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GEOLOGY OF THE FLANKS OF THE OZARK UPLIFT

NORTHEASTERN OKLAHOMA

BY

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PREFACE

The information made available to the people of the State in this bulletin summarizes the data gathered by geologists in approximately twelve man-years of field work and of twenty-five man-years of laboratory work, drafting and writing. Dr. Huffman devoted seven field seasons to the project and he directed 26 Master of Science theses in the area. Dr. Hugh D. Miser spent weeks in the field with Dr. Huffman and his students.

The detailed mapping shown on the plates, the numerous measured sections, and the precise stratigraphic material here presented are certain to be vital to development of limestone resources and of ground-water supplies and to be widely used in further search for petroleum and natural gas in the region. Careful fundamental research of this type is needed as an aid to industrial expansion in all parts of Oklahoma.

CARL C. BRANSON

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Geology of the South and West Flanks of the Ozark Uplift, Northeastern Oklahoma

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ABSTRACT

Northeastern Oklahoma lies on the southwestern flank of the Ozark Uplift, a broad, asymmetrical dome which occupies an area of approximately 40,000 square miles in Missouri, Arkansas, and Oklahoma. Portions of Ottawa, Craig, Delaware, Mayes, Wagoner, Muskogee, Cherokee, Adair, and Sequoyah Counties are included.

The Oklahoma Ozark Area lies in the drainage basin of the Arkansas River. The northern portion is drained by the Grand River which enters the Arkansas near Fort Gibson. The southern part is drained by Bayou Manard, Boudinot Creek, Greenleaf Creek, Cedar Creek, Illinois River, Vian Creek, Sallisaw Creek, and Lee Creek.

The rocks exposed at the surface in the Oklahoma Ozarks range in age from Precambrian to Middle Pennsylvanian. Locally these are overlain by a thin veneer of terrace gravels and alluvium.

The Precambrian Spavinaw granite is overlain by the Lower Ordovician Cotter dolomite in the vicinity of Spavinaw. In the southern part of the area, the Cotter is succeeded by the Burgen sandstone, Tyner shales and dolomite, Fite limestone, Fernvale limestone, and Sylvan shale of Ordovician age. Upper Ordovician Sylvan shale is overlain unconformably by the St. Clair limestone of Silurian age, which is in turn succeeded by the Frisco limestone and the Sallisaw sandstone and chert of Devonian age.

Devonian, Silurian, and Ordovician units are beveled northward by unconformity and are overlapped by the Chattanooga black shale and the basal Sylamore sandstone member (Late Devonian or Early Mississippian) which lie on the Sallisaw formation near Marble City and on the Cotter near Spavinaw.

The succeeding Osagean series, frequently referred to as the "Boone chert", includes the St. Joe, Reeds Spring, and Keokuk. The Osagean is overlain unconformably by various lithic units of Moorefield and Hindsville age. The Hindsville limestone is overlain by the Fayetteville black shale and Pitkin limestone of Upper Mississippian age. Lower Pennsylvanian strata include the Hale and Bloyd formations; the overlying Atoka is assigned to the Middle Pennsylvanian, Atoka series. Succeeding units of Desmoinesian age

truncate the Atoka northward in Mayes, Craig, and Ottawa Counties.

The formations strike in an arcuate pattern and dip away from the axis of the uplift, toward the west in the northern part and to the southwest and south in the southern part of the area. The general regional dip of 25 to 50 feet per mile is interrupted by a series of northeast-trending folds and faults whose alignment is roughly parallel to the axis of the Ozark uplift. Steeper dips are associated with beds in proximity to major faults.

The principal structural features in the Ozark Uplift of northeastern Oklahoma include the Miami syncline, Seneca graben, Horse Creek anticline, Whiteoak Creek fault (new), Locust Grove fault, Lost City fault (new), Clear Creek fault, Fourteenmile Creek fault, Gifford fault (new), Double Spring Creek fault, Hulbert fault, Tahlequah fault, South Muskogee fault, Qualls-Welling fault, Greenleaf Lake fault (new), South Qualls fault (new), Barber fault (new), North Cookson fault, South Cookson fault (new), Wauhillau fault (new), Blackgum fault, Red Springs fault (new), Linder Bend fault (new), Webber's Cove fault (new), Cedar Creek fault (new), Marble City fault, Lyons fault, Church fault, Little Lee Creek fault (new), Evansville fault, the North and the South Davidson faults and the Baron graben (new). The location and trend of these are indicated. Stratigraphic displacement on the major faults varies from a few feet to over 700 feet.

Structural development in northeastern Oklahoma is closely associated with the development of the Ozark geanticline, which underwent successive submergences and emergences during Paleozoic time. Southward tilting in pre-Chattanooga time is indicated by northward truncation of older units and overlap by the Chattanooga black shale, which rests on Devonian near Marble City and Lower Ordovician near Spavinaw. Renewed southward tilting in both pre-Hale and pre-Atoka time is indicated by northward truncation of the Pitkin and Bloyd formations respectively.

Final deformation took place during Pennsylvanian time. The folds and faults are post-Atoka and pre-Tiawah in age (early Senora) indicating deformation during Desmoinesian time. Parallelism of the folds and faults in this area with those in the Arkansas Valley syncline suggests a genetic relationship. It is believed that the deformation in this area is largely of a tensional nature caused by the stretching of the rock layers across the end of the positive Ozark structure during the loading of the McAlester Basin in Middle Pennsylvanian time, following the relaxation of the forces which deformed and thrust the Ouachita Mountains to the south.

The most important economic products are limestone, gravel, ground-water and hydroelectric power. Minor amounts of coal, building stone, tripoli, lead and zinc, phosphate, and asphaltic sandstone are present. Oil and gas prospects are summarized.

INTRODUCTION

Scope and purpose of investigation: This report is the result of a coordinated project under the joint sponsorship of the Oklahoma Geological Survey, the United States Geological Survey, and the School of Geology, University of Oklahoma. The project was designed to provide detailed information for the new state geological map of Oklahoma, and to study in detail large areas which are now flooded by the Fort Gibson and Tenkiller Ferry Reservoirs on the Grand and Illinois Rivers. In addition, several pertinent stratigraphic problems involving Mississippian strata and their correlations with the rocks in the Arbuckle region added impetus to the academic phase of the study.

The primary objectives of the study include: (1) detailed investigation and mapping of pre-Atokan units, (2) measurement and description of typical stratigraphic sections, (3) collection and identification of faunas from each lithic unit, (4) careful mapping and interpretation of structural relationships, and (5) a general appraisal of economic products associated with the rock units.

Location and Description of Area: The area under investigation comprises approximately 1,675 square miles on the south and west flanks of the Ozark Uplift in northeastern Oklahoma. It includes an arcuate belt from the Oklahoma-Arkansas boundary westward to the Arkansas River near Gore, thence northward to the vicinity of Vinita, extending from the north line of T. 12 N., into T. 26 N. and covering parts of Rs. 19 through 27 E. Portions of Adair, Cherokee, Sequoyah, Muskogee, Wagoner, Mayes, and Craig Counties are included (Figure 1).

History of previous investigations: According to Drake (1897, p. 327) Nuttall made several excursions into this region during his memorable travels in eastern Oklahoma. He recorded his trips up the Arkansas River to the Verdigris River, a trip up Grand River to the salt springs (near Chouteau), and short excursions in the vicinity of Sallisaw and Lee Creeks.

The first notable work of geologic nature in northeastern Oklahoma was by Drake (1897). He discussed the general stratigraphy and structure of the area and made a sketch map showing

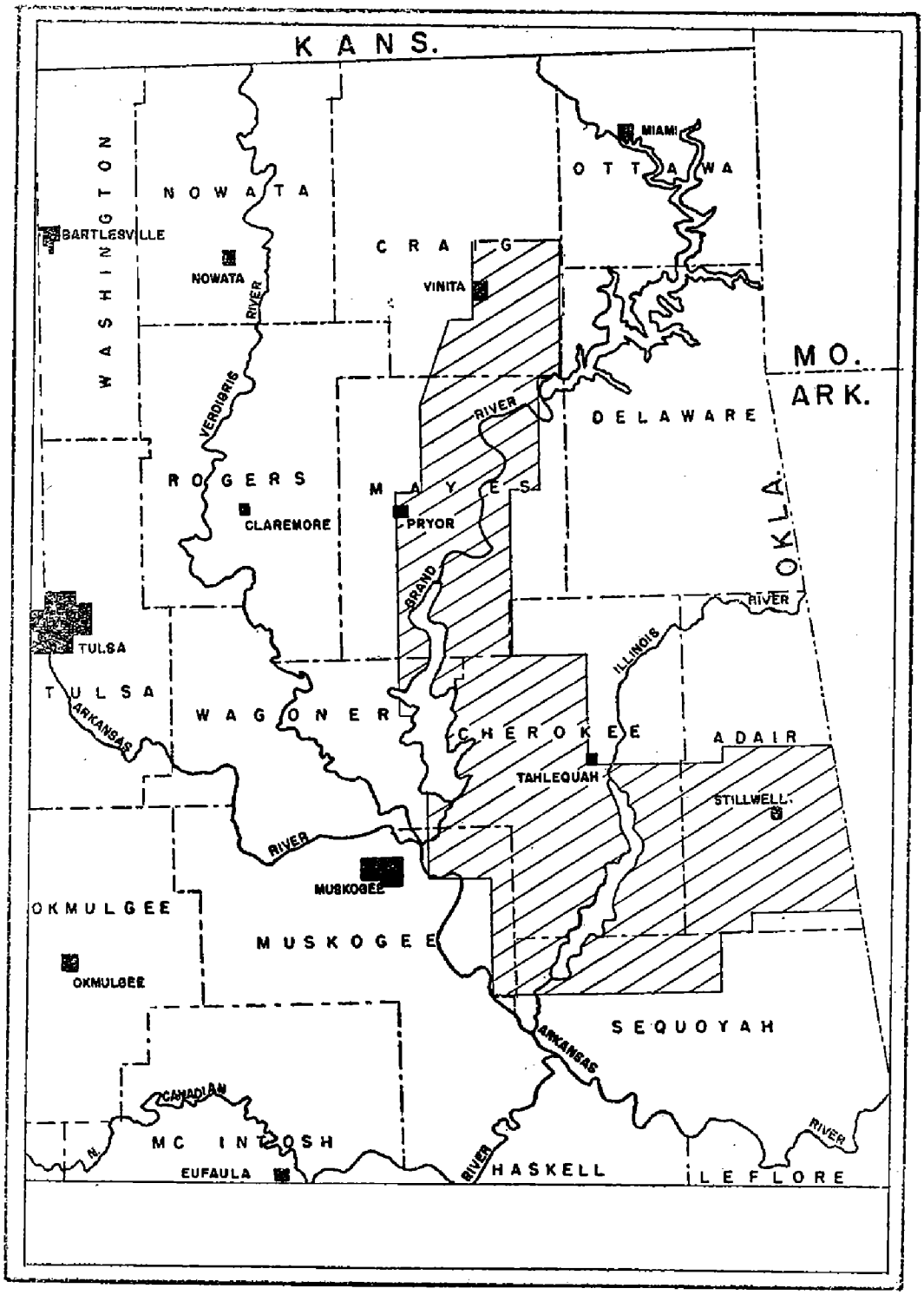

Figure 1. Index Map showing location of area.

the approximate position of the Mississippian-Pennsylvanian contact.

In 1903, Major G. D. Fitzhugh investigated the economic possibilities of the St. Clair limestone for the Kansas City Southern Railroad and prepared a report for that organization (Ham, 1943, p. 3). The Tahlequah and Muskogee Quadrangles were mapped by Taff and the geologic folios describing these areas were published in 1905 and 1906. The Wyandotte Quadrangle was mapped by Siebenthal (1907) and Ohern mapped the Vinita Quadrangle (1914). As a result of his work in the Wyandotte Quadrangle and adjoining areas, Siebenthal (1907) published a paper entitled "The Mineral Resources of Northeastern Oklahoma".

Snider (1912) published a preliminary report on the lead and zinc resources of the state. This was followed (1915) by a comprehensive report on the geology of northeastern Oklahoma with emphasis on the Chester group and its fauna.

Mather (1915) published a detailed report on the fauna of the "Morrow Group" in which he included numerous forms collected from northeastern Oklahoma.

The subsurface stratigraphy of northeastern Oklahoma was discussed by Aurin, Clark, and Trager (1921). Schuchert (1922) discussed the faunas of certain "unmapped Devonian" units near Marble City and Gould (1925) included the Ozark Mountain section and the Carboniferous of northeastern Oklahoma in "Index to the Stratigraphy of Oklahoma".

Buchanan (1927) discussed the distribution and correlation of the Mississippian of Oklahoma. As a part of a series of articles entitled "Oil and Gas in Oklahoma" published by the Oklahoma Geological Survey (1930), Ireland summarized the geology of Ottawa, Delaware, and Craig Counties; Cram reviewed the geology of Cherokee and Adair Counties; and the geology of northern Sequoyah County was included in a report by Stone and Cooper.

The "Geology of the Miami-Picher Zinc and Lead District" was published by Weidman (1932) and a careful study of the Tri-State District was completed by Fowler and Lyden (1930).

From 1930 to 1934, Cline made extensive studies on the "Osage formations of the Southern Ozark Region, Missouri, Arkansas, and Oklahoma". This was followed by Laudon (1939) with his

work on the "Osage subseries of Northeastern Oklahoma".

The Pennsylvanian stratigraphy of the Muskogee-Porum District of Muskogee and McIntosh Counties was studied by Wilson and Newell (1937). They divided the Atoka formation into several prominent sandstone members separated by unnamed shales.

In 1943, the Oklahoma Geological Survey (Ham, et al.) issued a mineral report on the St. Clair limestone near Marble City. The same year, members of the survey investigated the relationship of the Spavinaw granite and the overlying Cotter dolomite near Spavinaw, Oklahoma, and made possible more precise dating of the igneous mass (Ham and Dott, 1943).

Studies by Moore (1947) resulted in the extension of the Arkansas subdivisions of the Morrow series into northeastern Oklahoma. Laudon (1948) reviewed the Mississippian relations in the Ozark area, comparing and contrasting them with conditions in other parts of North America.

Since June 1949, graduate students working with the senior author have completed several theses in this area. These include those by Beckwith (1950), Bollman (1950), Branson (1952), Brąuer (1952), Chandler (1950), Christian (1953), DeGraffenreid (1951), Dobervich (1951), Douglass (1951), Hurt (1951), Kozak (1951), Lauderback (1952), McBryde (1952), Mills (1951), Mondy (1951), Powell (1950), Siemens (1950), Simpson (1951), Smith (1952), Slocum (1954), Snodgrass (1951), and Stafford (1951). The results of these have been summarized by the senior author (1951, 1953). Published theses include those by Brauer (Shale Shaker (1952), Douglass (Tulsa Geol. Soc. Digest 1952), Simpson (Tulsa Geol. Soc. Digest 1952), and DeGraffenreid (Shale Shaker 1952).

Additional studies of a closely related nature have been completed by Speer in Ottawa County (1951), by Gore in the Spavinaw, Salina, and Spring Creek Areas of Mayes, Cherokee, and Delaware Counties (1952), and by Montgomery (1951) along the Illinois River. Stratigraphic studies of pre-Osagean units from the vicinity of Flint (sec. 24, T. 20 N. R. 24 E.) to Qualls (sec. 35, T. 15 N., R. 21 E.) were made during the summer of 1952 by John Graves (unpublished report). Mapping and differentiation of post-Boone rocks in portions of Delaware and northern Adair

Counties were made by Slocum (1955). Comparison of Meramec and lower Chester strata in Oklahoma with those in southwestern Missouri and northwestern Arkansas were recently completed (Harris, 1956).

Acknowledgments: The authors wish to express their most sincere appreciation to Hugh D. Miser of the United States Geological Survey who initiated the program in conjunction with the new State Map of Oklahoma and who gave unselfishly of his time throughout the project. Robert H. Dott, William E. Ham, and Carl C. Branson of the Oklahoma Geological Survey accompanied the senior author on several field trips into the area. Financial assistance by the Oklahoma Geological Survey and the use of airplane photographs from its files made the fulfillment of the project possible. The manuscript was read and criticized by Carl C. Branson, William E. Ham edited the maps, and Thomas W. Amsden checked the Silurian and Devonian fossil lists. Drafting was done by members of the Oklahoma Geological Survey.

GEOGRAPHY

Climate: Northeastern Oklahoma is in a belt of warm, humid, continental-type climate. Wide seasonal variations are characteristic. The summer months are warm with temperatures frequently reaching 100 degrees and with an average of about 78 degrees. The winters are usually mild although zero temperatures and blizzards are not uncommon. The average winter temperature is about 38 degrees. The annual rainfall is approximately 40 inches and the growing season is about 200 days.

Cities and towns: The western edge of the area under discussion is located approximately 35 miles east of Tulsa and the southwestern corner is near Muskogee. The area includes within its boundaries four county seat towns, several villages, and numerous rural communities with the typical country store, filling station, and school.

The larger of the towns serve as the county seats of government. These are Vinita, county seat of Craig County with a population of 5,518; Pryor, the county seat of Mayes County with 4,486 inhabitants; Tahlequah, county seat of Cherokee County with a population of 4,750; and Stilwell, county seat of Adair County with 1,813. Wagoner, county seat of Wagoner county (population 4,395) is located three miles west of the western edge of the area and Sallisaw, county seat of Sequoyah County, lies several miles to the south (population 2,885).

Smaller towns include Ketchum (254), Langley (204), Pensacola (48), Strang (201), Spavinaw (213), Salina (905), Adair (299), Locust Grove, (730), Hulbert (approximately 300), Fort Gibson (1,496), Braggs (374), Marble City (385). Rural communities include Qualls, Blackgum, Gideon, Pettit, Barber, Cookson, Welling, Wauhillau, Bidding Springs, Baron, Lyons, Murphy, and Bunch.

Roads and Railroads: Northeastern Oklahoma is traversed by several state and federal highways. Secondary roads are in poor condition and in general are unsurfaced. In the northern portions of the area, as in Mayes and southern Craig Counties, secondary roads follow the section lines and are numerous. In eastern Wagoner, Cherokee, Adair, and northern Sequoyah Counties, secondary roads follow the stream valleys, are few, and are in a

poor state of repair.

The main north-south highways which serve this area are (1) Highway 69 from Muskogee to Vinita, paralleling the western border, (2) Highway 82 from Vian to Tahlequah along the east side of Tenkiller Ferry Reservoir, thence northwestward to Locust Grove, Spavinaw, Langley and the junction with highways 60, 66, and 69 east of Vinita, and (3) Highway 59 from Sallisaw through the eastern part of the area through Stilwell and Baron. The new northeast turnpike from Tulsa to Joplin cuts across the northwest corner of the area.

East-west roads include (1) Highway 62 which connects Muskogee, Fort Gibson, Tahlequah, and Westville; (2) Highway 51 from Wagoner to Hulbert, Tahlequah and Stilwell; (3) Highway 33 from Chouteau to Locust Grove, thence eastward to Siloam Springs, Arkansas; (4) Highway 28 from Adair to Pensacola and Langley; (5) Highway 20 from Pryor to Spavinaw; and (6) Highways 60, 66, and 69 from Vinita eastward across southern Craig County.

Five railroads service the area. These are (1) St. Louis and San Francisco (Frisco), which passes through Vinita from Tulsa to St. Louis; (2) Missouri, Kansas and Texas, which connects Muskogee, Wagoner, Chouteau, Pryor, and Vinita; (3) Kansas, Oklahoma, and Gulf, which connects Muskogee, Fort Gibson, Okay, Wagoner, Murphy, Locust Grove, Salina, Strang, and Ketchum; (4) Missouri Pacific, which enters the area at Wagoner, passes through Okay, Fort Gibson, and Braggs, paralleling the Arkansas River; and (5) Kansas City Southern, which connects Sallisaw, Marble City, Bunch, Stilwell, and Baron.

Industries: The principal industry in northeastern Oklahoma is agriculture. The type and products depend upon the topography and soil. Excellent crops are grown in river bottoms and on the relatively flat surface which extends from near Pryor to Vinita and beyond. Principal products include wheat, corn, and hay. In Cherokee and Adair Counties, where the topography is rugged, the growing of strawberries on the chert-covered hills and the raising of vegetables in the valleys constitute the important agricultural crops. A canning factory at Stilwell processes fruits and vegetables from this region.

Cattle raising is an important industry with individual herds varying from a few range cattle to several hundred head. Some dairying occurs in the Pryor and Vinita areas.

Lumbering and quarrying constitute important industries, especially in the southeastern portion of the area. Large construction projects as Fort Gibson and Tenkiller Ferry Dams have provided work for many local inhabitants. During the war, the Oklahoma Ordnance Plant located southeast of Pryor employed several hundred people. Today, several new industries including a paper mill, a wall-board factory, and an implement company are located southeast of Pryor where water and electrical power are available through the Grand River Dam Authority.

Development of the Tenkiller Ferry, Fort Gibson, and Grand Lake areas for recreational purposes has increased greatly the number of tourists, vacationists, and sportsmen who visit this area and as a result, there is increased demand for grocery stores, cafes, motels, and boat concessions.

PHYSIOGRAPHY

Physiographic Setting: The Ozark Uplift is a broad, asymmetrical dome which occupies an area of approximately 40,000 square miles in Missouri, Arkansas, and Oklahoma. It is bounded on the southwest by the Mississippi Lowlands, on the south by the Arkansas Valley, on the west and northwest by the Prairie Plains homocline. The axis trends northeast-southwest, passing through the St. Francis Mountains of eastern Missouri and plunging southwestward into northeastern Oklahoma.

The Ozark Region can be subdivided into three physiographic provinces, the Salem Platform carved on Ordovician and older rocks; the Springfield Structural Plain underlain largely by rocks of Mississippian age, especially the Boone chert and limestones; and the Boston Mountains, a dissected plateau capped by sandstone strata of early and middle Pennsylvanian age.

The Ozark Uplift extends into northeastern Oklahoma, including much of Ottawa, Delaware, Mayes, Wagoner, Muskogee, Cherokee, Adair, and Sequoyah Counties. Its western boundary coincides with the position of the Grand and Spring Rivers and their east flowing tributaries and the southern boundary is roughly

the northern side of the Arkansas River Valley. Westward, the strata pass beneath the gently dipping beds of the Prairie Plains homocline and southward beneath the Arkansas Valley syncline.

Topography and Drainage: The northern three-fourths of the area under investigation is in the Springfield Structural Plain with a small portion west of the Grand River extending into the Prairie Plains Province. The southern one-fourth lies in the Boston Mountain Plateau.

The topography of the Springfield Plain is that of a deeply dissected plateau. The upland surface formed on the cherts and limestones of the "Boone formation" is characterized by flat divides separated by deep, V-shaped stream valleys. A characteristic dendritic drainage pattern is formed.

West of the Grand River, thin Upper Mississippian and Pennsylvanian beds dip gently to the west to form the Prairie Plains homocline. Here the surface is gently rolling with low, east-facing escarpments and isolated buttes capped by resistant sandstone. Obsequent and subsequent drainage is developed by the eastward flowing tributary streams.

South of the Springfield Structural Plain is a narrow belt of rugged topography of the Boston Mountain Plateau. Here a series of northeast trending faults separates the area into prominent fault blocks with steep escarpment faces and gentle dip slopes capped by the resistant sandstones of the Atoka. Stream dissection has cut deep valleys through the ridges while major drainage lines are developed in the softer shales and limestone valleys paralleling the faulting.

The entire region lies in the drainage basin of the Arkansas River. The northern portion is drained by the Grand River, which is formed by the confluence of the Neosho and Spring Rivers near Wyandotte in Ottawa County and which flows southward into the Arkansas River near Fort Gibson. The Grand River is a mature stream with a broad, fertile floodplain. West flowing tributaries of the Grand River, including Lost Creek, Cowskin (Elk) River, Honey Creek, Sycamore Creek, Spavinaw Creek, Salina Creek, Spring Creek, Big Hollow Creek, Clear Creek, Fourteenmile Creek, Hickory Creek, Ranger Creek, and Flower Creek, flow across the limestones and cherts of the Osage series. They are typically

spring-fed and remarkably clear. From the west, the Grand River receives the waters of Cow Creek, Coal Creek, Hudson Creek, Horse Creek, Cabin Creek, Pryor Creek, Wolf Creek, Cole Creek, Brush Creek, Cat Creek, and Flat Rock Creek. These streams flow across the sandstones and shales of the Fayetteville, Atoka, and McAlester formations. They are sluggish, muddy, intermittent, and flow in channels only slightly below the general level of the land surface.

The southern and southeastern portions of this area are drained by Bayou Manard, Boudinot Creek, Greenleaf Creek, Cedar Creek, the Illinois River, Vian Creek, Sallisaw Creek, and Lee Creek. Main tributaries of the Illinois River include Flint Creek, Barren Fork, Caney Creek, Tahlequah Creek, Parkhill Creek, Hog Valley Creek, Dry Creek, Elk Creek, Signboard Creek, Burnt Cabin Creek, Salt Creek, Terrapin Creek, Linder Bend Creek, Swimmer Creek, Moonshine Hollow Creek, and Deep Branch Creek. The drainage pattern is well adjusted to the structural control.

Relief and Elevations: The maximum relief in this area is approximately 1,300 feet. Highest elevation of 1,750 feet is on the north end of Bugger Mountain (sec. 11, T. 16 N., R. 26 E.). Other points of maximum elevation include Sugar Mountain (sec. 28, T. 16 N., R. 23 E.) which is 1,200 feet; 1,550 feet in the southwest corner of Adair County, and 1,700 feet on Ross Mountain on the Oklahoma-Arkansas boundary. The lowest point of 450 feet is along the Arkansas River, sec. 34, T. 13 N., R. 20 E.

The surface of the Springfield Plateau slopes to the west, southwest, and south. In general, the valleys have been cut 200 to 300 feet below the general level while outliers and ridges rise 250 to 400 feet above the Boone surface.

Relief in the Boston Mountain Plateau is greater where valleys 300 to 500 feet deep are not uncommon. Tilting of fault blocks gives a stair-step effect, resulting in long, high, narrow ridges capped by gently dipping strata.

West of the Grand River, the relief is low and the surface gently undulating.

STRATIGRAPHY

General Statement

The rocks exposed at the surface over this area range in age from Precambrian, represented by the Spavinaw granite, to Middle Pennsylvanian Atoka, Hartshorne and McAlester formations. Locally these are overlain by a thin veneer of terrace gravels and alluvium of Pleistocene and Recent age (see figure 2).

The Precambrian is overlain unconformably by the Lower Ordovician Cotter dolomite near Spavinaw (T. 22 N., R. 22 E.). In the subsurface of Ottawa County (to the northeast) nearly 1,500 feet of Cambrian and Lower Ordovician strata intervene (Ireland, 1944). The Cotter is exposed near Qualls (Cherokee County) in sec. 35, T. 15 N., R. 21 E. where it is succeeded by the Burgen sandstone, Tyner shale and dolomite, Fite limestone, Fernvale limestone, and Sylvan shale, all of Ordovician age. Late Ordovician Sylvan shale is overlain unconformably by the St. Clair limestone of Silurian age, which is succeeded by the Frisco limestone and the Sallisaw formation of Devonian age.

Devonian, Silurian, and Ordovician units are beveled northward by unconformity and are overlapped by the Chattanooga black shale and its basal Sylamore sandstone member of late Devonian and early Mississippian age. The Chattanooga formation lies upon the Sallisaw formation (Devonian) near Marble City and upon the Cotter dolomite (Ordovician) near Spavinaw (Figure 3).

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 Meramec age, and the Hindsville, Fayetteville, and Pitkin formations, which are assigned to the Chesterian series.

The Upper Mississippian Pitkin formation is beveled northward by pre-Pennsylvanian erosion and is absent north of the former site of Yonkers in T. 18 N. The succeeding Morrow series, comprised of the Hale and Bloyd formations, is truncated by pre-Atoka unconformity and is overlapped northward by Atoka and younger units (Figure 4). The Bloyd is absent north of Union Mission (T. 19 N.) and the Hale has not been recognized north of Pensacola in T. 23 N. Northward, Atoka and younger Penn-

SYSTEM	SERIES	GROUP AND FORMATION	ROCK	FEET	CHARACTERISTICS AND FAUNAS
PENNSYLVANIAN	DESMOINESIAN	Mc ALESTER		50-150	Dark gray to black, laminated to fissile shale with layers of clay-ironstone concretions, and with three coals and associated underclay. Marked at base by Warner sandstone.
		HARTSHORNE		0-50	Conglomerate, underclay, coal, shale, and siltstone
	ATOKAN	ATOKA		0-600	Sequence of marine and non-marine shales and sandstones with occasional limestone beds. Typically developed in Muskogee-Porum District where it includes in ascending order the Coody sandstone and overlying shale; Pope Chapel sandstone and overlying shale; Georges Fork sandstone and overlying shale; Dirty Creek sandstone and overlying shale; Webbers Falls sandstone and overlying shale; and the Blackjack School sandstone and overlying shale. Units thin northward by convergence and overlap.
	MORROWAN	BLOYD		0-200	Blue-gray, unevenly bedded, fossiliferous limestone interbedded with gray, fissile shale. Limestones fossiliferous, with abundant Pentremites. Thins northward to extinction near Union Mission, T. 19 N.
		HALE		0-150	Massive, blue-gray, sandy limestone with basal beds of brown, calcareous sandstone. Grades laterally into cross-bedded sandstone. Weathers pitted and fluted. Thin conglomerate at base. Abundant Michelinia scopulose.
MISSISSIPPIAN	CHESTERIAN	PITKIN		0-80	Gray-blue, fossiliferous, rubbly-weathering limestone characterized by abundance of Archimedes (Archimedipora), Diaphragmus, Eumetria, Torynifera setigera. Thins northward to extinction in T. 18 N. near Mayes County line.
		FAYETTEVILLE		15-185	Sequence of black, fissile shale with thin interbedded blue-black, lithographic limestone. Fossiliferous with Diaphragmus, Eumetria, Spirifer increbescens, Spirifer leidyi, Torynifera setigera, Linoproductus ovatus.
		HINDSVILLE		0-48	Gray, medium crystalline limestone with Diaphragmus, Spirifer leidyi, Agassizocrinus.
	MERAMECIAN	MOOREFIELD		0-100	Blue-gray to brown calcareous siltstone with Leiorhynchus carboniferum, and overlying black shale Gray, oolitic, cross-bedded limestone with angular chert fragments Blue-gray to brown, argillaceous limestone with Leiorhynchus carboniferum, Moorefieldella eurekensis, Spirifer arkansanum, Griffithides pustulosus. Lies unconformably on Osagean limestones and cherts and on Chattanooga shale near Tenkiller Ferry Dam. Locally contains gray, cherty, crinoidal, glauconitic limestone at base.
	OSAGEAN	KEOKUK		0-250	Massive, white to tan-flecked, tripolitic weathered chert and blue-gray limestone
		REEDS SPRING		0-175	Blue-white to tan, thin-bedded chert with beds of blue-gray, finely crystalline limestone
		ST. JOE		0-25	Gray, fine-to medium-crystalline, nodular-weathering limestone and green calcareous shale
DEV.	KINDERHOOKIAN	CHATTANOOGA		0-70	Black, fissile shale, with basal Sylamore sandstone
	ULSTERIAN	SALLISAW		0-25	Brown, calcareous sandstone grading upward into tan and white chert
		FRISCO		0-8	Gray, coarsely crystalline limestone, near Marble City only
SIL.	NIAGARAN	ST. CLAIR			Pinkish-white, coarsely crystalline limestone. Thins northward to extinction near Qualls, T. 15 N.
ORDOVICIAN	CINCINNATIAN	SYLVAN		0-35	Yellow-brown to green, platy shale
		FERNVALE		0-25	Gray, coarsely crystalline limestone with Lenidocyclus carax
	CHAMPLAINIAN	FITE		0-8	Gray, lithographic, calcite-flecked limestone
		TYNER		0-75	Bright green shales and thin beds of buff sandy dolomite
		BURGEN		0-90	White to yellow, hard massive sandstone with occasional beds of sandy dolomite and green shale
	CANADIAN	COTTER		85-125	Gray to buff, finely crystalline, hard, thick-bedded dolomite with occasional thin beds of white sandstone
PRE CAMBRIAN		SPAVINAW		unknown	Red, coarse-grained granite exposed near Spavinaw, Oklahoma

GENERALIZED COLUMNAR SECTION FOR NORTHEASTERN OKLAHOMA

FIGURE 2.

sylvanian beds overlie the Fayetteville unconformably. In northern Mayes County and in Craig and Ottawa counties, shales of possible Hartshorne age (Branson, 1955) and the Warner sandstone member of the McAlester formation overlap the Atoka and rest upon eroded Mississippian strata.

Extensive high level and intermediate terrace gravels are present along the Grand River and east of the Arkansas floodplain. Many of the valleys are floored with deposits of Recent alluvium.

Precambrian Rocks

Spavinaw Granite

History of Nomenclature: The Spavinaw granite was named by Drake (1897) for exposures along Spavinaw Creek, Mayes County, Oklahoma.

Distribution: The Spavinaw granite is exposed in five small areas in the west one-half of sec. 15, T. 22 N., R. 21 E. The four larger exposures are in a straight line which trends N. 30° - 40° E. The belt of outcrop is about 1,600 feet long and from 100 to 300 feet wide (Ireland, 1930, pp. 7-8). The exposures are surrounded by Cotter dolomite, which dips away from the granite hills at angles of 5 to 10 degrees. A typical exposure is shown in Figure 5.

Character: The Spavinaw granite is a red, coarse-grained granitoid rock. The principal constituent is orthoclase, which gives the rock its distinctive red color. The quartz grains are microscopic while the hornblendes and micas are altered to chlorite. A detailed description by Drake (1897) follows:

"Feldspars, quartz, chlorite, and magnetite are the principal minerals of the rock, while hornblende and epidote occur sparingly. A holocrystalline texture is shown throughout the rock. The most striking and general microscopic feature is its granophyritic and micropegmatitic texture. Through most of the feldspar crystals, quartz is intergrown in a most intimate manner, so that each feldspar shows radiating or alterating quartz and feldspar in each crystal, the included quartz plates or prisms show the same orientation. Quartz occurs sparingly isolated in the larger crystals, but very rarely shows its outline. Feldspars are the predominating minerals. They are principally orthoclase, but plagioclase crystals are rather common. The feldspars have a fine granular appearance and a reddish color. Phenocrysts of feldspar are quite common but they do not show crystal faces. Magnetite occurs in small opaque masses many of which show crystal outlines. They show a slight grouping through the rock and in places give a blended appearance to the crystals. The hornblende is the greenish variety and of rather uncommon occurrence. The chlorite is common and occurs in greenish bands, spherular aggregates, and minute particles. Epidote is of rather common appearance"

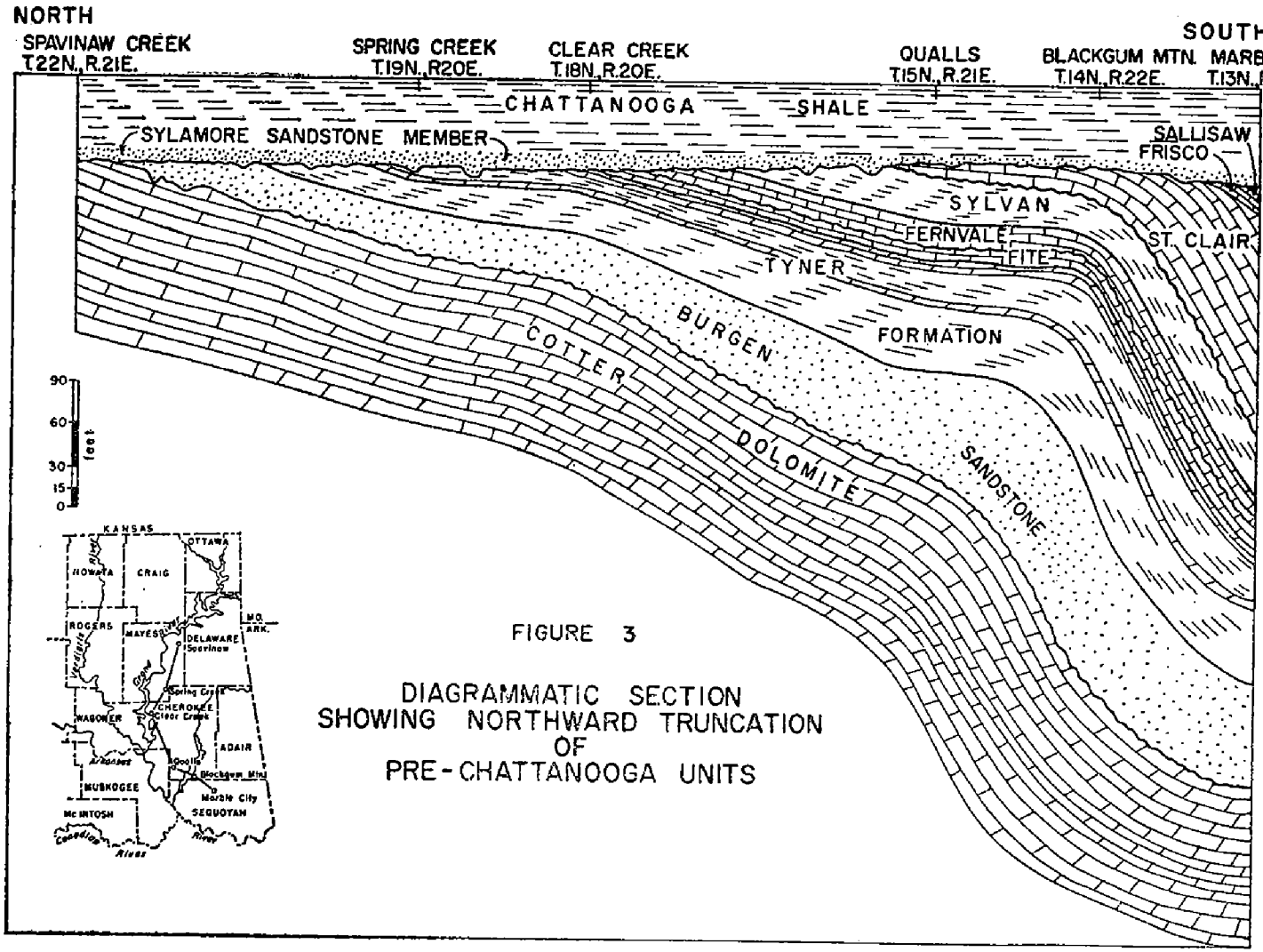

FIGURE 3

DIAGRAMMATIC SECTION
SHOWING NORTHWARD TRUNCATION
OF
PRE-CHATTANOOGA UNITS

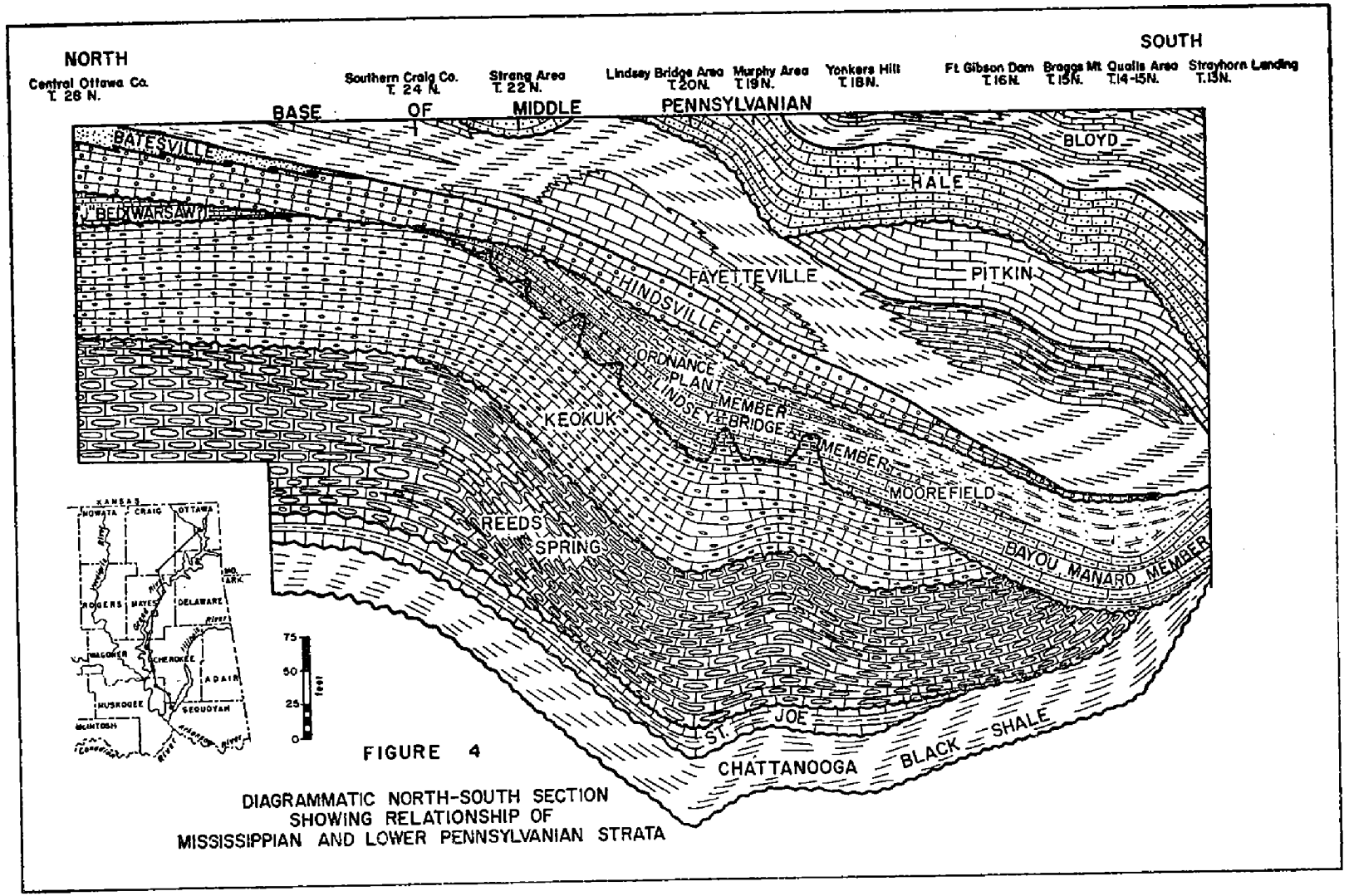

FIGURE 4

DIAGRAMMATIC NORTH-SOUTH SECTION
SHOWING RELATIONSHIP OF
MISSISSIPPIAN AND LOWER PENNSYLVANIAN STRATA

Stratigraphic Relations: The base of the Spavinaw granite is unknown. The granite is overlain unconformably by the Cotter dolomite, which contains detrital layers of granite fragments and boulders (Ham and Dott, 1943, p. 1628).

