type locality including *Colpomya* cf. *C. faba, Cyrtodonta* aff. *C. billingsi, Dalmanella jugosa, Isochilina* sp., *Leperditia caecagena, Liospira* cf. *L. micula, Lophospira perangulata, Plectambonites (Sowerbyella)* sp., and *Tetradium* sp.

Age and Correlation. Ulrich (Cram, 1930, p. 21) originally assigned a Blackriveran age to the Fite limestone, but later classed it as pre-Fernvale, Richmondian in age. Cram (1930, p. 21) tentatively correlated the Fite with the "dense lime" of the subsurface. Disney and Cronenwett (1955) compared it with the dense limestones of the Viola, whereas Huffman (1958, p. 25-26) stated that he believed it to be the equivalent of the Upper Bromide "dense" of the Arbuckle area.

The Fite is believed to be the equivalent of the Upper Bromide dense (Corbin Ranch) on the basis of lithologic similarity and the conformable relationship of the Fite and Tyner. Huffman (1958, p. 26) further correlated the Fite with the upper part of the Platteville of the Upper Mississippi Valley, part of the Plattin of Missouri, and the Witten of Virginia. Such correlations date the Fite as late Blackriveran in age.

FERNVALE LIMESTONE

History of Nomenclature. Hayes and Ulrich (1903, p. 2) named the Fernvale for exposures near Fernvale, Tennessee. Cram (1930, p. 22) extended the term to northeastern Oklahoma for beds of similar faunal and lithologic character.

Distribution. The Fernvale limestone crops out along Barren Fork (sec. 27, T. 17 N., R. 23 E.), at Camp Egan (secs. 11, 12, 13, 14, T. 17 N., R. 23 E.), along the Illinois River east of Tahlequah (sec. 26, T. 17 N., R. 22 E.), and along the Illinois River between the mouth of Pumpkin Hollow on the south and sec. 35, T. 18 N., R. 22 E., on the north. North of sec. 35 it is absent due to pre-Chattanooga truncation.

Character and Thickness. The Fernvale is a massive coarse-crystalline, fossiliferous, light-gray to pink limestone. It weathers into crumbly, fossiliferous boulders of lead-gray color. Along Barren Fork and at Camp Egan it forms bluffs with the underlying Fite.

The Fernvale limestone has a maximum thickness of 12.5 feet on Barren Fork and thins to the north. At Sparrowhawk Mountain it is 6.25 feet; it is 9 feet at the mouth of Pumpkin Hollow; at the Loosier School House (sec. 36, T. 18 N., R. 22 E.) it thins to 1 foot (fig. 7) and north of sec. 35, T. 18 N., R. 22 E. it is absent.

Stratigraphic Relations. Fernvale fillings in cavities in the subjacent Fite at Camp Egan substantiate their unconformable relationship. South of the area the Sylvan shale lies conformably upon the Fernvale. Within the area the Sylvan is absent and the Fernvale is succeeded unconformably by the Chattanooga.

Paleontology. The Fernvale is abundantly fossiliferous and fossils collected are: *Austinella kankakensis* (McChesney), *Bumastus* sp., *Doleroides gibbosus* (Billings), *Endoceras* sp., *Ephippiorthoceras laddi* Foerste, *Hebertella occidentalis sinuata* (?) (Hall), *Lepidocyclus capax* (Conrad), *Plaesiomys subquadrata* (Hall and Clarke), and *Stromatocerium* cf. *S. pustulosum.*

UPPER DEVONIAN-LOWER MISSISSIPPIAN SYSTEMS

CHATTANOOGA FORMATION

History of Nomenclature. The term "Chattanooga" was applied to the well-known "Black Shales" of Tennessee by Hayes and Ulrich (1903, p. 2) for exposures near Chattanooga. The term "Eureka" (preoccupied) had been previously applied by Branner (Penrose, 1891, p. 26) to beds in northern Arkansas. Drake (1897, p. 347) extended this term into Oklahoma. In southwestern Missouri stratigraphically similar black shales were termed Noel by Adams et al. (1904, p. 24) from typical exposures at Noel, McDonald County, Missouri. Taff (1905, p. 3) extended the term "Chattanooga" into Oklahoma.

Subdivisions. The Chattanooga formation is divided into the basal Sylamore sandstone member and the overlying Noel black shale member (Huffman and Starke, 1960b, p. 159-163).

SYLAMORE SANDSTONE MEMBER

History of Nomenclature. The Sylamore was named from Sylamore Creek, Stone County, Arkansas, by J. C. Branner (Penrose, 1891, p. 113, 114). Adams and Ulrich (1905, p. 2) classified it as the basal sandstone of the Chattanooga formation.

Distribution. The Sylamore is present throughout the area wherever the base of the Chattanooga is exposed. It crops out along Barren Fork in secs. 27 and 22, T. 17 N., R. 23 E.; at Camp Egan in secs. 11 and 12, T. 17 N., R. 23 E.; along the Illinois River north of the mouth of Pumpkin Hollow in sec. 9, T. 17 N., R. 23 E.; along Spring Creek west of Teresita; and in Bryant Hollow, a tributary of Spring Creek, which empties into Spring Creek in sec. 18, T. 19 N., R. 21 E.

FIGURE 8. Sylamore sandstone forming a waterfall ledge on Waterfall Creek. C S½ sec. 15, T. 19 N., R. 23 E.

Character and Thickness. The Sylamore sandstone is a white to black sandstone of well-rounded grains, containing angular to well-rounded phosphatic pebbles up to one-half inch in diameter. Locally its color ranges from white to yellow or pink to red and black. A fresh break reveals the typical salt-and-pepper appearance. Many of the sand grains display prominent crystal faces and the grains are generally medium to large. Basal portions are extremely ferruginous and contain phosphatic pebble conglomerates. These pebbles attain diameters up to 3 inches.

Normally the Sylamore is friable, but locally it is hard and forms light-gray to yellowish-brown pitted ledges resembling the Burgen (fig. 8) (sec. 15, T. 19 N., R. 23 E.). Locally it is quartzitic (sec. 25, T. 19 N., R. 21 E.).

The thickness of the Sylamore is extremely variable throughout the area. It is two inches thick at Camp Egan; approximately two feet thick in sec. 11, T. 19 N., R. 23 E.; two feet thick in sec. 12, T. 18 N., R. 22 E.; one foot thick in sec. 24, T. 19 N., R. 23 E.; and one foot thick in sec. 25, T. 19 N., R. 21 E. A maximum thickness for the sandstone in this area is 12 feet in sec. 15, T. 19 N., R. 23 E. Although thin, the Sylamore is present throughout the area.

Stratigraphic Relationships. The Sylamore sandstone unconformably overlies the Fernvale and Fite in the southern part of the area, and to the north it rests unconformably upon Tyner and older units. To the northeast, just outside the area, the Sylamore rests upon the Cotter. In secs. 10 and 11, T. 19 N., R. 21 E. and sec. 25, T. 19 N., R. 21 E., the Sylamore lies unconformably upon the Cotter and Burgen. The Sylamore is succeeded conformably by Noel black shale.

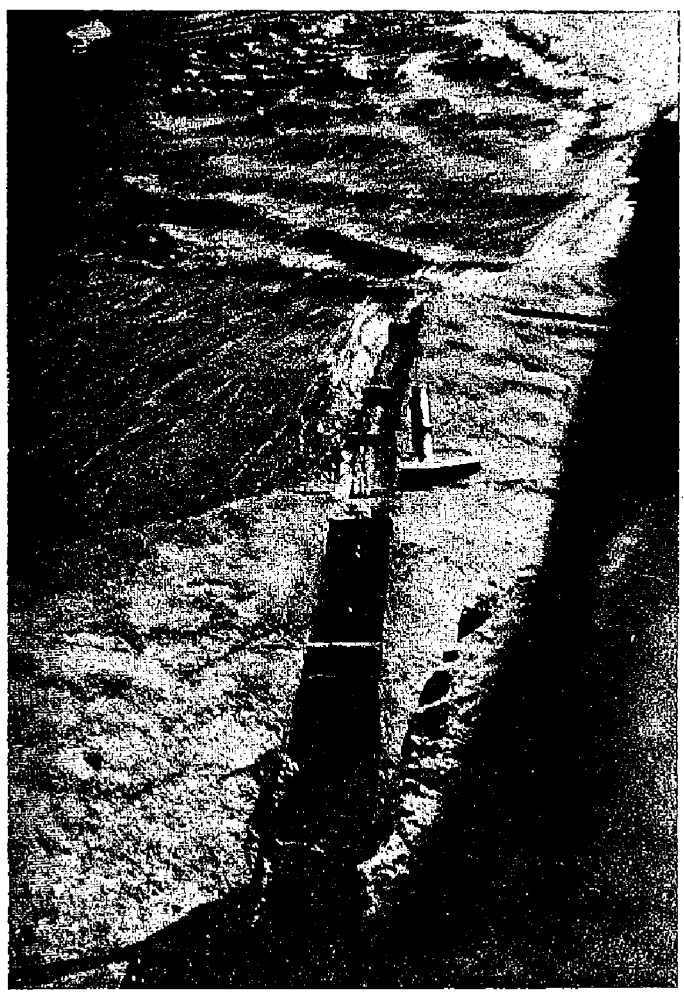

FIGURE 9. Molds of *Cordaites* in the Sylamore sandstone on the Illinois River at its junction with Black Fox Creek. NW¼ sec. 24, T. 19 N., R. 23 E.

Paleontology. The Sylamore is sparingly fossiliferous within the area. A small faunule was collected and identified as exotic fossils, such as *Lepidocyclus capax,* from the Fernvale.

In sec. 24, T. 19 N., R. 23 E., at the junction of Black Fox Creek and the Illinois River, casts and molds of the plant *Cordaites* (?) are abundant in association with some fucoids (fig. 9). Fragmentary bones of *Dinichthys* were reported in the Sylamore of the Fayetteville quadrangle (Adams and Ulrich, 1905, p. 3). At Sparrowhawk Mountain, SE¼ sec. 12, T. 17 N., R. 22 E., a thin conodont-bearing bed is present (Laudon, 1939, p. 334).

NOEL SHALE MEMBER

History of Nomenclature. The term Noel was applied to black shales of Chattanooga age by Adams (1905, p. 24) for exposures at Noel, McDonald County, Missouri. The term "Eureka Shale" (preoccupied) had been used previously by geologists in Arkansas (Adams and Ulrich, 1905, p. 2).