Age and Correlation: There have been, in general, two opinions concerning the age of the Spavinaw granite. One is that the granite is a dike intruded in post-Ordovician time; the other postulates that it is a Precambrian ridge. A careful summary of opinions concerning the age of the granite was presented by Ireland (1930). Petrographic studies by Tolman and Landes (1939) indicated that detrital material in the Cotter dolomite was derived from a hill of weathered Spavinaw granite exposed during Cotter deposition. Subsequent studies by Ham and Dott (1943) indicate that (1) detrital materials in the Cotter dolomite were derived from the weathering of a granite with petrographic characters similar to those of the Spavinaw granite, (2) that progressively younger beds of Cotter dolomite overlap successively higher portions of the granite ridge, and (3) the alignment of the granite mass and the present dips of the dolomite on the limbs are the result of post-Mississippian, probably Pennsylvanian, folding and have no genetic relation to the granite.

The Spavinaw granite is now assigned to the Precambrian.

Ordovician System

Cotter Dolomite

History of nomenclature: The Cotter dolomite was named by Ulrich (1911) for exposures at Cotter, Baxter County, Arkansas. Although originally included in the Jefferson City by Ulrich, it was later concluded that the Jefferson City limestone at the type locality is older than the beds at Cotter, Arkansas. These beds were originally referred to as the "Turkey Mountain" and as the "Ordovician Siliceous Limestone" (White, 1930, pp. 28-29) in northeastern Oklahoma.

Distribution: The southernmost exposure of the Cotter dolomite is in sec. 35, T. 15 N., R. 21 E. near Qualls, Oklahoma, where only the upper 4 feet is exposed. It is well developed near Spavinaw where the upper 17 feet is exposed at the south end of the Spavinaw dam in sec. 15, T. 22 N., R. 21 E. and a maximum of 125 feet is present along Spavinaw Creek where the underlying Spavi-

naw granite is brought to the surface. East of this area, Cotter dolomite is present along Spavinaw Creek (T. 22 N., Rs. 22 and 23 E.), and along Spring Creek (sec. 36, T. 19 N., R. 21 E.). East of the area of maps included in this report, 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.).

Character and thickness: The Cotter consists largely of white to gray dolomite with minor amounts of sandstone, shale, chert, and intraformational conglomerate. The lower part of the exposed portion is made up of massive layers of white, slightly sandy dolomite separated by thin layers of gray dolomite and bands of tan chert. Massive- to thin-bedded, dense to finely crystalline, gray dolomite forms the middle part. Overlying is a 3 to 4 foot zone of intraformational conglomerate composed of fragments of hard, cherty dolomite in a matrix of sightly sandy, oolitic dolomite. The upper portion consists of beds of massive, gray to white, finely crystalline dolomite with masses of gray-white to tan, vitreous chert having a concentric pattern suggestive of silicified algal structures (cryptozoons). Locally, stringers of white, fine-grained sandstone are present in upper portions.

The Cotter dolomite is silicified near its contact with the Spavinaw granite. Pyrite, dolomite, calcite, and quartz are present in crystal form in vugs and cavities. The silicification dies out within a short distance on either side of the granite masses.

The thickness of the Cotter dolomite in subsurface in northeastern Oklahoma ranges from zero to 270 feet with a fairly uniform thickness of 125 to 180 feet (Ireland, 1944). A maximum thickness of 125 feet has been measured in the Spavinaw area by Gore (1952).

Stratigraphic relations: The Cotter rests unconformably upon the Spavinaw granite. It contains arkosic bands and pebbles of weathered granite of the Spavinaw type (Ham and Dott, 1943). The dolomite overlaps the granite masses and thins across irregularities in the basement surface. The Cotter is succeeded disconformably by the Burgen sandstone near Qualls and along the Illinois River (outside of area of report). Near Spavinaw, the Chattanooga black shale is in contact with the Cotter except in several small areas where a thin bed of Burgen (?) sandstone in-

tervenes. Gore (1952, p. 156) has described cavities in the Cotter filled with Burgen sandstone.

Paleontology: The Cotter is sparsely fossiliferous. Numerous silicified cryptozoons appear in upper portions. Earlier workers have reported *Turritoma milaniformis, Orospira bigranosa, Liospira* (?) sp., *Liospira, Eotomaria, Ecclyomphalus, Archinacella,* and *Maclurites* (Ireland, 1930, p. 16).

Age and Correlation: The Cotter dolomite is classed as Lower Ordovician, Canadian, in age. It is considered equivalent to the Cotter dolomite of Arkansas and resembles the West Spring Creek formation of the upper part of the Arbuckle group in south central Oklahoma (Ham, personal communication, August, 1952).

Burgen Sandstone

History of nomenclature: The Burgen sandstone was named by Taff (1905) for exposures in Burgen Hollow, six miles northeast of Tahlequah in northern Cherokee County, Oklahoma.

Distribution: The Burgen is exposed near Qualls, sec. 35, T. 15 N., R. 21 E., and along the north bank of Spring Creek in sec. 12, T. 19 N., R. 20 E. Small, isolated exposures of white sandstone between Cotter dolomite and the Chattanooga have been referred to the Burgen by Gore (1952). The Burgen is well exposed outside the map area along the Illinois River near Ellersville, Scraper, and Chewey and along Flint Creek in southern Delaware County at Flint, Oklahoma.

Character and thickness: The Burgen formation, although predominantly sandstone, contains minor amounts of shale and thin dolomitic limestone. The sandstone is white to gray or yellow, relatively soft, and is loosely cemented except in upper portions where it is well cemented and is case-hardened to form resistant beds. The sand grains are medium to fine in size, angular to rounded in shape, and many exhibit secondary enlargement. Frosting, pitting, and etching are common. The cementing material is commonly silica with varying amounts of iron oxide. Traces of magnetite and zircon are present.

Thin beds of green, fissile shale and sandy dolomite are present in upper portions.

The Burgen has a thickness of 72 feet near Qualls where the entire thickness is exposed. Twenty-six feet is exposed along Spring Creek in sec. 12, T. 19 N., R. 20 E. It is meagerly represented in the Spavinaw area.

Outside the immediate map area, a thickness of over 100 feet was reported by Taff (1905) along the Illinois River and a water well near McSpaddin Falls northeast of Tahlequah penetrated 136 feet without reaching the base (Graves, 1952).

Stratigraphic relations: The Burgen sandstone rests unconformably upon the Cotter dolomite. Locally, as along Spavinaw Creek, caves and solution channels in the Cotter are filled with Burgen-like sandstones (Gore 1952). The Burgen is succeeded conformably by the Tyner shale in southern exposures but is truncated by the pre-Chattanooga erosion north of T. 19 N., where it is succeeded by the Sylamore sandstone member of the Chattanooga formation.

Paleontology: The Burgen is sparingly fossiliferous. Fucoidal markings are abundant in some layers. Cram (1930) collected a small fauna near McSpaddin Falls (sec. 1, T. 17 N., R. 22 E.) which contained *Matheria, Psiloconcha, Raphistomina, Lophospira, Primitia, Aparchites* (?), and a patelloid shell resembling *Palaeacmaea.*

Age and correlation: Satisfactory age assignment and correlation of the Burgen have not been accomplished. It has been correlated by Snider (1915), Giles (1930), Croneis (1930) and others with the St. Peter sandstone, which has been assigned to the Middle Ordovician. Ulrich (Cram, 1930, p. 12) suggested that the Burgen is younger than the St. Peter and is equivalent to the sandstone at the base of the Bromide in the Arbuckle region. White (1926) stated that the "True Wilcox" of the driller occurs above the Burgen horizon although Edson (1927) (1935) correlated the Burgen with the "True Wilcox" of the subsurface. Cram (1930) tentatively assigned the Burgen to the Oil Creek formation of the Arbuckle Mountains. Decker and Merritt (1931) recognied Tyner and Burgen lithologies in the McLish formation of the Arbuckles. Disney and Cronenwett (1955) compared the Burgen with the sandstone of the Oil Creek.

Precise dating of the Burgen is dependent upon correct correlation of the overlying Tyner with which it is conformable and possibly gradational. If the Tyner is the equivalent of the Bromide, as postulated by the senior author, then the Burgen is probably equivalent to the Lower Bromide sand (Tulip Creek).

Tyner Formation

History of nomenclature: The Tyner formation was named by Taff (1905) for exposures along Tyner Creek, a tributary of Barren Fork in northern Adair County near the town of Proctor. As originally defined, the Tyner included the beds between the Burgen sandstone and the Chattanooga black shale. Cram (1930) restricted the term Tyner to the lower 80 feet of green, fissile shale and thin sandy dolomite and applied the terms Fite and Fernvale to two distinctly different limestones formerly placed in the upper part of the Tyner by Taff.

Distribution: The Tyner formation is exposed along the west bank of Spring Creek, sec. 12, T. 19 N., R. 20 E.; along Clear Creek in secs. 30 and 31, T. 18 N., R. 20 E.; near Qualls in sec. 35, T. 15 N., R. 21 E. and in sec. 2, T. 14 N., R. 21 E.; on the north end of Blackgum Mountain, sec. 32, T. 14 N., R. 22 E.; along the Illinois River in secs. 30 and 31, T. 16 N., R. 23 E.; in Deep Hollow at the junction of secs. 17, 18, 19, 20, T. 16 N., R. 23 E.; and on Cornshell Mountain, sec. 25, T. 16 N., R. 22 E.

Excellent exposures of the Tyner occur along the Illinois River and along Barren Fork northeast of Tahlequah near Ellerville, Scraper, Chewey, Proctor, and in Baumgarner Hollow.

Character and Thickness: The Tyner is characterized by varying lithologies including shale, sandstone, dolomite, and limestone. The shales are dominantly blue-green although maroon and brown shale is locally present. Some of the shales are compact, sandy, or dolomitic, others are soft and earthy. The dolomites are tan to buff, thin- to heavy-bedded, and vary from soft and earthy to hard and sandy. The sandstones are hard, calcareous, and dolomitic. They grade laterally into thin beds of sandy dolomite. Limestone is restricted to the uppermost Tyner where a buff, dense, finely crystalline, dolomitic limestone immediately underlies the Fite limestone.

Cram (1930, pp. 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. These subdivisions can be recognized throughout much of northeastern Oklahoma.

Exposed thicknesses of the Tyner vary from 8 feet near Blackgum to over 90 feet on Cornshell Mountain, sec. 25, T. 16 N., R. 22 E. A total thickness of 79 feet is present near Qualls where both the upper and lower contacts are exposed. The Tyner thins northward by truncation and overlap of the Chattanooga, which lies on the Burgen and Cotter north of T. 19 N.

Stratigraphic relations: The Tyner rests conformably upon the Burgen sandstone. It is succeeded conformably by the Fite limestone in southern exposures. Near the contact, buff, dolomitic limestone alternates with white, lithographic limestone of the Fite to form a narrow transition one. The Fite is beveled by pre-Chattanooga erosion north of T. 18 N. where the Chattanooga rests on Tyner or older beds.

Paleontology: A fauna collected by Taff (1905) and identified by Ulrich included *Camarocladia rugosa* Ulrich, *Hesperorthis tricenaria* (Conrad), *Liospira americana* Billings, *Lophospira* sp. cf. *L. perangulata, Hormotoma gracilis, Leperditia* sp. cf. *L. fabulites, Ceraurus pleurexanthemus* Greene, *Psiloconcha inornata* Ulrich, *Psiloconcha sinuata* Ulrich, *Psiloconcha* sp. cf. *P. subovalis* Ulrich, *Rhytima* sp. and *Whiteavesia* sp.

Cram (1930) listed in addition *Streptelasma* (?), *Eurydictya, Ctenodonta, Hormotoma* sp. cf. *H. salteri, Pterygometopus,* and *Leperditella.* A fauna consisting of *Rafinesquina, Ctenodonta, Hormotoma, Leperditia fabulites, Leperditia* sp., *Leperditella,* and *Lophospira* was reported by Montgomery (1951, p. 152).

These fossils came from the upper part of the Tyner formation from exposures along the Illinois River northeast of Tahlequah.

Age and Correlation: Precise age and correlation of the Tyner are questionable. Taff assigned the Tyner to the Lorraine (Upper Ordovician) and Trenton and Black River on the basis of fossils (1905). Edson correlated the Tyner with the "post-Wilcox" beds

in the mid-continent and the Bromide in the Arbuckle Mountains (1927). According to Cram (1930) the upper part of the Tyner can be traced into the Bromide of the subsurface; the middle Tyner is gradually replaced by the "Wilcox" sand to the west; and the lower Tyner occurs far down in the Simpson section. The senior author has compared the upper Tyner with the dolomite development in the upper Bromide and the green shales with similar shales in the Marshall zone and possibly the Tulip Creek of subsurface.

The presence of *Camarocladia rugosa, Hesperorthis tricenaria,* and *Leperditia fabulites* suggests that the upper Tyner is equivalent 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, which have been classed as Black River.

Fite Limestone

History of nomenclature: The Fite limestone was originally included in the Tyner formation by Taff (1905). It was named and described by Cram (1930) for exposures on the estate of Dr. Fite (sec. 11, T. 17 N., R. 22 E.) northeast of Tahlequah.

Distribution: The Fite limestone crops out near Qualls (sec. 35, T. 15 N., R. 21 E.); at the base of the north side of Blackgum Mountain, sec. 32, T. 14 N., R. 22 E. (now flooded by Tenkiller Lake); along Horseshoe Bend of the Illinois River in secs. 25 and 36, T. 16 N., R. 22E. and secs. 19, 30 and 31, T. 16 N., R. 23 E.; in Deep Hollow, secs. 19 and 20, T. 16 N., R. 23 E. Additional exposures are present along the Illinois River northeast of Tahlequah. It is absent by truncation north of T. 18 N.

Character and thickness: The Fite limestone is predominantly a light gray, dense, lithographic limestone characterized by specks and streaks of clear calcite to give the rock a distinctive appearance on fresh surface. Near the base is a three-foot bed of buff, sandy dolomite of the "Tyner-type" underlain by two feet of gray, lithographic limestone of the Fite lithology. Upper beds are massive where fresh but weather into layers 4 to 20 inches in thickness.

The Fite maintains a relatively uniform thickness of 8 feet throughout much of the area. A maximum of 16 feet 9 inches is present along Horseshoe Bend of the Illinois River, secs. 30 and

31, T. 16 N., R. 23 E.

Stratigraphic relations: The Fite limestone is believed to lie conformably above the Tyner formation. Alternating ledges of Tyner and Fite lithologies in basal portions are thought to represent transition from the dominantly dolomite facies of the Tyner to the lithographic limestone of the Fite. The Fite is succeeded unconformably by the Fernvale limestone as indicated by the abrupt change of facies, the welded contact, and the marked faunal change.

Paleontology: Fossils are rare and are difficult to remove from the Fite limestone in identifiable condition. Fossils collected by Cram (1930) at the type locality include *Tetradium* sp., *Colpomya* cf. *faba, Cyrtodonta* aff. *C. billingsi, Lophospira perangulata, Liospira* cf. *micula, Dalmanella jugosa, Plectambonites* (*Sowerbyella*) sp., *Leperditia caecigena, and Isochilina* sp.

Montgomery (1951) collected *Colpomya* sp., *Lophospira* sp. *Dalmanella* sp., *Liospira* sp., *Leperditia caecigena,* and *Isochilina* sp. from the same locality.

Age and Correlation: According to Cram (1930) the Fite was originally classed as Black River by Ulrich, then later as of pre-Fernvale, Richmond age.

Edson (1927) had previously recognized three subdivisions in the Viola in the Arbuckle Mountains, (1) a lower dense, lithographic limestone as much as 200 feet in thickness, of upper Black River age, (2) 700 feet of limestones carrying graptolites at the base, Trentonian or Cincinnatian in age, and (3) a coarsely crystalline, gray, buff, or reddish-brown, fossiliferous limestone, in places 50 feet in thickness, Richmondian in age. Near Tahlequah she recognized the upper coarsely crystalline member (now known as Fernvale) underlain by a few feet of the lower lithographic member (now the Fite) with all of the thick, middle Viola missing.

Cram (1930) tentatively correlated the Fite with a similar limestone in subsurface known as the "dense lime". Disney and Cronenwett have compared it with dense limestones in the Viola (1955).

The senior author is of the opinion that the Fite limestone is the equivalent of the upper Bromide "dense" of the Arbuckle

Mountains. This opinion has been concurred in by both William E. Ham and Kaspar Arbenz who have examined the Fite limestone in the field with the senior author. It is believed to be equivalent to the upper part of the Platteville of the Upper Mississippi Valley, part of the Plattin of Missouri, and the Witten of Virginia. This places it as late Black River (Bolarian) or early Trentonian in age.

Fernvale Limestone

History of nomenclature: The Fernvale was named by Hayes and Ulrich (1903) for exposures near Fernvale, Tennessee. The term was extended into northeastern Oklahoma by Cram (1930) and applied to beds having a similar faunal and lithological character.

Distribution: The Fernvale limestone forms a prominent cliff in the Qualls area (sec. 35, T. 15 N., R. 21 E.) and on the Moeller Ranch (sec. 2, T. 14 N., R. 21 E.). It is brought to the surface by folding between secs. 14 and 15, T. 15 N., R. 20 E. It is well developed at the base of Blackgum Mountain (sec. 32, T. 14 N., R. 22 E.) where it is now concealed beneath the waters of Tenkiller Lake. Excellent exposures are along the Illinois River at Horseshoe Bend, secs. 25 and 36, T. 16 N., R. 22 E. and secs. 19, 30, and 31, T. 16 N., R. 23 E.; in Deep Hollow, secs. 19 and 20, T. 16 N., R. 23 E.; and along Highway 10 northeast of Tahlequah (sec. 12, T. 17 N., R. 22 E.) just south of the Fite Ranch gate. It is truncated northward by pre-Chattanooga erosion.

Character and thickness: The Fernvale formation is a massive, coarsely crystalline, fossiliferous, crinoidal limestone. It is light gray to pink and it weathers to a lead-gray. Together with the underlying Fite, it forms a conspicuous bluff throughout the area of exposure.

The Fernvale varies from zero feet in thickness northeast of Tahlequah to a maximum of 18 feet near Qualls. A uniform thickness of 14 feet is present in the Horseshoe Bend and Deep Hollow localities southeast of Tahlequah.

Stratigraphic relations: The Fernvale lies unconformably upon the Fite limestone and is succeeded conformably by the Sylvan shale in exposures south and east of Tahlequah. Northeast of

Tahlequah, it is overlain unconformably by the Chattanooga black shale.

Paleontology: The Fernvale limestone is highly fossiliferous. Silicified shells of *Lepidocyclus capax* (formerly *Rhynchotrema*) and *Plaesiomys subquadratus* are abundant on upper surfaces of beds. The fauna collected from the Fernvale is listed in Table 1.

Age and Correlation: The Fernvale limestone of northeastern Oklahoma is correlated with the Fernvale of Tennessee and the Fernvale of the Arbuckle region, classed as Upper Ordovician, Richmondian in age.

TABLE I

FAUNA FROM THE FERNVALE FORMATION

Brachiopoda

Austinella kankakensis (McChesney)
Austinella whitfieldi (Winchell)
Glyptorthis pulchra Wang
Hebertella occidentalis var. *sinuata* Hall
Hebertella frankfortensis Foerste
Hesperorthis sp. aff. *H. tricenaria* (Conrad)
Lepidocyclus capax (Conrad)
Lepidocyclus laddi Wang
Onniella quadrata Wang
Plaesiomys bellistriatus Wang
Plaesiomys subquadratus (Hall)
Plectambonites clarksvillensis Bassler
Plectambonites rugosus Meek
Strophomena sp. cf. *S. incurvata* (Shepard)
Tetraphalerella planodorsata Winchell and Schuchert

Mollusca

Ephippiorthoceras laddi Foerste

Sylvan Shale

History of nomenclature: The Sylvan shale was named by Taff (1902) for exposures near the village of Sylvan, Johnston County, Oklahoma. It is present in the Arbuckle Mountains of south-central Oklahoma and is widespread throughout the subsurface of the state. A green shale found below the St. Clair lime-

stone in a drill hole near Marble City, Sequoyah County, Oklahoma, was referred to the Sylvan by White (1928) who stated "The author is inclined to believe that a more diligent search of this area may yet discover an exposure of the base of the St. Clair in contact with the underlying Sylvan". A corresponding shale (42 feet in thickness) was described by Lantz (1950) from the Arkansas-Louisiana Gas Company No. 1 Barton in Franklin County, Arkansas, near the town of Ozark and a similar shale has been found in borings south of Marble City, Oklahoma (Cram, 1930).

The presence of Sylvan shale at the surface of northeastern Oklahoma was discovered by Beckwith and Mondy during the summer of 1949. Additional exposures were located by Mills, Kozak, and DeGraffenreid during the course of this project.

Distribution: The Sylvan shale crops out at four localities in Cherokee and Muskogee Counties, Oklahoma. The most southerly of these (now covered) is near the base of Blackgum Mountain, sec. 32, T. 14 N., R. 22 E. on the upthrown side of the Blackgum fault. A second exposure is in the vicinity of Qualls, Oklahoma, in sec. 35, T. 15 N., R. 21 E. and sec. 2, T. 14 N., R. 21 E., on the south flank of the Qualls dome on the upthrown side of the Qualls-Welling fault. The third and most extensive exposure is in the Horseshoe Bend area of the Illinois River in secs. 19, 30, and 31, T. 16 N., R. 23 E.; secs. 25 and 36, T. 16 N., R. 22 E.; and sec. 1, T. 15 N., R. 21 E., where pre-Chattanooga beds are brought to the surface by minor folding associated with the upthrown side of the Qualls-Welling fault. The fourth exposure is along the crest of Nigger Hollow anticline on the upthrown side of the South Muskogee fault in secs. 14 and 15, T. 15 N., R. 20 E.

Character and thickness: The Sylvan shale ranges from dark green and fissile to brown, silty, with concretionary weathering. Locally, thin stringers of brown, dolomitic sandstone occur in lower portions. Exposed thicknesses range from 12 feet to a maximum of 36 feet near Qualls. Approximately 34 feet is present in the Horseshoe Bend area and 22 feet is developed near Blackgum. It thins rapidly northward by pre-Chattanooga truncation and is essentially absent in Deep Hollow, one mile northeast of

Horseshoe Bend, in secs. 17, 18, 19, and 20, T. 16 N., R. 23 E.

Stratigraphic relations: The Sylvan lies with apparent conformity upon the coarsely crystalline Fernvale limestone. Near Qualls and on Blackgum Mountain, it is succeeded unconformably by the St. Clair limestone of Silurian age; northward in Nigger Hollow and in the Horseshoe Bend sections, it is overlain unconformably by the Chattanooga black shale of late Devonian-early Mississippian age.

Paleontology: The lower part of the Sylvan shale has yielded several specimens of *Dicellograptus complanatus* Lapworth, two of which have been figured and described by Decker and Huffman (1953).

Age and Correlation: This unit is correlated with the Sylvan shale of the Arbuckle Mountains and the subsurface of Oklahoma, classed as Upper Ordovician, Cincinnatian. This correlation is based on stratigraphic position, lithic similarity, and faunal evidence. *Dicellograptus complanatus* Lapworth, a graptolite characteristic of the Sylvan shale of the Arbuckle Mountains, is present in the Sylvan shale of northeastern Oklahoma. In color, texture, and composition, the Sylvan shale of northeastern Oklahoma resembles the Cason shale of Arkansas.

Silurian System

St. Clair Formation

History of nomenclature: The term St. Clair was proposed by Penrose (1890) for exposures in the vicinity of St. Clair Springs, Independence County, Arkansas. As originally defined, the St. Clair included the Kimmswick limestone, the Fernvale limestone, the Cason shale, and the St. Clair as known today. Williams (1892) restricted the term St. Clair to the uppermost of these four formations.

Distribution: The St. Clair is present in northeastern Oklahoma and northwestern Arkansas. In Oklahoma, the best exposures are in the Marble City area on the southern and eastern sides of Quarry Mountain, secs. 13, 14 and 23, T. 13 N., R. 23 E. Additional exposures are in Payne Hollow, secs. 15 and 22, T. 13 N., R. 23 E.; Walkingstick Hollow, secs. 1 and 2, T. 13 N., R. 23 E., and sec. 35, T. 14 N., R. 23 E.; Hastings Hollow and

Natural Bridge Hollow, sec. 36, T. 14 N., R. 23 E.; along Dry Creek and its tributaries in secs. 1 and 2, T. 14 N., R. 23 E.; along the north side of the Lyons fault in sec. 29, T. 14 N., R. 24 E.; in Maloy Hollow, secs. 4, 5, and 9. T. 14 N., R. 24 E.; in the center of sec. 4, T. 14 N., R. 24 E.; on the north side of Blackgum Mountain in sec. 32, T. 14 N., R. 22 E.; and near Qualls in sec. 2, T. 14 N., R. 21 E. and sec. 35, T. 15 N., R. 21 E.

Character and thickness: In southern and eastern exposures in the Marble City and Bunch vicinities, the St. Clair is a white to pink, medium to coarsely crystalline, massive-bedded limestone. Locally the rock has a bluish tint but preserves its other characteristics. Because of the lack of impurities and the coarse texture, the St. Clair has been called a "marble" by the quarry industry.

Within the formation are cavities filled with large, clear calcite crystals. Small pockets of sphalerite have been discovered in quarrying operations near Marble City and traces of galena occur near Bunch. Small vugs filled with light oil have been found in the Marble City quarry and empty vugs containing a bituminous residue left by evaporation of the oil are common. Stylolite sutures have been observed locally.

Detailed analyses by the Oklahoma Geological Survey show that the St. Clair is remarkedly free from clastic and other impurities (Ham, 1943). These analyses also reveal a three-fold subdivision of the St. Clair near Marble City into (1) a lower zone (75 feet exposed) of dolomitic limestone, (2) a middle zone (65 feet) of pure chemical limestone, and (3) a thin (5 to 12 feet) variable dolomite.

In the northwestern exposures near Blackgum and Qualls, the St. Clair is represented by blue-gray, finely crystalline, cherty limestone with oolitic development near the base. Upward it grades into gray-white to pink crinoidal limestone. These beds are believed to represent the basal phase of the St. Clair and may be concealed in the Marble City area.

Maximum thickness of the St. Clair has not been determined since the base and top are nowhere exposed in close proximity in areas of greatest development. One hundred and sixty-five feet has been measured in secs. 14 and 23, T. 14 N., R. 23 E. (Ham,

1943) and approximately 95 feet is exposed in the quarry operated by the Marble Stone Company near Marble City. Prospect holes have penetrated an additional 100 feet without reaching the base in sec. 14, T. 13 N., R. 23 E. (Taff, 1905, p. 2).

The St. Clair thins rapidly northwestward by truncation of upper units with only 23 feet present near Blackgum and 10 feet near Qualls. The St. Clair is absent north of Qualls in sec. 35, T. 15 N., R. 21 E. and appears to be absent elsewhere north of T. 14 N.

Stratigraphic relations: The base of the St. Clair is not exposed in the southeastern part of this area where it reaches maximum development. White (1926) reported a diamond drill hole near Marble City which encountered 15 feet of greenish-blue shale below the St. Clair. Near Qualls, sec. 35, T. 15 N., R. 21 E., and sec. 2, T. 14 N., R. 21 E. the St. Clair rests unconformably upon lower beds of the Sylvan. The St. Clair is succeeded unconformably by the Frisco limestone, the Sallisaw sandstone, or the Sylamore member of the Chattanooga formation. Locally, solution channels and cavities in the upper St. Clair contain blocks and fillings of Frisco limestone and Sylamore sandstone (Christian, 1953, p. 20).

Paleontology: The St. Clair has yielded a relatively large fauna although specimens are poorly preserved. A faunule collected by Beckwith (1950) from the Qualls locality includes a scaphopod resembling *Dentalium, "Orthoceras" simulator* Hall, *Favosites forbesi* var. *occidentalis* Hall, *Streptelasma* sp., *Dalmanites limuluris* var. *brevicaudatus* (Foerste), *Dalmanites* sp. cf. *D. verrucosus, Illaenus* sp. cf. *I. americanus* Billings, *Plectatrypa marginalis* (Dalman) and *Fardenia subplena* Conrad.

A fauna collected by Taff (1905) from the upper part of the St. Clair near Marble City includes *Caryocrinites* sp., *Calliocrinus corrugatus* Weller, *Pisocrinus gemmiformis* Miller, *Stephanocrinus osgoodensis* Miller, *Parmorthis elegantula* (Dalman), *Plectambonites* cf. *P. transversalis* (Wahlenberg), *Atrypa nodostriata* Hall, *Strophonella striata* Hall, *Cypricardinia arata* Hall, "*Orthoceras*" cf. "*O*". *medullare* Hall, and *Gyroceras* ? *elrodi* White.

Faunules collected in and around Marble City by Christian (1953) are listed in Table II. *Clorinda ventricosa* (Hall) and

Eospirifer cf. *E. radiatus* (Sowerby) are most characteristic. A fauna collected from the St. Clair in Maloy Hollow by Powell (1951) is listed in Table III.

TABLE II

FAUNA FROM THE ST. CLAIR FORMATION NEAR MARBLE CITY

Brachiopoda

Atrypa arctostriata Foerste
Atrypa niagarensis (Nettleroth)
Atrypa reticularis (Linne')
Atrypa tennesseensis (?) Amsden
Camarotoechia sp. aff. C. oklahomensis Amsden
Camarotoechia roadsi Foerste
Camarotoechia sp.
Clorinda ventricosa (Hall)
Eospirifer cf. E. radiatus (Sowerby)
Fardenia reedsi (?) Amsden
Isorthis arcuaria (?) (Hall and Clark)
Plectatrypa brownsportensis (?) Amsden
Sieberella roemeri (?) (Hall and Clark)
Stropheodonta convexa Prouty
Whitfieldella cylindrica (Hall)
Whitfieldella sp. aff. W. quadrangularis Foerste

Mollusca

Cyrtoceras hercules (?) Winchell and Marcy
"Orthoceras" crebristriatum Meek and Worthen
Platyceras sp.

Trilobita

Illinoides triloba Weller
Sphaerexochus romingeri Hall

Age and Correlation: According to Ulrich (1911), the fauna collected by Taff from the Upper St. Clair "reminds in some respects the Osgood, in others of presumably later Niagaran faunas at Chicago and Sweden". Cram (1930) correlated the typical St. Clair, which he thought present in northeastern Oklahoma below the beds of "Osgood" age, with the upper part of the Chimneyhill limestone, which he believed to be of Clinton age. Gould (1925) correlated the St. Clair with the Henryhouse shale, the Talihina chert, and the Missouri Mountain slate.

The senior author believes that the typical, pink to white, coarsely crystalline phase of the St. Clair limestone most nearly resembles the pink crinoidal member of the Chimneyhill formation of the Arbuckle Mountains, which is considered by some to be of Middle Silurian, Clinton age. The upper portion is probably equivalent to part or all of the Henryhouse of Oklahoma, the Brownsport of Tennessee, and the Bainbridge of Missouri. The lower, heavy-bedded, cherty, oolitic phase as identified near Qualls may be as old as the Chimneyhill limestone of Brassfield age. The middle portion is faunally like the Osgood, Laurel, Waldron, Bisher sequence of late Clinton age.

TABLE III

FAUNULE FROM THE ST. CLAIR FORMATION, MALOY HOLLOW SE¼ SECTION 5, T. 14 N., R. 24 E.

Anthozoa

Cystiphyllum lineatum (?) Davis

Crinoidea

Myelodactylus extensus Springer

Brachiopoda

Lissatrypa decaturensis (?) Amsden
Merista tennesseensis (?) Hall and Clark
Plectodonta prolongatus Foerste
Rhipidomella oklahomensis (?) Amsden
"Spirifer" obsoletus (?) Foerste
Eospirifer cf. E. radiatus (Sowerby)
Whitfieldella nitida (?) Hall
Whitfieldella quadrangularis Foerste

Mollusca

"Orthoceras" ignotum (?) Foerste

DEVONIAN SYSTEM

Frisco Limestone

History of nomenclature: The Frisco limestone was named by Reeds (1926) for outcrops near Frisco, Oklahoma, in the southern part of the state. The term was extended to northeastern Oklahoma by Cram (1930) and applied to beds in the Marble City area carrying an Oriskanian fauna.

Distribution: The Frisco is limited in distribution to a small area near Marble City. It crops out in Payne Hollow, secs. 15 and 22, T. 13 N., R. 23 E.; on the southern and eastern sides of Quarry Mountain, sec. 14, T. 13 N., R. 23 E.; and at the Big Bend of Sallisaw Creek, sec. 13, T. 13 N., R. 23 E. Outcrops are discontinuous and the formation is absent in surface exposures north of T. 13 N.

Character and thickness: The Frisco is composed of light to dark gray, fine- to medium-crystalline, thick-bedded, coquinoid, fossiliferous limestone. Locally, sandy, cherty, and dolomitic beds may be present.

The Frisco is thin, ranging from zero to 7 feet in thickness.

Stratigraphic relations: The Frisco lies unconformably upon the St. Clair limestone. It is separated from the overlying Sallisaw or Sylamore by unconformity and locally, small cavities in the Frisco are filled with Sylamore sandstone.

Paleontology: The Frisco carries an abundant fauna characterized by *Costellirostra peculiaris, Costispirifer arenosus,* and many *Platyceras*-type gastropods. The fauna collected and identified by Christian (1953) from the Marble City area is listed in Table IV.

Age and correlation: The Frisco is early Devonian (Deerparkian) in age and is correlated with the Oriskany sandstone of the Appalachians, the Little Saline of Missouri, the Harriman of Tennessee, and the Garden Island of Michigan.

TABLE IV

FAUNA OF THE FRISCO FORMATION NEAR MARBLE CITY

Anthozoa

Favosites schriveri (?) (Herzer)
Favosites sp.

Brachiopoda

Acrospirifer cyclopterus (Hall)
Acrospirifer murchisoni (Castlenau)
Beechia ovalis (?) Hall
Camarotoechia welleri Branson and Williams
Costellirostra peculiaris (Conrad)

Costispirifer arenosus (Conrad)
Eospirifer macropleurus (Conrad)
Fimbrispirifer divaricatus (Hall)
Leptaena rhomboidalis (Wilckens)
Leptaena ventricosa (Hall)
Leptostrophia magniventura (Hall)
Levenea lenticularis (Vanuxem)
Meristella carinata Stewart
Orbiculoidea (?) sp.
Plethorhyncha sp. aff. P. campbellana (Hall)
Plethorhyncha sp. cf. P. praespeciosa (Schuchert)
Pleurothyris sp. cf. R. stewarti Clark
Rensselaeria marylandica (?) Schuchert
Rhynchospirina sp. cf. S. formosa Hall
"Spirifer" modestus var. plicatus Maynard

Mollusca

Platyceras (Orthonychia) belli (Clarke)
Platyceras gebhardi Conrad
Platyceras magnificum Hall
Platyceras nodosum Conrad
Platyceras planovolvis Stewart
Platyceras trilobatum Hall
Platyceras (Platyostoma) ventricosum (Conrad)
Platyceras sp.
Strophostylus allani Stewart
Tentaculites sp.

Trilobita

Dalmanites sp.
Proetus protuberans Hall

Sallisaw Formation

History of Nomenclature: Cram (1930) applied the name Sallisaw to beds exposed along Sallisaw Creek near Marble City, Oklahoma. These exposures had been reported earlier by Schuchert (1922) who identified the fossils and assigned the beds to the Devonian system.

Distribution: The Sallisaw crops out in the Marble City area on the southeastern side of Jackson Mountain, sec. 22, T. 13 N., R. 23 E.; in Payne Hollow sec. 15 and 22, T. 13 N., R. 23 E.; on the slopes of Quarry Mountain secs. 12, 13, 14, and 23, T. 13 N., R. 23 E.; in Walkingstick Hollow, secs. 1 and 2, T. 13 N., R. 23 E.; and at the bend of Sallisaw Creek sec. 13, T. 13 N., R. 23 E. Northward its distribution becomes irregular and only a few isolated patches of questionable Sallisaw have been found.

Character and thickness: The Sallisaw formation is composed of several distinct lithologies. The most common is a light to dark gray, fine-grained, medium-bedded, calcareous sandstone which weathers gray to brown and grades laterally into sandy limestone. White to light gray chert is interbedded with the calcareous sandstone or sandy limestone.

In portions of secs. 15 and 22, T. 13 N., R. 23 E. the upper part of the Sallisaw is a fine-grained, yellow to reddish sandstone containing fragments of *Roemerella grandis,* a characteristic fossil of the Sallisaw. This is succeeded by a two-foot bed of brecciated chert which marks the top of the Sallisaw formation.

Locally the Sallisaw sandstone contains large amounts of dark, ferromagnesian minerals and some phosphatic material. The sandstone grains may show secondary enlargement. These beds resemble the overlying Sylamore from which they are distinguished by the presence of *Amphigenia curta* and *Protoleptostrophia perplana.*

Where the Sallisaw fills solution cavities in the underlying St. Clair, it is typically a gray, dense, fine-grained limestone containing fine sand grains. No bedding is obvious although locally a contorted layering effect is observable.

The upper Sallisaw is typically cherty and a chert-breccia, cemented with dark, medium- to coarse-grained sandstone of the Sylamore type marks the top. It is believed that this brecciated phase represents an old regolith whose blocks were recemented by the deposition of the Sylamore sandstone in the interstices.

Thickness of the Sallisaw reaches a maximum of 11 feet in sec. 15, T. 13 N., R. 23 E. It thins rapidly northward and is es-

sentially absent north of T. 13 N. Thin, isolated developments of brown sandstone near Qualls, sec. 35, T. 5, N., R. 21 E.; in secs. 2, 11, and 20, T. 13 N., R. 21 E.; and in sec. 29, T. 14 N., R. 24 E. have been referred tentatively to the Sallisaw. In each of these cases, total thickness is less than one foot.

Stratigraphic Relations: The Sallisaw lies unconformably upon the Frisco or St. Clair. It is succeeded unconformably by the Chattanooga shale or by its basal member, the Sylamore sandstone. Small pothole features in the upper Sallisaw filled with black shale (Chattanooga) are present along a stream bank in sec. 15, T. 13 N., R. 23 E.

Paleontology: Fossils are numerous in the Sallisaw formation. *Amphigenia curta* and *Roemerella grandis* are most common and characteristic. The fauna collected by Christian (1953) is listed in Table V.

TABLE V

FAUNA OF THE SALLISAW FORMATION NEAR MARBLE CITY

Brachiopoda

Amphigenia curta (Meek and Worthen)
Eodevonaria acutiradiata (Hall)
Eodevonaria arcuata (?) (Hall)
Fimbrispirifer sp. aff. F. divaricatus (Hall)
Leptocoelia flabellites (?) (Conrad)
Protoleptostrophia perplana (Conrad)
Roemerella grandis (Vanuxem)
Schuchertella pandora (?) (Billings)
"Spirifer" hemicyclus Meek and Worthen

Age and correlation: Schuchert (1922) compared the Sallisaw with the Camden chert of Tennessee. Cram (1930) considered it equivalent to the lower Arkansas novaculite and possibly the Penters chert of Arkansas. According to Miser (personal communication, June 1951) the upper Sallisaw is similar to the Penters chert.

Upper Devonian—Lower Mississippian
Chattanooga Formation

Sylamore Sandstone Member

History of nomenclature: The Sylamore was named by Branner for exposures in the vicinity of Sylamore Creek, Stone County, Arkansas (Penrose, 1891, pp. 113, 114).

Distribution: The Sylamore sandstone is erratic in distribution. It occurs in the Marble City area on the eastern side of Quarry Mountain, in Payne Hollow, and along the side of Walkingstick Hollow. It crops out near Bunch in sec. 29, T. 14 N., R. 24 E. and at the bottom of a canyon in sec. 4, T. 14 N., R. 24 E. It is present in the Wauhillau area in sec. 2, T. 16 N., R. 23 E. and in Prichards Hollow, sec. 9, T. 16 N., R. 23 E. In the Cookson area, it is present in Walkingstick Hollow in sec. 35, T. 14 N., R. 23 E.; in Natural Bridge Hollow, sec. 36, T. 14 N., R. 23 E.; in Hastings Hollow sec. 36, T. 14 N., R. 23 E.; and east of Dry Creek in secs. 1 and 2, T. 14 N., R. 23 E. It is poorly developed in the Qualls area in sec. 35, T. 15 N., R. 21 E. and in secs. 14 and 15, T. 15 N., R. 21 E. In the Yonkers area it is present in secs. 30 and 31, T. 18 N., R. 20 E. and in sec. 36, T. 18 N., R. 19 E. In southern Mayes County, it occurs along Spring Creek and in sec. 9, T. 19 N., R. 19 E. It is present locally in the vicinity of Lake Spavinaw.

Character and thickness: The Sylamore sandstone is a white, phosphatic sandstone with a "salt and pepper" appearance on fresh surface. The basal portion is composed of dark gray, sandy shale and bluish-gray, phosphatic, limy sandstone. It weathers light gray to yellowish-brown and pitted. The sand grains have well-developed crystal faces. Normally it is friable but locally it may be quartzitic.

The thickness of the Sylamore is extremely variable. It reaches a maximum thickness (for this area) of 18 feet in sec. 29, T. 14 N., R. 24 E. It thins abruptly northward and is absent throughout much of the area.

Stratigraphic relations: The Sylamore unconformably overlies the St. Clair, Frisco, and Sallisaw formations in the southern part of the area. Northward it comes to rest unconformably upon the

Tyner formation near Murphy (T. 19 N.) and upon the Burgen and Cotter along Spavinaw Creek. The Sylamore is succeeded conformably by the black shale member of the Chattanooga formation.

Paleontology: The Sylamore contains numerous small, phosphatic brachiopods of the genus *Lingula*. Fragments of "spirifers" and traces of fossil wood are present.

Age and correlation: The age of the Sylamore is highly debatable and final determination awaits precise dating of the overlying black shale member. It is believed to be the equivalent of the Misener sand of the subsurface.

Black Shale Member

History of nomenclature: C. W. Hayes (1894) named the Chattanooga shale from exposures of black, fissile shale near Chattanooga, Tennessee. The term was extended into Arkansas and Oklahoma to replace the local terms "Eureka" and "Noel".

Distribution: The Chattanooga black shale is widely distributed throughout the area. Near Marble City it is present around the sides of Jackson and Quarry Mountains and in intervening Payne Hollow; in Walkingstick Hollow; and in McEachin Hollow. Near Bunch, it is exposed along the Lyons fault in secs. 29 and 31, T. 14 N., R. 24 E. It is exposed in several deep stream cuts on the upthrown side of the Qualls-Welling fault in secs. 17, 18, 19, 20, 9, 10 and 16, T. 16 N., R. 23 E. and along the Illinois River in secs. 25 and 36, T. 16 N., R. 22 E., and secs. 19, 30 and 31, T. 16 N., R. 23 E.; along the North Cookson fault in sec. 2, T. 15 N., R. 23 E.; on Blackgum Mountain, secs. 32 and 33, T. 14 N., R. 22 E.; on the bluff in sec. 9, T. 14 N., R. 22 E. (now inundated); in the Tenkiller area in secs. 2, 10, 11 and 20, T. 13 N., R. 21 E.; at Qualls Dome in sec. 35, T. 15 N., R. 21 E.; along the crest of an anticlinal uplift (secs. 14 and 15, T. 15 N., R. 20 E.) near Fort Gibson: along Clear Creek in secs. 20, 29, 30 and 31, T. 18 N., R. 20 E. and in sec. 36, T. 18 N., R. 19 E.; along Spring Creek in secs. 1 and 12, T. 19 N., R. 20 E.; and along Spavinaw Creek in and around the vicinity of Spavinaw (see Figure 14).

Character and thickness: The Chattanooga black shale is fissile, pyritic, carbonaceous, and bituminous. It is commonly well-jointed and breaks into quadrilateral blocks. Locally, a thin, phos-

phatic sandstone bed occurs near the base a few feet above the Sylamore horizon. Cone-in-cone structure is present at many places in basal portions.

Stratigraphic relations: The Chattanooga black shale lies conformably upon the Sylamore sandstone where that member is locally developed. Elsewhere, the Chattanooga black shale lies with unconformity upon beds ranging in age from Lower Ordovician Cotter, as near Spavinaw, to the Sallisaw formation of Devonian age near Marble City. The Chattanooga is succeeded unconformably by the St. Joe or Reeds Spring limestones.

The thickness of the Chattanooga varies from a few inches near Bunch to over 65 feet near Spavinaw.

Paleontology: The fauna of the Chattanooga includes small linguloid brachiopods, conodonts, remains of *Dinichthys* (Taff, 1905, p. 3), and a unicellular plant, *Tasmanites huronensis.*

Age and correlation: On the basis of conodonts, the Chattanooga of Tennessee and its equivalents in the Eastern Interior have been classed as Upper Devonian and Lower Mississippian (Campbell, 1946). The Chattanooga of northeastern Oklahoma is correlated with the Chattanooga of Tennessee and the Woodford of Oklahoma. Conodonts collected by Miser and Hass from the Woodford and Chattanooga of Oklahoma contain both Devonian and Mississippian forms (personal communication, 1952).

Mississippian System

"Boone" limestones and cherts

Discussion: The term Boone was introduced into geologic literature by Simonds (1891) and by Penrose (1891). Branner had previously applied the term orally to rocks of Osagean age in Boone County, Arkansas. Taff (1905) extended the term into Oklahoma and correlated the non-cherty limestone at the base with the St. Joe limestone of Arkansas. Siebenthal (1907) divided the Boone of southwestern Missouri into (1) a lower chert and limestone member, (2) the Grand Falls chert, (3) a middle limestone member, (4) the Short Creek oolite, and (5) an upper limestone. Several of these subdivisions were recognized by early workers in eastern Oklahoma.

Osagean rocks in northeastern Oklahoma were studied by Cline (1934) and Laudon (1939). The latter divided the Osage

series into three formations; the St. Joe at the base, followed in ascending order by the Reeds Spring and Keokuk formations. Strata of Burlington age were believed to be absent in northeastern Oklahoma.

The St. Joe of southwestern Missouri has been raised to the rank of a group by Clark and Beveridge (1952) to include the Compton, Northview, and Pierson formations.

St. Joe Group

History of Nomenclature: The St. Joe was named by Hopkins (1893) for well-developed exposures at St. Joe, Searcy County, Arkansas, where it was designated the basal member of the Boone formation. Taff (1905) correlated the non-cherty portion of the "Boone" of northeastern Oklahoma with the St. Joe of Arkansas, thus establishing equivalency. Cline (1934) raised the St. Joe of Oklahoma to formational rank and Laudon (1939) divided it into a "reef phase" and a "non-reef phase". Kaiser (1950) considered the St. Joe of Missouri as a formation equivalent to the Pierson; the latter term to be suppressed as a synonym.

Clark and Beveridge (1952) raised the St. Joe to group rank to include from bottom to top, the Compton, Northview, and Pierson formations.

Distribution: The St. Joe is distributed rather widely in northeastern Oklahoma in a series of discontinuous outcrops. It is present on the east flank of an anticlinal uplift along Big Cabin Creek, secs. 23 and 26, T. 24 N., R. 20 E.; along Spavinaw Creek from its junction with Grand River northeastward to the margin of the area along Lake Spavinaw; along Salina Creek, secs. 25, and 36, T. 21 N., R. 20 E.; along Spring Creek, secs. 1, 11, 12, T. 19 N., R. 20 E.; along Clear Creek, secs. 20, 29, 30, 31, T. 18 N., R. 20 E.; along Fourteenmile Creek near Gideon, sec. 26, T. 18 N., R. 21 E.; along Barren Fork north of Stilwell, secs. 25 and 36, T. 17 N., R. 25 E., and sec. 31, T. 17 N., R. 26 E.; along Evansville Creek, secs. 17 and 18, T. 16 N., R. 26 E.; on upper Caney Creek, secs. 17 and 20, T. 16 N., R. 25 E.; secs. 1, 2, and 12, T. 14 N., R. 23 E.; north of Marble City in secs. 1, 2, 10, 11, 12, 13, 14, 15, 22, 23, T. 13 N., R. 23 E.; and in sec. 10, T. 16 N., R. 23 E. near Welling. Additional exposures along the Illinois

River (outside of map area) have been examined by the senior author.

Character and thickness: The St. Joe is most complete in northerly exposures, as near Spavinaw, and on Big Cabin Creek where a three-fold lithic development is present. The basal portion consists of approximately 10 feet of gray, nodular weathering limestone which is thin-bedded in upper portions. The middle part is composed of 3 to 5 feet of olive green, soft, limy shale. The upper unit consists of a maximum of 25 feet of gray, thick-bedded, finely crystalline limestone.

The St. Joe reaches a maximum of 40 feet in northeastern Oklahoma, but averages less than 10 feet.

Stratigraphic relations: The St. Joe rests unconformably upon the Chattanooga black shale as indicated (1) by a weathered zone of green and black shale immedately below the St. Joe and (2) local absence of the Chattanooga black shale below the St. Joe. The St. Joe thins southeastward by loss of lower units and by unconformity at the top. The St. Joe is succeeded unconformably by the Reeds Spring, which locally lies upon Chattanooga and older strata.

Paleontology: Laudon (1939, p. 327) listed the following diagnostic forms from the St. Joe of northeastern Oklahoma: *Cyathaxonia arcuata* Weller, *Schizoblastus moorei* Cline, *Evactinopora sexradiata* M. and W., *Rhipidomella oweni* Hall and Clarke, "*Dictyoclostus*" *fernglenensis* (Weller), *Spirifer rowleyi* Weller, *Spirifer vernonensis* Swallow, *Brachythyris suborbicularis* (Hall), *Athyris lamellosa* (Leveille), *Cliothyridina prouti* (Swallow) and *Platyceras paralius* Weller and Weller.

Forms listed by Bassler (1950, p. 215) from the St. Joe limestone near Tahlequah, Oklahoma, include *Amplexus brevis* Weller, *Cladochonus americanus* Weller, *Cyathaxonia arcuata* Weller, and *Favosites valmeyerensis* Weller.

Pseudosyrinx missouriensis Weller and *Allorhynchus* sp. were reported by Smith (1951), and Douglass (1951) collected *Actinocrinites* sp. cf. *A. ruber* (Weller) and *Leptaenella analoga* (Phillips).

the green shaly phase of the St. Joe northeast of Tahlequah, Okla-

Microcrinoids collected by Strimple and Koenig (1956) from

homa include: *Allagecrinus sculptus* Strimple and Koenig, *Kallimorphocrinus angulatus* Strimple and Koenig, *Lampadosocrinus minutus* (Peck), *Passalocrinus triangularis* Peck, *Trophocrinus bicornis* Strimple and Koenig, and *Trophocrinus brevis* Strimple and Koenig.

Age and Correlation: The St. Joe (Pierson portion) has been correlated with the Fern Glen of eastern Missouri (Moore, 1928), the New Providence of Kentucky and Tennessee (Butts, 1922) and the Lake Valley of New Mexico (Weller, 1909). The St. Joe of northeastern Oklahoma contains the lithic equivalents of the Compton, Northview, and Pierson of southwestern Missouri, classed as Kinderhookian and lower Osagean in age. Microcrinoids in the green shaly phase at the base of the upper limestone resemble those in the Lake Valley formation and those in a shale at the base of the Welden limestone near Ada (Strimple and Koenig, 1956).

Reeds Spring Formation

History of nomenclature: The Reeds Spring member of the Boone formation was named by Moore (1928) for exposures near Reeds Spring in southwestern Missouri. Formational rank was assigned by Cline (1934) and concurred in by Laudon (1939).

Distribution: The Reeds Spring formation is extensive throughout northeastern Oklahoma. It is typically exposed where deep stream erosion has cut through the overlying Keokuk strata with which it has been mapped. The contact of the Reeds Spring and Keokuk is at many places covered by rubble from the highly fractured Keokuk.

Character and thickness: The Reeds Spring consists of nearly equal amounts of thin, alternating, fine-grained, dense, thin-bedded limestone and dark gray to blue-gray chert. The beds are resistant to erosion and where exposed in stream valleys form nearly vertical cliffs.

The Reeds Spring formation reaches a maximum thickness of 175 feet along Salina Creek east of Pryor and along the west bank of Grand River, secs. 26 and 28, T. 21 N., R. 20 E. It thins southward to 50 feet near Bunch (T. 14 N., R. 24 E.); to 13 feet in sec. 13, T. 13 N., R. 23 E., near Marble City; and to zero near

Gore (sec. 10, T. 13 N., R. 21 E.) where the Moorefield rests upon the Chattanooga.

Stratigraphic relations: The Reeds Spring rests unconformably upon the St. Joe, the Chattanooga, and St. Clair formations. The Reeds Spring is succeeded unconformably by the Keokuk formation (see figures 7 and 13).

Paleontology: Few if any recognizable fossils were collected from the Reeds Spring formation during the course of this study. Forms collected and listed by Cline (1934) and Laudon (1939) include *"Dictyoclostus" fernglenensis* (Weller), *Schizophoria poststriatula* Weller, *Unispirifer vernonensis* (Swallow), *Spirifer carinatus* Rowley, and *Favosites valmeyerensis* Weller.

Age and Correlation: Moore (1933) and Cline (1934) have classified the Reeds Spring as pre-Burlington, upper Fern Glen in age and have assigned it to the Osagean series.

Keokuk Formation

History of nomenclature: The Keokuk limestone was named by Owen (1852) from exposures near the town of Keokuk, Iowa. Snider (1914) recognized fossils of Keokuk age in the Boone of northeastern Oklahoma and Girty (1915) stated that the Boone of Arkansas ranges from Fern Glen to Keokuk in age. The term Keokuk was extended into southwestern Missouri by Moore (1933) and applied to beds above the Reeds Spring by Laudon (1939).

Distribution: The Keokuk chert crops out at the surface of approximately 50 per cent of the area. It forms the surface rock throughout much of the Springfield Structural Plain. Its exposures are confined largely to the area east of the Grand River and north of T. 13 N. It is present throughout the eastern one-third of Mayes County, the eastern part of Wagoner County, and the northern one-half of Cherokee and Adair Counties. It is brought to the surface on the upthrown side of several major faults in the southern half of Cherokee and Adair Counties.

Character and thickness: The Keokuk formation consists of massive, white to buff and gray-mottled fossiliferous chert. It is locally interbedded with irregular stringers and masses of blue-gray, dense, fine-grained limestone. In the road cut east of Pryor at the cemetery hill and along the west bank of Grand River, sec. 4, T. 21 N., R. 20 E. large crinoidal reefs or bioherms are

Figure 5. Spavinaw granite, north roadside, Spavinaw, Oklahoma, sec. 15, T. 22 N., R. 21 E.

Figure 6. Contact of Moorefield formation and the Reeds Spring chert, north side of Snake Creek, sec. 33, T. 14 N., R. 22 E.

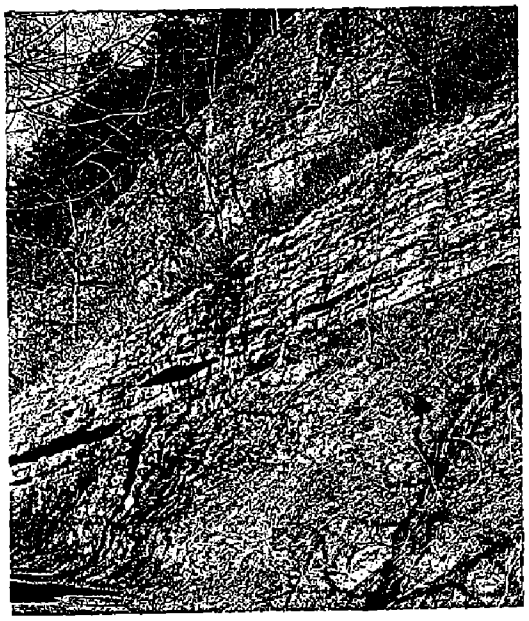

Figure 7. Even-bedded Reeds Spring chert overlying a two-foot bed of St. Joe limestone and the Chattanooga black shale, north side of road east of Baron, Oklahoma, sec. 36, T. 17 N., R. 25 E.

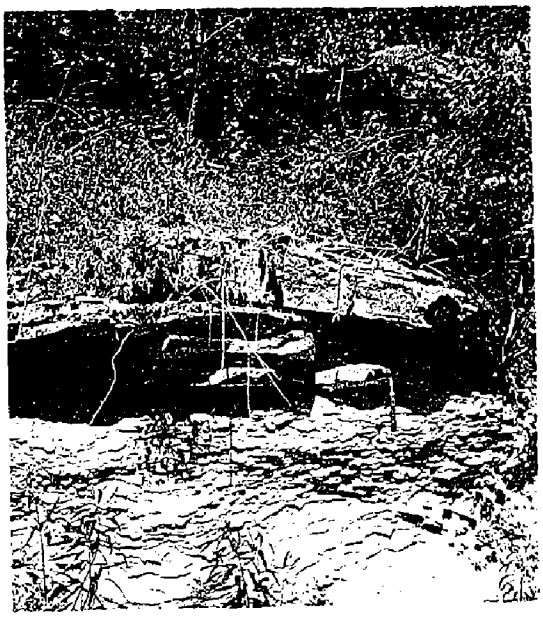

Figure 8. Short Creek oolite overlain unconformably by the Hindsville limestone, east side of creek, sec. 35, T. 16 N., R. 23 E.

present. The chert phase is typically fractured to give a brecciated appearance. It weathers tripolitic.

Locally at the top of the Keokuk there is a 10-foot bed of white oolite which is lithologically and faunally like the Short Creek oolite of Ottawa County and southwestern Missouri (Figure 8). This unit is best developed in secs. 26 and 35, T. 16 N., R. 23 E. along the road and creek south of Welling and on the Price Ranch, sec. 2, T. 15 N., R. 23 E. Smaller exposures have been noted in secs. 16, 17 and 20, T. 16 N., R. 24 E. and in sec. 32, T. 16 N., R. 23 E.

The Keokuk ranges in thickness from zero to 250 feet. It averages between 60 and 80 feet throughout the area. Maximum thickness of 250 feet was measured by Smith (1952) near Gideon in sec. 13, T. 18 N., R. 21 E. Powell (1951) found 176 feet in Buzzard Canyon, sec. 7 and 8, T. 14 N., R. 24 E. The Keokuk is absent through erosion near Marble City where the Moorefield rests on the Reeds Spring (sec. 13, T. 13 N., R. 23 E.) and in the vicinity of Tenkiller Ferry Dam (sec. 10, T. 13 N., R. 21 E.) where the Moorefield directly overlies the Chattanooga.

Stratigraphic relations: The Keokuk overlies the Reeds Spring with unconformity. This hiatus represents most or all of Burlington time. The Keokuk is succeeded unconformably by various facies of the Moorefield formation, the Hindsville, or locally by the Fayetteville shale. The top of the Keokuk marks an erosion surface of considerable relief across which younger units were deposited.

Paleontology: The Keokuk formation is abundantly fossiliferous, although the forms are preserved largely as molds and casts. Abundant forms include "*Dictyoclostus*" *crawfordsvillensis* (Weller), *Pseudosyrinx gigas* Weller, *Spirifer keokuk* Hall, *Spirifer logani* Hall, *Tetracamera subtrigona* (Meek and Worthen), *Werriea* (=*Orthotetes*) *keokuk* (Hall), and *Torynifera pseudolineata* (Hall) (see Table VI).

TABLE VI

FAUNA FROM THE KEOKUK FORMATION

Anthozoa

Amplexizaphrentis centralis (Edwards and Haime)
Neozaphrentis sp.

Brachiopoda

Allorhynchus heteropsis Winchell
Cliothyridina parvirostra (Meek and Worthen)
"Dictyoclostus" crawfordsvillensis (Weller)
Hamburgia typa Weller
Pseudosyrinx gigas Weller
Pseydosyrinx keokuk Weller
Spirifer floydensis Weller
Spirifer keokuk Hall
Spirifer logani Hall
Spirifer montgomeryensis Weller
Spirifer mortonanus (Miller)
Spirifer rostellatus Hall
Tetracamera subtrigona (Meek and Worthen)
Torynifera pseudolineata (Hall)
Werriea (=Orthotetes) keokuk (Hall)

The Short Creek oolite yielded an abundant fauna including *Brachythyris peculiaris* Shumard, *Camarotoechia mutata* (Hall), *Marginirugus magnus* (Meek and Worthen) *Marginicinctus wortheni* (Hall), *Spirifer keokuk* (Hall) and *Spirifer mortonanus* (Miller) (Table VII).

Age and correlation: Beds now classed as Keokuk were considered upper Burlington by Cline (1934). Laudon compared the fauna with that of the lower Keokuk of Iowa (Montrose chert member) and concluded that the massive chert formation above the Reeds Spring in northeastern Oklahoma most nearly resembles the lower Keokuk of the type section (1939).

TABLE VII

FAUNULE FROM THE SHORT CREEK OOLITE
(EAST SIDE OF ROAD, CENTER SEC. 35, T. 16 N., R. 23 E.)

Anthozoa

Amplexizaphrentis varsoviensis (Worthen)

Brachiopoda

Brachythyris peculiaris (Shumard)
Brachythyris suborbicularis (Hall)
Camarotoechia grosvenori (Hall)
Camarotoechia mutata (Hall)
Chonetes planumbona Meek and Worthen
Chonetes sp. cf. C. logani Norwood and Pratten
Cliothyridina parvirostra (Meek and Worthen)
Composita lewisensis Weller
Composita sp. aff. C. trinuclea (Hall)
Dielasma sp. aff. D. compressum Weller
Echinoconchus alternatus (Norwood and Pratten)
Marginicinctus wortheni (Hall)
Marginirugus magnus (Meek and Worthen)
Pseudosyrinx sp.
Spirifer keokuk (Hall)
Spirifer mortonanus (Miller)
Torynifera cooperensis (Hall)

Mayes Group

Discussion: The name Mayes was applied by Snider (1915) to the "basal formation of the Chester Group" of northeastern Oklahoma. It included the rocks lying between the top of the cherty "Boone formation" and the base of the Fayetteville black shale. The name was taken from Mayes County, Oklahoma, "where the formation attains its maximum thickness and areal extent and where its various phases are best shown".

The term Mayes was introduced into subsurface stratigraphy by Aurin, Clark, and Trager (1921) who suggested that the black limestone member of the Mississippi lime of the Okmulgee district is probably the equivalent of the Mayes of northeastern Oklahoma. This interpretation was followed by Buchanan (1927)

who correlated the "subsurface Mayes" with the Moorefield and Batesville formations of Arkansas and with a part of the Caney shale of the Arbuckle area. These he assigned to the Meramec and Chester series on the assumption that Osagean units are absent southwest of the area of outcrop.

Buchanan's interpretation was questioned by Cram (1930) who suggested that the black "subsurface Mayes" is a lateral facies of the Osagean cherts. Subsequent confusion and diversity of opinion developed concerning the relationships of the surface and subsurface Mayes. Buchanan's concept was supported by Cline (1934) and Laudon (1939, 1948) who demonstrated southward truncation of the Osage series and overlap by rocks of Meramecian age from south to north in northeastern Oklahoma. Conversely, Selk (1948) correlated the "subsurface Mayes" with the Sycamore of the Arbuckle Mountains, which he assigns to the Osage series.

Brant (1941) recommended that the term Mayes be discarded for sediments in northeastern Oklahoma and subdivided the beds formerly assigned to the Mayes of southern Mayes County into four lithic units to which he applied the names, Moorefield, Hindsville, Batesville and Grand River (in ascending order). He considered the lower three equivalent to units already established in Arkansas and applied the term Grand River (preoccupied) to rocks which he thought were younger than the typical Batesville sandstone.

Detailed mapping of these lithic units over a period of several years has led the senior author to question the validity of Brant's terminology. Comparison with the Arkansas and Missouri sections has been made and revised terminology is proposed.

Proposed terminology: The term Mayes is herein raised to group rank for surface units in northeastern Oklahoma. The type locality is along the north bank of Grand River in southern Mayes County below the site of the new Markham Ferry Dam (to be constructed). The strata assigned to the Mayes group can be divided into five lithic units comprising two formations of Meramec and Chester age. In ascending order these are (1) lower glauconitic limestone, (2) blue-gray to black, argillaceous lime-

stone, (3) chert-bearing calcarenite, (4) yellow-blue, calcareous siltstone, and (5) an upper gray, oolitic limestone. Units 1, 2, 3, and 4 resemble facies in the Moorefield of Arkansas (including the Ruddell shale) and unit 5 is homotaxial with the Hindsville of western Arkansas.

Moorefield Formation

History of nomenclature: The term Moorefield was proposed by Purdue, Ulrich, and Adams (1904) for beds between the Boone chert and the Batesville sandstone at Moorefield, Arkansas. Gordon (1944) restricted the term Moorefield to the lower limestone sequence and applied the name Ruddell to overlying brown shales. Advisability of the application of the term Ruddell to rocks in Oklahoma is questionable at this time, hence local terminology is being applied to its probable equivalent.

Subdivisions: The Moorefield of northeastern Oklahoma is herein divided into four distinct facies of member rank. These are: the lower, glauconitic limestone or Tahlequah member, the argillaceous Bayou Manard member, the chert-pebble calcarenite facies or Lindsey Bridge member, and the Ordnance Plant siltstone and shale member.

Tahlequah member (new)

Type locality: The Tahlequah member is named for exposures along the south side of a small creek south of the city limits of the town of Tahlequah, Oklahoma. Here the Tahlequah member is brought into fault contact with younger units of the Moorefield which occupy the stream bed and the north bank.

Distribution: The Tahlequah member is exposed near Tahlequah, from which it takes its name, in sec. 4, T. 16 N., R. 22 E. It is also present at the base of an outlier in sec. 32, T. 16 N., R. 23 E.; on Price's Ranch, sec. 2, T. 15 N., R. 23 E.; below the schoolhouse in sec. 7, T. 15 N., R. 23 E.; near Marble City on Sallisaw Creek, sec. 13, T. 13 N., R. 23 E.; and on southwest Quarry Mountain, sec. 14, T. 13 N., R. 23 E.; in sec. 21, T. 13 N., R. 23 E. and in sec. 11, T. 13 N., R. 23 E.; near Gideon in sec. 25, T. 18 N., R. 21 E.; and east of Fort Gibson in sec. 5, T. 15 N., R. 21 E.

Character and thickness: The Tahlequah member is a massive, light to dark gray, medium-crystalline, glauconitic limestone.

Large scale cross-bedding is developed locally. Near Tahlequah and along the creek east of Caney Creek on Price's Ranch, it contains nodules and stringers of whitish-tan chert. Southeast of Fort Gibson (sec. 5, T. 15 N., R. 21 E.) and near Marble City on Sallisaw Creek, it is characterized by large numbers of crinoid stem fragments which are so plentiful as to form a crinoidal coquinite. Westward toward Cookson, it passes into a black crinoidal limestone which grades into argillaceous limestone near Blackgum on Snake Creek, sec. 33, T. 13 N., R. 22 E. (Figures 6 and 10).

The Tahlequah member ranges from zero to 30 feet in thickness.

Stratigraphic relations: The Tahlequah member lies unconformably upon various portions of the "Boone" chert. South of Tahlequah it is draped over the uneven surface of the Keokuk chert; below the schoolhouse in sec. 7, T. 15 N., R. 23 E., it contains fragments and rounded pebbles of "Boone" chert and limestone. Near Marble City on Sallisaw Creek, sec. 13, T. 13 N., R. 23 E., it lies upon the Reeds Spring chert and on the Price Ranch (sec. 2, T. 15 N., R. 23 E.) it rests on the Short Creek oolite. The contact with the overlying argillaceous member appears to be conformable, but near Tahlequah it is marked by phosphatic (?) concretions which may indicate unstable depositional conditions and possible emergence of short duration.

Paleontology: The Tahlequah member is relatively unfossiliferous except for large numbers of crinoid stems which characterize several exposures. *Torynifera pseudolineata* (Hall), *Aviculopecten* sp., *Echinoconchus biseriatus* (Hall), *Triplophyllum spinulosum* (E. and H.), *Leiorhynchus carboniferum* Girty, *Moorefieldella eurekensis* Girty, *Werriea keokuk* (Hall), *Syringothyris texta* (Hall) have been collected.

Age and Correlation: The Tahlequah rock seems to occupy a position between typical Osagean strata and the characteristic argillaceous limestone of the Moorefield. Its stratigraphic position above the Short Creek oolite, the presence of light colored chert, the development of phosphatic (?) nodules near the top, and certain faunal similarities suggest that the Tahlequah member is essentially equivalent to the "J" bed of the Ottawa County sec-

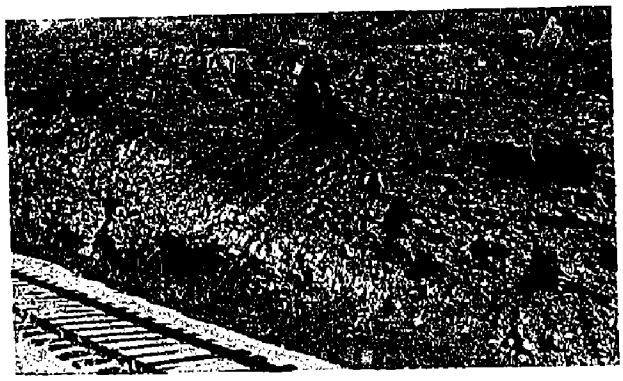

Figure 9. Onlap of Moorefield units against a Keokuk knob, railroad cut, Union Mission, sec. 16, T. 19 N., R. 19 E.

Figure 10. Moorefield formation overlying Reeds Spring chert, north bank of Snake Creek, sec. 33, T. 14 N., R. 22 E.

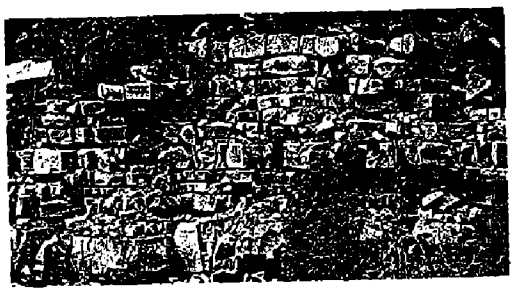

Figure 11. Lower lithographic limestone phase of the Fayetteville overlain by typical, black, fissile shale. North roadside, east of Murphy, Oklahoma, sec. 1, T. 19 N., R. 19 E.

Figure 12. Typical cross-bedded Hindsville limestone, east side of creek, sec. 27, T. 23 N., R. 20 E.

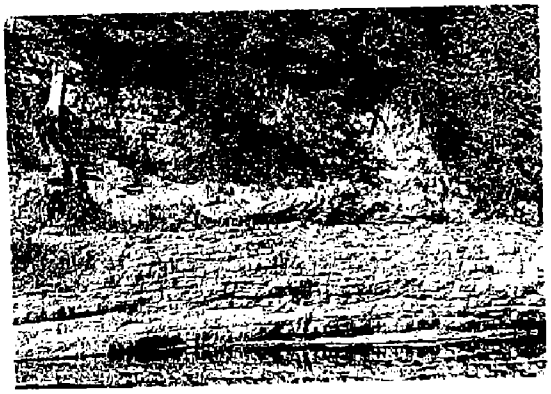

Figure 13. Even-bedded Reeds Spring chert and overlying massive to thick-bedded Keokuk chert exposed along Evansville Creek, secs. 8-17, T. 16 N., R. 26 E.

Figure 14. Chattanooga black shale, south side of Highway 20 west of Spavinaw, Oklahoma, sec. 16, T. 22 N., R. 21 E. Prominent cone-in-cone structure occurs near the base of exposure.

jointed in proximity to major faulting, forming large, rectangular blocks. The formation is highly fossiliferous and has a strong bituminous odor. Pyrite is commonly present and upon oxidation, yields a strong odor of hydrogen sulphide. Small cavities and hollow fossil interiors have yielded traces of live, green oil. Leaching of some of the more silty beds produces a light-weight, porous rock locally known as "light-rock".

The lithology of the Bayou Manard member remains fairly constant eastward to the vicinity of Stilwell where it intergrades with medium-crystalline limestone of the overlying Lindsey Bridge facies.

Along Grand River in Mayes and Wagoner Counties, the Bayou Manard member consists of a lower sequence of blue-gray, dense, fine-grained to lithographic limestone with thin beds and nodules of black chert. This is succeeded by an upper, thin to platy weathering limestone. Glauconite is present in basal portions, especially where the Bayou Manard member rests upon the eroded Keokuk. Locally, the upper portion contains large, tripolitic-weathering chert nodules.

Stratigraphic relations: The Bayou Manard member lies unconformably upon the uneven surface of the Keokuk chert in Mayes, Wagoner and western Cherokee Counties (Figures 9, 20), upon the Tahlequah member (Warsaw ?) near Tahlequah in Cherokee County and Marble City in Sequoyah County; upon the Reeds Spring in southwestern Cherokee County near Qualls; and upon the Chattanooga black shale in northwestern Sequoyah County, sec. 10, T. 13 N., R. 21 E.

Paleontology: The Bayou Manard member is highly fossiliferous. *Griffithides pustulosus* Snider is common at or near the base. Succeeding strata are characterized by *Leiorhynchus carboniferum* Girty, *Spirifer arkansanus* Girty, *Moorefieldella eurekensis* (Walcott), *"Dictyoclostus" manardensis* Sutton, *Orbiculoidea newberryi* (Girty), *Aviculopecten batesvillensis* Weller. A detailed faunal list is shown in Table VIII.

TABLE VIII

FAUNA FROM THE BAYOU MANARD MEMBER, MOOREFIELD FORMATION

Anthozoa

Amplexizaphrentis sp.
Amplexizaphrentis spinulosus (Edwards and Haime)

Bryozoa

Fenestella sp.

Brachiopoda

Avonia moorefieldanus (Girty)
Avonia oklahomensis Snider
Buxtonia arkansana (Girty)
Camarotoechia purduei var. agrestis Girty
Camarotoechia sp. aff. C. mutata (Hall)
Chonetes sp.
Cliothyridina sublamellosa (Hall)
Composita sp.
Composita sp. aff. C. humilis Girty
Composita subquadrata (Hall)
Composita subrotunda Snider
Composita trinuclea (Hall)
Cranaena globosa Weller
Diaphragmus cestriensis (Worthen) (rare)
Diaphragmus fasciculatus (McChesney)
"Dictyoclostus" sp. cf. "D." fosteri Sutton
"Dictyoclostus" manardensis Sutton
Dielasma arkansanum Weller
Echinocoelia levicula (Rowley)
Echinocoelia pilosa (Girty)
Echinoconchus biseriatus (Hall)
Eumetria costata (Hall)
Eumetria verneuiliana (Hall)
Girtyella brevilobata var. marginalis Girty
Leiorhynchus carboniferum Girty
Leiorhynchus carboniferum var. polypleurum Girty
Lingula batesvillae Girty
Linoproductus ovatus (Hall)
Moorefieldella eurekensis (Walcott)
Orbiculoidea batesvillensis Girty

Orbiculoidea newberryi var. marshallensis Girty
Orbiculoidea newberryi var. moorefieldana (?) (Girty)
Orthotetes sp. (= Werriea)
Productella hirsutiformis Walcott
Punctospirifer sp. aff. P. fayettevillensis (Girty)
Pustula moorefieldana var. pusilla (Girty)
Reticularia cooperensis Swallow
Schizophoria subelliptica (White and Whitfield)
Spirifer arkansanus Girty
Spirifer martiniiformis (Girty)
Spirifer moorefieldianus Girty
Torynifera setigera (Hall)

Mollusca

Allorisma neglectum Girty
Allorisma walkeri Weller
Aviculopecten batesvillensis (Weller)
Bellerophon sp.
Edmondia crassa Girty
Euomphalus sp.
Goniatites choctawensis Shumard
Goniatites newsomi Smith
Nuculana vaseyana (McChesney)
Mourlonia sp.
Shansiella sp.
Sphenotus meslerianus Girty
Sulcatipinna arkansana Weller

Trilobita

Griffithides pustulosus Snider

Age and correlation: The Bayou Manard member is post-Keokuk, hence post-Osagean in age. Locally it overlies beds tentatively classed as Warsaw. It is lithologically and faunally like the Moorefield (restricted) of the Arkansas section, which has been assigned a St. Louis age by Gordon (1944). The Bayou Manard member is similar to part of the lower Barnett of Texas (Cloud and Barnes, 1946) and resembles the lower calcareous Caney (Ahloso member of Elias, 1956, p. 60) of the Ada area (Lawrence Uplift) (Huffman and Barker, 1950) which is believed to be a northern, silty and shaly development of the Sycamore limestone of the Arbuckle anticline.