Distribution. The Noel black shale is widely distributed throughout the area. In the southern portion it crops out along Barren Fork and along the Illinois River two miles east of Tahlequah in secs. 24, 26, and 35, T. 17 N., R. 22 E. The Illinois River Valley displays an almost continuous outcrop from the mouth of Pumpkin Hollow (sec. 8, T. 17 N., R. 23 E.) northward throughout its length. Many of its tributaries, including Pumpkin Hollow, Tooley Hollow, Cedar Hollow, Waterfall Creek, and Black Fox Creek, afford excellent sections. These exposures are not continuous, but represent a series of separate outcrops. The Noel shale is exposed along Spring Creek and its tributary, Bryant Hollow, in T. 19 N., R. 21 E.

Outside the adjacent area, numerous exposures are present to the south (Huffman, 1958, p. 39), to the north and northwest (Gore, 1952, p. 161), and to the east and northeast (Montgomery, 1951, map).

Character and Thickness. The Noel black shale is a fissile, carbonaceous, pyritic, and bituminous black shale. It is jointed and breaks into characteristic quadrilateral blocks, the joint surfaces weathering red to brown. Cone-in-cone structure occurs sporadically throughout the formation.

At Camp Egan the Noel black shale is 39 feet thick; two miles east of Tahlequah, 35 feet; at Sparrowhawk Mountain (sec. 12, T. 17 N., R. 22 E.), 31 feet; two miles north of Sparrowhawk Mountain, 33 feet; at Eagle Bluff, 39 feet; at the junction of Black Fox Creek and the Illinois River (sec. 24, T. 19 N., R. 23 E.) it attains a maximum thickness for the area of 71 feet. Along Spring Creek it is 31 feet thick in sec. 36, T. 19 N., R. 21 E.; 38 feet thick in sec. 7, T. 19 N., R. 21 E.; and in Bryant Hollow (sec. 11, T. 19 N., R. 21 E.) it thins abruptly to 21 feet. These measurements indicate that the Noel thickens locally to the northeast.

Stratigraphic Relationships. The Noel black shale lies conformably upon the Sylamore sandstone throughout much of the area. Where the Sylamore is locally absent due to non-deposition, the Noel black shale lies unconformably upon beds ranging from Late Ordovician Fernvale to Early Ordovician Cotter in age. A local, thin, reworked shale zone at the top of the Noel black shale is the only evidence of its unconformable relationship with the overlying St. Joe group. Outside the area local absence of the Noel black shale below the St. Joe further attests to this unconformity (Huffman, 1958, p. 42).

The relief of the Chattanooga surface does not appear to have been great, although the time interval was significant. In southwest Missouri a definite unconformity exists, and the St. Joe lies locally upon the Sylamore sandstone (Clark and Beveridge, 1952, p. 15).

Paleontology. The Noel black shale is relatively unfossiliferous and no fossils were collected by the writer. Huffman (1958, p. 40) listed a meager faunule including linguloid brachiopods, conodonts, *Dinichthys,* and the plant *Tasmanites huronensis.*

Age and Correlation. The Chattanooga formation of Tennessee and its equivalents in the eastern interior have been classed as Upper Devonian and Lower Mississippian (Campbell, 1946). The Chattanooga of Tennessee and Alabama and the New Albany shale of Ohio have been correlated with the Chattanooga of northeastern Oklahoma. Conodonts of both Devonian and Mississippian age have been discovered in the Chattanooga of Oklahoma and in its Arbuckle equivalent, the Woodford shale, by Miser and Hass. The Noel black shale is classed as both Upper Devonian and Lower Mississippian, at least until further study.

Mississippian System

"Boone" Limestone and Cherts

Discussion. The term "Boone" was applied by Branner (Simonds, 1891, p. xii, 27) to a series of cherts and cherty limestones which forms the base of the "Carboniferous" system in Boone County, Arkansas. This term was extended into Oklahoma by Taff (1905, p. 5), who recognized the limestone at its base as being the equivalent of the St. Joe limestone of Arkansas. Adams and Ulrich (1905, p. 3) recognized the same unit in the Fayetteville quadrangle of Arkansas.

Laudon (1939, p. 325) divided the Osage of northeastern Oklahoma into: (ascending) St. Joe, Reeds Spring, and Keokuk.

St. Joe Group

History of Nomenclature. Hopkins (1893, p. 10) applied the term "St. Joe" to the basal Boone limestone for exposures at St. Joe, Searcy County, Arkansas. Taff (1905, p. 5) recognized the St. Joe equivalent in northeastern Oklahoma, and Cline (1934, p. 1137) elevated it to formational rank. Laudon (1939, p. 326) identified a "reef phase" and "non-reef phase." The St. Joe was considered the equivalent of the Pierson by Kaiser (1950, p. 2157), who suggested that the latter term be suppressed as a synonym.

Beveridge and Clark (1952, p. 75) elevated the St. Joe of Missouri to group rank and subdivided it into three distinct lithologic units. These are (ascending): Compton, Northview, and Pierson. Huffman (1958, p. 41) followed this usage for the St. Joe of northeastern Oklahoma. The Compton, Northview, and Pierson rock types are recognizable in northeast Cherokee County, but because they are extremely thin and variable, they have been mapped as a single unit.

Distribution. The St. Joe is widely distributed throughout the area. In the southern part it is exposed along Barren Fork and along the Illinois River two miles east of Tahlequah in secs. 24, 26, and 35, T. 17 N., R. 22 E. An almost continuous outcrop is along the Illinois River from the mouth of Pumpkin Hollow (sec. 8, T. 17 N., R. 23 E.) northward throughout its valley. Many of its tributaries, including Pumpkin Hollow, Tooley Hollow, Cedar Hollow, Waterfall Creek, and Black Fox Creek, afford excellent sections.

In T. 19 N., R. 21 E., along Spring Creek and its tributary, Bryant Hollow, numerous St. Joe sections are exposed. The exposures along Spring Creek and Bryant Hollow are actually numerous separate outcrops exposed at the surface by erosion of gentle folds in the strata.

Character and Thickness. The "non-reef phase" of the St. Joe in the area exhibits three rock types. The basal unit in northern portions is normally a thin-bedded, dense, light- to dark-gray, pyritic, nodular-weathering limestone five to six feet thick. This basal unit thins and is absent south of T. 18 N. It attains a maximum thickness of 11 feet at Eagle Bluff (sec. 13, T. 18 N., R. 22 E.). The middle unit averages two or three feet (attaining a maximum of six and one-third feet in the NW¼ sec. 24, T. 19 N., R. 23 E.) of soft, green, limy shale.

The upper, and most persistent unit, is three to four feet of gray, dense, thick-bedded, fine- to coarse-crystalline, pyritic limestone. The upper division forms a ledge owing to the weathering of the middle shale unit below it. The lower unit normally forms a rubbly slope covering much of the Noel black shale below it.

The "reef phase" is present in several localities in the area. Two characteristic examples are in secs. 18 and 19, T. 19 N., R. 21 E. and

FIGURE 10. Bioherms in the St. Joe (Msj) limestone at Eagle Bluff on State Highway 10. Draping of the Reeds Spring (Mkrs) across the bioherm is indicated by white line. SW¼ sec. 13, T. 18 N., R. 22 E.

at Eagle Bluff (fig. 10). These bioherms are composed of lenticular masses of crinoidal limestone interbedded with soft, green to gray, highly fossiliferous marlstones. These bioherms range in thickness from a few feet to approximately 70 feet at Eagle Bluff and 60 feet in secs. 18 and 19, T. 19 N., R. 21 E. Many locally abnormally thick St. Joe sections may be attributed to an associated bioherm which is not completely exposed by erosion. These bioherms appear to be confined largely to the upper division of the St. Joe.

Stratigraphic Relationships. The St. Joe group rests unconformably upon the Noel black shale, as shown by a weathered zone of green and black shale at the base of the St. Joe. Further evidence of this unconformity was cited by Huffman (1958, p. 42) who noted the local absence of the Chattanooga below the St. Joe outside this area. The St. Joe is succeeded unconformably by the Reeds Spring, the unconformity being indicated by local absence of the St. Joe. This unconformity may be observed at Hanging Rock (sec. 5, T. 18 N., R. 23 E.), where the St. Joe thins to extinction (fig. 11) allowing the Reeds Spring to rest upon the Noel black shale. Another unconformity is present within the St. Joe group at the top of the middle shale unit (Northview, of Missouri geologists) as shown by: (1) loss of lower units to the southeast, and (2) local loss or abrupt thinning of the middle shale division.

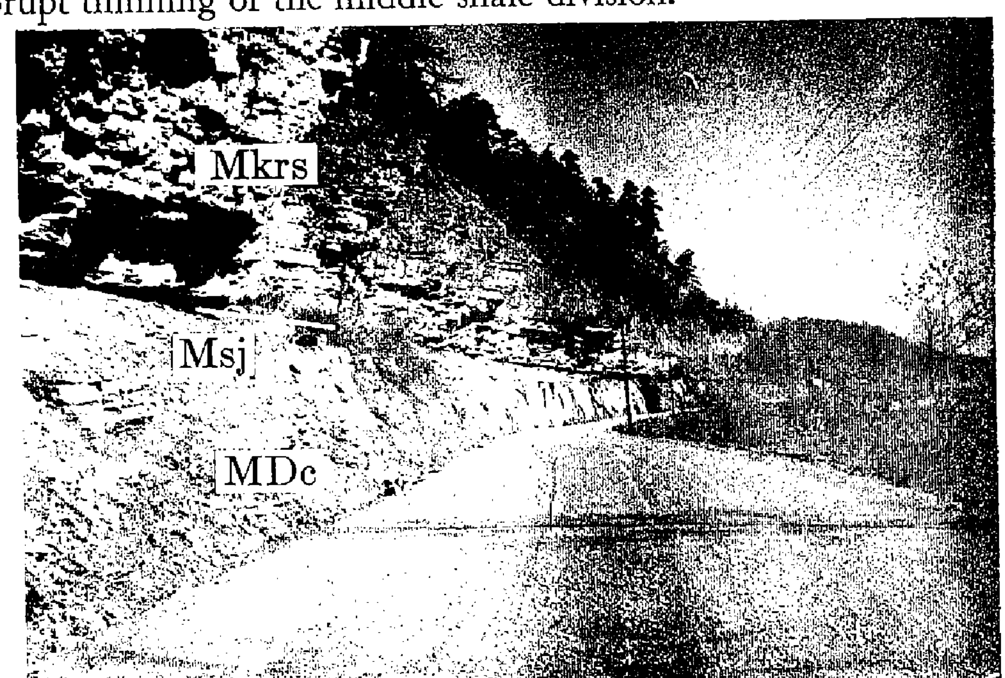

FIGURE 11. Chattanooga (MDc), St. Joe (Msj), and Reeds Spring (Mkrs) as observed at Hanging Rock. Note pinch out of St. Joe at telephone pole in the center of picture, west center of sec. 5, T. 18 N., R. 23 E.

Paleontology. The St. Joe is fossiliferous and the following faunule was collected:

Anthozoa
- *Amplexizaphrentis* sp.
- *Favosites* sp.

Bryozoa
- *Fenestella* (?) *filistriata* Ulrich

Brachiopoda
- *Athyris lamellosa* Léveille
- *Brachythyris* (?) *suborbicularis* (Hall)
- *Chonetes glenparkensis* Weller
- *Cliothyridina glenparkensis* Weller
- *Antiquatonia* sp.
- *Leptaena analoga* (Phillips)
- *Punctospirifer subelliptica* (McChesney)
- *Rhipidomella* sp.
- *Rhynchopora rowleyi* Weller
- *Spirifer grimesi* Hall
- *Spirifer rowleyi* Weller
- *Spirifer* sp. cf. *S. shepardi* Weller

Gastropoda
- *Platyceras paralius* (W. and W.)

Echinoderma
- *Actinocrinites* sp.
- *Schizoblastus* sp.

Trilobita
- *Phillipsia sampsoni* Vogdes

Laudon (1939, p. 327) listed additional forms, and Strimple and Koenig (1956) collected a fauna of microcrinoids.

Age and Correlation. The upper limestone unit of the St. Joe has been correlated with the Fern Glen of eastern Missouri (Moore, 1928, p. 144), the New Providence of Kentucky and Tennessee (Butts, 1922, p. 50), and the Lake Valley of New Mexico (Weller, 1910, p. 327). Although the terms were not here applied, the equivalents of the Pierson, Northview and Compton are present in the area. The unconformity at the top of the middle shale unit would occur likewise at the top of the Northview, which is the Osage-Kinderhook boundary (Beveridge and Clark, 1952, p. 75). On the basis of microcrinoids, Strimple and Koenig (1956, p. 1225) correlated the upper limestone unit with a shale at the base of the Welden limestone near Ada.

REEDS SPRING FORMATION

History of Nomenclature. Moore (1928, p. 190) applied the term "Reeds Spring" to the lower limestones and cherts of Osagean age at Reeds Spring in southwestern Missouri. Cline (1934, p. 1141) elevated the unit to formational rank, and Laudon (1939, p. 328) followed this assignment.

Distribution. The Reeds Spring, together with the Keokuk, underlies the uplands of the area. It is exposed only where streams have eroded deeply into the overlying Keokuk. Barren Fork, the Illinois River and its tributaries, Spring Creek and Double Spring Creek, afford excellent exposures. Rubble from the overlying Keokuk, which is highly fractured, masks the Reeds Spring-Keokuk contact at many places; therefore, the Reeds Spring and Keokuk have been mapped as a single unit.

Character and Thickness. The Reeds Spring formation consists of alternating beds of fine-grained, dense, thin-bedded limestone and dark-gray to blue-gray chert (fig. 12). The thin bedding is locally irregular, and some limestone beds are lenticular and are

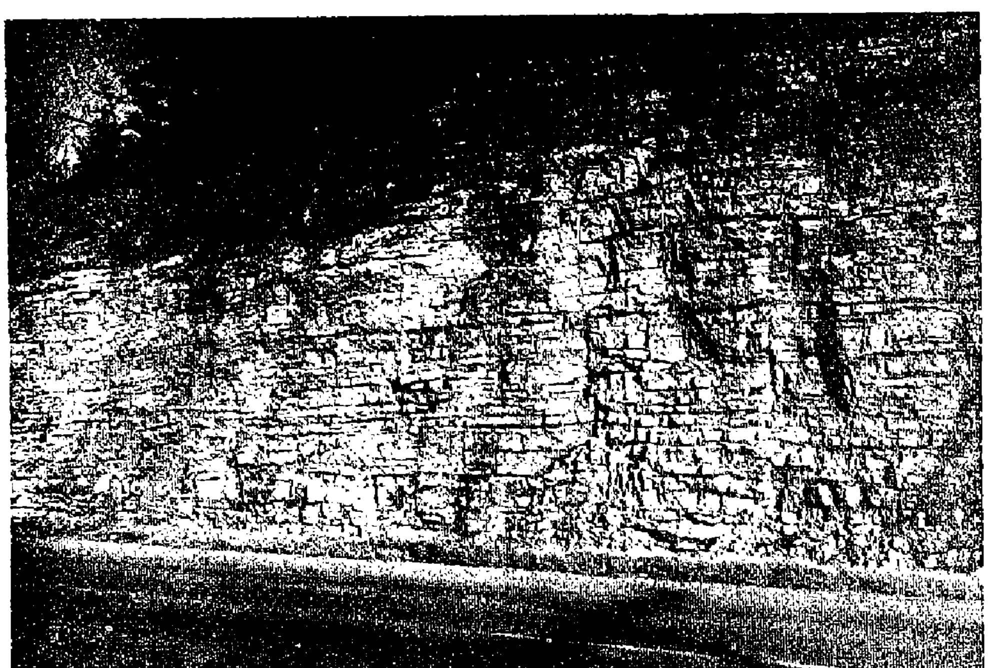

FIGURE 12. Reeds Spring formation exposed in road cut on State Highway 10. NE¼ sec. 23, T. 17 N., R. 22 E.

enclosed in chert. The cliffs formed by erosion in the resistant Reeds Spring are typically vertical to concave, and these cliffs are common throughout the area (fig. 11).

The Reeds Spring has a maximum thickness between 150 and 200 feet north of this area. Huffman (1958, p. 43) reported 175 feet several miles east of the area. It thins to approximately 100 feet in the Tahlequah vicinity where it is exposed along the Illinois River.

South of the area (T. 14 N., R. 24 E.) it thins to 50 feet and is absent in sec. 10, T. 13 N., R. 21 E. (Huffman, 1958, p. 44).

Stratigraphic Relationships. The Reeds Spring formation rests unconformably upon the St. Joe group and Noel black shale within the area and locally upon the St. Clair formation (Huffman, 1958, p. 44) south of the area. The Keokuk unconformably succeeds the Reeds Spring.

Paleontology. No fossils were collected in the course of this study. Cline (1934, p. 1144-1145) and Laudon (1939, p. 328) list *Marginatia fernglenensis* (Weller), *Favosites valmeyerensis* (Weller), *Schizophoria poststriatula* (Weller), *Spirifer carinatus* (Rowley), *Unispirifer vernonensis* (Swallow), and other species.

Age and Correlation. Moore (1928, p. 191) considered the Reeds Spring formation to be equivalent in age to part of the lower Burlington, but in 1933 (Cline, 1934, p. 1145) he revised this concept and classified it as pre-Burlington, Fern Glen in age.

KEOKUK FORMATION

History of Nomenclature. The Keokuk formation was named by Owen (1852, p. 91) from the town of Keokuk in southeastern Iowa. Girty (1915, p. 5) stated that the Boone of Arkansas ranges from Fern Glen to Warsaw in age; Moore (1928, p. 207) excluded the Warsaw from the Boone and applied the term Keokuk to late Osagean rocks in Missouri. He implied that it might be extended into Oklahoma, as indeed it was in 1939 by Laudon (p. 329), who applied the term "Keokuk" to the beds above the Reeds Spring.

Distribution. The Keokuk chert crops out over more than 80 percent of the area and forms the surface rock throughout much of the Springfield Structural Plain (Huffman, 1958, p. 44). It underlies the grassy prairies near Lowry and Moody. Its brecciated nature gives rise to a loose rubble which covers the areas of outcrop. Bed-rock exposures are few (fig. 13). Along the Illinois River, Barren Fork, and Spring Creek the Keokuk caps the bluffs formed by the Reeds Spring formation.

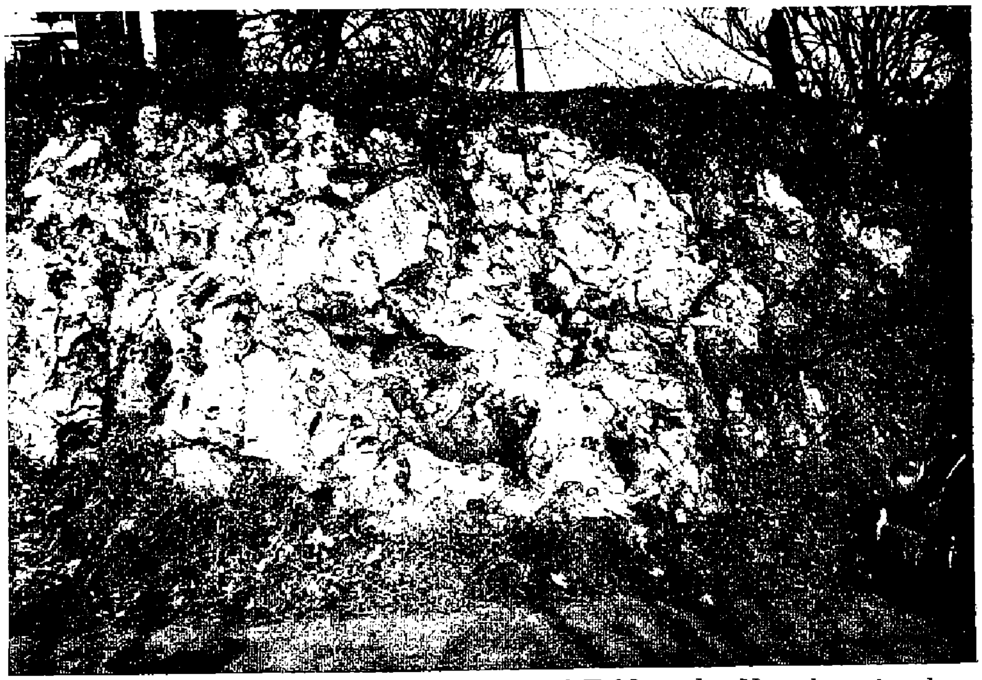

FIGURE 13. Keokuk exposure in the town of Tahlequah. Note brecciated appearance due to its highly fractured nature.