Lindsey Bridge Member (new)

Type locality: The Lindsey Bridge member is best developed in southern Mayes County along the north bank of Grand River in the cliff east of Lindsey Bridge, sec. 6, T. 20 N., R. 20 E.

Distribution: The Lindsey Bridge member is well exposed in a small quarry at the west end of the Low Water Dam, Oklahoma Ordnance Plant, secs. 11 and 14, T. 20 N., R. 19 E. Northward from there, its distribution is erratic. Good exposures may be seen in a small ravine in sec. 33, T. 22 N., R. 20 E.; in the pasture north of the road at the west end of the Strang Bridge, sec. 3, T. 22 N., R. 20 E.; and along Beng Creek, secs. 9 and 10, T. 22 N., R. 20 E. It maintains its identity to the vicinity of Pensacola (T. 23 N., R. 20 E.) where it lies upon the "Boone chert".

Southward, the Lindsey Bridge facies can be identified along Grand River and its tributaries to the vicinity of Ranger Creek, sec. 7, T. 16 N., R. 20 E. where its identity is lost by gradation into the underlying Bayou Manard member. It reappears with its characteristic development near Welling, secs. 7, 8, and 18, T. 16 N., R. 23 E.; on Quarry Mountain near Marble City, SE¼ sec. 11, T. 13 N., R. 23 E.; on the south end of Bugger Mountain, sec. 27, T. 16 N., R. 26 E., and south of Stilwell, south end of Stilwell Mountain, sec. 12, T. 15 N., R. 25 E. Throughout much of Adair County, the Lindsey Bridge facies and the Bayou Manard facies intergrade, both laterally and vertically.

Character and thickness: The Lindsey Bridge member is a gray, medium-crystalline, locally oolitic, cross-bedded calcarenite. It is characterized by an abundance of angular, white, tan, and blue chert fragments ranging in size from pebbles to microscopic specks. The size of chert fragments serves as an index to the proximity of old erosional remnants of the "Boone" chert which were the local sources of the chert detritus.

The thickness varies from zero to a maximum of 24.5 feet east of Lindsey Bridge, sec. 6, T. 20 N., R. 20 E. Here the contact with the underlying Bayou Manard member is transitional and difficult to establish. Near the Low Water Dam, secs. 11 and 14, T. 20 N., R. 19 E., the Lindsey Bridge member consists of a heavy, four-foot bed of limestone separated from an overlying two-foot ledge by approximately one foot of blue-yellow, silty

shale. Southward the thickness varies from 2 to 5 feet where typically developed.

Stratigraphic relations: The Lindsey Bridge member overlies the Bayou Manard member conformably. The contact, where well exposed, is quite sharp and is marked locally by "load casts" in the underlying calcilutite of the Bayou Manard member filled with medium-crystalline, gray limestone of the Lindsey Bridge facies. This relationship occurs within a single bed, normally less than 6 inches in thickness (Figure 15). The best exposure of this contact is at the Low Water Dam on the west wall of the quarry. Locally the Lindsey Bridge member overlaps the Bayou Manard and rests upon the Keokuk chert.

The Lindsey Bridge member is believed to be conformable with the overlying calcareous siltstone member. On weathered slopes and cliffs, the contact is sharply defined where the less resistant siltstone has been eroded back, leaving a prominent bench on the uppermost ledge of the Lindsey Bridge limestone. In some fresh exposures, as at the west end of the Low Water Dam (secs. 11 and 14, T. 20 N., R. 19 E.), the contact seems gradational, with silty shale incorporated below the uppermost ledge of the calcarenite facies and with transition from chert-bearing calcarenite to blue, calcareous siltstone within a single 12 inch bed.

Paleontology: The Lindsey Bridge member is sparingly fossiliferous. The fauna collected consists largely of brachiopods and pelecypods. *Leiorhynchus carboniferum* Girty, *Moorefieldella eurekensis* (Walcott), *Composita subquadrata* (Hall), and *Camarotoechia purduei* Girty are most common. The fauna in general seems to have a distinct Moorefield aspect (Table IX).

Age and Correlation: The Lindsey Bridge member is believed to be a clastic limestone facies of the Moorefield formation deposited in relatively shallow, clear water as a slight rise of sea level or a change in wave-base introduced the angular chert fragments as the Moorefield sea washed against weathered "knobs" of "Boone chert" which were standing as islands.

TABLE IX

FAUNA FROM THE LINDSEY BRIDGE MEMBER
MOOREFIELD FORMATION

Brachiopoda

Buxtonia multilirata (Girty)
Camarotoechia purduei var. agrestis Girty
Camarotoechia purduei var. inflata Girty
Composita acinus Girty
"Dictyoclostus" sp.
Dielasma arkansanum Weller
Echinoconchus sp.
Eumetria verneuiliana (Hall)
Hustedia multicostata Girty
Girtyella brevilobata var. marginalis Girty
Leiorhynchus carboniferum Girty
Lingula batesvillae Girty
Moorefieldella eurekensis (Walcott)
Orthotetes subglobosus Girty
Spirifer arkansanus Girty
Spirifer sp. aff. S. bifurcatus Hall
Spirifer martiniiformis Hall
Spirifer sp. aff. S. increbescens Hall
Syringothyris texta (Hall)
Tetracamera sp. cf. T. cuneata Hall

Mollusca

Aviculopecten batesvillensis Weller
Caneyella sp.
Edmondia crassa Girty
Mourlonia sp.

Trilobita

Griffithides sp. cf. G. pustulosus Snider

Ordnance Plant Member (new)

Type locality: The Ordnance Plant member is named for exposures along Pryor Creek within the Oklahoma Ordnance Plant area and at the west end of the Low Water Dam (secs. 11 and 14, T. 20 N., R. 19 E.), where all but the uppermost beds are completely exposed in the quarry. Uppermost beds are well developed

along the west side of Grand River below its confluence with Pryor Creek in sec. 27, T. 20 N., R. 19 E. The Ordnance Plant member takes its name from the Oklahoma Ordnance Plant located on the west side of Grand River southeast of the town of Pryor.

Distribution: The Ordnance Plant member is well developed along Grand River and its tributaries in southern Mayes County. It can be carried northward from the type locality to the vicinity of Pensacola (T. 23 N., R. 20 E.) where it is overlapped by younger units. It occurs along Grand River and its tributaries in Wagoner and western Cherokee Counties as far south as Fort Gibson Dam, sec. 7, T. 16 N., R. 20 E. It is well developed near the base of the Braggs Mountain escarpment on Highway 10, southeast of Muskogee. It thins southwestward from Braggs Mountain but has been identified along Cedar Creek, sec. 36, T. 13 N., R. 20 E. and northwest of Tenkiller Ferry Dam in sec. 10, T. 13 N., R. 21 E.

Eastward from Braggs Mountain, exposures are poor and incomplete. Some of the better exposures include (1) the Welling area, secs. 7, 8, and 18, T. 16 N., R. 23 E.; Quarry Mountain (sec. 11, T. 13 N., R. 23 E.); the south end of Bugger Mountain (sec. 27, T. 16 N., R. 26 E.); in the vicinity of Stilwell near the base of Stilwell and Taylor Mountains; and west of Stilwell on West Stilwell and Goat Mountains. It is present in the large quarry south of Stilwell on U. S. Highway 59, sec. 4, T. 14 N., R. 25 E.

Character and thickness: The Ordnance Plant siltstone member reaches its maximum development along Grand River in the Ordnance Plant area. Unfortunately, a portion of the section is now covered by the waters of Fort Gibson Reservoir. The Ordnance Plant member consists fundamentally of three parts, a lower, platy, blue to yellow siltstone (9 feet) (Figure 16), a middle (15 feet) heavy-bedded, blue, fine-grained, dense, calcareous siltstone which weathers yellow, silty, and into concentric elements of a concretionary nature (Figure 17), and an upper sequence of brown to black, platy siltstone and shale (10 feet). Maximum thickness is about 35 feet.

Northward from the type locality, the Ordnance Plant member loses the upper and part of the middle phase until only one or

Figure 15. Contact of the Bayou Manard member and the overlying Lindsey Bridge member of the Moorefield formation near the Low Water dam, sec. 14, T. 20 N., R. 19 E. (Note load casts)

Figure 16. Lower platy phase of the Ordnance Plant siltstone, east roadside, sec. 23, T. 19 N., R. 19 E.

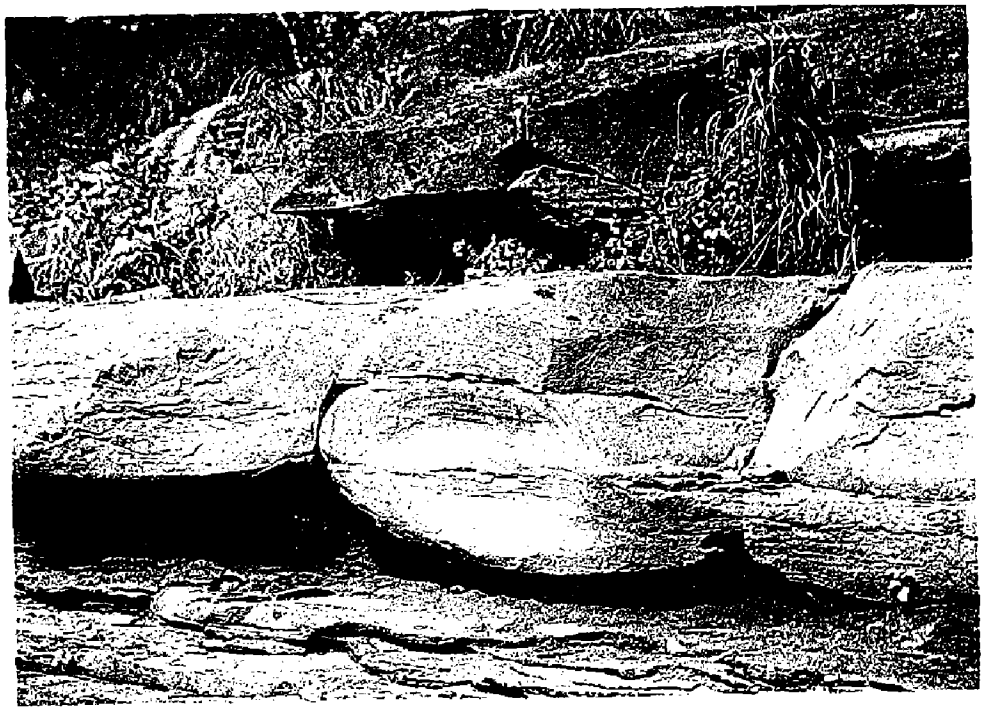

Figure 17. Middle portion of the Ordnance Plant siltstone, west side of Grand River, sec. 27, T. 20 N., R. 19 E. Note the concentric weathering of the lower bed.

two of the heavy ledges can be carried through. The lower platy phase grades into a thin-bedded lime sand near Strang Bridge, T. 22 N., R. 20 E. The middle ledges weather to a yellow, leached siltstone whose characteristics are constant over long distances. Where the middle ledges are missing by erosion, as near Pensacola (T. 23 N.), the lower, platy lime sand facies leaches to form a lightweight, porous sandstone which resembles the Batesville sandstone of the Ottawa County section which is stratigraphically higher in the section.

Southward from Mayes County, the heavy-bedded siltstone development thins by convergence and in Twps. 18 and 19 N., the entire sequence passes into thin, platy, silty shale with occasional ledges and concretions of dense, blue limestone. The silty shale development is well exposed near the base of Braggs Mountain southeast of Muskogee where approximately 30 feet is developed.

The yellow, platy, silty lithology with occasional interbeds of dense, blue, calcareous siltstone persists eastward through Cherokee and Adair Counties. Excellent exposures may be seen near Welling, on Quarry Mountain near Marble City, near the base of Stilwell, Taylor, and Goat Mountains near Stilwell; on Bugger Mountain northeast of Stilwell and near the Wauhillau Club, sec. 9, T. 16 N., T. 23 E. The northermost exposure examined is near Baron (sec. 26, T. 17 N., R. 25 E.), where a maximum of 9 feet is present.

Stratigraphic relations: The Ordnance Plant member is believed to rest conformably upon the Lindsey Bridge calcarenite facies or in its absence, upon the Bayou Manard member. Locally it overlaps onto "knobs" of Boone chert which protrude through the underlying units (see Figure 9).

The Ordnance Plant member is overlain unconformably by the Hindsville limestone, which rests upon the upper shaly phase north of the Highway 33 Bridge over Grand River in southern Mayes County, upon the middle heavy-bedded phase at Lindsey Bridge (sec. 6, T. 20 N., R. 20 E.) and upon the lower, platy, lime-sand development near Pensacola (T. 23 N.). The Hindsville truncates the Ordnance Plant member northward from Pensa-

cola and rests upon the "Boone" chert in Craig, Ottawa, and northern Delaware Counties.

In Cherokee and Adair Counties, the Hindsville rests unconformably upon various portions of the Ordnance Plant siltstone, which is overlapped northward and northeastward toward Delaware County and into Arkansas where the Hindsville lies upon the "Boone".

Paleontology: The Ordnance Plant member is sparingly fossiliferous although some of the heavy siltstone ledges in the middle portion carry profuse numbers of *Leiorhynchus carboniferum.* Pelecypods, especially *Aviculopecten batesvillensis,* are present in upper portions. *Agassizocrinus* sp. has been found sparingly in one or two localities. The fauna collected is listed in Table X.

TABLE X

FAUNA FROM THE ORDNANCE PLANT MEMBER, MOOREFIELD FORMATION

Anthozoa

Amplexus (?) sp.

Brachiopoda

Camarotoechia purduei Girty
Composita subquadrata (Hall)
Echinocoelia levicula (Rowley)
Echinoconchus alternatus (Norwood and Pratten)
Girtyella turgida var. elongata Weller
Leiorhynchus carboniferum Girty
Linoproductus ovatus (Hall)
"Marginifera" adairensis Drake
Torynifera setigera (Hall)

Mollusca

Allorisma walkeri Weller
Aviculopecten batesvillensis (Weller)
Caneyella vaughani (Girty)
Nucula rectangula McChesney
Sphenotus sp.
Rayonnoceras vaughanianum (Girty)

Age and Correlation: The abundance of *Leiorhynchus carboniferum* Girty as well as of other typical Moorefield forms and the lithic similarity of some of the beds with those in the Bayou Manard member indicate close relationship to the Moorefield formation. Stratigraphic position and lithic similarity, especially the development of concretions within the silty shale phase suggests correlation of the Ordnance Plant member with the Ruddell shale of Arkansas, which has been correlated with beds of Ste. Genevieve age by Gordon (1944). The lithology of the siltstone in southern Mayes County strongly resembles that of the Sycamore of the Arbuckle Mountains and the concretionary development is similar to the concretion-bearing beds of the lower calcareous "Caney" or "Ada Mayes" (Delaware Creek member of Elias, 1956, p. 62-65) on the Lawrence Uplift and the "false Mayes" of the subsurface.

Hindsville Formation

History of nomenclature: The Hindsville limestone was named by Purdue and Miser (1916) for exposures near Hindsville, Arkansas, where it was considered a calcareous facies or member of the Batesville sandstone. The Hindsville equivalent was recognized by Siebenthal (1907) in Ottawa County, Oklahoma, where it was mapped as the lower member of the Batesville formation. Following Miser's suggestion, the Hindsville of Ottawa County has been ranked as a formation (Reed, Schoff, Branson, 1955).

Brant (1941) applied the term Hindsville to the chert-pebble-bearing calcarenite (Lindsey Bridge member of this paper) in Mayes County which he thought was equivalent to the Hindsville of Arkansas. The senior author has presented evidence that the Hindsville of Brant is probably Moorefield in age and that the Grand River formation (preoccupied) of Brant is homotaxial with the Hindsville of Arkansas.

The term Hindsville is herein applied to the limestone strata between the Moorefield and Fayetteville in northeastern Oklahoma. It is the equivalent of the Grand River of Brant (1941).

Distribution: The Hindsville limestone is widespread throughout the area of this report. It is typically developed along Grand River and its tributaries in southern Mayes County where 36 feet

of the formation crops out. Northward from the Oklahoma Ordnance Plant (T. 20 N.) to Vinita and beyond, it floors a broad, level belt of grass and prairie country. Southward from Mayes County, it occurs chiefly along the cliffs and banks of streams. It thins southward to extinction southeast of Muskogee but can be traced eastward to the Arkansas line, forming a prominent ledge near the base of numerous outliers and fault blocks which characterize Cherokee and Adair County exposures.

Character and thickness: The lithology of the Hindsville is somewhat variable. In general, it consists of gray, medium-crystalline, thick-bedded, oolitic and fossiliferous limestone. In southern Mayes County, the base is marked by a 6-inch zone of crushed brachiopod fragments forming a soft, marly coquinite. Elsewhere, the base is commonly characterized by 2 to 3 feet of soft, green calcareous shale which forms a slope covered with nodules of soft, white limestone. The main body of the Hindsville consists of gray, oolitic limestone, which locally shows cross-lamination (Figure 12). Fine-grained, silty beds which weather to form light-20 and 21). Fine-grained, silty beds which weather to form lightweight siltstone are locally present within the main body of the limestone. The upper portion, normally 6 to 8 feet thick, may be dense and lithographic and to some extent resembles the limestones in the lower part of the Fayetteville.

The Hindsville weathers to form a soft, gray, crumbly limestone which is normally highly fossiliferous.

Thickness varies from zero (where Fayetteville laps onto "Boone" chert knobs) to a maximum of 50 feet in sec. 3, T. 16 N., R. 23 E. The average thickness is between 25 and 35 feet. It thins southward by onlap of uppermost beds. It is 5 feet thick near the base of Braggs Mountain southeast of Muskogee on Highway 10 and is absent southwest of a line running from Braggs to Marble City.

Stratigraphic relations: The Hindsville rests unconformably upon various portions of the Moorefield formation and the "Boone". Along Grand River in Mayes and Wagoner Counties, it succeeds the Ordnance Plant siltstone member of the Moorefield. It overlaps the Moorefield north of Pensacola (T. 23 N.) and lies upon the "Boone" chert in Craig and Ottawa Counties. East of Locust

Grove, it rests upon the middle Moorefield (Lindsey Bridge member). In central Adair County, near Baron, it rests upon middle Moorefield, secs. 2 and 3, T. 16 N., R. 25 E.; on the Ordnance Plant siltstone in sec. 26, T. 17 N., R. 25 E.; and upon Boone chert along Evansville Creek in secs. 33 and 34, T. 16 N., R. 26 E.

Where the Hindsville rests upon "Boone" chert, it contains a basal conglomerate composed of large, well-rounded pebbles of chert and limestone. Locally, as near Welling, the Hindsville contains small fragments of the underlying Ordnance Plant siltstone. The Hindsville grades upward into the Fayetteville, with which it is conformable.

Paleontology: The Hindsville is highly fossiliferous with such typical forms as *Agassizocrinus conicus* Owen and Shumard, *Chonetes chesterensis* Weller, *Composita subquadrata* (Hall), *Diaphragmus cestriensis* (Worthen) *"Marginifera" adairensis* (Drake), *Spirifer increbescens* Hall, *Spirifer leidyi* Norwood and Pratten, and *Stenoscisma cestriensis* (Snider) (See Table XI). The abundance of *Agassizocrinus* and *Diaphragmus cestriensis* (Worthen) in the Hindsville and their infrequent occurrence in the *Leiorhynchus*-bearing Moorefield formation serve as a valuable field tool in separation and recognition of these two formations. Several species of *Pentremites* occur in the Hindsville, especially in the lower green shale. A prominent zone of calcareous algae occurs three or four feet above the base of the Hindsville throughout much of Adair County.

Age and correlation: The Hindsville limestone of Mayes and southern Craig Counties can be traced laterally into the Hindsville limestone of Ottawa County, Oklahoma. The latter has been traced into southwestern Missouri and northwestern Arkansas where the upper portion is represented by the Batesville sandstone. The Hindsville of Cherokee and Adair Counties is homotaxial with the Hindsville of the Prairie Grove and Garfield areas of northwestern Arkansas.

The fauna of the Hindsville is indicative of early Chesterian age. The presence of *Eupachycrinus spartarius* Miller, *Phanocrinus nitidus* (Miller and Gurley), *Diaphragmus cestriensis* (Worthen), and *Agassizocrinus conicus* Owen and Shumard indicates an early

Chesterian age. Precise correlation with individual units in the Illinois area has not been accomplished.

TABLE XI

Fauna from the Hindsville Formation

Anthozoa

Amplexizaphrentis sp.
Amplexizaphrentis spinulosus (Edwards and Haime)
Pleurodictyum sp. cf. P. meekanum (Girty)

Echinoderma

Abrotocrinus cymosus Miller and Gurley
Agassizocrinus conicus Owen and Shumard
Eupachycrinus spartarius Miller
Mooreocrinus bowsheri Strimple
Pentremites sp.
Pentremites godoni (Defrance)
Pentremites sp. cf. P. godoni pinguis Ulrich
Phanocrinus nitidus Miller and Gurley

Bryozoa

Archimedes sp.
Archimedes distans Ulrich
Archimedes proutanus Ulrich
Batostomella spinulosa (?) (Ulrich)
Fenestella serratula Ulrich
Fenestella cestriensis Ulrich

Brachiopoda

Athyris cestriensis Snider
Buxtonia arkansana (Girty)
Camarotoechia purduei Girty
Camarotoechia purduei var. agrestis Girty
Camarotoechia purduei var. laxa Girty
Chonetes chesterensis Weller
Cliothyridina sublamellosa (Hall)
Composita subquadrata (Hall)
Composita trinuclea (Hall)
Diaphragmus cestriensis (Worthen)
Diaphragmus fasciculatus (McChesney)
"Dictyoclostus" inflatus (McChesney)

Dielasma arkansanum Weller
Dielsma formosum var. whitfieldi Girty
Dielasma shumardanum Miller
Eumetria vera (Hall)
Eumetria verneuiliana (Hall)
Eumetria costata (Hall)
Girtyella indianensis (Girty)
Girtyella turgida var. elongata Weller
Linoproductus ovatus (Hall)
"Marginifera" adairensis Drake
Orbiculoidea batesvillensis Weller
Punctospirifer transversus (McChesney)
Spirifer increbescens Hall
Spirifer leidyi Norwood and Pratten
Spirifer pellaensis Weller
Stenoscisma cestriensis (Snider)
Stenoscisma explanata (McChesney)
Torynifera setigera (Hall)
Werriea (=Orthotetes) kaskaskiensis (Weller)
Werriea (=Orthotetes) subglobosus (Girty)
Werriea (=Orthotetes) subglobosus var. batesvillensis (Girty)

Pelecypoda

Allorisma walkeri Weller
Aviculopecten batesvillensis Weller
Edmondia equilateralis Girty
Schizodus chesterensis Meek and Worthen
Sphenotus sp.

Gastropoda

Bellerophon sp.
Bembexia sp.
Orthonychia mayesensis Snider
Platyceras subrotundum Snider

Cephalopoda

Gastrioceras caneyanum Girty
Liroceras sp.

Trilobita

Paladin mucronatus (Girty)

Fayetteville Formation

History of nomenclature: The Fayetteville formation was named by Simonds (1891) from exposures in the vicinity of Fayetteville, Washington County, Arkansas. The Wedington sandstone member (Adams, Purdue, Ulrich, 1904) is present in the upper portion of the formation in western Arkansas and extreme eastern Oklahoma.

Distribution: The Fayetteville formation is widespread throughout northeastern Oklahoma. It has been traced almost continuously from northeast of Vinita in Craig County southward to the vicinity of Gore (T. 14 N.), thence eastward to the Arkansas line. In southern Mayes and Wagoner Counties, it is exposed along Grand River and its tributaries where it forms a grass-covered slope between the ledges of the Pitkin-Hale sequence and the Hindsville limestone. In northern Mayes and southern Craig Counties, it, together with the Hindsville, forms a broad, flat area between Grand River and the Pennsylvanian escarpment which parallels Highway 69. In Cherokee and Adair Counties, the Fayetteville is restricted to the slopes of outliers which rise above the "Boone" surface and to areas on the upthrown side of major fault blocks.

Character and thickness: The Fayetteville formation is typically developed on the Braggs Mountain escarpment southeast of Fort Gibson (secs. 21-29, T. 15 N., R. 20 E.) along Highway 10 where a thickness of 110 feet is developed. There the lower 95 feet is composed largely of black, fissile shale with occasional thin interbeds of blue-black, lithographic limestone. Large septarian concretions are common. The upper part of the Fayetteville consists of interbedded limestone and shale. The limestone ledges are in most cases less than one foot thick and are separated by black, fissile shale. The Fayetteville grades upward into the overlying Pitkin through a 6.5-foot transition zone of rubbly, nodular-weathering, black to gray, lithographic limestone.

Near Murphy and on the grounds of the Oklahoma Ordnance Plant in southern Mayes County, the Fayetteville formation consists of two well defined lithologies. The lower is gray to black,

lithographic limestone in beds 1 inch to 1 foot in thickness. It weathers into sub-cubical blocks with a whitish surface. The thickness near Murphy is 36 feet; it increases to 50 feet in sec. 31, T. 20 N., R. 20 E. The upper portion consists of soft, black fissile shale with a thickness of 30 feet (see Figure 11).

Northward, in the vicinity of Strang, the lower part of the Fayetteville passes into gray-green, calcareous shale with beds of dark gray, medium-crystalline, fossiliferous limestone. The upper black shale facies is essentially removed by pre-Hale erosion, occurring only along the Seneca graben, where 18 feet is present.

The gray-green calcareous lithology persists northward beyond Vinita into Ottawa County where the Fayetteville is cut out by unconformity.

In eastern Adair County, the Fayetteville reaches a thickness of 165 feet. The lower 100 feet consists of black, fissile shale with black, lithographic, septarian concretions. Overlying is the Wedington sandstone member of brown to buff, thinly laminated sandstone ranging from zero to 25 feet in thickness. Succeeding strata are largely covered but consist of gray to brown, iron-stained shale. The Wedington sandstone thins westward by convergence to zero in the vicinity of Stilwell. Clay ironstone concretions mark its approximate position just west of the zero line. Thin interbeds of nodular phosphate occur near Marble City and in the Cookson area.

Stratigraphic relations: The Fayetteville formation lies conformably upon the Hindsville limestone. Where the Hindsville is absent due to non-deposition, the Fayetteville rests upon "Boone" chert knobs. The Fayetteville grades upward into the Pitkin limestone and the boundary is difficult to determine in many sections. North of Yonkers (T. 8 N.) the Pitkin is missing through erosion and the Hale formation rests upon the Fayetteville. In northernmost exposures in Craig County, the Fayetteville is succeeded unconformably by sandstones and shales of Middle Pennsylvanian age.

Paleontology: The black fissile shales of the Fayetteville are essentially barren of fossils. The limestones are abundantly fossiliferous, with *Linoproductus ovatus* (Hall), *Spirifer increbescens* (Hall), *Athyris cestriensis* Snider, *Brachythyris ozarkensis* Snider, "*Marginifera*" *adairensis* (Drake), *Diaphragmus cestriensis* (Worthen), *Buxtonia arkansana* (Girty), *Pleurodictyum meekanum* (Girty), *Archimedes* (several species), *Chonetes chesterensis* Weller, *Werriea* (=*Orthotetes*) *kaskaskiensis* (McChesney).

An ostracode fauna reported by Harlton (1929) from the southwest corner of sec. 15, T. 25 N., R. 21 E., Craig County, includes *Bassleria fayettevillensis* Harlton [=*Graphiodactylus arkansus* (Girty)], *Jonesina reticulata, J. vinitaensis, Healdia vinitaensis, Seminolites conspicuus, Bairdia granireticulata, Bairdia subrotundata,* and *Bairdia lanulata.*

The fauna collected during the course of this project is listed in Table XII.

TABLE XII

Fauna from the Fayetteville Formation

Anthozoa

Amplexizaphrentis spinulosus (Edwards and Haime)
Amplexus expansus Easton
Paleacis cuneata Snider
Pleurodictyum meekanum Girty

Echinoderma

Agassizocrinus sp.
Heliosocrinus aftonensis Strimple
Mantikosocrinus castus Strimple
Pentremites sp.
Pentremites pyriformis Say
Phanocrinus alexanderi Strimple
Phanocrinus cylindricus (Miller and Gurley)
Phanocrinus formosus (Worthen)

Bryozoa

Archimedes compactus Ulrich
Archimedes communis Ulrich
Archimedes distans Ulrich
Archimedes inflatus Ulrich
Archimedes intermedius Ulrich
Archimedes invaginatus Ulrich
Archimedes proutanus Ulrich
Archimedes swallovanus Hall
Fenestella cestriensis Ulrich
Fenestella tenax Ulrich
Septopora cestriensis Prout

Brachiopoda

Athyris cestriensis Snider
Brachythyris ozarkensis Snider
Buxtonia arkansana (Girty)
Camarotoechia purduei Girty
Camarotoechia purduei var. agrestis Girty
Camarotoechia purduei var. laxa Girty
Chonetes tumescens Easton
Chonetes chesterensis Weller
Chonetes oklahomensis Snider
Cliothyridina sublamellosa Hall
Composita acinus Girty
Composita subquadrata (Hall)
Composita trinuclea (Hall)
Diaphragmus cestriensis (Worthen)
Diaphragmus fasiculatus (McChesney)
"Dictyoclostus" inflatus (McChesney)
Dielasma arkansanum Weller
Dielasma shumardanum (Miller)
Echinocoelia levicula (Rowley)
Echinoconchus alternatus (Norwood and Pratten)
Echinoconchus biseriatus (Hall)

Eumetria costata (Hall)
Eumetria lata Snider
Eumetria pitkinensis Snider
Eumetria vera (Hall)
Eumetria verneuiliana (Hall)
Eumetria welleri Croneis
Hustedia multicostata Girty
Lingulidiscina batesvillensis Weller
Linoproductus ovatus (Hall)
"Marginifera" adairensis (Drake)
Orbiculoidea sp.
Punctospirifer transversus (McChesney)
Reticulariina spinosa (Norwood and Pratten)
Spirifer increbescens Hall
Spirifer leidyi Norwood and Pratten
Spirifer pellaensis Weller
Stenoscisma cestriensis (Snider)
Stenoscisma explanata (McChesney)
Torynifera setigera (Hall)
Werriea (=Orthotetes) subglobosus (Girty)
Werriea (=Orthotetes) subglobosus var. batesvillensis (Girty)

Pelecypoda

Allorisma walkeri Weller
Aviculopecten ozarkensis Snider
Caneyella nasuta Girty
Caneyella vaughani Girty
Edmondia crassa Girty
Edmondia pitkinensis Snider
Leda vaseyana McChesney
Myalina compressa Snider
Sphenotus sp. cf. S. meslerianus Girty

Gastropoda

Bellerophon sublaevis Hall
Euomphalus similis Meek and Worthen
Naticopsis sp.
Platyceras subrotundum Snider

Cephalopoda

Bactrites sp. cf. B. quadrilineatus Girty
Cycloceras sequoyahense Snider
Endolobus ornatus Girty
Eumorphoceras bisulcatum Girty
Gastrioceras sp.
Goniatites choctawensis Shumard
Rayonnoceras vaughanianum Girty
Tylonautilus nodosocarinatus (Roemer)

Trilobita

Kaskia chesterensis Weller and Weller
Paladin mucronatus Girty

Vertebrata

Cladodus ozarkensis Croneis
Deltodus cingulatus Newberry and Worthen

Plantae

Lepidodendron sp.

Age and correlation: The Fayetteville is similar to the black Caney shale (Sand Branch member of Elias, 1956, p. 65) of the Arbuckle Mountains with which it is correlated. It is assigned to the Chester series and is believed to correlate with the Golconda-Glen Dean sequence of Illinois (Weller, 1948) and with the Gasper-Golconda-Bangor sequence of Alabama (Croneis, 1930).

Pitkin Formation

History of nomenclature: The Pitkin formation was named by Adams and Ulrich (1904) for exposures near Pitkin postoffice in Washington County, Arkansas. The Pitkin is the "Archimedes limestone" of early workers.

Distribution: The Pitkin underlies the Hale formation throughout Wagoner, Cherokee, and Adair Counties. It can be traced from T. 18 N. southward to the vicinity of Gore (T. 13 N.), thence eastward to the Arkansas line. Together with the overlying Hale, the Pitkin forms a conspicuous bluff along major streams and around the outliers on the post-Boone surface. The Pitkin is absent locally in the vicinity of Baron and Walkingstick Mountain north of Stilwell and is cut out by unconformity north of the Mayes-Wagoner County line.

Character and thickness: The Pitkin formation consists largely of gray to blue-gray, dense, finely crystalline to lithographic, iron-stained limestone. The upper and lower portions characteristically weather in a rubbly fashion. Intermediate beds are oolitic, crinoidal, and in a few cases, granular. Dark gray, calcareous shale partings occur throughout and black fissile shale is present in lower portions. Along Flat Rock Creek (sec. 18, T. 18 N., R. 19 E.) a five-foot bed of black shale occurs.

Thickness varies from zero in the northern parts of Wagoner and Cherokee Counties to a maximum of 82 feet in the River Bluff section, sec. 32 T. 15 N., R. 20 E. The average thickness is 25 to 30 feet. Thickness is variable because of the unconformable relationship of the overlying Hale formation.

Stratigraphic relations: The Pitkin formation is conformable with the subjacent Fayetteville. Where the upper Fayetteville consists of rubbly-weathering limestone, the contact is gradational and difficult to determine accurately. The Pitkin is succeeded unconformably by the Hale formation (Figures 18 to 19).

Paleontology: The Pitkin is characterized by the presence of large numbers of the spiral bryozoan *Archimedes*. This fossil serves to distinguish the Pitkin from the Hale where lithologies are similar. Other forms common to the Pitkin are *Diaphragmus cestriensis* (Worthen), *Eumetria pitkinensis* Snider, *Spirifer leidyi* Norwood and Pratten, *Composita trinuclea* (Hall), *Pentremites godoni* (Defrance), *Stenoscisma cestriensis* (Snider), "*Linoproductus*" *ovatus* (Hall), and *Paladin mucronatus* (Girty) (see Table XIII).

Crinoids described by Strimple from the Pitkin of Oklahoma (J. Paleo. 1951, Jour. Wash. Acad. Sci. 1951) include the following forms: *Pianocrinus durus* Strimple, *Pianocrinus aptus* Strimple, *Bronaughocrinus figuratus* Strimple, *Agassizocrinus patulus* Strimple, *Tholocrinus foveatus* Strimple, *Telikosocrinus caespes* Strimple, *Telikosocrinus residuus* Strimple. *Phanocrinus irregularis* Strimple, *Phanocrinus modulus* Strimple, and *Cymbiocrinus pitkini* Strimple (1955).

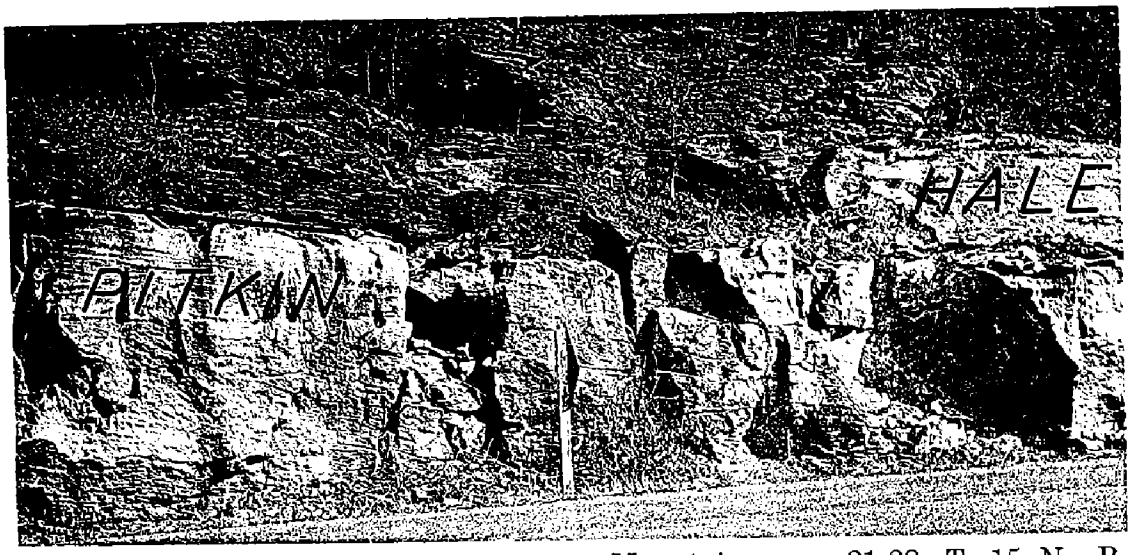

Figure 18. Pitkin-Hale contact, Braggs Mountain, secs. 21-28, T. 15 N., R. 20 E. Note the typical pitted and fluted weathering of the Hale formation as opposed to the smoother weathering of the underlying Pitkin.

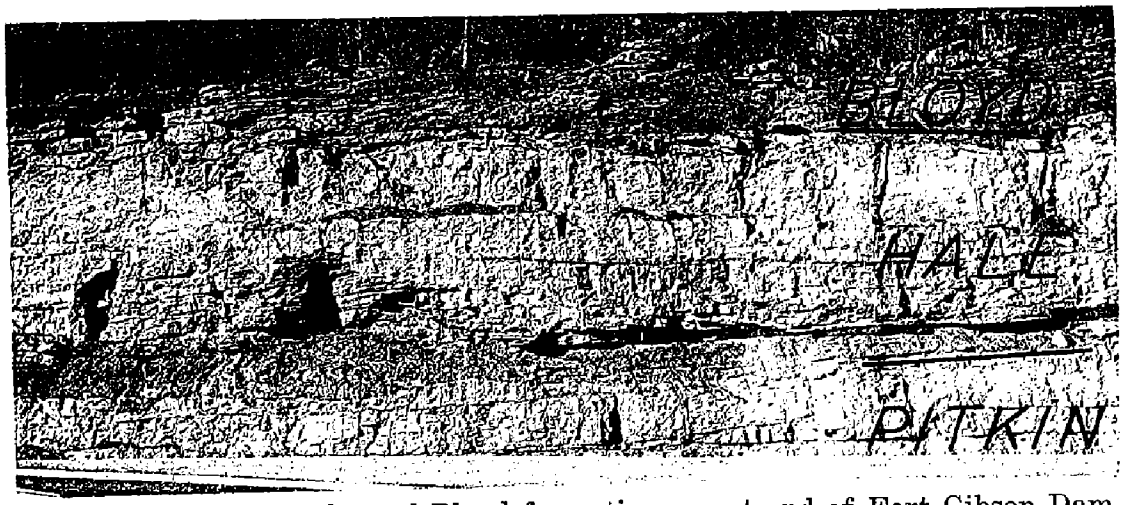

Figure 19. Pitkin, Hale, and Bloyd formations, west end of Fort Gibson Dam, sec. 13, T. 16 N., R. 19 E. Note the thick development of the Hale conglomerate.

Figure 20. Moorefield formation (Bayou Manard facies) resting unconformably upon the Keokuk chert, railroad cut, Pryor Ordnance Plant, sec. 11, T. 20 N., R. 19 E. Note irregular contact.

TABLE XIII

FAUNA FROM THE PITKIN FORMATION

Anthozoa

Amplexizaphrentis spinulosus (Edwards and Haime)

Echinoderma

Pentremites godoni (Defrance)
Pentremites interlineatus Easton
Pentremites obesus Lyon
Scytalocrinus garfieldi Laudon

Bryozoa

Archimedes communis Ulrich
Archimedes compactus Ulrich
Archimedes distans Ulrich
Archimedes intermedius Ulrich
Archimedes invaginatus Ulrich
Archimedes meekanus Hall
Archimedes pitkinensis Elias
Archimedes proutanus Ulrich
Archimedes swallovanus Hall
Fenestella sp.

Brachiopoda

Athyris cestriensis Snider
Buxtonia arkansana (Girty)
Chonetes chesterensis Weller
Chonetes oklahomensis Snider
Chonetes sericeus Girty
Chonetes tumescens Easton
Cliothyridina sublamellosa (Hall)
Composita acinus Girty
Composita subquadrata (Hall)
Composita trinuclea (Hall)
Diaphragmus cestriensis (Worthen)
"Dictyoclostus" inflatus (McChesney)
Dielasma arkansanum Weller
Dielasma formosum Hall
Dielasma illinoisense (Girty)
Echinoconchus alternatus (Norwood and Pratten)

Echinocoelia levicula (Rowley)
Eumetria costata (Hall)
Eumetria pitkinensis Snider
Eumetria vera (Hall)
Eumetria verneuiliana (Hall)
Girtyella indianensis (Girty)
Linoproductus ovatus (Hall)
Orbiculoidea newberryi var. moorefieldana (Girty)
Reticulariina spinosa (Norwood and Pratten)
Spirifer leidyi (Norwood and Pratten)
Spirifer pellaensis Weller
Stenoscisma cestriensis (Snider)
Torynifera setigera (Hall)
Werriea (=Orthotetes) kaskaskiensis (McChesney)
Werriea (=Orthotetes) subglobosus (Girty)

Pelecypoda

Allorisma walkeri Weller
Aviculopecten pitkinensis Snider
Conocardium sp.
Leda vaseyana (McChesney)
Myalina sp.
Nuculana pandoriformis ? (Stevens)
Nuculopsis rectangula (McChesney)
Schizodus chesterensis Meek and Worthen
Sphenotus cherokeensis Snider
Sphenotus quadriplicatus Snider
Sulcatipinna sp. cf. S. arkansana Girty

Gastropoda

Bellerophon chesterensis Weller
Bellerophon pitkinensis Snider
Euphemites sp.
Platyceras subrotundum Snider
Straparollus planidorsatus (Meek and Worthen)

Cephalopoda

Cycloceras sequoyahense Snider
Eoasianites globosus Easton

Trilobita

Paladin mucronatus (Girty)

Age and correlation: The Pitkin formation is assigned to the upper part of the Chesterian series (Easton, 1942) and has been correlated with the Clore, Degonia, and Kinkaid formations of the Illinois section (Weller, 1948). Similarity of corals with those in the Kinkaid has been noted by Easton (1945). The Pitkin is probably represented in part by the upper portion of the Caney shale in the Arbuckle Mountains and by the Goddard shale of the Ardmore Basin; the latter contains *Archimedes* near Milo, Oklahoma (Elias, 1955). Selk (1948, p. 305) reported beds which resemble the Pitkin in subsurface along the north side of the Wichita Mountain front.

Pennsylvanian System

Hale Formation

History of nomenclature: The name Hale was given by Adams and Ulrich (1905) to the basal sandy member of the Morrow formation. It was named from Hale Mountain, Washington County, Arkansas, to replace the earlier name "Washington" (preoccupied) which had been given this unit by Simonds (1891). The Morrow was raised to group rank by Purdue (1907) and the Hale became a formation.

Distribution: The Hale formation is widely distributed throughout northeastern Oklahoma. It is conspicuous along the cliffs bordering Grand River from southern Mayes County to the vicinity of Fort Gibson. Together with the underlying Pitkin, it forms prominent cliffs along the fault blocks of southern Cherokee and Adair Counties and on the "post-Boone" outliers in northern Cherokee and Adair Counties.

The Hale is essentially absent north of T. 20 N., being present as isolated exposures in the northwest corner of sec. 31, T. 21 N., R. 20 E.; along the Seneca fault, sec. 29, T. 21 N., R. 19 E.; in Salt Creek northeast of Pryor in sec. 5, T. 21 N., R. 19 E.; in the Seneca graben, sec. 2, T. 21 N., R. 19 E., and in secs. 15, 16, 20, 21, and 29, T. 22 N., R. 20 E.; and as small outliers in sec. 8, T. 22 N., R. 20 E., and secs. 31 and 32, T. 23 N., R. 21 E.

Character and thickness: Throughout much of its area of outcrop, the Hale is marked at the base by a thin conglomerate containing pebbles and fragments of underlying Mississippian rocks.

This conglomerate reaches its maximum observed thickness at the east and west ends of Fort Gibson Dam where a thickness of 3 feet is attained (Figure 19). Elsewhere, the basal portion of the Hale consists of calcareous sandstone which grades both laterally and vertically into sandy limestone. Upon weathering, the surface takes on a pitted or cavernous appearance and a thin-bedded, cross-lamination is cleary visible (Figure 18). The upper portion consists largely of gray or blue-gray, to brown, fine- to medium-crystalline, oolitic, crinoidal, and fossiliferous limestone.

In easternmost exposures (T. 15 N., R. 26 E.) a shale development is present in the lower part of the Hale. The shale is brown to gray, iron-stained, and platy. It reaches a thickness of 15 feet in sec. 17 and 20 feet in sec. 15, T. 15 N., R. 26 E. This lower shale development resembles the Cane Hill member of the Hale formation of western Arkansas (Miser, personal communications, 1949, 1951) and is lithologically similar to the shale in the railroad cut near the University campus at Fayetteville, Arkansas. Succeeding units of thick-bedded sandstone and limestone are comparable to the Prairie Grove member of the Arkansas section as established by Henbest (1953).

The Hale ranges in thickness from zero in portions of Mayes and Craig Counties to 136 feet on Ross Mountain, sec. 1, T. 14 N., R. 26 E. and secs. 35 and 36, T. 15 N., R. 26 E. It averages 100 feet over much of Adair and Cherokee Counties, thinning westward to approximately 60 feet along Grand River in western Cherokee County.

Stratigraphic relations: The Hale rests with pronounced unconformity upon Pitkin and older strata. North of the Mayes-Cherokee, Wagoner County line, the Pitkin is missing and the Hale rests upon progressively older portions of the Fayetteville to its northernmost exposure in T. 23 N., R. 22 E. The conglomerate at the base of the Hale contains reworked fossils of Pitkin and Fayetteville age.

The Hale grades upward into the Bloyd formation and the contact is typically placed at the base of the first prominent shale above the massive Hale limestone.

Paleontology: The Hale formation is fossiliferous with abundant *Michelinia scopulosa* Moore and Jeffords (formerly *Pleuro-*

dictyum eugeneae (White), *Striatopora oklahomensis* Snider (=*Thamnopora carbonaria* (Mather)), "*Dictyoclostus*" *morrowensis* (Mather), *Composita ovata* Mather, *Spirifer rockymontanus* Marcou, and *Lepidodendron* sp.

Large coralline faunas have been reported by Moore and Jeffords (1945) from localities near Fort Gibson and Braggs, Oklahoma. The Hale formation in the Keough Quarry, sec. 36, T. 16 N., R. 19 E. yielded *Lophophyllidium blandum* Moore and Jeffords, *L. metum* Moore and Jeffords, *Lophamplexus captiosus* Moore and Jeffords, *Michelinia teniucula* Moore and Jeffords, *M. scopulosa* Moore and Jeffords, *Acaciapora subcylindrica* (Mather), *Amplexocarina corrugata* (Mather), *Lophotichium vescum* Moore and Jeffords, *L. amoenum* Moore and Jeffords, *Dibunophyllum* ? *inauditum* Moore and Jeffords, *Hapsiphyllum crassiseptatum* Moore and Jeffords, *Pseudozaphrentoides nitellus* Moore and Jeffords, *Chaetetes eximius* Moore and Jeffords, and *Neokoninckophyllum simplex* Moore and Jeffords.

The locality near Braggs at the base of the Greenleaf dam, sec. 10, T. 13 N., R. 20 E. yielded *Lophophyllidium angustifolium* Moore and Jeffords, *L. exile* Moore and Jeffords, *L. minutum* Moore and Jeffords, *Lophotrichium vescum* Moore and Jeffords, *L. improcerum* Moore and Jeffords, *L. densum* Moore and Jeffords, *Lophamplexus captiosus* Moore and Jeffords, *Amplexocarinia corrugata* (Mather), *Pseudozaphrentoides nitellus* Moore and Jeffords, *Michelina tenuicula* Moore and Jeffords, *M. scopulosa* Moore and Jeffords, *Acaciapora subcylindrica* Mather, and *Cladochonus fragilis* Mather.

Cephalopod faunas from the Morrow (undifferentiated Hale and Bloyd) of northeastern Oklahoma (Miller and Moore, 1938) (Miller and Owen, 1944) include *Coloceras* sp., *Cravenoceras* ? *morrowense* Miller and Moore, *Eoasianites oblatus* (Miller and Moore), *Gastrioceras branneri* Smith, "*Gastrioceras*" *pygmaeum* Mather, and *Pseudoparalegoceras kesslerense* (Mather).

The fauna collected during the progress of this study is listed in Table XIV. The fauna is quite distinct from that of the underlying Pitkin and Fayetteville but closely resembles that of the overlying Bloyd.

TABLE XIV

Fauna from the Hale Formation

Anthozoa

Amplexocarinia corrugata (Mather)
Caninia torquia (Owen)
Lophophyllidium sp.
Michelinia scopulosa Moore and Jeffords
Striatopora oklahomensis (Snider)
Zaphrentis ? gibsoni White

Echinoderma

Echinocrinus sp.
Ethelocrinus sp.
Pentremites godoni angustus Hambach
Pentremites rusticus Hambach

Bryozoa

Archimedes swallovanus Hall (=A. juvenis Mather, 1915)
Cyclotrypa matheri Moore and Dudley
Cystodictya morrowensis Mather
Fenestella morrowensis Mather
Fenestella venusta Mather
Polypora magna Mather
Polypora purduei Mather
Polypora triseriata Mather

Brachiopoda

Buxtonia sp.
Chonetes chouteauensis Mather
Composita deflecta Mather
Composita gibbosa Mather
Composita ovata Mather
Composita ozarkana Mather
Composita transversa Mather
Composita wasatchensis White
Condrathyris perplexa (McChesney)
"Dictyoclostus" gallatinensis (Girty)
"Dictyoclostus" morrowensis (Mather)

"Dictyoclostus" welleri (Mather)
Dielasma arkansanum Weller
Dielasma subspatulatum Weller
Echinoconchus sp. aff. E. semipunctatus var. knighti Dunbar and Condra
Hustedia miseri Mather
Linoproductus altonensis (Norwood and Pratten)
Linoproductus platyumbonus Dunbar and Condra
Linoproductus ovatus (Hall)
Neospirifer goreii (Mather)
Punctospirifer campestris (White)
Rhynchopora magnicosta Mather
Schizophoria resupinoides Cox
Spirifer rockymontanus Marcou
Wellerella osagensis (Swallow)
Wellerella triangularis (?) (Mather)

Pelecypoda

Astartella concentrica Meek
Aviculopinna americana Meek
Aviculopecten sp.
Edmondia maccoyii (?) Hall
Edmondia subtruncata Meek
Myalina orthonota Mather
Schizodus wheeleri ? Swallow
Sphenotus halensis Mather

Gastropoda

Amphiscapha catilloide (Conrad)
Bellerophon sublaevis Hall
Euconospira arkansana Mather
Platyceras parvum (Swallow)

Trilobita

Paladin morrowensis (Mather)

Vertebrata

Petalodus sp.

Plantae

Lepidodendron sp.

Age and correlation: The Hale is the oldest Pennsylvanian unit in northeastern Oklahoma. It is the basal portion of the Morrow series of the mid-continent section. It has been correlated with the Union Valley formation of the Lawrence Uplift (Miller and Owen, 1944), the Primrose of the Ardmore Basin and the frontal Ouachita Mountains (Harlton, 1938) and with the Cromwell of the subsurface. The basal shale (Cane Hill equivalent) is tentatively correlated with the upper part of the Springer of the Ardmore Basin.

Bloyd Formation

History of nomenclature: The Bloyd formation was named by Purdue (1907) from Bloyd Mountain, 9 miles southwest of Fayetteville, Washington County, Arkansas. As defined, the Bloyd formation includes the Brentwood (Pentremital) limestone; the Woolsey shale containing the Baldwin coal (Henbest, 1953, p. 1943); the Kessler limestone; and an upper, unnamed shale. According to Moore (1947), only the Brentwood portion of the Bloyd is typically developed in northeastern Oklahoma.

Distribution: The Bloyd is widely distributed in northeastern Oklahoma. It can be traced around the various outliers and fault blocks from the Arkansas line westward to the Arkansas River Valley, thence northward to the Mayes-Wagoner County line where it is beveled by pre-Atoka erosion. The most northerly exposures so-far identified are along Highway 69 on the north side of Brush Creek near the junction of Highways 69 and 33 (one-half mile west of the margin of this area) and near Union Mission, secs. 17 and 20, T. 19 N., R. 19 E.

The Bloyd typically forms a grass- and tree-covered slope between the cliff-forming ledges of the underlying Hale and the overlying Atoka.

Character and thickness: The Bloyd formation is best described as a sequence of alternating shales and limestones. The lithology of the limestone is variable, ranging from blue-gray to black, from fine to coarsely crystalline in texture, and from massive- to thin-bedded.

The shale is black, brown or greenish-gray, normally non-

calcareous, fissile, and it contains limestone concretions. A few beds are calcareous; these range in color from brown to gray.

Sandstones or sandy limestone occur near the base and top of some sections. Occasional siltstones are present, in most cases near the top. These are brown to gray, micaceous, and thin-bedded. A thin bed of coal (0.8 feet) exposed along Highway 10, sec. 20, T. 15 N., R. 20 E. has been placed in the Bloyd by Moore (1947) and tentatively correlated with the Baldwin coal of Arkansas. It is possible that this coal is in the lower Atoka inasmuch as it is associated with sandstones, shales, underclay, and conglomerates which closely resemble those in the overlying Atoka.

The Bloyd reaches a maximum thickness of 225 feet in the Stilwell area on North Double Head Mountain, NE¼ sec. 23, T. 15 N., R. 25 E. It thins westward toward Muskogee with only 58 feet present at Braggs Mountain, secs. 21 and 29, T. 15 N., R. 20 E. It thins northward to extinction near the Mayes-Wagoner County line.

Stratigraphic relations: The contact of the Bloyd with the subjacent Hale is conformable and gradational. The Atoka formation lies unconformably upon the Bloyd as far north as T. 18 N., where it cuts down onto the Hale. North of Pryor, the Hale is missing and the Atoka formation rests unconformably on the Fayetteville.

Paleontology: In general, the fauna of the Bloyd resembles that of the underlying Hale with several species of *Composita,* "*Dictyoclostus*" and *Dielasma* in common. One of the most conspicuous elements in the faunal assemblage is *Pentremites angustus,* which characterizes many of the limestone ledges. A classic locality for collection of these is the spillway of Greenleaf Dam, sec. 10, T. 13 N., R. 20 E.

Crinoids collected and identified by Moore and Plummer (1938) from the Keough Quarry northeast of Fort Gibson, Oklahoma, and Braggs Mountain southeast of Fort Gibson include the following forms: *Acrocrinus pirum* Moore and Plummer, *Cibolocrinus tumidus* Moore and Plummer, *Cibolocrinus regularis* Moore and Plummer, *Hydriocrinus ? rosei* Moore and Plummer, *Morrowcrinus fosteri* Moore and Plummer, *Ulrichicrinus oklahomae*

Springer, *Ethelocrinus oklahomensis* Moore and Plummer, *E. papulosus* Moore and Plummer, *E. costalis* Moore and Plummer, *E. hispidus* Moore and Plummer, *E. subsinuatus* Moore and Plummer, *Xystocrinus ? acicularis* Moore and Plummer, *Sciadiocrinus ? crassacanthus* Moore and Plummer, *Plaxocrinus strigosus* Moore and Plummer, *Perimestocrinus pumilis* Moore and Plummer, *Utharocrinus pentanodus* (Mather), *Delocrinus matheri* Moore and Plummer, *Delocrinus ? pendens* Moore and Plummer, *Paradelocrinus aequabilis* Moore and Plummer, *Paradelocrinus dubius* (Mather), *Paradelocrinus ? simus* Moore and Plummer, *Aaesiocrinus* sp., *Diphuicrinus croneisi* Moore and Plummer, and *Stereobrachicrinus pustullosus* Mather.

The fauna collected by the writers is listed in Table XV.

Age and correlation: The Bloyd of Oklahoma is correlated with the Bloyd of Arkansas, which has been compared with the Wapanucka of east-central and southern Oklahoma by Mather (1915), Harlton (1938), and Miller and Owen (1944).

Atoka Formation

History of nomenclature: The Atoka formation was named by Taff and Adams (1902) for exposures in the vicinity of Atoka, Oklahoma. Wilson and Newell (1937) subdivided the Atoka into six prominent sandstone members separated by varying thicknesses of unnamed shales. From bottom to top, these are (1) Coody sandstone member, (2) Pope Chapel sandstone member, (3) Georges Fork sandstone member, (4) Dirty Creek sandstone member (5) Webbers Falls sandstone member, and (6) Blackjack School sandstone member.

Distribution: The Atoka formation is widespread from the Arkansas line westward to the Arkansas River southeast of Muskogee. It forms the surface rock over hundreds of square miles in the Boston Mountain province. In northern Adair and Cherokee Counties, it forms the cap-rock on many of the post-Boone outliers. In southern Cherokee and Adair Counties, and in northern Sequoyah County, it caps the prominent ridges which border the major northeast trending faults.

The Atoka formation is continuous along Grand River in Wagoner and Mayes Counties, capping the cliffs along the river and its tributaries and dipping gently westward into the Prairie Plains homocline.

TABLE XV

Fauna from the Bloyd Formation

Anthozoa

Acaciapora subcylindrica (Mather)
Amplexocarinia corrugata (Mather)
Chaetetes eximius Moore and Jeffords
Lophophyllidium minutum Jeffords
Michelinia scopulosa Moore and Jeffords
Michelinia exilimura Mather
Striatopora oklahomensis (Snider)

Echinoderma

Echinocrinus sp.
Ethelocrinus oklahomensis Moore and Plummer
Lasanocrinus sp.
Paradelocrinus dubius (Mather)
Pentremites godoni angustus Hambach
Pentremites rusticus Hambach

Bryozoa

Fenestella venusta Mather
Fenestella morrowensis Mather
Polypora magna Mather
Polypora triseriata Mather

Brachiopoda

Buxtonia sp.
Composita deflecta Mather
Composita gibbosa Mather
Composita ovata Mather
Composita ozarkana Mather
Composita wasatchensis White
Condrathyris perplexa (McChesney)
"Dictyoclostus" fayettevillensis (Mather)
"Dictyoclostus" gallatinensis (Girty)
"Dictyoclostus" morrowensis (Mather)
"Dictyoclostus" welleri (Mather)
Dielasma subspatulatum Weller
Hustedia brentwoodensis Mather
Hustedia miseri Mather

Lindströmella patula (Girty)
Linoproductus altonensis (Norwood and Pratten)
Linoproductus platyumbonus Dunbar and Condra
Neospirifer goreii (Mather)
Punctospirifer kentuckyensis (Shumard)
Pustula globosa Mather
Pustula sublineata Mather
Punctospirifer fayettevillensis Mather
Punctospirifer campestris (White)
Rhynchopora magnicosta Mather
Schizophoria resupinoides (Cox)
Spirifer rockymontanus Marcou

Pelecypoda

Edmondia subtruncata Meek
Myalina orthonota Mather
Nucula kessleriana Mather
Sphenotus halensis Mather

Gastropoda

Amphiscapha catilloide (Conrad)
Bellerophon crassus Meek and Worthen
Bellerophon sublaevis Hall
Euconospira arkansana Mather
Platyceras parvum (Swallow)
Strophostylus subovatus (Worthen)
Zygopleura rugosa Meek and Worthen

Cephalopoda

Gastrioceras pygmaeum Mather
Pseudorthoceras (?) sp.

Trilobita

Paladin morrowensis (Mather)

The Atoka is overlapped by the Hartshorne-McAlester sequence in the vicinity of Adair (T. 23 N.). Scattered outliers of probable Atoka have been mapped in the area southeast of Vinita, Twps. 24 and 25 N., along Highway 82 south of the junction with Highway 66 (figure 22).

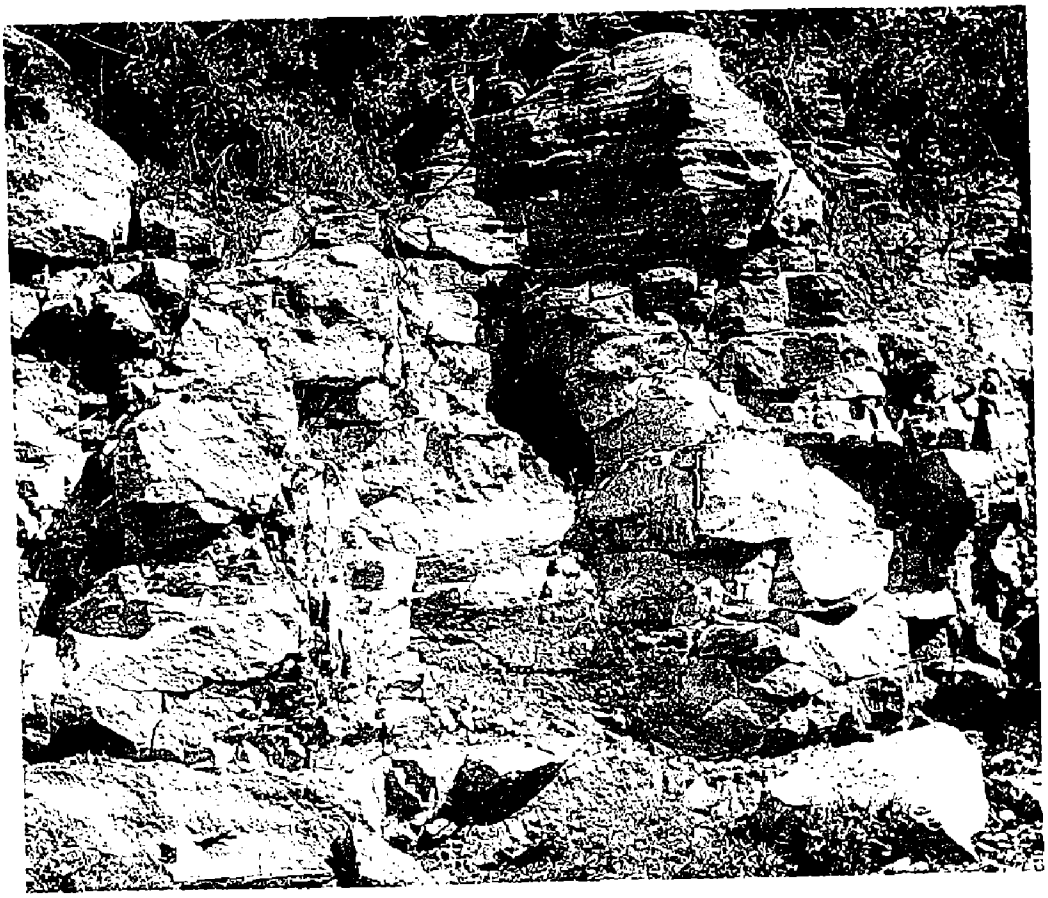

Figure 21. Typical Hale limestone as exposed in a quarry, sec. 36, T. 20 N., R. 18 E. Note the distinctive weathering of the upper layers of the Hale.

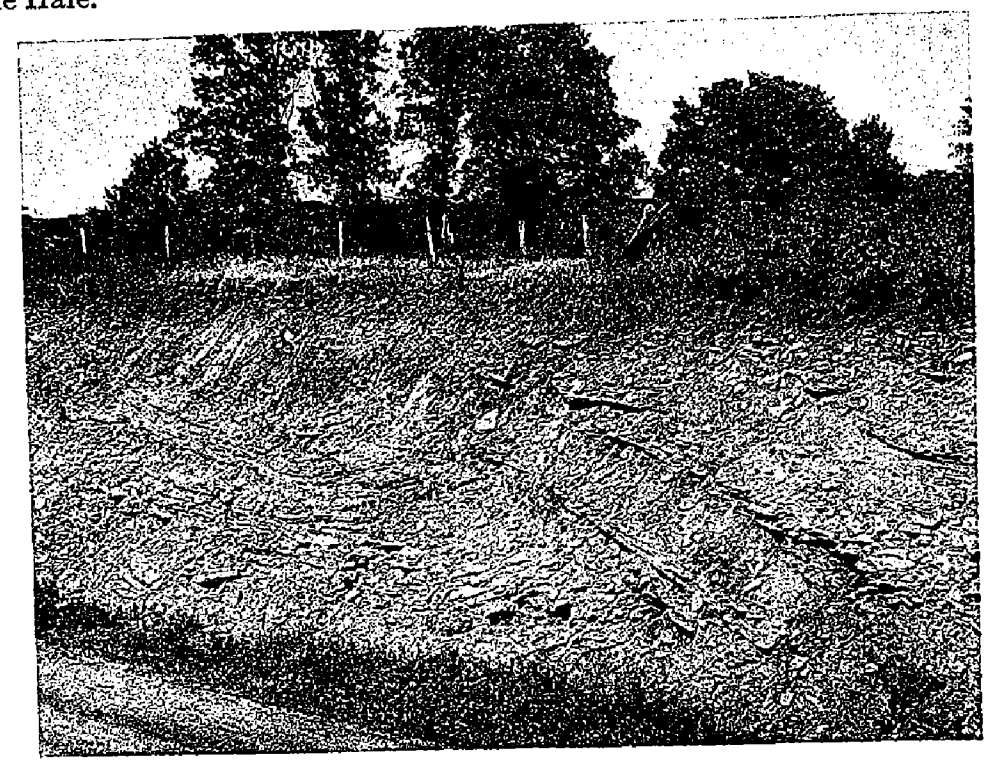

Figure 22. Channel sandstones in the Atoka formation resting on the Fayetteville shale, east roadside, Highway 82, sec. 3, T. 24 N., R. 21 E.

Character and thickness: The Atoka formation consists of sandstones, siltstones, interbedded shales, and a few thin limestones. The sandstones are brown, locally calcareous, massive to cross-bedded, and iron-stained. The siltstones are typically thin-bedded, brown to gray, micaceous, non-calcareous, and iron-stained. The shales are brown to black, fissile, and iron-stained.

Limestones are present locally in the Atoka in T. 17 N., R. 19 E. These are gray, massive, medium-crystalline, glauconitic, and fossiliferous.

The Atoka thins northward from a maximum of 600 feet southeast of Muskogee to zero near Adair (T. 23 N.) where it is truncated and overlapped by younger units. Northward thinning is by convergence, loss of lower members by progressive northward overlap, and unconformity above. The Webbers Falls member is believed to be most extensive.

True thickness of the Atoka cannot be ascertained throughout much of the area because the Atoka is the youngest unit present and upper portions have been removed by erosion. Approximately 250 feet was measured near Marble City and Bunch.

Thin coals of possible Atoka age occur near Fort Gibson (sec. 10, T. 15 N., R. 19 E.). Coal in the vicinity of Eli (Lost City) T. 18 N., R. 20 E., previously classed as Atoka, is considered to be of Hartshorne age by Branson (personal communication, 1955).

Stratigraphic relations: The Atoka lies with unconformity upon the Bloyd, Hale, and Fayetteville formations. It is truncated by erosion and overlapped northward by shales, clays, and sandstones of the Hartshorne-McAlester sequence.

Paleontology: The sandstone, siltstones, and shales of the Atoka are essentially unfossiliferous. *Taonurus*, a fucoidal marking, is common, especially in the siltstone layers. A few brachiopods and pelecypods are associated with the more calcareous units (Table XVI).

Age and correlation: The Atoka formation of Oklahoma is correlated with the Lake Murray formation of the Ardmore Basin, the Big Saline, Lemon Bluff, and Smithwick formations of North Central Texas, and the Upper Pottsville, Kanawha group, of the Appalachian area. It is assigned to the Atoka series of Middle Pennsylvanian age.

TABLE XVI

FAUNA FROM THE ATOKA FORMATION

Anthozoa

Lophophyllidium profundum (Edwards and Haime)

Brachiopoda

Chonetes granulifer var. armatus Girty
Cleiothyridina orbicularis (McChesney)
Composita subtilita (Hall)
Dielasma bovidens (Morton)
Echinoconchus semipunctatus (Shepard)
Hustedia mormoni (Marcou)
Lindstroemella patula (Girty)
Lissochonetes geinitzianus (Waagen)
Lissochonetes geinitzianus var. senilis (Dunbar and Condra)
"Marginifera" muricatina Dunbar and Condra
Neospirifer occidentalis (Girty)
Orbiculoidea missouriensis (Shumard)
Punctospirifer kentuckyensis (Shumard)

Pelecypoda

Aviculopecten sp.
Myalina sp.
Schizodus sp.

Gastropoda

Euconospira turbiniformis (Meek and Worthen)

Hartshorne Formation

Discussion: The Hartshorne formation, according to Branson (Reed, Schoff, and Branson, 1955) includes the beds between the top of the Atoka and the base of the Warner sandstone in northeastern Mayes and southeastern Craig Counties. Here the Atoka is overlapped by a sequence of shales and siltstones, previously assigned to the Blackjack School member of the Atoka formation (Newell, 1937, pp. 34, 184) but considered to be of Hartshorne age (Reed, Schoff, and Branson, 1955, p. 64). A maximum of 50 feet is included.

McAlester Formation

Discussion: The McAlester formation in northern exposures is marked at its base by the Warner sandstone, which has been

traced by Branson (1955, p. 66) through Wagoner, Mayes, Craig, and Ottawa Counties. The Warner is a light buff, cross-laminated sandstone ranging in thickness from 6 to 23 feet. It is succeeded by underclay, coal, shale, and siltstone of the McAlester formation, which occupy the area in the vicinity of Vinita, T. 25 N., Rs. 20 and 21 E.

The McAlester and underlying Hartshorne formations are now included in the Krebs group of lower Desmoinesian age.

Quaternary System

Alluvium and terrace deposits

Deposits of Recent alluvium occur along the valley floor of all of the major streams and many of their tributaries. The most extensive belt of alluvium is that of the Arkansas River east of Muskogee where the broad, fertile floodplain varies from one to four miles in width. A well defined floodplain with a width of over one-half mile parallels the Grand River from the Pensacola Dam to the junction of the Grand River and the Arkansas near Fort Gibson. Extensive alluvium is developed in the tributary valleys of the Grand and Arkansas Rivers. The floodplain of the Illinois River is narrow and poorly developed and only minor amounts of alluvium are present in its lower portions.

Much of the floodplain of the Illinois and Grand Rivers is now covered by the waters of the Tenkiller Ferry and Fort Gibson Reservoirs. Construction of the proposed Markham Ferry Dam near Locust Grove will inundate the balance of the fertile floodplain of the Grand River below the Pensacola Dam.

Locally, along Grand River in northern Wagoner and Mayes Counties, a "second bottom" or terrace lies approximately 20 to 40 feet above the present flood-plain level. This terrace deposit consists of sand, silt, and chert gravels. Only portions of this level remain above the waters of the Fort Gibson Lake. The town of Locust Grove, southern Mayes County, T. 20 N., R. 20 E. is located on this intermediate level. Gravels at the former site of Yonkers, T. 18 N., R. 20 E. and those at the old Poindexter Ferry site, T. 18 N., R. 20 E. are believed to be at this level.

High level terrace gravels are developed extensively along Grand River from Highway 33 to the vicinity of Pensacola, T. 23 N., R. 20 E. These consist of a maximum of 30 feet of well-rounded, water-worn, chert pebbles. They are typically found at an elevation of approximately 600 feet, which is between 50 and 75 feet above the present water level.

The most extensive of these high level deposits is near Pensacola, Oklahoma, where approximately 20 square miles are covered by thick gravel deposits. Other deposits occur in the vicinity of Salina, T. 21 N., R. 20 E.; along Grand River at the Oklahoma Ordnance Plant, T. 20 N., R. 19 E.; along Highway 33 east of Chouteau, T. 20 N., R. 19 E.; west of Murphy at the old Adair Ferry site, T. 19 N., R. 19 E. and in scattered patches east of Fort Gibson Reservoir near Highway 51, T. 17 N., R. 20 E.

One of the most extensive terrace deposits in the area borders the Arkansas River alluvium near the town of Braggs, T. 14 N., R. 20 E. where approximately 18 square miles are covered with terrace gravels and wind-blown material from the floodplain. The western edge of this terrace is sharply defined by an abrupt 40 foot rise above the level of the alluvium. The eastern edge is indefinite as the wind-blown material merges with the mantle on the Atoka formation.

Other extensive terrace deposits occur near the town of Fort Gibson, extending south and east to the alluvium of Bayou Manard. These deposits include sand, silt, and gravel, some of which is wind-derived from the Arkansas River floodplain. The edge of this terrace forms a conspicuous ridge running southward from Fort Gibson and crossing Highway 10 approximately two miles east of the junction with Highway 62 east of Muskogee.

Terrace and alluvial deposits are poorly developed in the more dissected areas of eastern Cherokee and Adair Counties. Minor amounts of alluvium are present in the floors of major streams. Terrace gravels are well-developed along Evansville Creek and Barren Fork in the area northeast of Stilwell.

STRUCTURE

General Regional Picture

Northeastern Oklahoma lies on the southwest end of the Ozark uplift. The formations strike in an arcuate pattern and dip away from the axis of the uplift, toward the west and northwest in northern portions and to the southwest and south in southern portions of the area. The general regional dip of 25 to 50 feet per mile is interrupted by a series of northeast-southwest trending folds and faults with alignment roughly parallel to the axis of the Ozark uplift. Steeper dips occur close to major faults.

Faulting is most pronounced in the Boston Mountain Plateau in Cherokee and Adair Counties where large, parallel, normal faults divide the rocks into a series of fault blocks tilted to the southeast.

In the northern part of the area, the folds and faults die out to the west and the dip merges with the gentle westerly dip of the Prairie Plains Homocline. In the southern portion, the faults disappear to the northeast in the "Boone chert" and pass southwestward into gentle anticlinal folds which continue across the Arkansas River into the Muskogee-Porum district.

Structural development in northeastern Oklahoma is closely associated with the development of the Ozark geanticline, which underwent successive submergences and emergences during Paleozoic time. Southward tilting in pre-Chattanooga time is indicated by northward truncation of older units and overlap by the Chattanooga black shale which rests on Devonian near Marble City and Lower Ordovician near Spavinaw. Renewed southward tilting in both pre-Hale and pre-Atoka time is indicated by northward truncation of the Pitkin and Bloyd formations respectively.

Major deformation took place during Pennsylvanian time. The folds and faults are post-Atoka and pre-Tiawah in age (early Senora) indicating deformation during Desmoinesian time. Parallelism of the folds and faults in this area with those in the Arkansas Valley syncline suggest a genetic relationship. It is believed that the deformation in this area is largely of a tensional nature caused by the stretching of the rock layers across the end of the positive Ozark structure during the loading of the McAlester Basin in Middle Pennsylvanian time, following the relaxation of the forces which deformed and thrust the Ouachita Mountains to the south.

Major Structures

Miami syncline: The Miami syncline enters Ottawa County, Oklahoma, on the north line of sec. 17 T. 29 N., R. 23 E., trends S 25° W., and passes just to the west of the town of Afton. It enters the Vinita-Pensacola map area of this report in sec. 36, T. 26 N., R. 21 E. and continues southwestward into sec. 12, T. 25 N., R. 21 E. The structure is well exposed in the "Frisco" railroad cut in sec. 1, T. 25 N., R. 21 E. where a dip of 23 degrees is present on the western limb and a six degree dip is on the eastern.

Whiteoak Creek fault (new): Whiteoak Creek fault was discovered and mapped during the course of this project. It occurs about four miles south of Vinita and is named from White Oak Creek, a tributary to Big Cabin Creek. It runs almost east-west from Highway 69 to Highway 82, then turns rather abruptly to the northeast, disappearing in the "Boone chert" in sec. 36, T. 25 N., R. 21 E. The Whiteoak Creek fault is normal and is downthrown to the north, bringing Atoka and Fayetteville in contact with the Keokuk chert. Displacement is estimated at about 100 feet.

Horse Creek anticline: The Horse Creek anticline, named and identified by Siebenthal (1907), is an asymmetrical fold which starts about 5 miles southeast of Big Cabin and trends northeastward to the mouth of Cowskin River (outside map area) where it intersects the Seneca fault. The average dip on the north side is 150 to 200 feet per mile, that on the south varies from 5 to 18 degrees. The Horse Creek anticline is faulted locally along its crest, as in the road cut along Highway 82 in secs. 21 and 22, T. 24 N., R. 21 E.

Seneca graben: The Seneca graben is a discontinuous line of breakage which extends from near Pryor, Oklahoma, northeastward to Spurgen, Missouri. Locally the Seneca graben is a simple fault block varying in width from one-eighth to over one-half mile. Maximum displacement brings the Atoka, Hale, and Fayetteville in contact with the "Boone", giving a stratigraphic throw of less than 300 feet. Dips of 10 to 15 degrees or even 25 degrees are common close to the faulting. Laterally the faulting may become less pronounced and pass into a simple fold or become

lost completely in the brecciated "Boone" chert. Numerous minor faults occur in proximity to the Seneca graben.

Locust Grove fault: The Locust Grove fault extends southward from the vicinity of Locust Grove across T. 19 N., R. 20 E. to the southern boundary of Mayes County. The eastern side is upthrown, bringing the Keokuk chert to a position above the Mississippian and Pennsylvanian beds to the west. Maximum displacement of 200 feet was assigned by Snider (1915).

Lost City fault: The Lost City fault, named by Douglass (1951), begins in sec. 13, T. 17 N., R. 19 E. runs northward into sec. 33, T. 18 N., R. 20 E. where its trend changes eastward. It terminates in sec. 22, T. 18 N., R. 21 E. The south side is downthrown, bringing the Atoka in contact with the Keokuk for a stratigraphic displacement of 150 to 300 feet. Smaller associated faults to the south intersect the larger fault as shown.

Clear Creek fault: The Clear Creek fault (Douglass, 1951) can be traced from sec. 30, T. 18 N., R. 20 E. northeastward across secs. 19 and 20. Southward it disappears in the bed of Clear Creek. It may be continuous with a fault in sec. 36, T. 18 N., R. 19 E. Stratigraphic displacement is 50 to 125 feet.

Fourteenmile Creek fault: This fault begins in sec. 3, T. 17 N., R. 20 E. and extends along the course of Fourteenmile Creek northeastward through secs. 1 and 2, T. 17 N., R. 20 E.; 4, 5, and 6, T. 17 N., R. 21 E.; and secs. 24, 25, 26, 27, 33, and 34, T. 18 N., R. 21 E. passing just north of Gideon. Atoka beds on the north are downfaulted aganst the Boone south of Lost City; near Gideon the Hindsville formation is in fault contact with the Chattanooga. Maximum displacement approximates 200 feet. Small branching faults intersect the major line of breakage.

Gifford fault: The Gifford fault (Dobervich 1951) parallels Fourteenmile Creek fault on the south. Its western extremity is in sec. 8, T. 17 N., R. 20 E. It intersects the Fourteenmile Creek fault in sec. 6, T. 17 N., R. 21 E. Units ranging in age from Keokuk to Pitkin are in contact with the Bloyd formation. It is downthrown to the south.

Double Spring Creek fault: This fault extends from T. 17 N., R. 20 E. northeastward into T. 18 N., R. 22 E. where it may be

continuous with a fault crossing the Illinois River near Ellerville (outside map area). The fault is downthrown on the north and has a maximum stratigraphic displacement of 275 feet. The fault block formed by the Gifford-Fourteenmile Creek and Double Springs Creek faults is tilted southward.