Character and Thickness. The Keokuk consists of massive, white to buff, gray-mottled, brecciated, fossiliferous chert. Irregular stringers and masses of blue-gray, dense, fine-grained limestone are present locally. The Keokuk exhibits tripolitic weathering.

The Keokuk averages 70 to 80 feet in thickness throughout the area, but ranges from zero to approximately 200 feet along Spring Creek.

Stratigraphic Relations. The unconformity between the Keokuk and the Reeds Spring represents most or all of Burlington time (Huffman, 1958, p. 45). Within the area the Keokuk formation is succeeded unconformably by the Moorefield and Hindsville formations. The erosion surface at the top of the Keokuk is one of considerable relief, and the Keokuk-Moorefield contact in NW¼ sec. 26, T. 17 N., R. 23 E., is readily apparent.

Paleontology. The Keokuk is abundantly fossiliferous and molds and casts are plentiful. The fauna collected consists of:

Anthozoa
- *Neozaphrentis* ? sp.

Bryozoa
- *Fenestella regalis* Ulrich
- *Fenestralia sanctaludovici* (Prout)
- *Polypora varsoviensis* Prout

Brachiopoda
- *Chonetes multicosta* Winchell
- *Antiquatonia? crawfordsvillensis* (Weller)
- *Dielasma* sp.
- *Orthotetes keokuk* (Hall)
- *Spirifer floydensis* (Weller)
- *Spirifer keokuk* (Hall)
- *Spirifer montgomeryensis* (Weller)
- *Spirifer mortonanus* (Miller)
- *Spirifer* sp. (internal mold)
- *Spirifer* sp. cf. *S. vernonensis*
- *Tetracamera subtrigona* (Meek and Worthen)

Trilobita
- *Phillipsia* sp. ?

Age and Correlation. Cline (1934, p. 1154) considered the Keokuk beds in Boone County, Arkansas, to be upper Burlington. Laudon (1939, p. 329) concluded that the Burlington is absent in Oklahoma and stated that the Keokuk fauna of Oklahoma resembles the faunal assemblage of the transition zone between Burlington and Keokuk at the type section at Keokuk, Iowa.

MAYES GROUP

Discussion. Snider (1915, p. 27) proposed the term "Mayes" for the "basal formation of the Chester Group" of northeastern Oklahoma embracing rocks between the Keokuk chert and the Fayetteville black shale. The unit was named for Mayes County, Oklahoma, where it crops out prominently.

Confusion and diversity of opinion developed concerning the relationship of the surface and subsurface Mayes. Buchanan (1927) correlated the "subsurface Mayes" with the Moorefield and Batesville formations of Arkansas and with a part of the Sycamore-Caney sequence of the Arbuckle area. Cline (1934, p. 1155) and Laudon

(1939, p. 338) supported him, but Selk (1948) considered the Sycamore of the Arbuckle area to be the equivalent of "subsurface Mayes" of Osagean age.

Huffman (1958, p. 48) elevated the Mayes of northeastern Oklahoma to group rank and subdivided it into the Moorefield and Hindsville formations. He further subdivided the Moorefield formation into four lithic units of member rank (see below).

MOOREFIELD FORMATION

History of Nomenclature. Adams, Purdue, and Ulrich (1904, p. 26) applied the term "Moorefield" to limestone and shale lying above the Boone "formation" at Moorefield, Arkansas. Gordon (1944, p. 1629) restricted the term "Moorefield" to the lower limestone (formerly Spring Creek member) and applied the term "Ruddell" to the upper brown shales. The term "Ruddell" has not been extended into Oklahoma and local terminology (Ordnance Plant member of the Moorefield formation) is used for its probable equivalent.

Huffman (1958, p. 49) subdivided the Moorefield into four members: the lower, glauconitic limestone or Tahlequah member; the argillaceous Bayou Manard member; the chert-pebble calcarenite facies of Lindsey Bridge member; and the Ordnance Plant

FIGURE 14. Mooretield formation on the Davis farm. SW¼ sec. 24, T. 19 N., R. 22 E.

siltstone and shale member. Inasmuch as these units are thin and generally absent in northeastern Cherokee County, they have not been differentiated nor mapped separately.

Distribution. The Moorefield formation is present as small outliers in the SE¼ sec. 32, T. 19 N., R. 21 E.; NW¼ sec. 7, T. 19 N., R. 23 E; SW¼ sec. 24, T. 19 N., R. 22 E. (fig. 14); NE¼ sec. 25, T. 17 N., R. 22 E.; and NW¼ sec. 26, T. 17 N., R. 22 E.

Character and Thickness. The Moorefield formation is thin within the area and is composed of black to dark gray limestones with interbedded brown to black, calcareous shales. The limestones vary from lithographic to coarse-crystalline; some are argillaceous. Locally nodules and stringers of chert have been weathered and leached to form a soft, porous, tan "cotton rock."

Stratigraphic Relationships. The Moorefield lies unconformably upon the "Boone" chert and occupies depressions upon the old erosional surface. On the Ward farm, draping of the Moorefield over the old Keokuk surface is well exposed (fig. 15). The contact is not exposed elsewhere.

Paleontology. The Moorefield is locally highly fossiliferous. The following fauna was collected at the Davis farm (SW¼ sec. 24, T. 19 N., R. 22 E.):

Bryozoa
- *Fenestella* sp.

Brachiopoda
- *Auloprotonia manardensis* (Sutton)
- *Leiorhynchus carboniferum* Girty
- *Moorefieldella eurekensis* (Walcott)
- *Spirifer arkansanus* Girty
- *Syringothyris textus* Hall

Pelecypoda
- *Edmondia* or *Sphenotus* (weathered mold)

Gastropoda
- *Bembexia nodimarginata* (McChesney)
- *Mourlonia* sp. ?

Age and Correlation. The Bayou Manard and Ordnance Plant members are developed locally within the area. The Bayou Manard member of the Tahlequah area is lithologically and faunally similar to the Moorefield (restricted) of the Arkansas section which

FIGURE 15. Draping of the Moorefield formation (Mm) across the uneven Keokuk (Mk) surface. NE¼ sec. 35, T. 17 N., R. 23 E.

Gordon (1944, p. 1631) correlated with the St. Louis limestone of the Mississippi Valley. Cloud and Barnes (1948, p. 52) correlated it with the lower part of the Barnett of Texas and Huffman (1958, p. 54) stated that it resembles the Ahloso (Elias, 1956, p. 60) member of the Caney shale of the Ada area.

On the basis of stratigraphic position and lithic similarity, the Ordnance Plant is tentatively correlated with the Ruddell shale of Arkansas (Huffman, 1958, p. 61), and with part of the Delaware Creek member of the Caney shale.

HINDSVILLE FORMATION

History of Nomenclature. Purdue and Miser (1916, p. 12) named the Hindsville formation for exposures near Hindsville, Arkansas. They regarded it as a calcareous member of the Batesville formation. Siebenthal (1907) recognized the Hindsville in Ottawa County, Oklahoma, and mapped it as a lower member of the Batesville. Reed, Schoff, and Branson (1955, p. 57) elevated the Hindsville to formational rank. Huffman (1958, p. 61) stated that the Grand River (preoccupied) formation of Brant (1941) is equivalent to the Hindsville.

Distribution. The Hindsville is present in a single outlier on the Ward farm (NE¼ sec. 25, T. 17 N., R. 22 E.) where it is approximately 20 feet thick.

Character and Thickness. The Hindsville is a gray, medium-crystalline, medium-bedded, fossiliferous limestone. It weathers to a soft, gray, crumbly, fossiliferous limestone.

Stratigraphic Relationships. At its outcrop within the area the Hindsville succeeds the Moorefield formation unconformably. Huffman (1958, p. 62) reported that the Hindsville rests upon several units of the Moorefield in Mayes, Wagoner, and Ottawa Counties.

The relationship of the Hindsville and the Fayetteville is one of conformity (Huffman, 1958, p. 63).

Paleontology. The Hindsville yielded abundant *Agassizocrinus conicus* (Owen and Shumard), *Aviculopecten batesvillensis* Weller, *Camarotoechia purduei* Girty, *Composita sulcata* Weller, *Composita trinuclea* (Hall), *Girtyella indianensis* (Girty), *Ovatia ovata* (Hall), *Inflatia adairensis* (Drake), *Punctospirifer transversus* (McChesney), and *Spirifer leidyi* Norwood and Pratten. A large fauna is listed by Huffman (1958, p. 64, 65).

Age and Correlation. Huffman (1958, p. 63) classed the Hindsville formation as early Chesterian in age, but precise correlation with the Illinois section was not attempted. He stated that the Hindsville of northeastern Oklahoma is equivalent to the lower part of the Batesville formation of southwestern Missouri and northwestern Arkansas.

QUATERNARY SYSTEM

ALLUVIUM AND TERRACE DEPOSITS

Deposits of Recent alluvium are present along the valley floor of the Illinois River, its tributaries, and along Spring Creek. Terrace deposits of well-rounded chert gravels are also present, but they have been so dissected by erosion and masked by colluvium that they are difficult to separate and map. Differentiation along the valley of the Illinois River proved to be most difficult, whereas Spring Creek and Barren Fork display well-defined terraces up to an estimated 40 feet thick. Taff (1906, p. 5) assigned these terrace deposits to the Pleistocene, and the alluvium to the Recent.

STRUCTURAL GEOLOGY

General Regional Geology

Northeastern Cherokee County is on the southwestern flank of the Ozark uplift. The extension of the Ozark uplift into Oklahoma is delineated by the Springfield Plain. The regional dip of two to three degrees to the south and southwest is interrupted by northeast-trending folds and faults which create steeper dips locally. These folds and faults are sub-parallel to the axis of the Ozark uplift and are visible where pre-Boone strata are exposed along river and stream valleys. The faults and folds disappear in the Keokuk-covered hills to the northeast and southwest.

Structural development throughout northeastern Oklahoma is closely associated with the development of the Ozark geanticline, which was active during Paleozoic time. Southward tilting in pre-Chattanooga time is evidenced by northward truncations of older units and overlap of the Chattanooga formation. Renewed southward tilting occurred in both pre-Hale and pre-Atoka time (Huffman, 1958, p. 89), although no evidence of this renewed southward tilting is present within this area.