Hulbert fault: The Hulbert fault passes about two miles south of Hulbert in a northeasterly direction, extending from sec. 11, T. 16 N., R. 20 E. into sec. 29, T. 17 N., R. 21 E. where it dies out in the Keokuk chert. Approximate maximum stratigraphic displacement is 155 feet (Dobervich, 1951).

Crittenden fault: The Crittenden fault was mapped by Dobervich (1951). It is a smaller fault located between the Hulbert and Double Spring Creek faults. It is downthrown to the south, with a maximum stratigraphic displacement of 100 feet.

Flower Creek faults: The Flower Creek faults trend northeast-southwest, paralleling the course of Flower Creek (T. 16 N., Rs. 19 and 20 E.) bringing the Pitkin and older units into contact with the Bloyd and Atoka. Displacement probably does not exceed 50 feet.

Tahlequah fault: The Tahlequah fault originates in the chert hills of sec. 10, T. 16 N., R. 21 E., extending northeastward into sec. 29, T. 17 N., R. 22 E. It is downthrown to the north, bringing the Fayetteville, Hale, and Bloyd into contact with the Keokuk.

South Muskogee fault: This fault begins near Muskogee and passes under the alluvium of the Arkansas River. It trends northeastward parallel to the course of Bayou Manard and Highway 62 to a point one mile southeast of Tahlequah. It appears to be continuous with the fault which crosses the lllinois River in secs. 24 and 26, T. 17 N., R. 23 E. northeast of Tahlequah. Throughout most of its length, beds ranging in age from "Boone" through Hale are in contact with the Atoka sandstone. Northeast of Tahlequah (sec. 26, T. 17 N., R. 23 E.) the Tyner and Chattanooga are faulted against the "Boone". The fault is downthrown on the north and maximum stratigraphic displacement is 250 to 300 feet.

Flat Rock syncline: North of the South Muskogee fault in the valley of Bayou Manard Creek, the beds are deformed into an asymmetrical syncline with steeply dipping beds on the south

limb. The structure is the result of drag along the South Muskogee fault. Bobtail Creek and Bayou Manard occupy this syncline, which has been named by Mills (1951).

Nigger Hollow anticline: Immediately south of the South Muskogee fault is a well defined asymmetrical anticline. The dip on the south flank is approximately three degrees while along the north flank, the beds dip from eight to fifteen degrees. This anticlinal structure has been breached along the axis, exposing beds of Ordovician age. On the south limb, south-dipping beds of Mississippian and Pennsylvanian age form a prominent north facing excarpment called the Braggs escarpment (Beckwith, 1950).

Braggs fault block: The area between the South Muskogee fault and the Qualls-Welling fault has been referred to as the Braggs fault block by Moore (1947). This block shows southward tilting.

Qualls-Welling fault: The Qualls-Welling fault begins in sec. 2, T. 14 N., R. 21 E.; cuts across secs. 25 and 35, T. 15 N., R. 21 E.; secs. 19, 20, 17, 8, 9, 4, and 3, T. 15 N., R. 22 E.; secs. 34, 35, and 25, T. 16 N., R. 22 E.; and secs. 17, 18, 19, 8, 9, 3, and 2, T. 16 N., R. 23 E. extending from the vicinity of Qualls to a point about four miles northeast of Welling. Maximum stratigraphic throw is approximately 325 feet bringing Ordovician rocks to the surface near Qualls (sec. 35, T. 15 N., R. 21 E.) and along the Illinois River. Elsewhere along this fault, "Boone" chert is in contact with Upper Mississippian and early Pennsylvanian beds.

Qualls Dome: In sec. 35, T. 15 N., R. 21 E., erosion along the Qualls fault has revealed a domal uplift with beds ranging in age from Reeds Spring to Atoka on the downthrown side (north) and beds of Ordovician Cotter to Reeds Spring on the upthrown (south) side. The formations close against the fault and reversal of dip completes the anticlinal structure.

Greenleaf Lake fault: The Greenleaf Lake fault was recognized and mapped by Mondy (1950). It is a normal fault, downthrown to the northwest, bringing the Atoka in contact with Upper Mississippian strata. Stratigraphic displacement varies from 40 to 175 feet. Identity is lost northeastward in sec. 3, T. 14 N.,

R. 21 E.; it parallels Greenleaf Creek on the south through secs. 9, 16, 17, 20, 19, and 30, T. 14 N., R. 21 E.; crosses Greenleaf Lake in sec. 36, T. 14 N., R. 20 E.; parallels Greenleaf Lake on the northwest through secs. 35, T. 14 N., R. 20 E. and secs. 3, and 9, T. 13 N., R. 20 E., passing finally beneath the alluvium of the Arkansas River.

Little Terrapin Creek fault block (Mondy, 1950): This name has been applied to the small area bounded on the north by the Greenleaf fault and on the south by the South Qualls fault.

South Qualls fault (Mondy, 1950): This fault begins in sec. 22, T. 14 N., R. 21 E. and continues northeastward into sec. 1, T. 14 N., R. 21 E. Stratigraphic displacement varies from 40 to 250 feet as beds of Moorefield through Bloyd are brought into contact with the Atoka.

Pettit fault block: This term was proposed by Moore (1947) for the area bounded on the north by the Qualls fault and on the south by the Cookson fault. This block has been tilted southward, with warping in central portions.

North Cookson fault: The North Cookson fault strikes northeast from sec. 8, T. 14 N., R. 22 E. past the site of the old Cookson postoffice (now covered by Tenkiller Lake) in sec. 3, T. 14 N., R. 22 E. through the northwest corner of sec. 21, T. 15 N., R. 23 E. near Barber and extending to a point about three miles northeast of Wauhillau. It is downthrown to the north with "Boone" and younger units faulted against the Atoka with a stratigraphic displacement of 200 to 310 feet.

Wauhillau fault (Mills, 1950): The Wauhillau fault extends from sec. 35, T. 16 N., R. 23 E. northeastward through the edge of the old Wauhillau town site where its trace is lost in the "Boone" chert. It is downthrown to the south with Hale sandstone in contact with the "Boone".

South Cookson fault (Mondy, 1950): This fault originates near the former townsite of Cookson (now inundated), passes southwestward through sec. 9, T. 14 N., R. 22 E., and continues into sec. 26, T. 14 N., R. 21 E. where it passes into anticlinal folding. Beds ranging in age from "Boone" through Bloyd are in fault contact with the Atoka, giving a miximum stratigraphic displacement of 300 feet. It is downthrown on the south.

Cookson fault block: The Cookson fault block (Moore, 1947) is bounded on the north by the South and North Cookson faults and on the southeast by the Blackgum fault.

Barber fault (new): The Barber fault, named from the small town of Barber, originates in the southwest corner of sec. 31, T. 15 N., R. 23 E. and continues northeastward into the northwest corner of sec. 28, T. 15 N., R. 23 E. A maximum stratigraphic displacement of 300 feet occurs where the Bloyd formation is faulted against the Keokuk chert. It is downthrown on the south.

Blackgum fault: The Blackgum fault begins along the Illinois River in sec. 1, T. 13 N., R. 21 E. and continues northeastward across southern Cherokee County to sec. 8, T. 14 N., R. 23 E. where it dies out in the Boone chert. It is downthrown to the north with the Atoka formation faulted against the "Boone" to give a stratigraphic displacement of approximately 250 to 300 feet. Prior to flooding by the Tenkiller Ferry Lake, a complete sequence of units from the Tyner to the Atoka was exposed on the north side of Blackgum Mountain, sec. 32, T. 14 N., R. 22 E.

Blackgum fault block: The Blackgum fault block is bounded on the northwest by the Blackgum fault and on the southeast by a series of faults extending from near Vian to the vicinity of Lyons. The rocks in this block have been elevated to form a horst and the medial portion is depressed into a broad, shallow syncline which Moore (1947, p. 56) considered a continuation of the Porum syncline of southern Muskogee County.

Red Springs fault (Brauer, 1952): The Red Springs fault extends from sec. 20, T. 14 N., R. 23 E. to the southern portion of sec. 35, T. 15 N., R. 23 E. It has an estimated stratigraphic displacement of 200 feet with Keokuk in contact with the Hale. It is downthrown to the north.

Linder Bend fault: This fault was mapped by Siemens (1950). It extends from sec. 1, T. 13 N., R. 21 E. to the center of sec. 21, T. 13 N., R. 21 E. where it intersects the Webber's Cove fault. The fault is normal, downthrown to the south, and has a displacement of from 30 to over 200 feet with the Atoka locally in contact with the Moorefield.

Webber's Cove fault (Siemens, 1950): The Webber's Cove fault strikes N. 65° E. from sec. 29, T. 13 N., R. 21 E. to the site of Tenkiller Ferry Dam on the Illinois River. It is downthrown to the southeast, with a displacement of 50 to 130 feet.

Cedar Creek fault (Siemens 1950): This is a normal fault, downthrown to the southeast and extending from sec. 29, T. 13 N., R. 21 E. southwestward to the alluvium of the Arkansas River. At maximum displacement, the Moorefield is faulted against the Atoka.

Marble City fault: The Marble City fault begins at the Arkansas River west of Vian and continues northeastward to the vicinity of Marble City, Oklahoma, where it intersects the Lyons fault. Stratigraphic displacement is over 700 feet, with the St. Clair limestone of Silurian age faulted against the Atoka.

Lyons fault: The Lyons fault begins about two miles northeast of Lyons, passes southward along Sallisaw Creek west of Bunch and intersects the Marble City fault on the bend of Sallisaw Creek one mile north of Marble City. Stratigraphic displacement of 700 feet is in sec. 30, T. 14 N., R. 24 E. where the St. Clair is faulted against the Atoka (Powell, 1951). Paralleling the Lyons fault on the south or downthrown side is a small syncline. A smaller fault southeast of Lyons brings the Hale against the Keokuk chert in sec. 36, T. 15 N., R. 24 E., and sec. 2, T. 14 N., R. 24 E.

Church fault: The Church fault originates southwest of Bunch in sec. 29, T. 14 N., R. 24 E. Westward it passes into a small synclinal fold (Iron Springs syncline of Powell, 1951). It continues northeastward across Adair County to the northwest corner of sec. 6, T. 14 N., R. 26 E. Maximum displacement is about 200 feet; the fault is downthrown to the southeast.

Little Lee Creek fault (Snodgrass, 1951): This fault begins in sec. 1, T. 14 N., R. 25 E. and extends due east to within one-half mile of the Arkansas line in sec. 1, T. 14 N., R. 26 E. "Boone" chert is faulted against the Hale and Bloyd with 300 feet maximum displacement. It is downthrown on the south. Alignment is closely associated with that of the Church fault immediately to the northwest.

North and South Davison faults: These enter Oklahoma from Arkansas in secs. 12 and 13, T. 14 N., R. 26 E. The north fault has about 150 feet of displacement with upper Bloyd against the Hale. Displacement on the south fault is considerably less and the intervening block is tilted to the north about 8 degrees.

Greasy Creek fault: The Greasy Creek fault was located by Branson in 1950. Its western portion was mapped by Powell (1951) and its southeastern end by White (1955). It extends from the SE¼ sec. 8, T. 13 N., R. 24 E. striking N. 59° E. into southern Adair County, turns abruptly to the southeast, passing into the Salt Hallow anticline in secs. 13, T. 13 N., R. 25 E., and sec. 19, T. 13 N., R. 26 E., where it intersects the Akins fault (outside map area). The upthrown side is on the southeast and in Christie Hollow (secs. 2 and 3, T. 13 N., R. 25 E.) it has maximum displacement of 530 feet, with Atokan rocks in contact with the Keokuk. Southwestward it passes into a small anticlinal flexure, the Greasy Creek anticline (sec. 8, T. 13 N., R. 24 E.).

Greasy Creek graben: (Powell, 1951) A depressed area lying between the Church fault to the north and the Greasy Creek fault to the south.

Evansville fault: The Evansville fault is exposed for a distance of two miles in secs. 34, 35, and 36, T. 16 N., R. 26 E. Here the Fayetteville formation is faulted against the "Boone" chert. Both ends of the fault are concealed by the alluvium of Evansville Creek but alignment suggests that it is a continuation of the Evansville fault of Arkansas.

Baron graben (new): The Baron graben faults enter the area in secs. 25 and 26, T. 17 N., R. 25 E. The easternmost fault continues southwestward into sec. 10, T. 16 N., R. 25 E. where its identity is lost in the Keokuk chert. The western fault passes southwestward between terrace gravels in sec. 34, T. 17 N., R. 25 E. and in sec. 3, T. 16 N., R. 25 E. Moorefield, Hindsville, Fayetteville, and Hale formations in the graben are faulted against the Keokuk chert on either side. Dips of 75 degrees have been recorded along the east side of the graben, sec. 2, T. 16 N., R. 25 E., where the Hale is faulted against the "Boone" and Hindsville. Maximum stratigraphic displacement is estimated to be 200 feet.

Minor folds and faults

Craig and Mayes Counties: Well defined anticlinal uplifts are present in southern Craig County in secs. 3 and 4, T. 25 N., R. 21 E. and in secs. 15, 16, 21, and 22, T. 25 N., R. 21 E. where Hindsville limestone is brought to the surface by warping. Strong arching exposes the Chattanooga and St. Joe along Cabin Creek in secs. 23 and 26, T. 24 N., R. 20 E. The Precambrian Spavinaw granite and overlying Cotter dolomite are exposed in an eroded fold near Spavinaw. Additional minor folds occur on Salina Creek in sec. 31, T. 21 N., R. 20 E. where Chattanooga and St. Joe are brought to the surface; along Spring Creek, T. 19 N., Rs. 20 and 21 E. where Ordovician Burgen and Tyner are exposed beneath the Chattanooga shale. West of Grand River in southern Mayes County, Union Mission dome (now inundated) brings the Chattanooga and St. Joe to the surface with dips of 5 to 25 degrees on the surface. Chouteau Creek anticline (sec. 32, T. 20 N., R. 19 E.) exposes strongly arched Moorefield at the surface in the stream bed (now inundated).

Minor faults include (1) a line of breakage just south of the Whiteoak Creek fault in T. 24 N., R. 20 E., (2) Pryor Cemetery fault with Keokuk faulted against Fayetteville; (3) three small faults in secs. 32 and 33, T. 21 N., R. 19 E. and sec. 4, T. 20 N., R. 19 E. where Fayetteville and Hale are in contact with the Atoka and (4) small faults in secs. 29, 31, and 32, T. 20 N., R. 19 E.; sec. 16, T. 19 N., R. 19 E.; secs. 8, 17 and 18, T. 19 N., R. 19 E.; sec. 25, T. 19 N., R. 19 E. and sec. 30, T. 19 N., R. 20 E.

Cherokee and Wagoner Counties: Minor anticlinal folding is present along Clear Creek sec. 36, T. 18 N., R. 19 E. and secs. 29, 30 and 31, T. 18 N., R. 20 E. where the Ordovician Tyner formation is brought to the surface; on Ranger Creek secs. 7 and 8, T. 16 N., R. 20 E.; and the McBride anticline in sec. 1, T. 16 N., R. 19 E. and sec. 6, T. 16 N., R. 20 E. The latter is bounded on two sides by faults which intersect to form a triangular upthrown block.

Anticlinal warping associated with the Qualls-Welling fault has exposed the Tyner and Chattanooga east of Tahlequah in secs. 25, 26, 31 and 36, T. 17 N., R. 22 E.; the Tyner, Fite, Fernvale, and

Sylvan in secs. 17, 18, 19 and 20, T. 16 N., R. 23 W. and along the Illinois River in secs. 25 and 36, T. 16 N., R. 22 E., secs. 30 and 31, T. 16 N., R. 23 E., and sec. 1, T. 15 N., R. 22 E.; beds from the Cotter through the Chattanooga at Qualls Dome, sec. 35, T. 15 N., R. 21 E. The crest of a small anticline is exposed in Salt Branch Creek in sec. 36, T. 14 N., R. 21 E. and the St. Clair limestone is exposed at the crest of a small fold in sec. 36, T. 14 N., R. 23 E.

Minor faulting includes (1) small fault in sec. 13, T. 18 N., R. 19 E. and sec. 18, T. 18 N., R. 20 E. with Fayetteville and Pitkin against Atoka; (2) secs. 5, 8, and 17, T. 18 N., R. 19 E.; (3) secs. 6 and 7, T. 18 N., R. 19 E.; (4) Pecan Creek faults in secs. 31, 32 and 33, T. 17 N., R. 21 E.; (5) Hickory Creek fault in sec. 6, T. 17 N., R. 20 E. and secs. 1, 12, and 13, T. 17 N., R. 19 E., (6) Fulcher fault, sec. 1, 10 and 11, T. 17 N., R. 19 E.; (7) Nigger Creek fault, secs. 9 and 16, T. 17 N., R. 19 E.; (8) "Highway" 51 fault, sec. 22, T. 17 N., R. 18 E.; (9) McBride faults associated with the McBride anticline; (10) Ranger Creek faults associated with the Ranger Creek uplift in secs. 7 and 8, T. 16 N., R. 20 E.; (11) a small fault in sec. 22, T. 15 N., R. 22 E.; and (13) secs. 31 and 32, T. 15 N., R. 23 E.

Adair County: Minor folding includes the Greasy Creek anticline in secs. 7 and 8, T. 13 N., R. 24 E.; the Iron Springs syncline in sec. 6, T. 13 N., R. 24 E.; and a small anticlinal warping in secs. 14 and 15, T. 14 N., R. 26 E.

Minor faults are present (1) secs. 5, 6, and 7, T. 15 N., R. 25 E., (2) secs. 9 and 16, T. 15 N., R. 25 E., (3) sec. 18, T. 14 N., R. 26 E., and (4) secs. 3, 4, and 10, T. 14 N., R. 26 E.

Sequoyah County: Small, unnamed faults occur in (1) sec. 6, T. 13 N., R. 22 E. and sec. 1, T. 13 N., R. 21 E.; (2) on the south side of Cedar Hill, secs. 35 and 36, T. 13 N., R. 20 E. Anticlinal folding exposes the St. Clair limestone in secs. 20 and 21, T. 13 N., R. 21 E.

ECONOMIC POSSIBILITIES

Oil and Gas: The prospects for oil and gas have been summarized by Cram (1930) and by Ireland (1930). Except for a small depleted gas field near Mazie (secs. 26 and 27, T. 19 N., R. 18 E.) bordering the western edge of the area included in this study, commercial production of oil and gas has not been established. Small gas fields have been discovered near Vinita in secs. 16 and 21, T. 25 N., R. 21 E. and in sec. 24, T. 25 N., R. 20 E. One shut-in gas well is in sec. 36, T. 19 N., R. 18 E. near the junction of Highways 33 and 69 just west of the boundary of this area. A small gas well in SW¼ sec. 33, T. 14 N., R. 24 E. supplies gas for limited domestic purposes. Recent tests in the Big Cabin Creek area, secs. 22, 23, 26, and 27 have had some slight indications of oil. Oil shows were encountered in a recent water well at the fish hatchery in Tahlequah, but commercial production in the area has not been established (Leon Davis, personal communication, July, 1956).

Abundant reservoir rocks, source rocks, and favorable structural anomalies are present, but the strata which produce at depth a few miles to the west are exposed or are near the surface in this area and oil that may have been present has escaped or has been flushed out by water.

Potential reservoir rocks include the Burgen sandstone, sandstones in the Tyner, the Sylamore sandstone, the Wedington sandstone member of the Fayetteville formation, the Hale sandstone, and the sandstones in the Atoka, as well as numerous limestones, cherts, and dolomites with local porosity. Source rocks include the Tyner shales, Sylvan shale, Chattanooga shale, Moorefield and Hindsville formations, Fayetteville shale, Bloyd shale, and the black shales in the Atoka.

Slight indications of oil and gas have been observed in the progress of this study. Several formations, especially the Moorefield and Hindsville, are characterized by a strong bituminous odor and the hollow interiors of fossils in the Moorefield have yielded small amounts of live, green oil. Gas seeps have been noted along Chouteau Creek (sec. 32, T. 20 N., R. 19 E.) on Nigger Hollow anticline (secs. 14 and 15, T. 15 N., R. 20 E.), and on Salt Branch anticline (sec. 36, T. 14 N., R. 21 E.). Traces of oil and gas have

been reported from water wells and sufficient gas is obtained from the "Boone" chert in sec. 10, T. 22 N., R. 20 E. and from the Atoka in sec. 1, T. 14 N., R. 21 E. for domestic purposes. Staining and asphaltic residue have been found in the Atoka sandstone southeast of Vinita.

Oil seeps and asphaltic residue are reported from quarries in the Hindsville limestone northeast of Adair, sec. 24, T. 23 N., R. 19 E., and in sec. 30, T. 23 N., R. 20 E. (Edward Stoever, Jr., personal communication, October, 1956, also Okla. Geology Notes, vol. 16, no. 12, pp. 139-140).

Several of the more promising structures, such as Mission Dome (secs. 8, 9, and 16, T. 19 N., R. 19 E.) and Chouteau Creek anticline (sec. 32, T. 20 N., R. 19 E.), have been drilled and quantities of salt water are now flowing from these openings. Many structures remain untested, but due to failure of previous attempts, further drilling for oil and gas at this time is not encouraged.

Immediately west of the Ozark Uplift in Muskogee, western Wagoner, Mayes, Craig, and Rogers Counties, sand conditions improve and numerous small fields have been discovered.

Coal: Thin coal beds have been observed southeast of Fort Gibson, NE¼ sec. 20, T. 15 N., R. 20 E.; along Fourteenmile Creek, sec. 1, T. 17 N., R. 20 E.; on Double Spring Creek in sec. 26, T. 17 N., R. 20 E.; and near Lost City in secs. 35 and 36, T. 18 N., R. 20 E. The coals range in thickness from 4 inches near Fort Gibson to 22 inches near Lost City where a bed has been mined in the past.

Limestone: Limestone for aggregate is found throughout the area, with the St. Clair, Hindsville, Hale, and Bloyd furnishing the most suitable stone. Extensive quarrying of the Hindsville in Mayes and southern Craig Counties includes operations east of Vinita in secs. 16 and 22, T. 25 N., R. 21 E. and the Weaver Brother's operation southeast of Pryor in sec. 33, T. 21 N., R. 19 E. A large quarry in the Hindsville and Moorefield formations south of Stilwell in sec. 4, T. 14 N., R. 25 E. furnishes crushed limestone for road surfacing. Crushed rock for the Tenkiller Ferry Dam was obtained from a quarry in the Bloyd formation in sec. 10, T. 13 N., R. 21 E. and the crushed stone for Fort Gibson Dam was

taken from a quarry in the Hale and Pitkin in sec. 15, T. 16 N., R. 20 E.

High-calcium limestone for quicklime and for agricultural purposes has been obtained from the St. Clair limestone near Marble City since 1937. Present production is said to approximate 1,000 tons per day. Unlimited amounts of the St. Clair limestone are present in the Marble City area on the upthrown side of the Marble City and Lyons faults. These have been described by Ham et al. (1943). Underground quarrying operations are now in progress.

Additional exposures of the St. Clair are near Bunch in Maloy Hollow, secs. 4, 5, and 9, T. 14 N., R. 24 E.; in sec. 29, T. 14 N., R. 24 E.; and in Dry Creek, secs. 1 and 2, T. 14 N., R. 23 E. The top of the St. Clair is exposed northwest of Tenkiller Dam in secs. 20 and 21, T. 13 N., R. 21 E.

Crinoidal limestones in the "Boone" along the west bank of Grand River, T. 21 N., R. 20 E., may offer a source of high-calcium limestone.

Gravel: Unlimited quantities of rounded chert gravels occur in Mayes County along Grand River from the vicinity of Highway 33 east of Chouteau northward to the vicinity of Pensacola (T. 23 N.). Additional deposits occur south of Baron and along the streams of Cherokee and Adair Counties. Distribution of terrace gravels is indicated on the maps and pits are shown with the appropriate symbol.

Building stone: The Atoka sandstone has been used rather widely as a siding for houses, especially rural homes. The upper calcareous siltstone member of the Moorefield formation in secs. 3 and 10, T. 22 N., R. 20 E. has been quarried for this purpose. Additional possibilities include the Wedington sandstone of eastern Adair County. Limestone for building blocks can be obtained from several limestones, especially the St. Clair. Many of the country homes are faced with cobbles and boulders of "Boone" chert secured in a matrix of concrete.

Tripoli: Tripoli forms as a result of the leaching of soluble material from the Keokuk chert to leave a soft, white, porous rock which can be used for filters and abrasives. A small amount of tripoli has been mined in northeastern Oklahoma, but there is no commercial production at this time.

Lead and zinc: Traces of lead and zinc minerals have been reported in this area, but deposits of commercial value have not been found. Anticipation remains high and the possibility of finding sufficient quantities for mining still remains.

Asphaltic sandstone: Sandstone impregnated with bituminous material occurs in the Atoka formation in southeastern Craig County. It can be seen along Highway 82, especially in sec. 28, T. 24 N., R. 21 E.

Phosphate: Thin beds of black, nodular phosphate are associated with the Fayetteville formation near Marble City and in the Cookson Hills. Two localities showing maximum development are (1) south roadside SW¼ NW¼ SW¼ sec. 15, T. 13 N., R. 23 E. where thin beds are scattered throughout 25 feet of the Fayetteville formation, and (2) on the east branch of Terrapin Creek along old road 2 to 2.5 miles south of the Cookson store and in the NE¼ sec. 24, T. 14 N., R. 22 E. where a three-inch bed of phosphate is present.

Water Supplies: Water for domestic purposes may be obtained from several horizons. Shallow waters are present in the terrace and alluvial deposits, in the Atoka and Hale sandstones, and in some of the porous limestones. Water from the Moorefield and Hindsville limestones is not suitable for drinking purposes because of the release of hydrogen sulphide from decomposition of pyrite within the formation.

The best source of ground water in northeastern Oklahoma is the highly fractured and porous "Boone" chert. Quantities of soft, clear water are plentiful in nearly all parts of the area in this unit. Lack of natural filtration may render this water impure and careful analyses should be made before the water is used for human consumption.

Springs are numerous throughout the area. Generally they occur at the base of the "Boone" at the contact with the under-

lying Chattanooga shale. Many large, perennial springs are associated with major faults which bring the "Boone" chert against impervious strata of various ages.

Spavinaw Lake furnishes the water supply for the City of Tulsa. Other large supplies of water include Grand River, which furnishes water for the industries near the steam generating plant of the Grand River Dam Authority southeast of Pryor; Fort Gibson Reservoir, Greenleaf Lake, and Tenkiller Ferry Reservoir.

Hydroelectric power: Construction of the Pensacola, Fort Gibson, and Tenkiller Ferry Dams has made northeastern Oklahoma an important center of hydroelectric power (Huffman, 1955). Pensacola Dam impounds a lake covering 55,000 acres with 1,200,000 feet of power storage and 540,000 acre feet of storage for flood control. Six turbines generate over 300,000,000 kilowatt hours of electrical energy per year. Fort Gibson Reservoir covers 51,000 acres, has a storage capacity of 1,287,000 acre feet, and a generating capacity of 180,700,000 kilowatt hours per year. Tenkiller Ferry Reservoir covers 21,000 acres, has a total storage of 1,230,000 acre feet and furnishes 107,000,000 kilowatt hours of power per year.

GEOLOGIC HISTORY

The geologic history of northeastern Oklahoma is closely related to that of the Ozark geanticline, of which it is a part. The Ozark Uplift persisted as a positive feature throughout Paleozoic time with frequent oscillations, both to the south and to the north and with numerous inundations by shallow seas. During much of its history, portions of the uplift were sufficiently high to serve as a source (Ozarkia) for many of the clastics which accumulated around its flanks.

The present Ozark dome is a broad, nearly circular uplift with local areas of Precambrian granite surrounded by rocks of Cambrian, Ordovician, Silurian, Devonian, Mississippian, and Pennsylvanian rocks. In general, the Mississippian and Pennsylvanian strata dip gently away from the uplift, forming a series of cuestas with gentle dip slopes.

Sedimentary history of the Ozark region began with the advance of the Upper Cambrian seas across the irregular surface of the Precambrian. Basal Upper Cambrian Lamotte sandstone succeeded by the Bonneterre, Elvins, Potosi, and Eminence formations of limestone, shale and dolomite was deposited around the flanks of the Ozark Uplift. Early Ordovician Van Buren, Gasconade, Roubidoux, and Jefferson City formations are present in the subsurface of Craig and Ottawa Counties, Oklahoma (Ireland, 1944).

The oldest sedimentary rock at the surface in Northeastern Oklahoma is the Cotter dolomite, which laps across the highest knobs of the Precambrian granite near Spavinaw. The Cotter contains weathered fragments of the Spavinaw granite in the area of overlap. The dolomitic, sandy, and algal nature of the Cotter is believed to be indicative of near-shore deposition with portions of "Ozarkia" to the east supplying the sand.

Northeastern Oklahoma was uplifted in post-Canadian time and erosion cut into the Cotter formation leaving channels and solution cavities which were filled with later sediments.

Chazyan and early Black River time saw the advance of the Burgen (St. Peter) sea across the Ozark Area. The Burgen is believed to be the basal sand of a transgressive sea and to corres-

pond in position here to the Tulip Creek or "Third Bromide" of the Arbuckle area. The Burgen grades upward into the Tyner green shales and sandy dolomites, an offshore deposit of late Chazyan or Black River age. Clearing of the seas resulted in the deposition of the lithographic limestone of the Fite, which has been correlated with the Bromide Dense of the Arbuckle Mountains.

Northeastern Oklahoma was probably emergent during much of Trenton time inasmuch as strata equivalent to the Viola limestone have not been recognized. Submergence in late Ordovician Richmond time was followed by the deposition of the fossiliferous, coarsely crystalline Fernvale limestone and the succeeding Sylvan shale.

Emergence of probable short duration led to the removal of all but the lower portion of the Sylvan shale, the graptolites found therein being indicative of lower Sylvan age as compared to the Arbuckle Mountain section. Subsequent submergence during early Silurian time was followed by the deposition of the chemically pure St. Clair limestone.

Seas were absent from the Ozark area during Cayugan time. During Oriskany time, the Frisco limestone was deposited unconformably on the upper surface of the eroded St. Clair. Following the deposition of the Frisco, the area was again uplifted and the Frisco was subjected to extensive erosion. The Sallisaw sea advanced across an irregular surface on the Frisco and St. Clair formations. The initial deposit of sandstone filled the cavities and irregularities in the underlying units. Subsequent deposition of limestone and chert followed to complete the Sallisaw formation.

Northeastern Oklahoma was tilted abruptly to the south in post-Sallisaw (about Middle Devonian) time and the upturned strata of Devonian, Silurian, and Ordovician age were subjected to extensive erosion which beveled the units from south to north removing the younger units except along the southern flank.

Erosion of the upper portion of the Sallisaw produced a regolith of large chert blocks and fragments which was recemented and filled by the basal deposits of the advancing Chattanooga sea.

In late Devonian and early Mississippian time, the Chattanooga sea advanced across the Ozark area. The basal deposit, the Sylamore, consists of irregular lenses of phosphatic sandstone deposited in the low areas on the pre-Chattanooga surface. Succeeding beds of black pyritic shale accumulated under euxinic conditions which characterized late Devonian-early Mississippian deposition throughout the central interior of North America.

Clear, warm, relatively shallow seas prevailed throughout late Kinderhookian and Osagean time. Deposition of the limestones and shales of the St. Joe group was succeeded by the limestone and cherts of the Reeds Spring formation. It is believed that much of the Reeds Spring chert is primary because of its intricate interbedding with layers of limestone. It is thought that the Reeds Spring formation accumulated under conditions where a delicate balance between calcium carbonate and silica existed. Slight changes in the *Ph* of this solution would cause alternate precipitation of limestone and chert. The massive Keokuk chert was deposited initially as a thick-bedded, cross-laminated, crinoidal limestone and was replaced by silica at a much later time.

Following the deposition of the Osagean series, Northeastern Oklahoma was uplifted and tilted to the north. Subsequent erosion removed most of the Osagean in southern exposures and produced an irregular, knobby surface on the northern flank.

The basal deposit of the onlapping Meramec seas is a coarsely crystalline, glauconitic, crinoidal limestone which rests on Reeds Spring near Marble City and on Keokuk near Tahlequah. This so-called "Warsaw" or Tahlequah member grades southwestward into black, argillaceous limestone of the Moorefield type.

Slight emergence following deposition of the Tahlequah member is indicated by a zone of phosphatic nodules at the contact south of Tahlequah. Elsewhere conformable relations with underlying strata seem apparent.

The Moorefield sea then advanced northward around the flanks of the Ozark uplift. Generally turbid conditions are indicated by the argillaceous character of the Bayou Manard member, which overlaps the Tahlequah member northward and lies with unconformity on the Keokuk erosion surface. Local wave activity and erosion of the Keokuk "knobs" supplied the detrital chert which became incorporated in the Lindsey Bridge member. Continued northward overlap in late Moorefield time resulted in the deposition of the Ordnance Plant siltstone, which becomes increasingly sandy to the northeast and grades southwestward into platy, silty shale like that in the Ruddell formation of Arkansas.

Emergence of short duration occurred in post-Moorefield time. The overlying Hindsville limestone was deposited unconformably on the eroded surface of the Moorefield, overlapping northward to rest upon the Keokuk chert. Initial deposits of the Hindsville include soft green shale, a marly coquinite, and beds of greenish, silty limestone. Succeeding layers of medium crystalline limestones filled with fossil fragments attest to the relatively shallow nature of the Hindsville sea. Northeastward the Hindsville limestone becomes sandy in upper portions and grades into a near-shore facies, the Batesville sandstone.

Environmental conditions changed as the Fayetteville black shales were deposited conformably on the sandstones of the Batesville and the limestones of the Hindsville. The Fayetteville resembles the Sand Branch member of the Caney shale of the Arbukles and represents the return of euxinic conditions to the Ozark area. The Wedington sandstone member, which is confined to exposures in eastern Adair and Delaware Counties, is a near-shore deposit with an eastern source.

Clearing of seas in late Fayetteville time was followed by the deposition of the Pitkin limestone. Abundance of lime-secreting organisms indicates warm, shallow, and relatively stable seas during Pitkin time.

Southward tilting of the Ozark area in post-Pitkin time is indicated by the northward truncation of the Pitkin and its absence through erosion north of T. 18 N.

Early Pennsylvanian, Morrowan seas advanced across the eroded surface on the Mississippian beds. Initial deposits include

conglomerate and shale, followed by deposition of sandstone and limestone. The Hale formation grades both laterally and vertically from sandstone to limestone, being more sandy in basal portions and increasing in sand content eastward, indicating an eastward source.

Sedimentation during Bloyd time was essentially a continuation of Hale sedimentation with no significant break in deposition. The Bloyd consists largely of dark shales which are interbedded with blue, fossiliferous limestone. The Bloyd thins northward to extinction in T. 19 N. due to post-Morrow tilting and subsequent erosion.

Middle Pennsylvanian Atoka sandstones, shales, and thin limestones lie with marked unconformity upon the Morrow and older beds. Progressive northward spread of Atoka seas is indicated by overlap of younger members of the Atoka from south to north. The Atoka is overlain by a thin development of shales assigned to the Hartshorne (Branson, 1955); these are cyclic in nature and contain thin coals and underclays. Clastic deposition continued into McAlester time and the Warner sandstone marks its base in Craig and Ottawa Counties. Succeeding units, previously referred to as "Cherokee" are cyclic in nature and are a reflection of the instability of the shelf area of northern Oklahoma during Middle Pennsylvanian time.

In Middle Pennsylvanian time (pre-Tiawah limestone) (pre-Senora) the Ozark Uplift was elevated and a series of large, normal faults developed parallel to the general elongation of the Ozark Uplift. The fault pattern in general parallels the structures in the Arkansas syncline to the south and is believed to be the result of tension created by loading in the McAlester basin to the south together with positive movements in the Ozark area causing a stretching of the rocks and associated faulting.

Peneplanation and intermittent uplift during Pleistocene are indicated by widespread upland gravels and by two distinct terrace levels above the Grand and Arkansas Rivers.

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APPENDIX

MEASURED SECTIONS*

1. SECTION AT BLUFF SIDING

Southeast Corner of Section 27, T. 13 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hale:		
Sandstone, medium-grained, calcareous, cross-bedded (not measured)		
Limestone, blue-gray, medium crystalline, sandy, fossiliferous	50.6	50.6
Pitkin:		
Limestone, gray, crystalline, limonite-stained, uneven-bedded, fossiliferous, with crinoid fragments and *Archimedes*	4.2	50.5
Covered	1.0	46.3
Limestone, gray, medium-crystalline, in thin beds with shale partings, crinoid stems prominent on weathered surface	2.0	45.3
Limestone, blue-gray, crystalline, oolitic, massive-bedded, *Archimedes*	6.0	43.3
Limestone, dove-gray, dense with crystalline white calcite streaks, thin and weathers smooth and rubbly	7.5	37.3
Limestone, blue-gray, crystalline, extremely fossiliferous, with *Archimedes*, *Linoproductus*, and *Polypora*	0.5	29.8
Limestone, gray, dense, brittle, weathers smooth	1.2	29.3
Shale	0.2	28.1
Limestone, gray, medium crystalline, oolitic, medium-bedded, fossiliferous	2.6	27.9
Covered	17.0	25.3
Limestone, gray, coarsely crystalline, oolitic, limonite-stained, weathers rough	8.3	8.3
Base of exposure.		

2. PARTIAL SECTION OF THE MOOREFIELD

Section 36, T. 13 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Fayetteville:		
Shale, black, fissile, interbedded with thin blue-black limestone stringers	41.5	41.5
Moorefield:		
Siltstone, yellow-brown, platy, shaly	5.5	49.5
Limestone, black, dense, argillaceous, weathers gray and shaly	4.0	44.0
Shale, poorly exposed	8.0	40.0
Limestone, blue-black, silty, fossiliferous, with *Leiorhynchus carboniferum*	3.0	32.0
Covered	6.0	29.0
Limestone, gray, dense, argillaceous, fossiliferous	4.0	23.0
Shale, gray, platy, calcareous	2.0	19.0

* Several of the sections included in the appendix are now partially or completely inundated by the waters of the Tenkiller Ferry and Fort Gibson reservoirs. They are incorporated here to give thickness and facies information in areas now flooded.

Limestone, gray, argillaceous, massive-bedded, weathers shaly, contains many large productid brachiopods	3.0	17.0
Shale, and limestone, poorly exposed	10.0	14.0
Limestone, blue-gray, silty, massive-bedded, fossiliferous	3.0	4.0
Shale (in creek bed north of hill), black, hard, jointed into rectangular blocks	1.0	1.0
Base of exposure.		

3. MEASURED SECTION, STRAYHORN LANDING
Section 10, T. 13 N., R. 21 E.*

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Pitkin:		
Limestone, blue-gray, crystalline, massive-bedded, fossiliferous	23.0	23.0
Fayetteville:		
Shale, black, and interbedded thin black limestone stringers, poorly exposed	10.0	31.6
Limestone, dark blue-gray, finely crystalline	0.9	21.6
Shale, poorly exposed, few limestone beds	6.0	20.7
Limestone, dark blue, dense, hard	1.6	14.7
Shale, gray, platy, weathers to buff	7.0	13.1
Limestone, black, dense, fossiliferous	0.7	6.1
Shale, black, fissile	1.5	5.4
Limestone, black, lithographic	0.3	3.9
Shale, black	0.2	3.6
Limestone, blue-black, lithographic, weathers gray, sub-cuboidal fracture	0.9	3.4
Shale, black, fissile, fossiliferous	0.8	2.5
Limestone, black, dense	0.2	1.7
Shale, black, fissile, concretionary	1.0	1.5
Limestone, black, fossiliferous	0.5	0.5
Moorefield:		
Shale, yellow-brown, silty, platy, partially covered	11.5	55.2
Limestone, black, dense, with a thin fossiliferous zone near the middle, *Moorefeldella eurekensis*	1.2	43.7
Siltstone, buff, slightly calcareous	0.9	42.5
Limestone, blue-gray, weathers shaly, fossiliferous	0.7	41.6
Limestone, blue-black, dense, fossiliferous, petroliferous odor	1.7	40.9
Shale, black, calcareous	0.3	39.2
Limestone, blue, dense, fossiliferous	0.5	38.9
Shale, platy, calcareous, contains many crushed and distorted fossils	3.0	38.4
Limestone, blue, dense, weathers gray	1.1	35.4
Shale, gray, calcareous	0.6	34.3
Limestone, gray-brown, fossiliferous, leaches to a buff, non-calcareous siltstone	5.0	33.7
Limestone, gray, argillaceous, weathers platy	2.6	28.7
Shale, gray, calcareous	1.5	26.1
Limestone, buff-weathering, shaly, non-fossiliferous	1.5	24.6
Limestone, gray, argillaceous, thin-bedded	4.0	23.1
Limestone, black, lithographic	1.9	19.1
Limestone, gray, weathers shaly	0.5	17.2
Shale, blue-black, calcareous, concretionary	2.7	16.7
Limestone, black, dense, partially leached to a buff, non-calcareous siltstone	0.6	14.0

Shale, black, calcareous	1.0	13.4
Siltstone, buff, non-calcareous, porous	0.2	12.4
Shale, black, calcareous, weathers gray	0.2	12.2
Limestone, blue-black, dense, hard, has a petroliferous odor	2.0	12.0
Limestone, black, dense, argillaceous	5.0	10.0
Shale, black, calcareous, non-fossiliferous jointed	2.9	5.0
Limestone, black, dense, leaches to a buff siltstone	1.1	2.1
Shale, black, hard, calcareous, jointed into rectangular blocks	1.0	1.0
Chattanooga:		
Shale, black, fissile, hard	4.0	4.0

* Lower part of section now inundated by water of Tenkiller Lake.

4. SECTION ALONG ROAD, CENTER OF WEST SIDE
Section 10, T. 13 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, brown, medium- to fine-grained, poorly exposed to top of hill	44.0	44.0
Bloyd:		
Shale, gray-brown, fissile	3.0	144.6
Limestone, reddish, crystalline, thin-bedded, fossiliferous, weathers shaly	7.0	141.6
Limestone, light gray, medium-crystalline, ranging to dense near top, thin- to thick-bedded	27.0	134.6
Shale, gray, fissile, interbedded with thin blue, dense, limestone stringers	12.7	107.6
Limestone, gray, coarsely crystalline, massive-bedded, fossiliferous	6.0	94.9
Shale and limestone, poorly exposed	25.0	88.9
Limestone, gray, coarsely crystalline, weathers buff	0.9	63.9
Shale, gray to black, concretionary	16.0	63.0
Limestone, gray, uneven bedded, weathers shaly	7.0	47.0
Shale	3.0	40.0
Limestone, blue-gray, thin to medium-bedded with thin shale partings	11.0	37.0
Limestone, blue, massive-bedded, hard, weathers smooth	3.0	26.0
Sandstone, gray, hard, calcareous, leaches to porous, ferruginous sandstone	1.5	23.0
Covered	2.0	21.5
Limestone, gray, coarsely crystalline, massive-bedded	4.0	19.5
Shale	3.0	15.5
Limestone, gray, limonite-stained	0.8	12.5
Shale	6.0	11.7
Limestone, gray, medium crystalline, massive-bedded with streaks of white calcite	1.2	5.7
Sandstone, ferruginous, calcareous cement	0.5	4.5
Shale, gray, platy	4.0	4.0
Hale:		
Covered	5.0	48.4
Sandstone, brown, poorly exposed, one thin bed of blue limestone near the middle	6.8	43.4
Covered	8.0	36.6
Sandstone, brown, thick-bedded, non-calcareous	1.5	28.6
Covered	17.0	27.1
Sandstone, brown, thin-bedded and cross-bedded, calcareous	6.0	10.1

Limestone, gray, sandy, weathers smooth	0.5	4.1
Sandstone, fine-grained, cross-bedded	3.0	3.6
Conglomerate, brown, reworked limestone pebbles, sandy, non-calcareous matrix	0.6	0.6

5. SECTION AT WEBBER'S COVE
Section 17, T. 13 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Bloyd:		
Limestone, brown-gray, thin-bedded, sandy, fossiliferous	2.5	74.3
Covered	4.0	71.8
Limestone, gray, hard, fossiliferous	1.1	67.8
Shale, poorly exposed	6.0	66.7
Limestone, gray, crystalline, massive, crinoid stems..	3.0	60.7
Shale, gray, fissile, several thin coarsely crystalline, rubbly weathering limestone beds near the middle..	19.0	57.7
Limestone, gray to brown, crystalline, in medium beds, sandy, with thin shale partings	5.0	38.7
Shale, gray, fissile	1.0	33.7
Limestone, gray, with lenticular greenish spots, sandy, weathers pitted	3.7	32.7
Shale	6.0	29.0
Limestone, light-gray, massive-bedded, weathers rough and knobby	5.0	23.0
Shale, gray, interbedded with gray limestone, poorly exposed	18.0	18.0
Hale:		
Limestone, blue-gray, sandy, weathers platy, thin shale partings	7.0	52.2
Limestone, gray, crystalline, massive-bedded, weathers smooth	3.4	45.2
Limestone, gray, oolitic, weathers into rounded, rubbly blocks	3.0	41.8
Sandstone, tan, medium-grained, calcareous	0.5	38.8
Limestone, gray, medium-crystalline, massive-bedded, weathers smooth	4.0	38.3
Shale, gray	1.0	34.3
Limestone, light-gray, coarsely crystalline, medium-bedded, fossiliferous, weathers shaly	6.0	33.3
Sandstone, brown, medium-sized grains of clear quartz sand, cross-bedded, noncalcareous	0.8	27.3
Covered	4.0	26.5
Limestone, gray, thin-bedded, crinoidal	5.0	22.5
Limestone, dark-blue, dense, weathers brown	3.0	17.5
Limestone, light gray, coarsely crystalline, medium-bedded, with thin shale partings	6.5	14.5
Limestone, reddish-brown, sandy, weathers platy	1.0	8.0
Covered	5.5	7.0
Sandstone, brown, ferruginous, fine- to medium-grained, sub-rounded, cross-bedded	0.9	1.5
Conglomerate, brown, contains reworked flat limestone pebbles up to two and one-half inches across, cross-bedded, with a sandy matrix	0.6	0.6

Pitkin:		
Covered	1.0	28.0
Limesotne, tan, dense, calcite streaks, weathers rubbly	2.0	27.0
Covered	6.0	25.0
Limestone, blue-gray, coarsely crystalline, massive-bedded, weathers smooth, *Archimedes*	15.0	19.0
Limestone, blue-gray, limonite-stained, coarsely crystalline, fossiliferous, with *Archimedes* and crinoid stems	4.0	4.0
Fayetteville:		
Shale, black, fissile, and Limestone, blue-black, dense, weathers into subcuboidal blocks	58.0	58.0

6. PARTIAL SECTION—McEACHIN HOLLOW
SW¼ NE¼ SE¼ and SE¼ NE¼ SE¼ of Section 3, T. 13 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Covered to Top of Hill		
Atoka:		
Siltstone, light brown, sometimes medium gray, occasionally slightly calcareous, white mica, worm impressions on bedding planes, limonite concretions in lower part, bedding planes irregular, thin-bedded, weathers medium brown and irregularly	13.8	38.9
Covered	20.3	25.1
Siltstone, streaked medium brown or grayish brown and dark brown, non-calcareous, white mica, worm impressions on bedding planes, bedding planes fairly even, thin-bedded, weathers medium brown and somewhat irregularly	4.8	4.8
Bloyd:		
Covered	26.5	170.5
Limestone, medium brownish gray, dense to very finely crystalline, in a single bed, weathers light brownish gray and rubbly	2.3	144.0
Limestone, medium brownish gray, very finely crystalline, in a single bed, weathers fairly smoothly	1.6	141.7
Limestone, medium gray, finely crystalline, silty, platy, weathers with silty layers standing out in places	1.3	140.1
Covered	6.3	138.8
Siltstone, dark brownish gray and dark gray, somewhat streaked, calcareous, bedding planes very thin and irregular, weathers medium brown and irregularly	3.4	132.5
Covered	5.1	129.1
Shale, medium to dark greenish brown, non-calcareous, rarely white mica, nodular to platy, weathering not known	1.2	124.0
Covered	6.6	122.8
Siltstone, medium to dark brownish gray, very calcareous, bedding planes very irregular, very thin-bedded, weathers medium brown, irregularly, and somewhat leached	2.5	116.2
Covered (probably mostly shale)	58.9	113.7

Limestone, dark medium bluish gray, some yellow-brown to orange spots, dense to finely crystalline, zone of *Chaetetes milleporaceus* in middle, some incipient bedding planes, massive, weathers medium gray and rather irregularly	7.4	54.8
Covered	4.0	47.4
Shale, dark greenish brown to black, non-calcareous, platy, tends to be nodular	0.8	43.4
Covered	6.4	42.6
Poorly exposed:		
Shale, dark brown, non-calcareous, fissile	0.3	36.2
Covered	2.7	35.9
Limestone, medium to dark gray or brownish gray, some earthy orange sopts, finely crystalline with some coarse crystals, rarely oolitic, bedding planes irregular and discontinuous, thin-bedded	6.8	33.2
Covered	4.5	26.4
Sandstone, streaked medium gray and medium brown, fine-grained, very calcareous, thin-bedded, bedding planes fairly regular, weathers leached	1.0	21.9
Sandstone, streaked medium gray and medium brown, fine-grained, very calcareous, in a single bed, weathers leached	0.6	20.9
Covered	1.8	20.3
Limestone, dark gray with some orange spots, medium crystalline with some coarser crystals, occasionally somewhat sandy, thin-bedded	4.7	18.5
Covered	13.8	13.8
Hale:		
Limestone, dark gray with earthy orange spots, very finely crystalline, oolitic, in a single bed	0.5	19.5
Sandstone, light gray or brownish gray to dark gray, intergrading and streaked, some iron-staining, fine-grained, calcareous, light gray sandy limestone at top, fossiliferous, bedding of sandstone is somewhat irregular, medium- to thin-bedded, weathers brown and honeycombed in places	6.5	19.0
Limestone, medium to dark gray, orange earthy spots and some orange calcite crystals, medium crystalline, bedding obscure	2.3	12.5
Sandstone, streaked medium gray and brown, orange calcite crystals, fine-grained, very calcareous, bedding thin and irregular (cross-bedding),	1.2	10.2
Limestone, dark gray with earthy orange spots, finely crystalline with many large crystals, *Chaetetes milleporaceus*, platyceratid gastropod, irregularly bedded (cross-bedded?)	2.3	9.0
Covered	2.6	6.7
Limestone, light to medium brownish gray with orange earthy spots, finely crystalline with some coarser crystals, carbon spots, bedding planes numerous, irregular, possibly cross-bedded, weathers brownish gray	4.1	4.1
Covered below		

7. PARTIAL SECTION—McEACHIN HOLLOW

SE¼ SE¼ NE¼ and NE¼ NE¼ SE¼ of Section 3, T. 13 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Covered Above		
Bloyd (Incomplete):		
Limestone, dark gray with earthy orange spots, coarsely crystalline, thin-bedded at top and bottom, rest is massive, weathers gray and smoothly	4.7	31.4
Limestone, dark gray, very fine-grained, somewhat oolitic, in a single bed, weathers gray and smoothly	0.8	26.7
Covered	4.3	25.9
Shale, medium to dark greenish brown, calcareous, some thin, irregular, discontinuous limestone in middle, shale is platy to fissile, weathering not known; limestone is fine-grained and fossiliferous..	3.0	21.6
Covered	18.6	18.6
Hale:		
Sandstone, dark gray, fine-grained, very calcareous, bedding obscure, weathering not known	1.9	24.6
Covered	0.7	22.7
Limestone, dark gray and medium brown, sometimes streaked, earthy orange spots, medium crystalline, sandy, very sandy in places, bedding planes obscure, weathers medium brown to medium grayish brown, and sometimes leached	5.5	22.0
Covered	0.8	16.5
Limestone, with minor amounts of sandstone: Limestone, light to dark gray with earthy orange spots, medium crystalline, sandy (fine grains), unit is fossiliferous, *Dictyoclostus morrowensis*, crinoid remains, others, bedding planes irregular, thin- to medium-bedded, weathers medium brown or grayish brown, smoothly, but sometimes leached and irregular; sandstone is light- to medium-gray, very calcareous, weathers brown	2.9	15.7
Limestone, dark medium gray, medium crystalline, thin-bedded (?), weathering not known	1.3	12.8
Sandstone, streaked light gray and light brown, medium-grained, calcareous, in a single bed	0.5	11.5
Limestone, dark gray, occasionally medium brown, rarely orange spots, finely crystalline, some coarser crystals, sandy in places, bedding planes irregular, medium-bedded	2.2	11.0
Covered	1.2	8.8
Limestone medium to dark brownish gray, finely crystalline, dense in places, usually very sandy (medium grains), sandstone near base that grades into limestone, limestone is fossiliferous, *Dictyoclostus morrowensis*, others, bedding planes irregular, thin-bedded, weathers medium grayish brown, and irregularly; sandstone is brown, medium-grained, very calcareous, weathers brown	4.4	7.6
Covered	0.8	3.2
Limestone, medium gray with some orange spots, finely crystalline with some large crystals, sandy (medium grains), may be cross-bedded, in a single bed (massive), weathers brown and fairly smoothly	2.4	2.4

Pitkin:		
Limestone, light brownish gray, finely crystalline, oolitic, conchoidal fracture, in a single bed, weathers medium gray	0.7	19.8
Limestone, light brownish gray, medium to finely crystalline, rarely somewhat oolitic at top, massive, weathers medium gray and irregularly	3.7	19.1
Limestone, light to medium brownish gray, finely crystalline with some coarser crystals, rarely oolitic, medium to massive-bedded, weathers medium brownish gray	5.1	15.4
Covered	1.1	10.3
Limestone, medium brownish gray, finely crystalline, oolitic, in a single bed, weathers brownish gray and rather smoothly	1.2	9.2
Limestone, medium brownish gray, finely crystalline with some larger crystals, fossiliferous, medium- to massive-bedded, weathers medium gray and fairly smooth	8.0	8.0
Fayetteville:		
Covered	19.2	21.9
Shale, black, non-calcareous, platy at bottom, fissile at top, often with minutely pitted or irregular bedding planes, weathers black and often iron-stained..	2.7	2.7
Hindsville:		
Limestone, dark gray, very finely crystalline, silty, thinly and rather irregularly bedded	1.0	44.3
Limestone, dark brown to dark gray, very finely crystalline, conchoidal fracture, irregularly and thinly bedded	0.4	43.3
Covered	1.7	42.9
Limestone, medium brownish gray, finely crystalline, some larger crystals, slightly oolitic, many small crinoid stems, bedding planes poorly developed, medium-bedded, weathers medium gray and irregularly	1.5	41.2
Limestone, medium brownish gray, dense to finely crystalline, some coarser crystals, bedding planes poorly developed, massive, weathers medium gray and irregularly	3.8	39.7
Limestone, dark medium gray, medium crystalline, slight carbonaceous odor, upper contact arbitrary, thin-bedded, bedding planes irregular and poorly developed	2.9	35.9
Covered	4.5	33.0
Limestone, medium gray or brownish gray, finely to medium crystalline, oolitic, thin-bedded	6.1	28.5
Limestone, medium to dark medium gray or brownish gray, finely crystalline with many larger crystals, fossiliferous, especially in lower part, *Agassizocrinus*, *Paladin mucronatus*, bryozoans, gastropods, grades above into oolitic limestone, bedding planes irregular, medium-bedded, weathers fairly smoothly	3.4	22.4
Limestone, dark medium gray or brownish gray, finely crystalline, silty, silt in layers, unit is thin-bedded, weathers with silty layers standing out	3.1	19.0
Covered, may include some Moorefield	15.9	15.9
Moorefield:		
Tahlequah member:		
Limestone, black, medium crystalline, glauconitic, thin-bedded, weathers medium gray, smoothly	9.9	15.3
Covered	5.4	5.4

8. PARTIAL SECTION—PAYNE HOLLOW
NE¼ NW¼ SE¼ of Section 10, T. 13 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Covered Above		
St. Joe:		
Limestone, light bluish gray, finely crystalline with some coarser crystals, somewhat crinoidal, pyritiferous, sometimes in nodules, has black, calcareous, phosphatic inclusions, limestone is medium-bedded, weathers smoothly and light medium gray	1.4	4.1
Shale, medium to (occasionally) dark green or yellow-brown, non-calcareous, (phosphatic?) nodules near top, tendency to be blocky, weathers medium green or yellow-brown	2.7	2.7
Chattanooga:		
Shale, black, non-calcareous, platy, weathers black and brownish (iron-stained)		

9. JACKSON MOUNTAIN SADDLE SECTION
NE¼ NW¼ SW¼ and SW¼ SW¼ NW¼ of Section 10, T. 13 N., R. 23 E., and SE¼ SE¼ NE¼ of Section 9, T. 13 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Covered to Top of Hill		
Atoka:		
Siltstone, light brown, non-calcareous, bedding planes irregular, very thin-bedded, weathers light brown and irregularly	2.9	24.1
Covered	20.7	21.2
Sandstone, black and medium greenish brown, fine-grained, non-calcareous, shaly and cherty inclusions, in a single bed, weathers medium to dark brown or reddish and irregularly	0.5	0.5
Bloyd:		
Shale, dark green with limonite concretions, non-calcareous, fissile, weathers bright red to light brown (iron-stained)	7.4	140.0
Covered	31.8	132.6
Limestone, light to medium brown-gray with orange earthy spots, finely crystalline with some coarser crystals, silty, coquina in places (small fossils), thin-bedded, may be cross-bedded, weathers medium brown and irregularly	4.9	100.8
Covered	2.5	95.9
Limestone, medium brownish gray, finely crystalline, some larger crystals, fossiliferous, very crinoidal in upper part, bedding planes irregular, thin- to massive-bedded weathers medium gray and medium brown and rubbly	7.2	93.4
Covered	31.0	86.2
Limestone, medium brownish gray with earthy orange spots, finely crystalline with coarser crystals to coarsely crystalline (changes laterally), very fossiliferous, *Composita*, *Spirifer*, *Dictyoclostus morrowensis*, massive-bedded, weathers medium brownish gray, irregularly, and is often rotten	5.5	55.2

Covered; probably has *Chaetetes milleporaceus* zone....	17.0	49.7
Shale, dark green, non-calcareous, tendency to be nodular, good shaly parting, weathers dark green with some brownish staining	1.7	32.7
Covered	7.7	31.0
Limestone, medium brownish gray, very finely crystalline, sandy (medium grains), fossiliferous in a single bed, weathers medium brown and smoothly..	0.8	23.3
Limestone, light to medium brown with medium to dark gray streaks, finely crystalline with some coarser crystals, very sandy (coarse medium grains), bedding planes irregular, thin-bedded, tends to become exceedingly thin-bedded some faint cross-bedding, weathers medium brown and irregularly....	2.0	22.5
Sandstone, dark grayish brown, medium-grained, very shaly, calcareous, in a single bed, weathers dark brown and irregularly	0.3	20.5
Covered	11.7	20.2
Shale, dark green to medium yellow-brown (rare), non-calcareous, has limonite concretions which are calcareous, good shaly parting, weathers dark green and iron-stained	8.5	8.5
Hale:		
Limestone, dark bluish gray, finely crystalline with some larger crystals, thin-bedded, weathering not known	1.0	32.3
Covered	0.2	31.3
Limestone, dark bluish gray, finely crystalline with some larger crystals, fossiliferous, thin-bedded, weathering not known	1.4	31.1
Limestone, dark medium bluish to brownish gray, finely crystalline, but often oolitic, some coarser grains, somewhat sandy, weathering not known.....	1.6	29.7
Limestone, dark bluish gray, very finely crystalline with some larger crystals, hard, in a single bed.....	0.9	28.1
Limestone, dark bluish gray to dark brownish gray, finely to medium crystalline, sandy in places, very poor bedding, weathers medium gray and in places rottenly	1.7	27.2
Limestone, medium to dark medium brownish gray, dense to finely crystalline, very oolitic in center, becoming less so to top and bottom, top contact arbitrary, bedding obscure, weathers light gray	2.5	25.5
Covered	0.9	23.0
Limestone, medium to dark brownish gray, fine medium crystalline with some coarser grains, sandy in places, bedding very poorly defined, massive, weathers rather roughly	6.6	22.1
Limestone, dark gray, finely crystalline with some larger crystals, oolitic, in a single bed, upper contact arbitrary	2.3	15.5
Covered	2.2	13.2
Limestone, medium to dark gray, occasionally brownish, earthy orange spots, finely crystalline with some coarser grains, moderately sandy, fossiliferous, weathers medium brown and fairly smoothly.....	2.2	11.0
Limestone, dark medium brownish gray, finely crystalline, very fossiliferous, in a single bed, weathers medium gray and rather irregularly	1.1	8.8
Sandstone, medium brown and dark gray, medium-grained, very calcareous, in a single bed, weathers medium brown, irregularly, and tends to be rotten....	0.5	7.7

Limestone, dark brownish gray to light brown, very fine-grained, oolitic, very sandy (medium grains), in a single bed, weathers medium brown and irregularly	1.7	7.2
Limestone, medium brownish gray, coarsely crystalline, sandy (medium grains), many crinoid stems, other fossils present, very rough cross-bedding, no other bedding, weathers medium grayish brown and irregularly	2.5	5.5
Covered	0.8	3.0
Sandstone, medium brown to dark medium brown, medium-grained, calcareous, phosphatic nodules (?), faintly cross-bedded, rather massive, weathers medium brown and with some faint ridges showing the cross-bedding	2.2	2.2
Pitkin:		
Limestone, medium to dark medium brownish gray, finely crystalline with many coarser crystals, very fossiliferous, many crinoid stems, bedding planes discontinuous, rather irregular, generally massive, weathers medium gray and rather irregularly, base concealed	9.0	9.0
Fayetteville:		
Covered, but laterally the presence of typical Fayetteville float confirms the presence of the Fayetteville in this interval. Some lower Pitkin is also included, but this is probably negligible	23.0	23.0
Hindsville:		
Limestone, dark grayish brown, fine medium crystalline, dense at very top and bottom, in a single bed (but thin-bedded laterally), weathers medium gray and fairly smoothly	4.4	24.6
Limestone, brownish black, finely crystalline, silty (current bedded), bedding planes very irregular, weathers medium bluish gray and smoothly	0.8	20.2
Covered	2.9	19.4
Limestone, medium to dark brownish gray, finely crystalline, rarely dense, coquina in places, slightly carbonaceous odor in places, somewhat silty, does not appear cross-bedded, massive, weathers medium gray and somewhat irregularly	8.1	16.5
Siltstone and limestone, cross-bedded, siltstone, medium brown, calcareous, part of cross-bedding, weathers medium brown; limestone, medium to dark brownish gray, finely crystalline non-fossiliferous, part of the cross-bedding, weathers medium brownish gray	1.1	8.4
Limestone, medium grayish brown, fine medium crystalline, silty, obscurely cross-bedded, upper contact arbitrary, coquina in places, massive, weathers medium gray and rather irregularly	5.3	7.3
Covered	2.0	2.0
"Boone":		
Chert, medium brownish or bluish gray with darker spots, generally calcareous, no bedding apparent, fractured, weathers medium gray and angularly	0.9	107.2
Covered	10.6	106.3
Chert, medium to light gray or white, numerous irregular spots, mostly gray, some black, calcareous, has irregular masses of limestone, chert is very fractured, poorly bedded, seems to range between thin		

and medium bedding, weathers medium gray to white and angularly; limestone is brownish gray with irregular dark spots of blue-black, weathers smoothly and medium gray or blackish	29.1	95.7
Covered	9.9	66.6
Chert, light gray with dark gray spots, generally calcareous, dark gray spots look like filled vugs, bedding planes very obscure, fractured	11.9	56.7
Covered	3.4	44.8
Chert, mottled white and light gray or tan, slightly calcareous, occasionally very calcareous, occasional masses of limestone, bedding of chert is very obscure, weathers white to light bluish gray, angularly, and sometimes leached; limestone is dark medium brown, weathers smoothly and light gray	9.2	41.4
Covered	5.8	32.2
Chert, white and light gray, mottled, to dark bluish gray or dark gray, usually calcareous, at least in spots or veins, small masses of limestone, chert is very fractured, bedding planes visible only near top, there they are pitted and undulating thinly to medium-bedded, weathers angularly and light to medium gray or medium to dark bluish gray; limestone is medium gray, fine-grained, weathers smoothly and light gray	26.4	26.4
St. Joe:		
Limestone, medium gray to medium brownish gray, finely crystalline with many larger crystals, some crinoid stems, pyritiferous in a single bed, weathers smoothly and medium gray; has scattered, brownish-black to black inclusions much like edgewise conglomerate, calcareous, calcite crystals show on fresh surface, may be phosphatic	0.5	4.1
Covered	2.8	3.6
Shale, medium greenish brown, dark brown, or light greenish gray, non-calcareous, rather nodular, weathers light greenish gray to medium brown	0.8	0.8
Chattanooga:		
Shale, black, non-calcareous, micaceous (?), rather blocky, weathers black	1.9	58.1
Covered	1.6	56.2
Shale, black, non-calcareous, fissile to almost platy, weathers black	2.3	54.6
Covered	1.3	52.3
Shale, black, non-calcareous, fissile to platy, almost blocky, weathers black	4.6	51.0
Covered	1.5	46.4
Shale, black, non-calcareous, somewhat pyritiferous, good shaly parting, weathers black	0.7	44.9
Covered	4.7	44.2
Shale, black, non-calcareous, pyritiferous, iron-stained along bedding planes, platy to fissile, weathers black	11.7	39.5
Covered	2.3	27.8
Shale, black, non-calcareous, platy, weathers black	3.1	25.5
Covered	11.9	22.4
Shale, black, non-calcareous, pyritiferous, carbonaceous odor, platy, weathers black	0.8	10.5
Covered	9.7	9.7

Sylamore Sandstone member:
Sandstone, medium brown, somewhat streaked, rather coarse-grained to medium-grained, calcareous in places, friable, rather contorted, weathers smoothly and medium brown to very light gray
Base not exposed.

10. WEST QUARRY MOUNTAIN SECTION
N½ SE¼ SE¼ of Section 10, T. 13 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Fayetteville:		
Hindsville:		
Limestone, medium grayish brown, finely crystalline, silty in places, occasionally fossiliferous, *Torynifera setigera*, thin- to medium-bedded, weathers medium gray and rather irregularly	2.2	23.9
Covered	2.6	21.7
Limestone, medium grayish brown, finely crystalline, very uniformly so, somewhat fossiliferous, productids, weathers medium gray and somewhat irregularly	0.4	19.1
Limestone, medium grayish brown to dark medium gray, finely crystalline and medium crystalline, fossiliferous, thin-bedded, weathers medium gray and rather irregularly	2.4	18.7
Covered	12.1	16.3
Shale, medium brown, calcareous, fissile, weathers medium brown	2.3	4.2
Limestone, medium bluish gray, very finely crystalline with many larger crystals, *Agassizocrinus*, *Pleurodictyum* present, thin-bedded, weathers medium brown and medium gray	0.5	1.9
Covered	1.4	1.4
Moorefield:		
Bayou Manard member:		
Limestone, and shale, interbedded: Limestone, dark medium brownish gray, finely crystalline with many coarser crystals, slight carbonaceous odor, fossiliferous, *Leiorhynchus carboniferum*, thin-bedded; weathers medium brownish gray and rather smoothly shale, dark brownish gray, very calcareous, very thinly platy, weathers brown	0.5	21.2
Limestone, dark brownish gray, very fine-grained, silty, in a single bed, weathers medium brownish gray and rather angularly	0.2	20.7
Shale, dark brown, calcareous, good shaly parting, weathers brown	0.3	20.5
Limestone, black, finely crystalline, weathers light grayish brown and smoothly interbedded with black, coarsely crystalline limestone, many phosphatic pebbles, some chert, shark's teeth, strong carbonaceous odor, *Leiorhynchus carboniferum*, *Moorefieldella eurekensis*, weathers dark brown and fairly smoothly	0.5	20.2
Covered	3.3	19.7

Limestone, light gray to medium brownish gray, finely crystalline, exceedingly fossiliferous, *Leiorhynchus carboniferum*, *Moorefieldella eurekensis*, *Composita*, in a single bed, weathers light brownish gray and irregularly	0.5	16.4
Limestone, medium brownish gray, finely crystalline with many larger crystals, phosphatic nodules, fossiliferous, large productid, in a single bed, weathers light brown to gray	0.2	15.9
Covered	0.7	15.7
Limestone, brownish black, finely crystalline, chert pebbles, incipient shaly parting in places, weathers light brownish gray	0.7	15.0
Shale, brownish black, calcareous, silty, irregular shaly parting, weathers light brownish gray	0.4	14.3
Covered	2.7	13.9
Limestone, black, finely crystalline, some phosphatic nodules, fossiliferous, gastropods, others, gastropods are silicified, some quartz apparently deposited along bedding planes, thin-bedded, weathers dark brown and rather irregularly	0.5	11.2
Limestone, brownish black, very finely crystalline, fossiliferous, *Leiorhynchus carboniferum* others, in a single bed, weathers rather angularly and light brownish gray	1.2	10.7
Shale, black, calcareous, silty, good shaly parting, weathering not known	0.4	9.5
Limestone, black, finely crystalline, in a single bed, weathering not known	0.9	9.1
Covered	2.0	8.2
Limestone, dark brownish gray, very finely crystalline, fossiliferous, in a single bed but has incipient, very irregular planes of parting, well-jointed, weathers rather irregularly and light brownish gray	1.3	6.2
Limestone and shale, intergrading:		
Limestone, dark brownish gray, very finely crystalline, weathers smoothly and light brownish gray; shale, dark brownish gray, calcareous, silty, fossiliferous, shaly parting poor, irregular, weathers light brownish gray	0.8	4.9
Shale, brownish black, calcareous, silty, good shaly parting (but irregular), not resistant, weathers black	0.8	4.1
Shale, dark brownish gray, calcareous, large phosphatic nodules, few fossils, silty, uneven shaly parting, resistant, weathers medium brown-gray and rather irregularly	0.6	3.3
Limestone, dark gray to black, finely crystalline, rarely has black phosphatic nodules, slight carbonaceous odor, nonfossiliferous, in a single bed, weathers gray (?)	0.5	2.7
Covered	1.0	2.2
Limestone, dark brownish gray, fine to medium crystalline, some phosphatic nodules, non-fossiliferous, slight carbonaceous odor, weathering not known	1.2	1.2

Tahlequah member:		
Limestone, medium brown or light to dark gray, many earthy orange spots, very uniformly medium crystalline, glauconitic, carbonaceous odor, massive to medium-bedded, weathers medium gray and smoothly, sometimes rottenly	3.5	12.6
Covered	9.1	9.1

11. SCHOOLHOUSE ROAD SECTION
E½ SE¼ of Section 11, T. 13 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Fayetteville Shale		
Hindsville:		
Limestone, medium gray, medium crystalline, fossiliferous in upper part, obscurely cross-bedded, bedding rather irregular, weathers medium gray and fairly smoothly	1.3	24.3
Limestone, dark medium gray, medium to finely crystalline, weak carbonaceous odor, massive-bedded, weathers medium gray and fairly smoothly	2.4	23.0
Covered	2.8	20.6
Limestone, dark medium gray, dense with occasional large crystals, calcite stringers, somewhat fossiliferous, silty and probably cross-bedded, weathers light blue-gray and very smoothly	0.4	17.8
Limestone, medium gray, medium crystalline, weak carbonaceous odor, very fossiliferous, thin-bedded (planes obscure), weathers medium gray and fairly smoothly	4.2	17.4
Limestone, brown-gray, medium crystalline, somewhat silty, fossiliferous, obscurely cross-bedded, single massive bed, weathers medium gray	1.7	13.2
Covered, probably some limestone	8.0	11.5
Siltstone, medium brown, clayey, calcareous, has yellow, irregular calcareous nodules toward top, weathers light brown, is almost fissile; has masses of limestone scattered at base, which are dark gray, dense, containing *Pleurodictyum*, rarely *Agassizocrinus*, weathers light brown or yellowish brown	3.5	3.5
Moorefield:		
Ordnance Plant member:		
Siltstone, light brown intermixed with and changing to dark brown at top, occasionally somewhat calcareous, clayey, scattered nodules of dense black limestone at approximate position of color changes, rather blocky when fresh, weathers light brown, becomes almost fissile	3.0	7.5
Covered, one poor exposure of black, non-calcareous shale	4.5	4.5
Lindsey Bridge member:		
Limestone, dark gray, medium to coarsely crystalline, mostly coarsely crystalline, many phosphatic nodules, shark's teeth-strong carbonaceous odor, conglomeratic, worn chert and limestone pebbles up to 0.4 foot, limonite specks (formerly glauconite?), massively though somewhat irregularly bedded, weathers medium dark gray, thins laterally	2.5	2.5

Bayou Manard member:		
Shale, dark gray-brown, calcareous, silty, relatively massively bedded in spots, but mostly is platy in varying degrees, weathers medium brown and rather irregularly	0.8	14.4
Shale, dark brown-gray, calcareous, silty, in relatively thick beds which have poor shaly parting, weathers medium brown and rather irregularly	0.5	13.6
Limestone, dark gray, hard, shaly, fossiliferous, single massive bed, weathers smoothly and light gray-brown	0.8	13.1
Shale, dark brown-gray, calcareous, good shaly parting, weathers medium to light gray-brown	0.2	12.3
Limestone, medium gray, hard, shaly, silty in spots, fossiliferous, with many fossils apparently phosphatic, weathers dark brown (when silt is present) to light gray, and smoothly	0.2	12.1
Limestone, dark gray, shaly, hard, very fossiliferous unit is a single bed, weathers fairly smoothly and medium to light gray	1.7	11.9
Shale, dark gray, calcareous, platy, becoming more and more thin-bedded toward top, weathers light gray	1.2	10.2
Shale, dark gray, calcareous, relatively massive, weathers smoothly and light gray	0.5	9.0
Shale, dark gray, calcareous, silty toward top, in thick beds which have poor shaly parting, weathers fairly smoothly and medium to rather dark brown, the silty portion weathers leached	1.3	8.5
Siltstone, medium brown with some very fine black particles, calcareous, occasionally blocky but mostly in small, thin plates, weathers medium brown	1.5	7.2
Limestone, dark gray to brown-gray, fine-grained, hard, shaly, abundant trilobite remains, whole unit is a single bed, weathers light gray and quite smoothly	2.6	5.7
Shale, dark gray or medium brown, calcareous, in thin, somewhat irregular plates, weathers medium brown	1.1	3.1
Shale, dark gray to gray-brown, calcareous, phosphatic nodules on upper surface, in thick beds which have poor shaly parting, weathers somewhat irregularly and dark brown	1.3	2.0
Covered, probably shale	0.3	0.7
Limestone, light brown to fairly dark gray, fine-grained, silty, weathers light brown and smoothly	0.4	0.4
Tahlequah member:		
Limestone, fairly dark gray, coarsely crystalline, pyritiferous nodules and streaks of iron-stained rock, fairly strong carbonaceous odor, glauconitic, medium-bedded, weathers somewhat irregularly and with large pits (caused by the pyrite), color when weathered dark gray with reddish yellow to black stains around pits	4.2	20.2
Limestone, medium gray, coarsely crystalline, crinoidal, abundantly glauconitic, carbonaceous odor, massive, weathers dark gray upper surface is very irregular (may be caused by stylolites)	4.1	16.0
Obscured, blocks slumped	2.2	11.9

Limestone, medium gray, coarsely crystalline, crinoidal, abundantly glauconitic, carbonaceous odor, massive, weathers dark gray and rather irregularly	4.3	9.7
Obscured, blocks slumped	3.0	5.4
Covered	2.4	2.4

"Boone":

12. PARTIAL SECTION—VIAN CREEK

NE¼ SE¼ NW¼ and NW¼ SW¼ NE¼ of Section 12, T. 13 N., R. 22 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Covered Above		
Atoka:		
Siltstone, tan, non-calcareous, very thin- to massive-bedded, weathers medium brown and rather irregularly	11.3	25.1
Covered	1.0	13.8
Siltstone, tan to grayish tan, non-calcareous, white mica, bedding planes very irregular, very thin-bedded, rarely more heavily bedded, weathers medium brown and irregularly	12.8	12.8
Bloyd:		
Covered	7.7	89.8
Shale, black, non-calcareous, fissile to somewhat platy, weathers black and iron-stained	1.1	82.1
Covered, probably mostly shale	36.3	81.0
Shale, greenish to brownish black, non-calcareous, platy to fissile, some very shaly sandstone nodules, weathers brownish black, sometimes iron-stained	4.1	44.7
Covered	1.5	40.6
Shale, dark brown to greenish black, non-calcareous, fissile, weathers dark brown to dark green and sometimes iron-stained	1.6	39.1
Covered, shale poorly exposed in upper half	14.1	37.5
Siltstone, medium gray, sometimes streaked with medium brown, calcareous, much white mica, bedding planes very irregular, thin-bedded, weathers medium brown, sometimes medium gray, and irregularly	4.1	23.4
Limestone, medium gray to medium brownish gray, very finely crystalline, very oolitic, algal "pebbles", shaly inclusions, thin-bedded, weathers light brownish gray and irregularly	1.2	19.3
Covered	0.3	18.1
Shale, with limestone inclusions:		
Shale, medium brown, non-calcareous, fossiliferous, fenestrate bryozoans, others, fissile, weathers medium brown and occasionally is stained dark brown; limestone is medium gray to medium brownish gray, finely crystalline with some larger crystals, exceedingly shaly, also many large, cylindrical, sandy and shaly inclusions, limestone is up to 0.6 foot thick, weathers brown and very irregularly	2.7	17.8
Shale, greenish to brownish black, non-calcareous, limonite concretions, fissile to somewhat platy, weathers dark greenish gray to greenish black and often iron-stained	14.3	15.1

Formational Description	Thickness in Feet Of Unit	To Base of Fmtn.
Limestone, medium brownish gray, finely crystalline, with some coarser crystals, fossiliferous, Bryozoa, crinoid stems, light to dark brown shaly inclusions, especially at top, in a single bed, weathers light to medium bluish gray with irregular light brown spots and rather irregularly	0.8	0.8

Covered below.