Folding and faulting affect the entire sequence of rocks in the area with the exception of the Moorefield-Hindsville sequence, the outcrops of which are too restricted to determine their structural significance. Huffman (1958, p. 89) stated that the major deformation occurred during Pennsylvanian (Desmoinesian) time.

Stress is considered to have been largely tensional, instituted by the stretching of rock layers across the flanks of the positive Ozark structure during the loading of the McAlester basin in Middle Pennsylvanian time. Folding is primarily associated with these faults, but some folding is partly attributed to differential compaction.

Major Structures

South Muskogee Fault

The South Muskogee fault extends as far westward as Muskogee (Huffman, 1958, p. 92) and trends from there northeastward to a point one mile southeast of Tahlequah, where it disappears in the Keokuk-covered hills. It reappears on the Illinois River in sec. 26, T. 17 N., R. 23 E., where the Chattanooga, Fernvale, and Fite formations are against "Boone" cherts. From this point it is beneath the alluvium of the Illinois River, but again is evident in sec. 3, T. 17 N., R. 23 E., where the Chattanooga is in contact with the "Boone" chert. The fault is visible farther to the northeast in the center of sec. 35, T. 18 N., R. 23 E. where Reeds Spring and St. Joe limestones are in contact with Tyner shales. The fault is downthrown to the north with a maximum stratigraphic displacement of 250 to 300 feet.

DOUBLE SPRING CREEK FAULT

The Double Spring Creek fault extends from T. 17 N., R. 20 E., northeastward into T. 18 N., R. 22 E. and crosses the Illinois River at Eagle Bluff, exposing "Boone" cherts in contact with Tyner shales and dolomites. A small associated fault is present directly north of the main fault at Eagle Bluff and a graben is developed between the two. A complex of northeastward-trending faults in secs. 7, 8, and 18, T. 18 N., R. 23 E. is considered a continuation of the main fault as it disappears in T. 18 N., R. 23 E. This fault is downthrown to the north with a maximum stratigraphic displacement of 275 feet.

PUMPKIN CREEK FAULT (NEW NAME)

A fault at the mouth of Pumpkin Hollow (secs. 8 and 9, T. 17 N., R. 23 E.) parallels the South Muskogee fault and exposes the Fite, Fernvale, and Chattanooga formations in contact with Reeds Spring limestones, and cherts (fig. 16), and is here named the Pumpkin Creek fault. It is considered to be continuous with the fault in the east center of sec. 34, T. 18 N., R. 23 E., where the Chattanooga is in contact with "Boone" cherts. The fault is downthrown to the south and has a maximum stratigraphic displacement of 250 to 300 feet.

PUMPKIN CREEK GRABEN (NEW NAME)

A depressed area between the Pumpkin Creek fault to the north and the South Muskogee fault to the south is here named the Pumpkin Creek graben.

FIGURE 16. View of the Pumpkin Creek fault. Reeds Spring (Mkrs) is in contact with Fernvale (Ofe) and Chattanooga (MDc). Road cut, NW¼ sec. 9, T. 17 N., R. 23 E.

Miscellaneous Folds

The largest structure of anticlinal nature in the area is the anticline which elevates the top of the Burgen sandstone 100 feet above the Illinois River in sec. 31, T. 18 N., R. 23 E. The axis of the anticline strikes northeastward and plunges rapidly both to the northeast and southwest. Another northeastward-trending fold associated with the Double Spring Creek fault at Eagle Bluff exposes the Burgen in sec. 18, T. 18 N., R. 23 E. A parallel anticline with its axis striking through sec. 36, T. 19 N., R. 23 E. has exposures of Burgen sandstone and many exposures of Tyner along the Illinois River.

A northeast-trending anticline extending from sec. 19, T. 19 N., R. 21 E. to secs. 10 and 11, T. 19 N., R. 21 E., brings the Chattanooga formation to the surface along Spring Creek and the Chattanooga, Burgen, and Cotter formations along Bryant Hollow. In sec. 25, T. 19 N., R. 21 E., upon another fold of undetermined axial direction, is exposed the Cotter dolomite.

Many small undulations account for the discontinuous outcrops of the Chattanooga-St. Joe along Spring Creek and the Illinois River.

GEOLOGIC HISTORY

The geologic history of northeastern Cherokee County is closely related, as indeed is all of northeastern Oklahoma, to that of the Ozark geanticline, of which it is a part. During Paleozoic time the Ozark uplift persisted as a positive feature and during much of its history was sufficiently high to serve as a source (Ozarkia) for many of the clastics which accumulated around its flanks. Frequent oscillations, both to the north and south, and inundations by shallow seas were commonplace.

The Ozark uplift is a broad, elongate dome with its axis extending from the vicinity of Tahlequah through the St. Francois Mountains of eastern Missouri. In Oklahoma Ordovician and Mississippian strata dip gently to the southwest off the flanks of the uplift.

No Lower or Middle Cambrian sediments are present in the central interior of North America and sedimentary history began with Upper Cambrian seas advancing across the irregular Precambrian surface.

A post-Cambrian emergence was followed by inundation by Lower Ordovician seas. These clear seas deposited dolomites and limestones (Cotter in the area) and lapped against small Precambrian granite knobs near Spavinaw. Post-Cambrian regression of the seas left the Cotter to be eroded, and a karst topography was developed.

Late Chazyan seas advanced across the land surface, and the Burgen sandstone was deposited as the normal basal sand in a transgressive sea. Sinks and depressions were filled in the old Cotter erosional surface. Burgen sandstones were gradually replaced by Tyner shales and dolomites during late Chazyan time. If a stratigraphic break is present at the base of the middle Tyner, as suggested by Cram (1930, p. 19), it represents the withdrawal of late Chazyan seas.

In early Blackriveran time Tyner shales, sandstones, and dolomites were deposited. In late Blackriveran time the seas cleared and Tyner type of deposition gave way to that of the lithographic limestone of the Fite.

At the close of Blackriveran time the seas once again retreated and the area remained positive until Late Ordovician time. Richmond seas deposited the fossiliferous, coarsely crystalline Fernvale limestone and the succeeding Sylvan shale.

It is impossible to determine whether or not Silurian and Devonian seas inundated the area inasmuch as the sediments are absent, due either to erosion or to non-deposition, although the former seems more probable. Silurian-Devonian rocks are well developed in the Marble City area to the south.

In Late Devonian time, northeastern Oklahoma was tilted to the south and extensive erosion beveled the pre-Chattanooga units from south to north.

Late Devonian and Early Mississippian seas advanced across the area and the Sylamore sandstone was deposited in low areas where sediments were available. This sandstone is erratic in distribution and contains phosphatic pebbles. Euxinic conditions followed and the pyritic Noel black shale which was deposited is typical of Late Devonian-Early Mississippian deposition throughout the central interior of North America.

After a short interval of erosion a warm, clear, relatively shallow sea invaded the area, depositing the basal units of the St. Joe limestone; then it withdrew. This withdrawal of the sea marks the close of Kinderhookian time. The seas again invaded the area in Osagean time and the remainder of the St. Joe limestone was deposited. Bioherms were commonplace in the clear, warm seas.

After deposition of the St. Joe limestone, a brief period of erosion followed and once more the land was inundated by the Osage seas, which deposited the Reeds Spring chert and limestones. A delicate balance between calcium carbonate and silica is visualized in the Reeds Spring seas. Chert and limestone were alternately precipitated as the pH factor of the solution varied.

Keokuk seas deposited thick crinoidal limestones, which were later replaced by silica. Chert pebbles in the overlying Moorefield (Smith, 1952, p. 92) indicate that the Keokuk was silicified prior to Meramecian deposition. Bioherms were common in the seas and have been reported outside the area.

At the close of the Osagean epoch, northeastern Oklahoma was uplifted and tilted to the north. An erosional surface of notable relief developed on the Keokuk surface, and farther south the Osage group was completely removed.

Meramec seas inundated the area and a basal deposit of coarsely crystalline, glauconitic, crinoidal limestone of the Tahlequah member was deposited in depressions on the weathered Keokuk surface. As the Moorefield sea advanced northward about the flanks of the Ozark uplift, marine waters became muddy, and argillaceous limestones and shales of, the Bayou Manard member succeeded the Tahlequah member. The Bayou Menard member overlaps the Tahlequah member to the north (Huffman, 1958, p. 108) and lies unconformably upon the Keokuk.

Post-Moorefield erosion was short-lived and the Hindsville limestone was deposited upon the eroded Moorefield surface and upon the Keokuk chert. The Hindsville grades northeastward into its near-shore facies, the Batesville sandstone.

Late Mississippian seas deposited the Fayetteville shale and Pitkin limestones. Southward tilting of the Ozark area at the close of Pitkin time and subsequent erosion truncated the sediments toward the north, and Pennsylvanian seas deposited the Hale, Bloyd, Atoka, Hartshorne, and McAlester formations across the beveled surface.

In Middle Pennsylvanian time the Ozark uplift was elevated. Due to simultaneous loading in the McAlester basin, and associated stretching of strata across the positive Ozark geanticline, faulting occurred across the area essentially paralled to the axis of the Ozark uplift.

Widespread upland gravels were deposited during Pleistocene time (Huffman, 1958, p. 109). The two distinct terrace levels above the Grand and Arkansas Rivers indicate several "pulsations" of uplift followed by erosion.

ECONOMIC GEOLOGY

Numerous oil and gas shows have been reported from water wells in the Tahlequah area over the past several decades, but no successful attempt has been made to produce either. The fact that the possible reservoir rocks crop out at short distances from prospective producing structures minimizes the possibility of economic accumulation of oil or gas because of water flushing and escape. The possibility of minor gas production should not be overlooked, however, and Tahlequah would constitute an ideal market, since at present it is using butane.

Potential reservoir rocks include the Burgen formation, Tyner sandstone, and the Sylamore sandstone. Source rocks include the Tyner shales and Noel black shale.

Crinoidal limestones in the St. Joe group along the Illinois River and Spring Creek offer a possible source of high-calcium limestone.

Unlimited quantities of rounded chert gravels are available along the Illinois River, Barren Fork, and Spring Creek. These are quarried extensively for road construction at the present time.

Little satisfactory building stone is available within the area, although many of the local homes are faced with cobbles and boulders of "Boone" chert. Some of the limestones in the Moorefield formation have been utilized for road culverts, but the availability and quantity are limited.

Although several reports of galena were heard of by the writer, no deposits were discovered.

Numerous springs at the base of the "Boone" were encountered throughout the area, but lack of natural filtration in the highly fractured and porous chert makes careful analysis mandatory before the water is considered suitable for human consumption. The Illinois River affords a potential source of future hydroelectric power.

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APPENDIX

MEASURED SECTIONS

1. Road cut at junction of highways 62, 51, and 10, NE¼ sec. 26, T. 17 N., R. 22 E.

	Feet	Inches
MISSISSIPPIAN:		
Reeds Spring (50 feet, estimated):		
Chert and limestone sequence; chert, thin-bedded, light to dark-gray; limestone, thin, even-bedded, light-gray	50	0
St. Joe (2 feet, 6 inches):		
Shale, clayey, greenish-brown	0	4
Limestone, massive-bedded, gray, crystalline	2	1
Limestone, gray, soft	0	1
Chattanooga (35 feet exposed):		
Noel:		
Shale, black, fissile, pyritic, cone-in-cone structure common; base covered	35	0

2. East bank of Illinois River, SE¼ sec. 7, T. 18 N., R. 23 E.

	Feet	Inches
MISSISSIPPIAN:		
Reeds Spring (20 feet, estimated):		
Chert and limestone sequence	20	0
St. Joe (5 feet, 8 inches):		
Shale, soft, light-green to yellow, iron stained	0	4
Limestone, crystalline, gray-spotted, staining due to limonite after pyrite	2	9
Shale, soft, gray	1	0
Limestone, dense, light-gray pyritic, abundant *Amplexizaphrentis*; upper 5 inches and lower 7 inches shaly	1	7
Chattanooga (10 feet exposed):		
Noel:		
Shale, black, fissile; base covered	10	0

3. Upper part of stream, NE¼ NE¼ sec. 18, T. 18 N., R. 23 E.

	Feet	Inches
MISSISSIPPIAN:		
Reeds Spring:		
Chert and limestone sequence; not measured		
St. Joe (9 feet, 8 inches):		
Limestone, gray even-bedded in 3- to 4-inch layers with shale partings	1	0
Limestone, gray, soft, forms recess	0	5
Limestone, gray, crinoidal, forms 6-inch beds	2	3
Limestone, shaly, gray	5	10
Shale, soft, yellow-green	0	2
Chattanooga (30 feet, 6 inches):		
Noel (30 feet):		
Shale, black, fissile, pyritic; estimated	30	0
Sylamore (6 inches):		
Sandstone, black	0	6
ORDOVICIAN:		
Tyner:		
Shale, green and yellow, exposed sporadically; not measured		

4. Stream bed in Black Foa Hollow, SE¼ sec. 11, T. 19 N., R. 23 E.

	Feet	Inches
MISSISSIPPIAN:		
Chattanooga:		
Noel:		
Shale, fissile, black pyritic; not measured		
Sylamore (1 foot, 7 3/4 inches):		
Sandstone, black with white, salt and pepper appearance, hard, pyritic	0	3
Shale, black, fissile	0	2½
Sandstone, as above	0	4¼
Shale, black, sandy, forms ledges	0	6
Sandstone, black, medium-grained, weathers smooth with small pits	0	4
ORDOVICIAN:		
Tyner:		
Sandstone, shaly, yellow with black mottling; not measured		

5. Creek bed, SW¼ NE¼ sec. 12, T. 18 N., R. 22 E.

	Feet	Inches
MISSISSIPPIAN:		
Chattanooga:		
Noel:		
Shale, black, fissile, pyritic; not measured		
Sylamore (1 foot, 7½ inches):		
Sandstone, gray to black, coarse-grained, salt and pepper	0	2
Shale, black, fissile	0	2½
Sandstone, gray to black, coarse-grained, salt and pepper	0	4
Sandstone, as above with middle 2 inches slightly shaly	0	7½
Sandstone, shaly, coarse-grained, gray to black, salt and pepper	0	3½
ORDOVICIAN:		
Tyner:		
Siltstone, gray-green; base covered, not measured		

6. Junction of Black Fox Creek and Illinois River, NW¼ sec. 24, T. 19 N. R. 23 E.

	Feet	Inches
MISSISSIPPIAN:		
Reeds Spring:		
Chert and limestone sequence; not measured		
St. Joe (16 feet, 2½ inches):		
Limestone, dark-gray, shaly, crystalline	0	2
Limestone, buff, fine-grained, pyritic	0	7
Limestone, buff, sublithographic, pyritic	0	4
Covered	0	2
Limestone, dark-gray, crystalline, pyritic	1	½
Limestone, light-gray, crystalline	0	8
Limestone, light-gray, shaly, soft	0	7
Limestone, light-gray, compact; weathers unevenly	0	11
Shale, light-gray to light-green, calcareous	1	0
Covered, probably shale as above	5	4
Limestone, dark-gray, nodular weathering, compact	5	5

Chattanooga (73 feet, 9¼ inches):		
Noel (71 feet, 7 inches):		
Shale, black, fissile, pyritic	71	7
Sylamore (2 feet, 2¼ inches):		
Sandstone, dark-gray to light-gray and brown, coarse-grained, salt and pepper; some pebbles	0	4
Sandstone, black, coarse-grained, well-cemented; much iron staining, weathers to form ledge	0	2
Sandstone, black, soft, shaly	0	2¾
Shale, black, fissile	0	1½
Sandstone, black, coarse-grained, salt and pepper; weathers brown, contains numerous plant molds and some casts	0	4
ORDOVICIAN:		
Tyner (3 feet exposed):		
Shale, soft, gray-green with black mottling; base covered	3	0

7. *North bank of Spring Creek, SE¼ sec. 25, T. 19 N., R. 21 E.*

	Feet	*Inches*
MISSISSIPPIAN:		
Reeds Spring:		
Chert and limestone sequence; not measured		
St. Joe (14 feet, 7 inches):		
Limestone, dark-gray, shaly, nodular weathering; chert nodules	0	6
Limestone, brown to dark-gray, coarsely crystalline, glauconite	0	4
Limestone, gray, dense, massive, crystalline; pyrite nodules up to ¼ inch	2	7
Shale, soft, calcareous, gray to light-green; some thin limestone beds	5	0
Limestone, crystalline, light-gray to cream, nodular weathering, glauconitic, pyritic; thin shale partings	6	0
Shale, black to gray; iron staining	0	2
Chattanooga:		
Noel (10 feet exposed):		
Shale, black, fissile, pyritic; base covered	10	0

8. *Hanging Rock, west bank of Illinois River, NW¼ sec. 5, T. 18 N., R. 23 E.*

	Feet	*Inches*
MISSISSIPPIAN:		
Keokuk:		
Chert, white, massive, fractured; not measured		
Reeds Spring:		
Chert and limestone sequence; not measured		
St. Joe (17 feet, 10¼ inches):		
Limestone, light-gray, dense, crystalline, nodular weathering	3	0
Limestone, dark-gray, dense, crystalline, pyritic	1	2
Siltstone, shaly, calcareous; weathers into soft, shaly blocks	0	5
Limestone, light- to dark-gray, shaly, pyritic	0	10
Shale, light-green, soft	0	2
Limestone, gray, crystalline, pyritic; shale partings	0	4½
Limestone, dark-gray, crystalline, pyritic, nodular weathering	3	7
Shale, light-gray, soft	0	¼
Limestone, dark-gray to black, crystalline, nodular weathering	2	4

	Feet	Inches
Chattanooga:		
Noel (10 feet exposed):		
Shale, black, fissile, pyritic; base covered	10	0

9. *Slope in hollow, SW¼ sec. 32, T. 19 N., R. 23 E.*

	Feet	Inches
MISSISSIPPIAN:		
Chattanooga:		
Noel:		
Shale, black, fissile; not measured		
Sylamore (5¾ inches):		
Sandstone, gray, salt and pepper	0	4¼
Sandstone, black, coarse-grained	0	1½
ORDOVICIAN:		
Tyner (4 feet exposed):		
Shale, green and gray, soft; base covered	4	0

10. *South side of Waterfall Hollow, north center sec. 22, T. 19 N., R. 23 E.*

	Feet	Inches
MISSISSIPPIAN:		
Reeds Spring:		
Chert and limestone sequence; not measured		
St. Joe (12 feet, ½ inch):		
Limestone, dark-gray, crystalline, glauconite; weathers into thin plates	0	10
Limestone, dark-gray, crystalline, glauconitic	0	9
Limestone, light- to dark-gray	1	5½
Shale, light-gray, soft	0	1
Limestone, light-gray; pyrite nodules partially altered to limonite where weathered	0	4
Limestone, gray, shaly	0	3½
Limestone, light-gray, crystalline, pyritic; 1 inch of light-gray shale in middle	0	7½
Covered, probably shale	4	8
Limestone, crystalline, massive, gray; weathers into ledge	1	6
Limestone, gray, crystalline, nodular weathering	1	6
Chattanooga (67 feet, 3 inches):		
Noel (64 feet, 10 inches):		
Shale, black, fissile, pyritic	64	10
Sylamore (2 feet, 5 inches):		
Sandstone, gray, coarse-grained; salt and pepper appearance	0	8
Shale, black, fissile	0	½
Sandstone, gray to dark-gray, coarse-grained, salt and pepper	0	6
Shale, black, fissile	0	1
Sandstone, black to white and yellow; conglomerate at base	1	1½
ORDOVICIAN:		
Tyner (11 feet, 5 inches exposed):		
Shale, orange, dolomitic; bands of crystalline dolomite	0	2½
Dolomite, shaly, light-gray with green and yellow mottling; orange bands of crystalline dolomite	1	3
Shale, dolomitic, buff with black mottling	0	4
Dolomite, fine-grained, earthy, buff, with bands of crystalline dolomite	1	10
Shale, gray and buff, dolomitic, soft	1	2½
Covered	2	0

	Feet	Inches
Dolomite, light-gray and buff	0	2
Dolomite, light-gray and brown with black markings	0	11
Shale, gray and orange, dolomitic	0	3
Dolomite, light-gray, fine-grained, sandy	0	7
Dolomite, dark-gray with small chocolate-brown sand lenses, crystalline	1	2
Shale, gray with thin buff banding, soft; base covered	1	6

11. Creek flowing into Spring Creek, SE¼ sec. 25, T. 19 N., R. 21 E.

	Feet	Inches
MISSISSIPPIAN:		
Chattanooga:		
Noel:		
Shale, black, fissile; not measured		
Sylamore (1 inch):		
Shale, brown, earthy; grades upward into black, fissile shale	0	1
ORDOVICIAN:		
Burgen (1 foot, 2 inches):		
Quartzite, white to black, salt and pepper	1	2
Cotter (6 feet, 4 inches):		
Shale, yellow to brown, soft; contains organic matter; grades laterally into sand, coarse-grained, siliceous cement	0	4
Dolomite conglomerate; contains chert fragments and pebbles of light-green, soft shale	1	0
Dolomite conglomerate, gray to buff; abundant light-gray, vitreous chert in fragments; weathers into highly irregular masses and grades laterally into the overlying quartzite and/or conglomerate	5	0

12. Second hollow south of Camp Egan on Federal Highway 62, C sec. 14, T. 17 N., R. 23 E.

	Feet	Inches
MISSISSIPPIAN:		
Reeds Spring:		
Chert and limestone sequence; not measured		
St. Joe (4 feet, 3½ inches):		
Limestone, gray, dense, nodular weathering	0	6
Limestone, dark-gray, crystalline, fossiliferous, pyritic	0	2½
Covered, probably shale	0	2
Limestone, dark-gray, coarse-crystalline, glauconitic, pyritic; abundant crinoid stems	0	7
Limestone, gray, crystalline, pyritic; crinoid stems	1	11
Shale, gray, brown to black	0	11
Chattanooga:		
Noel (11 inches exposed):		
Shale, black, fissile; base covered	0	11

13. Camp Egan, NW¼ sec. 13, T. 17 N., R. 23 E.

	Feet	Inches
MISSISSIPPIAN:		
Reeds Spring:		
Chert limestone sequence; not measured		

St. Joe (3 feet):		
Limestone, gray, crystalline, glauconitic; abundant crinoid stems; top 2 inches shaly	1	2
Limestone, gray, crystalline, glauconitic; abundant crinoid stems; shaly at base	0	4
Limestone, as above; shaly at base	0	6
Limestone, light-gray, fine-grained; no fossils, nodular weathering	0	8
Shale, brown to black	0	4
Chattanooga (39 feet, 6½ inches):		
Noel (39 feet, 5 inches):		
Shale, black, fissile	39	5
Sylamore (1½ inches):		
Sandstone, black to red, poorly sorted, conglomeratic; iron cement, pebbles up to 1 x ¼ inches; thickness from zero to a maximum of	0	1½
ORDOVICIAN:		
Fernvale (3 feet, 9 inches):		
Limestone, buff, crystalline, dirty, glauconitic; fills small irregularities in limestone beneath	1	10
Limestone, buff, crystalline, fossiliferous; calcite crystals	1	5
Limestone, as above, filling cavities in limestone beneath it	0	6
Fite (10 feet, 1 inch):		
Limestone, brownish-gray with buff markings, sub-lithographic, glauconitic	0	6
Limestone, light-gray, lithographic, calcite crystals; top 2 inches nodular weathering	1	1
Limestone, gray, lithographic; calcite crystals; nodular weathering; lower 1 inch weathers rough	0	4
Limestone, lithographic; gray with buff markings; calcite crystals	0	7
Limestone, lithographic; gray with buff markings, calcite crystals; massive except for upper foot which is nodular weathering	3	4
Limestone, buff to gray, sub-lithographic	1	5
Limestone, gray, lithographic; calcite crystals	1	11½
Covered, recess	0	½
Limestone, gray, lithographic; calcite crystals	0	10
Tyner (7 feet, 6 inches exposed):		
Dolomite, buff to gray, fine-crystalline	2	0
Dolomite, buff, fine-crystalline	1	3
Dolomite, buff to gray, fine-crystalline, massive; covered to base	4	3

14. South end of Barren Fork bridge, C sec. 27, T. 17 N., R. 23 E.

	Feet	*Inches*
MISSISSIPPIAN:		
Chattanooga:		
Sylamore (1 foot, 3 inches):		
Sandstone, pink, red, white, and yellow, salt and pepper, case hardened	1	3

	Feet	Inches
ORDOVICIAN:		
Fernvale (12 feet, 6 inches):		
Limestone, coarse - crystalline, fossiliferous; abundant *Lepidocyclus capax, Plaesiomys subquadrata, Austinella kankakensis*	12	6
Fite (9 feet, 8 inches exposed):		
Limestone, gray with buff markings, lithographic; calcite crystals; base covered in river	9	8

15. Eagle Bluff, SW¼ sec. 13, T. 18 N., R. 22 E.

	Feet	*Inches*
MISSISSIPPIAN:		
Keokuk:		
Chert, white, massive, fractured; not measured		
Reeds Spring (70 feet):		
Chert and limestone sequence	70	0
St. Joe (28 feet, ½ inch):		
Limestone, light-gray, crystalline, pyritic; many broken crinoid stems; shale partings up to 1 inch thick	15	6½
Limestone, dark-gray, shaly, concentric-weathering	1	4
Limestone, light- to dark-gray, crystalline, shaly to massive, fossiliferous, nodular-weathering; interbedded shale is calcareous, gray to light-green	11	2
Chattanooga (39 feet, 7¾ inches):		
Noel (39 feet, 1 inch):		
Shale, black, fissile, pyritic; cone-in-cone structure common	39	1
Sylamore (6¾ inches):		
Conglomerate, shaly; phosphatic pebbles up to 2 inches in diameter, ferruginous cement	0	2
Sandstone, gray to black, coarse-grained; salt and pepper appearance	0	1½
Conglomerate, coarse-grained matrix of ferruginous cement, phosphatic pebbles	0	¾
Shale, brown, dirty	0	½
Chert nodules and buff dolomite pebbles	0	2
ORDOVICIAN:		
Tyner (78 feet, 6½ inches):		
Dolomite, buff; large pieces of white to gray chert in basal foot	2	2
Dolomite, gray to buff; dense, quartz crystals up to ¼ inch in vugs	1	7
Dolomite, light gray, very fine-grained; color banding of gray and brown	1	1
Dolomite, light-gray to buff	1	2½
Sandstone, gray to green, soft	0	3
Sandstone, green, pyritic; veins of black quartz crystals; outcrop weathers to dark brown	0	10
Shale, light-green, silty, concentric-weathering	1	0
Shale, light-green	0	9
Dolomite, buff to light-gray, pyritic	1	9
Shale, gray to green, pyritic, sandy streaks	1	0
Dolomite, light-gray, pyritic; weathers buff	1	½
Shale, gray-green to olive green, silty; concentric-weathering up to 1 foot in diameter; grades into dolomite above	4	9

Dolomite, buff; pyrite nodules	1	0
Shale, dark-green, concentric-weathering	1	3
Shale, buff to olive-green, pyritic; interbedded with sandy brown dolomite	6	1
Shale, olive-green, dolomitic, concentric-weathering; more massive and buff near top	2	4½
Sandstone, black, coarse-grained; buff dolomite pebbles and green shale interbedded throughout	0	8
Dolomite, buff, shaly, pebbly; forms lower dolomite	0	7
Dolomite, buff, massive, with brown sandy dolomitic streaks; upper 6 inches sandy	3	6
Siltstone, light-green; concentric weathering up to 6 inches in diameter	1	0
Shale, dark-green	0	3½
Shale, olive-green, silty; concentric to blocky weathering	0	6
Shale, dark-green, dolomitic, concentric-weathering	3	10
Dolomite, buff with dark-brown sandy banding	1	7
Dolomite, buff to green, sandy, shaly	0	3
Shale, olive-green, dolomitic, concentric-weathering	0	9
Shale, olive-green to buff, sandy, dolomitic	0	11
Shale, olive-green to dark-green, dirty; thin sandy beds display mud-crack fillings	4	8
Shale, olive-green to buff, dolomitic; upper 1 inch dark-green; thin buff dolomite beds forming one-foot thick ledges	5	7
Shale, dark-green; weathers into smooth slope	7	1
Dolomite, buff, shaly; brown, crystalline dolomite bands	1	0
Shale, dark-green	0	5
Shale, buff, dolomitic	0	5
Shale, dark-green	0	3
Dolomite, buff, fine-crystalline	0	3
Dolomite, buff, shaly, soft, earthy	0	6
Shale, dark-green	1	0
Dolomite, buff, earthy	0	3
Dolomite, buff with gray banding, fine-crystalline, sandy	0	2½
Shale, gray-green, soft	0	1½
Sandstone, buff with gray-green banding, dolomitic	0	2
Shale, dark gray-green; weathers into small pieces	0	7
Sandstone, mottled buff and dark-gray to green, dolomitic	1	11
Shale, dark-gray, brittle	0	8
Sandstone, fine-grained, dolomitic; thin banding of dark gray, medium-grained sandstone	1	5
Shale, light-green, dolomitic, sandy; weathers shaly and blocky	2	2
Sandstone, light-gray, fine-grained, dolomitic; irregular bedding; weathers gray and buff	0	9
Shale, light gray-green, dolomitic, sandy	0	4
Sandstone, light-gray to white, fine-grained, dolomitic; weathers buff with light-gray banding; some light-gray sandy shale streaks	5	10½
Shale, dolomitic, sandy, light gray-green	0	4
Sandstone, white, fine-grained, dolomitic; weathers rough and buff; base covered	0	7

16. Mouth of Pumpkin Hollow, NW¼ sec. 9 and SW¼ sec. 4, T. 17 N., R. 23 E.

	Feet	Inches
MISSISSIPPIAN:		
Reeds Spring:		
Chert and limestone sequence; not measured		
St. Joe (10 feet, 10½ inches):		
Limestone, dark-gray, coarse-crystalline, shaly, glauconitic, nodular-weathering	0	6
Limestone, dark-gray, coarse-crystalline, glauconitic	0	2
Covered	0	4
Limestone, light-gray, nodular-weathering	3	0
Covered	1	7½
Limestone, light-gray, pyritic	1	0
Covered	2	11
Limestone, light-gray, nodular-weathering	0	4
Shale, green; grades into black shale below	1	0
Chattanooga (28 feet, 1½ inches):		
Noel (27 feet, 11 inches):		
Shale, black, fissile, pyritic	27	11
Sylamore (2½ inches):		
Sandstone, white to yellow, coarse-grained; salt and pepper appearance	0	2½
ORDOVICIAN:		
Fernvale (9 feet):		
Limestone, light to dark-gray, coarse-crystalline, fossiliferous	9	0
Fite (14 feet, 6½ inches):		
Limestone, brownish-gray, lithographic, calcite crystals; thin buff banding	5	4
Limestone, light-gray to buff, lithographic to sub-lithographic; calcite crystals	1	5
Dolomite; buff at base, grades into light-gray, lithographic limestone with calcite crystals	1	3
Dolomite, buff; interbedded with light-gray, lithographic limestone	0	4
Dolomite, buff	1	2
Dolomite, buff, fine-grained; top 1 inch light-gray lithographic limestone	1	6
Limestone, light-gray, lithographic; calcite crystals	2	7
Limestone, light-gray, lithographic; calcite crystals	0	11½
Tyner (45 feet, 9¾ inches exposed):		
Dolomite, dark-gray, crystalline; upper 4 inches buff	3	0
Dolomite and interbedded chert; dolomite is crystalline, dark-gray; chert is white, gray to buff	1	6
Dolomite and chert nodules; dolomite gray; chert gray to white	0	6
Dolomite, chocolate brown, massive, calcareous	1	10
Sandstone, fine-grained, buff to white and green; large well-rounded sand grains throughout	2	0
Shale, dark green, brittle	0	5½
Siltstone, buff, shaly	0	5½
Siltstone, buff, concentric-weathering; basal foot shaly	4	2
Siltstone, buff, concentric-weathering	1	2
Silestone, buff, concentric-weathering	2	3
Siltstone, green; weathers blocky	0	8

	Feet	Inches
Sandstone, gray-green, shaly	0	4
Sandstone, light-gray	0	7
Shale, green to dark-green; brittle 2-inch ledge of siltstone in center	3	1
Dolomite, buff, sandy; crystalline dolomite in veins; shaly in upper 6 inches	1	1
Sandstone and interbedded siltstone; sandstone is light-green; siltstone light-green, weathers blocky	2	9
Shale, light-green, sandy, hard; weathers into small pieces	2	7
Dolomite, buff, sandy, shaly; upper 6 inches sandy, forms ledge	1	5
Dolomite, buff, sandy	3	4
Siltstone, light-green, medium-grained; well-rounded sand grains; several interbedded beds of soft iron-stained shale	1	5
Shale; grades from dark-green at top to light-green at base, concentric-weathering	7	4
Sandstone, yellow to brown, interbedded white sandstone; merges into overlying shale	0	4
Sandstone, yellowish-brown, with interbedded bands of white, coarse-grained sandstone	0	6¾
Shale, green, soft; base covered	3	0

17. State Highway 10 at Sparrowhawk Mountain SE¼ sec. 12, T. 17 N., R. 22 E.

	Feet	*Inches*
MISSISSIPPIAN:		
Keokuk:		
Chert, white, highly fractured; not measured		
Reeds Spring (120 feet):		
Chert and limestone sequence; chert, white, thin-bedded; limestone, gray, irregularly bedded	120	0
St. Joe (3 feet, 10 inches):		
Limestone, light-gray, fine- to medium-crystalline, pyritic, nodular-weathering	3	1
Shale, grayish-green	0	9
Chattanooga (32 feet, 6 inches):		
Noel (31 feet, 2 inches):		
Shale, black, fissile, pyritic	31	2
Sylamore (1 foot, 4 inches):		
Sandstone, black to brown, coarse-grained, hard to soft; iron staining	0	6
Conglomerate, brown to black, calcareous; iron cement; maximum of	0	5
Shale, black, sandy; upper 4 inches brown and soft, resembling old soil	0	5
ORDOVICIAN:		
Fernvale (6 feet, 3 inches):		
Limestone, dark-gray, coarse-crystalline, fossiliferous, massive- to nodular-weathering	6	3
Fite (16 feet, 11 inches):		
Limestone, gray, lithographic; calcite crystals; nodules and bands of coarse-grained, yellow and brown sandstone	1	3
Limestone, gray, lithographic; calcite crystals	2	2
Limestone, dark-gray, lithographic; calcite crystals; thin bands of buff and darker gray limestone	1	1

Limestone, light-gray, lithographic; calcite crystals	4	8
Limestone, light-gray, lithographic, massive; calcite crystals	1	1
Limestone, light-gray, lithographic, thin-bed-; ded; calcite crystals	0	7
Limestone, light-gray with buff markings, sub-		
Limestone and interbedded dolomite	5	7
lithographic; fractures blocky	0	6
Tyner (9 feet, 7½ inches exposed):		
Dolomite, buff, massive, with black and gray dolomite crystals, black mottled	0	10
Dolomite, gray, crystalline, dense, with gray chert nodules and fragments	1	0
Sandstone, black	0	2
Dolomite, brown, fine-grained, massive	0	7
Dolomite, brown; weathers blocky	0	6
Shale, brown, soft; resembles old soil	0	3½
Shale, soft, black	0	2
Sandstone, white, coarse-grained, with green shale or glauconite streaks; brown dolomite in places in upper 6 inches	1	6
Sandstone, white with tan streaks, coarse-grained; grades into underying shale	0	4
Shale, green	0	3
Dolomite, brown, soft, earthy; base covered	4	0

18. *State Highway 10 at Loosier School, C east line, sec. 35, T. 18 N., R. 22 E.*

	Feet	*Inches*
MISSISSIPPIAN:		
Chattanooga:		
Noel (33 feet):		
Shale, black, fissile, pyritic	33	0
Sylamore:		
Covered, if present		
ORDOVICIAN:		
Fernvale (1 foot, 1 inch):		
Limestone, gray with brown speckling, coarse-crystalline; chert fragments in basal 6 inches	1	1
Fite (17 feet, 8 inches):		
Limestone, light-gray, lithographic; calcite crystals	7	6
Dolomite, buff to pink, massive	1	5
Limestone, light-gray with buff markings, lithographic; middle sub-lithographic	1	3
Dolomite, buff, hard; dark-brown splotches	2	2
Limestone, light-gray, lithographic; calcite crystals	0	8
Dolomite, gray; middle has 2-inch thick light-gray, lithographic limestone	1	9
Dolomite and limestone sequence; dolomite, buff; limestone is lithographic to sub-lithographic, with light-gray calcite crystals	2	11
Tyner (37 feet, 10 inches exposed):		
Dolomite, buff, with bands of white to gray chert	0	8
Dolomite, black, crystalline; fills small holes in underlying unit	0	3
Dolomite, light- to dark-gray	1	2
Sandstone, coarse, frosted, well-rounded; glauconitic shale pellets; upper part grades into dark-gray dolomite	1	4

Shale, green with yellow iron staining	0	2
Siltstone, light grayish-green, blocky-weathering	0	8
Siltstone, light gray-green, dolomitic, blocky-weathering; lower 4 inches shaly	1	2
Dolomite, buff to gray, knobby-weathering; small black dendrites	1	5
Shale, dark-green, brittle, pyritic; black markings	0	10
Dolomite, buff, nodular-weathering	0	4
Shale, buff to light-green, soft	5	1
Dolomite, light-green and buff, sandy, shaly, shaly-weathering; buff and massive in upper 9 inches	1	8
Shale, light- to dark-green	3	8
Sandstone, white to buff, coarse-grained, dolomitic	0	9
Shale, greenish-gray, with alternating stringers of coarse-grained white sand in upper 10 inches	2	7
Sandstone, buff, dolomitic, salt and pepper	0	5
Shale, dark-green, brittle	2	0
Sandstone, green, shaly	0	6
Sandstone, white with brown and green banding, coarse-grained; some interbedded green shale	0	2
Dolomite, buff to yellow, somewhat shaly, nodular-weathering; round sand fillings	1	0
Dolomite, buff, massive	4	7
Shale, light-green	0	10
Dolomitic, buff, ledge-forming	0	7
Shale, light-green, sandy; some concentric weathering	1	2
Siltstone, mottled green and brown, sandy	0	7
Shale, dark-green, brittle; base covered	4	3

19. Waterfall on Waterfall Creek, C S½ sec. 15, T. 19 N., R. 23 E.

	Feet	*Inches*
MISSISSIPPIAN:		
Chattanooga:		
Noel:		
Shale, black, fissile, pyritic; not measured		
Sylamore (12 feet, 3 inches):		
Sandstone, white to yellow, coarse-grained, salt and pepper, case hardened; weathers dark brown and forms ledge	2	6
Covered; forms recess, probably shale	0	2
Sandstone, white, yellow and dark-brown, coarse-grained	1	2
Covered; rubble indicates soft sandstone	1	0
Sandstone, white with much iron staining, coarse-grained; hard on surface due to case hardening, but little cement and crumbles easily when broken	2	0
Sandstone, white, brown and yellow, coarse-grained; much iron staining, fairly well cemented	5	5
ORDOVICIAN:		
Tyner (2 feet exposed):		
Shale, mottled gray, green and yellow; base covered	2	0

20. *McSpaddin Falls (from Cram, 1930, p. 8), sec. 1, T. 17 N., R. 22 E.*

	Feet	Inches
ORDOVICIAN:		
Burgen (43 feet, 9 inches exposed):		
Sandstone, white to ferruginous, massive, fine- and even-grained, mostly angular; forms ledge for water falls	15	0
Sandstone, white, somewhat ferruginous, fine, angular, somewhat friable, even-bedded in 5-inch layers	6	0
Sandstone, thin- and uneven-bedded, somewhat shaly, merges with above	1	6
Shale, green, sandy, full or rounded quartz grains	1	0
Covered, probably sandstone or shaly sandstone	2	6
Sandstone, white, fine-grained, massive, somewhat ferruginous	8	6
Sandstone, white to green, interbedded with sandy green shale	3	6
Shale, sandy; alternating thin laminae of green shale and sand	0	5
Limestone, shaly, sandy, dolomitic; appears conglomeratic	0	4
Sandstone, white, calcareous, hard, thin-bedded; thin shale bed at base; few pelecypods	0	9
Sandstone, calcareous, white; many pelecypods	0	6
Shale, green, slaty; streaks of sand	0	6
Shale, shaly sand, thin sandstone, and sandy dolomitic limestone; more shaly near top	1	3
Sandstone, white, very fine-grained	1	2
Limestone, buff, sandy, dolomitic; numerous cephalopods	0	4
Sandstone, white, very fine-grained	0	6
Covered to river		