13. BIG BEND SALLISAW CREEK SECTION
S½ SW¼ SW¼ and SW¼ SE¼ SW¼ Section 13, T. 13 N., R. 23 E.

Formational Description	Thickness in Feet Of Unit	To Base of Fmtn.
Covered to top of hill.		
Atoka:		
Siltstone, light brown, occasionally grayish, non-calcareous, white mica locally abundant, bedding planes very poorly developed, essentially a single bed, current bedding in upper part, weathers light brown, iron-stained along cracks, and fairly smoothly	27.5	85.9
Covered	16.7	58.4
Siltstone, dark gray, non-calcareous, bedding planes very poorly developed, weathers medium brown and irregularly	1.0	41.7
Sandstone, medium brown, fine-grained, non-calcareous, has a few relatively large quartz grains, other (chert?) particles also, molds of crinoid stems, bedding planes very poorly developed, massive, weathers dark brown and fairly smoothly	2.6	40.7
Siltstone, light to medium brown or dark gray, mostly light brown, non-calcareous, mostly thin-bedded with irregular bedding planes, but some massive beds, weathers brown and fairly smoothly	38.1	38.1
Bloyd:		
Covered	49.7	116.3
Limestone, dark gray, finely crystalline, somewhat oolitic, in a single bed, weathers medium blue to brownish gray and fairly regularly	0.7	66.6
Limestone, dark gray, finely crystalline, *Chaetetes milleporaceus* abundant, massive, weathers medium brownish gray and irregularly	2.2	65.9
Limestone, dark gray, very finely crystalline, hard, massive, weathers medium bluish gray and irregularly	3.5	63.7
Covered	44.8	60.2
Limestone, dark brownish gray, very finely crystalline, fossiliferous, has chert nodules at top, somewhat calcareous, apparently chertified oolite, chert is brownish black, limestone is massive, weathers medium gray and smoothly to somewhat irregularly, sometimes weathers rottenly	4.2	15.4
Covered	11.2	11.2
Hale:		
Limestone, medium brownish gray with earthy orange spots, medium crystalline, sandy, fossiliferous, rarely poorly developed bedding planes, weathers medium gray or brown and rather smoothly, sometimes rottenly	1.8	21.8

Sandstone, medium gray, fine-grained, very limy, medium-bedded, weathers medium brown, rather roughly, and with leached sandstone stringers protruding	2.0	20.0
Limestone, medium gray, medium crystalline, rather sandy, in a single bed, weathers gray and fairly smoothly, sometimes rottenly	2.1	18.0
Covered	8.8	15.9
Shale, medium to dark brown or dark green, sometimes iron-stained, non-calcareous, fissile, weathers dark green to medium brown	2.1	7.1
Limestone, medium brownish gray with earthy orange spots, medium crystalline, very sandy, cross-bedded, in a single bed, (massive), weathers medium brown and rather smoothly	5.0	5.0
Pitkin:		
Limestone, medium brownish gray, very finely crystalline, with some larger crystals, oolitic in spots, crinoid stems, appears to be current-bedded, in a single bed, weathers medium gray and smoothly, with a tendency to be fluted	0.5	18.0
Covered	0.4	17.5
Limestone, medium brownish gray, finely crystalline, crinoid stems, other fossils, in a single bed, weathers medium gray and smoothly	1.0	17.1
Covered	0.3	16.1
Limestone, light brown gray, very finely crystalline, conchoidal fracture, weathers very irregularly and light gray	0.7	15.8
Slightly slumped:		
Limestone, medium gray, very oolitic, sometimes finely crystalline, small *Chaetetes*, other fossils, medium-bedded, weathers medium gray and rather irregularly	2.6	15.1
Covered	1.2	12.5
Limestone, medium to dark brownish gray, very finely to finely crystalline, a few larger crystals, oolitic in places, occasionally very fossiliferous, *Archimedes*, *Pentremites*, others, a few irregular, orange-colored veins, may be sideritic, uppermost part rarely fractured, unit weathers medium gray and smoothly	11.3	11.3
Fayetteville:		
Limestone, brownish black, finely crystalline, phosphatic, conchoidal fracture, thin-bedded, weathers light creamy brown and smooth	0.4	23.6
Covered, but with creamy brown, dense, phosphatic limestones scattered over slope, and some patches black shale	23.2	23.2
Hindsville:		
Limestone, medium grayish brown, finely to medium crystalline, *Agassizocrinus*, other fossils, medium-bedded, weathers medium gray and smoothly, rotten in places	1.4	4.7
Covered	1.7	3.3
Limestone, medium brownish gray, medium crystalline with many larger crystals, *Agassizocrinus*, slight carbonaceous odor, in a single bed, weathers medium gray and fairly smooth	0.5	1.6
Limestone, medium brown to dark medium brownish gray, dense with some larger crystals, oolitic, frac-		

tured, thin-bedded, weathers medium gray and fairly smooth	0.7	1.1
Limestone, medium brownish gray, very finely crystalline, very silty, changes laterally, weathers medium brownish gray and smooth	0.2	0.4
Siltstone, dark brown, calcareous, thin-bedded	0.2	0.2
Moorefield:		
Ordnance Plant member:		
Covered	7.8	11.0
Shale, medium brown to black, calcareous, silty, nodular and blocky when fresh, weathers fissile and medium brown to black	2.2	3.2
Covered	1.0	1.0
Bayou Manard member:		
Limestone, dark grayish brown, finely to medium crystalline, very silty and shaly, fossiliferous, tends toward irregular parting, in a single bed, weathers dark brown and fairly smooth	0.4	20.9
Shale, dark brown, calcareous, very silty, good shaly parting, weathers brown	0.6	20.5
Covered	2.8	19.9
Limestone, with a thin, irregular, distinctive limestone at top: Limestone, medium grayish brown, finely crystalline, silty, productids, fractured, bedding planes irregular, tends to become shaly, medium-bedded, weathers light grayish brown and rather irregularly, with leached silt stringers standing out; irregular limestone is dark gray, medium crystalline, small phosphatic nodules, strong carbonaceous odor, weathers medium gray and fairly smoothly	2.3	17.1
Covered	3.2	14.8
Limestone, dark brownish gray, very finely crystalline, fossiliferous, *Leiorhynchus carboniferum*, gastropods, phosphatic nodules abundant, some gastropods replaced by phosphate, in a single bed, weathers medium yellow-brown to dark brown and with a rough surface	0.5	11.6
Limestone, dark medium brownish gray, very finely crystalline, fossiliferous, shaly at top and bottom, in a single bed, weathers medium brown and smoothly	0.8	11.1
Shale, with minor amounts of limestone:		
Shale, dark brownish gray, calcareous, many crushed fossils, *Leiorhynchus carboniferum*, well-jointed, nearly fissile, blocky, or irregularly platy, upper contact gradational, weathers light grayish brown; limestone is medium brownish-gray, very fine-grained, hard, grades into shale in all directions, weathers light grayish brown and smoothly	1.8	10.3
Covered	0.6	8.5
Shale, brownish black, calcareous, uppermost part very limy, unit is silty, shaly parting, resistant, well jointed, weathers brown	1.6	7.9
Covered	0.7	6.3
Shale, with minor amounts of limestone:		
Shale, brownish black, calcareous, silty, good shale parting, almost fissile, fairly resistant, weathers medium brown; limestone is brownish black, very finely crystalline, weathers medium brown	0.8	5.6
Covered	0.8	4.8

Limestone, brownish black, finely crystalline, shaly, fossiliferous, trilobites, gastropods, phosphatic on upper surface, has a few silicified fossils, unit well-jointed, some joints have veins of calcite and siderite, in a single bed, weathers light brownish gray and smoothly	1.3	4.0
Covered	2.7	2.7
Tahlequah member:		
Limestone, light or dark gray, medium to coarsely crystalline, finely crystalline in uppermost part, upper part has strong carbonaceous odor, irregular boundary with lower part, unit is glauconitic, somewhat crinoidal, massive-bedded, weathers medium gray, at places with large irregular pits	18.2	28.9
Limestone, medium to light gray, coarsely crystalline, glauconitic, abundant crinoid stems, other fossils poorly preserved, rare, occasionally small pieces of chert near base, massive-bedded, with numerous poorly developed bedding planes, weathers medium gray and fairly smooth	10.7	10.7
"Boone":		
Chert, mottled light and dark gray, calcareous along cracks and in small vugs, has irregular masses of limestone, chert occasionally is in banded nodules, bedding planes irregular, not too well-defined, weathers mottled light and medium gray, dark blue, and shades of light yellow and brown; limestone is medium gray, hard, finely crystalline, weathers medium gray and smooth	2.0	2.0

Base not exposed.

14. OLD QUARRY SECTION, BIG BEND OF SALLISAW CREEK
SW¼ SW¼ SW¼ of Section 13, T. 13 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Covered Above:		
Sallisaw (Corrected for Dip):		
Sandstone, light gray to light brown with some irregular black spots, fine-grained, very calcareous, rarely *Amphigenia curta* present, medium-bedded, weathers light gray and smooth, has masses of chert, which are light gray, calcareous in places, and weathers light gray with bluish and brownish places	4.8	4.8
Frisco:		
Limestone, medium gray to dark medium gray, finely crystalline, usually with many coarser crystals, finely sandy streaks near base, coquina, *Costispirifer arenosus*, platyceratid gastropods, crinoid stems, bedding planes poorly defined, massive, weathers medium gray and somewhat roughly	4.4	4.4
St. Clair:		
Limestone, pinkish cast, coarsely crystalline, small silty deposits, massive-bedded, weathers medium gray and smoothly, sometimes rottenly	16.5	16.5
Base of exposure:		

15. QUARRY SECTION, MARBLE STONE COMPANY, INCORPORATED
NE¼ SE¼ SE¼ of Section 14, T. 13 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Covered Above		
Frisco:		
Limestone, light gray, finely crystalline, dolomitic, coquinal, *Costispirifer arenosus*, others, has large banded light and dark gray chert nodules, in a single bed, weathers light gray with smooth surface	0.7	0.7
St. Clair:		
Limestone, light gray to light pinkish gray, finely to coarsely crystalline, mostly medium, very fossiliferous at top, *Sphaerexochus romingeri*, *Dalmanites*, *Atrypa*, others, massive- to medium-bedded, upper part weathers medium gray and smooth, at places rotten and crumbly	94.8	94.8
Base of exposure.		

16. SOUTHEAST QUARRY MOUNTIAN SECTION
SW¼ NE¼ SE¼ and NE¼ NW¼ SE¼ of Section 14, T. 13 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Fayetteville:		
Hindsville:		
Limestone, medium brownish gray, medium crystalline, some fossils, thin-bedded, weathers medium gray and fairly smoothly	0.4	19.1
Limestone, dark medium brownish gray, finely crystalline, oolitic, some fossils, productids, in a single bed, weathers medium gray and fairly smoothly	0.6	18.7
Limestone, medium brownish gray, finely crystalline, fossiliferous, in a single bed, weathers medium gray and smoothly	0.6	18.1
Limestone, dark brownish gray, very finely crystalline (nearly dense), in a single bed, weathers medium gray and smoothly	0.3	17.5
Covered ("Calcareous siltstone"?)	17.2	17.2
Moorefield:		
Bayou Manard member:		
Siltstone, medium brownish gray, very limy, fossiliferous, *Leiorhynchus carboniferum*, in a single bed, incipient thin, platy parting, weathers medium grayish brown and somewhat irregularly	0.3	23.2
Covered	2.9	22.9
Limestone, medium gray with earthy yellow-brown spots, medium crystalline, many phosphatic pebbles, some chert fragments, up to 0.15 inch, carbonaceous odor, fossils appear worn, *Spirifer arkansanus*, in a single bed, thickens laterally, weathers medium gray and fairly smoothly	1.4	20.0
Covered	2.8	18.6
Limestone, medium brown-gray, sometimes dark, finely crystalline, very silty, *Leiorhynchus carboniferum* abundant, much incipient thin parting but in a single bed, weathers smoothly on bedding planes, but irregularly elsewhere, and medium gray	1.6	15.8
Covered	14.2	14.2

Tahlequah member:		
Limestone, light to medium gray or brownish gray, medium to finely crystalline, generally medium, some glauconite, many earthy orange spots, carbonaceous odor in places, medium- to thin-bedded, mostly medium, weathers medium gray and smoothly, sometimes rottenly	22.9	22.9
"Boone":		
Chert, white to medium brownish or bluish gray, generally calcareous, bedding planes undulating, sometimes obscure, fractured, massive- to thin-bedded, weathers light gray to bluish gray and irregularly	21.8	25.5
Covered, St. Joe member and perhaps a little Chattanooga shale in this interval	3.7	3.7
Chattanooga:		
Shale, black non-calcareous, platy to fissile, nodular in places, weathers black and occasionally iron-stained	2.0	53.2
Covered; scattered, poorly exposed black shale outcrops	51.2	51.2
Sylamore Sandstone Member:		
Sandstone, dirty grayish brown, somewhat streaked, medium-grained, non-calcareous, phosphate pellets rare, tiny white flecks of chert (?), *Lingula*, massive, in a single bed, weathers medium brown and rather irregularly	2.1	2.4
Sandstone, gray to brown, great variation in color, coarse-grained, calcareous, many phosphatic grains, *Lingula*, quartzitic in places, in a single bed, weathers brown; angular chert fragments in this matrix, calcareous, often leached, up to several inches in this exposure	0.3	0.3
Sallisaw (slightly slumped):		
Covered, but in immediate vicinity have slumped breccia with large chert blocks, so probably belong in this formation	2.1	8.2
Sandstone, light and dark gray, fine-grained, very calcareous, medium-bedded, bedding planes undulating, weathers medium brownish gray and somewhat irregularly; has several masses and thin veins of white to light gray calcareous chert, which weathers white and sometimes leached	3.1	6.1
Chert, white, slightly calcareous in places, fractured, dies out in a short distance, bedding very indistinct, weathers white and irregularly	0.6	3.0
Limestone, white to light gray, finely crystalline, exceedingly sandy (fine grains), apparently a chert-lined cavity present (walls very thin), upper contact very undulating, bedded chert occurs laterally, limestone is in a single bed, weathers fairly smoothly and medium brownish gray	1.2	2.4
Chert, light gray to white, slightly calcareous, fractured, bedding very indistinct, weathers white to light gray	0.5	1.2
Limestone, light pinkish gray, finely crystalline, very sandy (fine grains), in a single bed, weathers light gray or brownish gray and smoothly	0.5	0.7
Chert, white to light gray, calcareous, somewhat fractured, in a single bed, weathers white to light gray and irregularly	0.2	0.2
Covered below.		

17. PARTIAL SECTION, SOUTHEAST QUARRY MOUNTAIN

SW¼ NE¼ SE¼ and NE¼ NW¼ SE¼ of Section 14, T. 13 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Sallisaw: (Distance to top, 9.6 feet)		
Frisco:		
Limestone, light gray, medium crystalline, in a single bed, weathers medium gray	0.3	7.0
Covered	1.3	6.7
Limestone, light gray, medium to finely crystalline, fossils rare, massive (in a single bed), weathers medium gray and fairly smoothly	1.7	5.4
Limestone, light to medium gray, finely crystalline, coquina, *Costellirostra peculiaris*, many others, slight carbonaceous odor, in a single bed, weathers medium gray and somewhat irregularly	0.7	3.7
Limestone, dark gray, finely crystalline, in a single bed, weathers medium gray and smoothly	0.3	3.0
Covered (Frisco?)	2.7	2.7
St. Clair:		

18. JACKSON MOUNTAIN ROAD SECTION

SW¼ NW¼ SW¼ of Section 15, T. 13 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Covered above		
Hale (Top not exposed):		
Sandstone, light grayish brown to medium brown, fine-grained, calcareous in places, obscurely cross-bedded, bedding planes obscure, weathers brown and is poorly pitted on upper surface	2.2	19.8
Limestone, dark gray, medium crystalline, in a single bed, weathering not known	0.7	17.6
Covered	8.5	16.9
Shale, brownish black, calcareous, somewhat irregular shaly parting, weathers brownish black	0.4	8.4
Limestone, dark gray to medium brownish gray, orange earthy spots and black calcite crystals, upper part has *Chaetetes milleporaceus*, fairly numerous, black shale of overlying unit deposited in the upper irregularities, much crinoidal material, irregular yellowish calcareous spots, massive, weathers medium gray and rather irregularly	1.9	8.0
Covered	0.5	6.1
Limestone, medium brown-gray to dark medium gray, medium crystalline with both coarser and finer crystals, sandy, especially toward base where unit intergrades with lower beds, crinoidal, shark's tooth, yellow calcareous masses on upper surface, weathers gray to brown with leached sandstone stringers in places, but generally smoothly and almost fluted	3.4	5.6

Sandstone and limestone, interbedded: Sandstone, medium brown to light brown or white, often with light yellow to gray places, medium-grained, calcareous, rare phosphatic nodules, in part obscurely cross-bedded, weathers medium to dark brown; Limestone, medium gray with brown spots, fine-grained, with some coarser crystals, very sandy, rotten, rare phosphatic nodules	2.2	2.2
Pitkin:		
Limestone, light to medium gray, oolitic, in a single bed	0.7	9.2
Limestone, medium gray to medium or light grayish brown, many orange earthy spots, oolitic with many larger crystals, crinoid stems abundant, massive, weathers medium gray and smoothly	1.5	8.5
Limestone, light brownish gray, oolitic with many crystals, some crinoidal fragments, lower boundary gradational, massive, weathers very fluted and medium gray	1.5	7.0
Limestone, medium grayish brown to medium bluish gray, finely crystalline with many larger crystals, many crinoidal fragments, massive, weathers somewhat fluted and medium gray	5.5	5.5
Fayetteville:		
Covered	7.4	27.1
Limestone, black, finely crystalline, phosphatic nodules, whole bed is phosphatic, thickness variable, in a single bed, weathers dark brown with black spots, and irregularly	0.2	19.7
Limestone, black, dense, phosphatic, calcite veinlets, no bedding apparent, weathers light creamy brown and rather irregularly	0.5	19.5
Shale, brown to brownish black, usually very calcareous, has a few irregular yellowish calcareous nodules, some phosphatic nodules, good shaly parting, weathers brown to dark brown	0.2	19.0
Limestone, black, dense with a few larger crystals, a few phosphatic nodules at the top, whole limestone is phosphatic, fossiliferous, very irregularly bedded, may be current-bedded upper surface exceedingly knobby, weathers light brownish gray to yellowish brown and irregularly	1.1	18.8
Shale, calcareous, has irregular, yellowish, calcareous nodules, thins exceedingly rapidly laterally, weathers brown	0.3	17.7
Shale, dark brown, non-calcareous, many small, rounded, phosphatic (?) pellets, blocky at base	0.5	17.4
Covered	3.4	16.9
Limestone and shale, interbedded and intergrading: Limestone, dark brown to dark gray, dense, phosphatic, sometimes becoming shaly laterally, thin-bedded, bedding planes generally smooth, beds are of remarkably even thickness (in general) weathers very smoothly and light gray-brown to light creamy brown, sometimes reddish-yellow stained along cracks; shale, dark brown, very calcareous, almost a limestone, often nodular, irregular shaly parting, weathers light gray-brown	12.4	13.5
Covered	1.1	1.1

Hindsville:		
Limestone, dark gray and medium to dark grayish brown, finely crystalline with many larger crystals, *Agassizocrinus*, other fossils, rather massive, weathers medium gray and slightly fluted	1.3	11.5
Limestone, dark gray, dense, in a single bed, weathers light gray and smoothly	0.2	10.2
Limestone with lesser amounts of shale:		
Limestone, dark gray, finely to very finely crystalline, phosphatic, sometimes has shaly inclusions, in beds up to 0.4 foot thick, bedding planes fairly even to uneven, weathers smoothly and light grayish brown and creamy brown; shale, dark brown, calcareous, laterally transitional into limestone, very irregular shaly parting, weathers light grayish brown	1.8	10.0
Covered	0.8	8.2
Limestone, medium brownish gray, very finely crystalline, very silty, cross-bedded, bedding planes irregular, thin-bedded, weathers medium brownish gray and smoothly	1.8	7.4
Covered	0.2	5.6
Limestone, medium gray streaked with brown, finely crystalline with streaks of coarser crystals, cross-bedded, very silty, weathers medium gray and medium brown and smoothly but with leached silty stringers	0.4	5.4
Limestone, medium brownish gray spotted with white, medium crystalline, oolitic, in a single bed, weathers medium gray and fairly smoothly	0.4	5.0
Limestone, medium brownish gray to medium gray, very finely crystalline with some larger crystals, oolitic in places, in a single bed, weathers irregularly and grayish brown	0.4	4.6
Covered	0.4	4.2
Limestone, dark gray, dense to finely crystalline with many larger crystals, fossiliferous, *Pleurodictyum*, very irregular, thin-bedded, weathers irregularly and medium gray	1.1	3.8
Covered, probably occupied by shale with yellow calcareous nodules	2.2	2.7
Limestone, medium gray to dark gray, finely crystalline, with many larger crystals, fossiliferous, *Agassizocrinus*, *Paladin mucronatus Composita*, in places has phosphatic nodules at base, in a single bed, weathers medium bluish gray and rather irregularly	0.5	0.5
Moorefield:		
Bayou Manard member:		
Limestone, dark gray to dark medium brown, finely crystalline, fossiliferous, *Leiorhynchus carboniferum* abundant, very silty at top, thin layer at top is irregularly bedded, rest is a single bed, weathers smoothly and grayish brown	1.1	18.5
Shale, black to medium brown-gray, calcareous, a few calcite crystals, silty, irregularly platy, upper contact gradational, weathers back to medium blue-gray	1.4	17.4
Covered	0.9	16.0
Limestone, black to dark medium gray, very finely-crystalline, impure, has irregular, poor, platy part-		

ing in upper portion, rest is in a single massive bed, weathers smoothly, almost fluted, and medium brown to blue-gray	2.9	15.1
Shale, brownish black, calcareous, irregularly and thinly platy in lower part, becoming platy in upper..	1.9	12.2
Shale, medium gray to medium gray-brown, calcareous, very silty, irregularly bedded, rather blocky, weathers medium brownish gray	0.5	10.3
Limestone, dark gray to dark brownish gray, very finely crystalline (almost dense), impure, in a single bed, weathers rather fluted and light brown-gray	1.1	9.8
Shale, dark brown, calcareous, silty, thin platy to rather blocky, weathering not known	0.5	8.7
Limestone, dark gray, finely crystalline, impure, fossiliferous, in a single thin bed, weathers light gray-brown and smoothly	0.2	8.2
Shale, black to dark brown, calcareous, silty, irregularly platy	0.6	8.0
Shale, black, calcareous, silty, irregularly platy, blocky, weathers medium gray	3.2	7.4
Covered	4.2	4.2

"Boone":

19. PARTIAL SECTION—PAYNE HOLLOW

Center of North Line, SW¼ SE¼ of Section 15, T. 13 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Chattanooga:		
Sallisaw:		
Sandstone, medium gray to brownish gray, fine- to medium-grained, rarely calcareous, phosphatic pellets occasionally abundant, some large chert fragments in upper part, bedding of sandstone somewhat irregular, thin-bedded, weathers brown and rather irregularly; chert is dark gray (the sandstone is Sylamore, the chert Sallisaw; more sandstone than usual is present)	1.2	11.3
Sandstone, medium gray, fine-grained, calcareous, thin-bedded, weathers medium gray, fairly smoothly, and sometimes leached and dark brown	1.4	10.1
Sandstone, light to medium gray or brownish gray, fine-grained, calcareous, some thin, abundantly fossiliferous zones (laterally the fossils in some of these zones are chertified), thin- to medium-bedded, weathers medium gray and smoothly	8.7	8.7
Covered below.		

20. BUCKSKIN HOLLOW ROAD SECTION

NW¼ NW¼ NW¼ and SW¼ NW¼ NW¼ of Section 19, T. 13 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Covered to Top of Hill		
Atoka:		
Sandstone, irregular patches of dark gray and dark brown, fine-grained, calcareous in places, very shaly, extremely irregular bedding, weathers dark gray to brownish gray and very irregularly	0.8	0.8
Bloyd:		
Covered, poor shale exposures	9.0	70.4
Shale, dark green, non-calcareous, limonite concretions, white mica, fissile, weathers dark gray	1.7	61.4
Covered, some limestone in this interval	10.0	59.7
Shale, black and dark brown, non-calcareous, white mica, somewhat platy, weathers fissile and black to brown, and iron-stained in places	6.9	49.7
Poorly exposed:		
Shale, brown, non-calcareous, limonite concretions, fissile (?), weathers brown	0.2	42.8
Covered	2.0	42.6
Siltstone, streaked black and dark to light grayish brown, calcareous, very irregularly bedded, weathers medium brown or grayish brown	1.2	40.6
Covered	1.3	39.4
Limestone, dark bluish to medium brownish gray, finely crystalline, coquina of small fossils, especially pelecypods, massive-bedded, obscurely cross-bedded, weathers medium bluish gray	4.2	38.1
Covered	4.5	33.9
Shale, medium brown, calcareous, some sandy limestone, shale has irregular parting, weathers medium brown, sandy limestone is extremely shaly, and dark brownish gray	2.0	29.4
Covered	1.8	27.4
Shale, dark green, sometimes black, non-calcareous, has a thin, brown, fossiliferous shale zone near middle, some limonite concretions, fissile, weathers dark green	11.5	25.6
Siltstone, dark brown and black, calcareous in places, much white mica, shaly, irregularly and thinly bedded, weathers dark brownish gray and irregularly	0.4	14.1
Shale, medium brown, very calcareous, some dark gray, finely crystalline limestone nodules, other nodules are sandy, still others limonitic, has irregular limonitic layers, very fossiliferous, spirifers, bryozoans, very poor parting, weathers medium brown to yellow-brown	0.9	13.7
Shale, medium brown, very calcareous, fossiliferous, has shaly limestone lens, shale has irregular, poor, shaly parting, weathers medium brown; shaly limestone is dark gray and finely crystalline	0.8	12.8
Covered	1.0	12.0
Limestone, medium gray to medium brownish gray, finely crystalline, occasionally small shaly inclusions, medium- to thin-bedded, weathers medium brownish gray and somewhat irregularly	1.8	11.0
Covered	1.8	9.2

Shale, light yellowish brown, darker in spots, calcareous in places, has some limestone lenses, shale has very thin (papery) parting, weathers light yellowish brown; limestone is dark gray and finely to medium crystalline	1.4	7.4
Siltstone, light brown, slightly calcareous in places, some medium brown calcareous nodules, thinly and irregularly bedded, weathers light brown and irregularly	0.3	6.0
Limestone, medium brownish gray, very finely to finely crystalline, fossiliferous, straight and coiled cephalopods, silty at top, in a single bed, weathers medium gray and irregularly	0.7	5.7
Covered	1.7	5.0
Shale, light to dark brown, mostly light brown, calcareous, very thin (papery) parting, has limestone nodules, weathers light brown and sometimes dark brown; nodules are medium brownish gray to dark gray, very clayey, very finely crystalline, weathers light yellowish brown	1.2	3.3
Limestone, dark gray, very finely crystalline, irregular bedding planes, rubbly at top, weathers rather irregularly and mixed light yellowish brown and dark gray	1.2	2.1
Shale, light to dark brown, mostly light brown, calcareous, irregular, very thin (papery) parting, has limestone nodules, weathers light to dark brown; nodules are dark gray, very finely crystalline, weathers light yellowish brown	0.6	0.9
Limestone, dark gray, very finely crystalline, rubbly, thin-bedded, weathers light yellowish brown and irregularly	0.3	0.3
Obscured below (Slumped)		

21. MOOREFIELD—HINDSVILLE

SE¼ SW¼ NE¼ and SW¼ SE¼ NE¼ of Section 21, T. 13 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Fayetteville:		
Hindsville:		
Limestone, medium to dark grayish brown, very finely crystalline to medium-crystalline, carbonaceous odor, bedding planes irregular, medium-bedded, weathers rather roughly and medium gray, with an irregular layer at the top weathering smoothly and creamy brown	2.2	14.8
Covered		
Limestone, dark medium brownish gray, finely crystalline, *Agassizocrinus*, in a single bed, irregular surface, weathers medium gray	0.4	0.4

Moorefield:		
Bayou Manard member:		
Covered, lower part has Moorefield float	7.7	12.0
Limestone, dark medium gray with black calcite crystals, medium crystalline with a great many fine crystals, slight carbonaceous odor *Leiorhynchus carboniferum* present, at base is very silty with some parting, greater part of unit is a single bed, weathers medium gray to medium brown-gray	0.8	4.3
Covered, lowermost portion (too thin to measure) is composed of phosphatic pebbles, silicified fossils, and chert fragments plastered onto the "glauconitic limestone" member (Tahlequah)	3.5	3.5
Tahlequah member:		
Limestone, medium to dark medium gray, medium crystalline with many larger crystals, crinoidal, very glauconitic, carbonaceous odor, rather massive, sometimes rotten, weathers medium blue-gray and smoothly	3.1	21.6
Limestone, medium to dark gray, dominantly coarsely crystalline but with some medium and finely crystalline spots, very glauconitic, carbonaceous odor, has a thin (0.2 foot) siliceous limestone layer that weathers leached and is not laterally continuous, uppermost layer of unit becomes rather rotten laterally, unit is medium-bedded, weathers medium blue-gray and rather smoothly	2.3	18.5
Limestone, dark brown, medium crystalline, glauconitic, very rotten, slight carbonaceous odor, massively bedded, weathers rather fluted but with rough surface, sometimes pitted, and medium gray	4.5	16.2
Limestone, dark medium gray, coarsely crystalline, very glauconitic, in a single bed, weathers light blue-gray and smoothly	0.6	11.7
Covered	1.6	11.1
Limestone, medium to dark gray, sometimes streaked or mottled, finely to coarsely crystalline, mostly coarse medium crystalline, very glauconitic, carbonaceous odor, cross-bedded, laminae are only bedding, sometimes rotten, weathers medium gray to light blue-gray and smoothly	9.5	9.5
"Boone":		

22. SMITH HOLLOW ROAD SECTION
SW¼ SW¼ NW¼ of Section 22, T. 13 N., R. 23 E., and NE¼ of Section 21, T. 13 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Covered to top of hill:		
Atoka:		
Siltstone, white to dark brown, irregularly colored, iron-stained, almost a fine-grained sandstone, massively to rather thin-bedded, weathers brown	12.3	131.2
Covered	1.1	118.9
Siltstone, light brown, somewhat streaked, non-calcareous, massive-bedded except for occasional thin-bedded phase, weathers medium brown	9.1	117.8

Covered	32.1	108.7
Covered, probably siltstone	16.8	76.6
Siltstone, light brown to dark brown or dark gray, intermingled, non-calcareous, very thin-bedded, bedding planes irregular, weathers dark brown	5.6	59.8
Siltstone, light brown, stained dark red in places, non-calcareous, iron-stained along cracks and bedding planes, large limonite concretions, blocky, bedding planes poorly defined, weathers medium to dark gray in some areas	2.7	54.2
Covered	46.5	51.5
Siltstone, light to medium brown or gray and dark gray mingling to give a streaked effect, occasionally a solid gray or brown, fairly calcareous, bedding planes very irregular, thin, weathers medium to to dark brown	5.0	5.0
Bloyd:		
Shale, dark brown to dark gray, nodular, calcareous, very poor and irregular shaly parting; nodules are dark medium gray with limonite stains, very finely to finely crystalline, calcareous	1.0	56.2
Limestone, medium to dark brownish gray, very finely crystalline with some larger crystals, very fossiliferous, productids, spirifers, others, thickness varies somewhat	0.4	155.2
Shale, dark brown, moderately calcareous, hard, very poor and irregular shaly parting, thickness varies laterally	0.6	154.8
Limestone, medium to dark brown-gray, finely crystalline, fossiliferous, impure, has a thin silty facies, rather massive, weathers medium gray and smoothly; siltstone facies is dark brown calcareous, unevenly bedded	3.3	154.2
Covered, probably both shale and limestone	38.0	150.9
Shale, medium green-brown to dark brown, noncareous, near base has a few beds of limestone, is fissile, weathers medium brown; limestone in shale is darker medium brown to brownish gray, finely to medium crystalline, weathers rather roughly and light brown	12.6	112.9
Limestone, dark medium blue-gray, very finely crystalline to finely crystalline, both with some larger grains, fossiliferous, thin- to medium-bedded, weathers medium gray, light blue-gray, and brownish (intermingled)	3.3	100.3
Interbedded limestone and shale:		
Limestone, dark medium gray, very finely crystalline, shaly, impure, in nodules and irregular masses, weathers light yellowish brown and somewhat smoothly; Shale, medium brown, calcareous, very irregular parting, weathers medium to light brown..	1.7	97.0
Limestone, medium to dark gray or brown (or intermingled), very finely to coarsely crystalline, fossiliferous, *Pentremites*, crinoidal material, impure, bedding planes very irregular, from thin-bedded to massive, thickens greatly laterally, weathers medium gray to light to medium brown	1.8	95.3
Interbedded limestone and shale:		
Limestone, dark medium gray to yellowish brown, finely crystalline to very finely crystalline, very irregular, exceedingly nodular, very fossiliferous, in		

thin irregular layers, weathers light yellowish brown and roughly; Shale, medium brown, calcareous, very irregular parting, weathers medium brown	2.8	93.5
Limestone, medium gray to medium brown (gradational), finely to coarsely crystalline, fossiliferous, shale pockets, varies from very thin-bedded to massive, weathers medium brown and rubbly to rather smoothly; shale in pockets is blackish-brown, slightly calcareous, blocky, sandy, and weathers medium brown	7.8	90.7
Limestone, medium gray to medium gray and brown, medium to coarsely crystalline, fossiliferous in upper part, crinoidal, has some yellowish nodules in lower part, obscurely cross-bedded, massively bedded, weathers medium gray with some yellow (in lower part), and rather roughly	8.1	82.9
Shale, medium brown, calcareous, has irregular yellow calcareous nodules	0.3	74.8
Limestone, dark medium gray-brown, very finely crystalline to finely crystalline, fossiliferous, almost entirely composed of algal "pebbles", no bedding, weathers light brownish yellow and very irregularly	1.0	74.5
Shale, medium brown, calcareous, many algal "pebbles", in very tiny flakes	0.1	73.5
Limestone, medium brown to medium gray, oolitic, very fossiliferous, exceedingly impure, some algal "pebbles", no bedding, weathers very irregularly with irregular yellowish nodules and light brownish yellow to medium brown	0.8	73.4
Covered	1.0	72.6
Limestone, medium gray-brown to dark medium gray, dense, irregular silty masses and stringers, rather massive-bedded, bedding planes few irregular, weathers smoothly to rubbly and medium blue-gray and light brown (silty masses)	1.5	71.6
Limestone, medium brown to medium gray, very finely crystalline with some larger crystals, massive-bedded, some incipient bedding planes at top, weathers medium gray and smoothly	2.8	70.1
Shale, medium brown and dark green-brown, non-calcareous, rather fissile, weathers light green and light brown; has a thin layer of shaly limestone and limy shale near top; the shaly limestone is dark medium gray, medium crystalline, and weathers medium to light brown and very roughly; the limy shale is brown and weathers brown	18.6	67.3
Limestone, dark medium gray, finely to medium crystalline, rather sandy, occasionally orange iron oxide stains, massively bedded, weathers medium brown and rather smoothly	2.4	48.7
Limestone, medium brown to dark gray, coarse medium crystalline, yellowish calcareous masses in lower part, slightly sandy, cross-bedded in lower part, weathers medium gray and fairly smoothly	3.4	46.3
Shale, black and light brown, non-calcareous, has irregular, pale yellow calcareous nodules, fissile, weathers light brown	1.3	42.9
Limestone, medium to dark brown or dark medium gray, fine to medium crystalline, very sandy (medium to fine grains), light brown, gray, or reddish shaly		

inclusions, thin phosphatic beds near and at top, cross-bedded, thin- to medium-bedded, weathers rather roughly with leached sandy masses and stringers protruding, and medium brown	11.6	41.6
Limestone, dark medium gray, medium crystalline, sandy, cross-bedded, intercalated with shale beneath, weathers dark medium brown and irregularly to somewhat smoothly	1.6	30.0
Shale, dark green-brown, non-calcareous, rather fissile, often iron-stained, has a few thin, non-calcareous sandy beds near top, weathers red-brown	16.1	28.4
Covered	12.3	12.3
Hale:		
Limestone, dark medium gray, very oolitic, a few thin calcite veins run through it, massive-bedded, bedding planes somewhat irregular, weathers fluted and light gray	2.1	39.5
Sandstone, medium to dark brown, medium-grained, somewhat calcareous (leached), fossil molds, irregularly bedded, weathers very irregularly and light brown	0.4	37.4
Covered	0.8	37.0
Limestone, streaked medium brown and light gray with some dark gray, medium crystalline, very sandy, some dark calcite grains, cross-bedded, in a single bed, weathers medium gray and roughly, sometimes rottenly	0.7	36.2
Limestone, dark medium to light gray or light gray-brown, medium crystalline to coarsely crystalline, very sandy, also sandy patches, scattered limonite stains, small pieces of carbon, much crinoidal material, massive- to thin-bedded, sometimes cross-bedded, weathers medium brownish gray and roughly	8.2	35.5
Limestone, light gray, fine medium crystalline, fossiliferous, sandy (medium grains), obscurely cross-bedded with irregular sand stringers marking cross-bedding and also scattered in rock, massively bedded, weathers medium gray and brown (sandstone stringers) and roughly	5.3	27.3
Covered	6.5	22.0
Limestone, dark medium gray to dark brownish gray, occasionally sand grains, cross-bedded in lower part, massive, weathers somewhat roughly in lower part, smoothly in upper part, and medium gray	2.0	15.5
Limestone, dark medium gray, medium crystalline, sandy (medium grains), fossiliferous, thin sandstone stringers mark cross-bedding, in a single bed, weathers roughly with sandstone stringers and fossils standing out, and medium gray and brown	1.4	13.5
Obscured, probably sandy limestone	1.2	12.1
Sandstone, tan, medium-grained, non-calcareous, unevenly bedded, mostly thin-bedded, weathers smoothly and medium brown to black (iron-stained)	2.2	10.9
Obscured, probably sandy limestone	1.8	8.7
Limestone, medium gray, medium crystalline, quite sandy, fossiliferous, *Pentremites*, occasional small masses of carbon, massively, irregularly bedded, weathers medium gray-brown and roughly (due to fossils)	2.3	6.9
Obscured, probably sandy limestone	3.1	4.6

Limestone, dark medium gray, medium crystalline, extremely sandy, (medium grained), fossiliferous, obscurely cross-bedded, weathers leached, dark brown, and roughly	1.5	1.5
Pitkin:		
Limestone, dark medium brownish gray, coarsely or finely crystalline, somewhat sandy (fine grains), *Archimedes* and crinoid stems abundant at some horizons, cross-bedded (alternating beds of coquina and somewhat sandy limestone), medium-bedded, rarely rubbly, weathers light to medium gray with exception of the coquina horizons	3.3	12.6
Limestone, medium brown to brown gray, coarsely to medium crystalline, oolitic in places, slight carbonaceous odor, coquina in places, bryozoans, especially *Archimedipora*, abundant, massive-bedded, occasionally rubbly, weathers light bluish gray and generally smoothly except for a few rubbly places	9.3	9.3
Fayetteville:		
Limestone, dark medium brown, dense with a few larger crystals, phosphatic, weathers a light creamy brown	0.1	35.7
Covered, upper part has some limestone	8.8	35.6
Limestone, black, fine medium crystalline, phosphatic, weathers roughly and with pebbles, and fossils protruding and dark brown	0.4	26.8
Limestone, black, dense, phosphatic, blends into bed above, weathers smoothly and very light creamy brown	0.2	26.4
Limestone, black, dense, calcite stringers and masses, slight carbonaceous odor, irregular current-bedded silt stringers, some silt masses, irregular bedding planes, somewhat thin-bedded, weathers smoothly with silt leaching out and standing out from rock, and light blue-gray with red-yellow or light to very light brown marking the silty places	0.8	26.2
Shale (?), medium brown, non-calcareous, filled with small, rounded, phosphatic (?) pellets, blocky at base, blocky portion weathers light yellowish brown	0.2	25.4
Shale, black, non-calcareous, fissile, weathers black and iron-stained	0.4	25.2
Limestone, medium red-brown, medium to coarsely crystalline, very silty, fossiliferous, slight carbonaceous odor, in a single bed, weathers roughly and mottled red-brown, medium gray, and medium brown	0.6	24.8
Partially covered, lower part limestone and shale, upper part shale, black, non-calcareous, fissile, weathers black and iron-stained	20.2	24.2
Limestone, medium brown, very finely crystalline with many coarse crystals, fossiliferous, especially bryozoans, in a single bed, slight carbonaceous odor, weathers mottled gray and very light brown and light yellow, and roughly	0.8	4.0
Limestone and shale:		
Limestone, dark gray, dense, phosphatic, in 0.2-0.3 foot beds, weathers very smoothly and very light creamy brown; intercalated with shale, medium brown, calcareous, somewhat silty weathers light brown	3.2	3.2

Hindsville:		
Limestone, dark medium gray-brown, medium to coarsely crystalline, very fossiliferous, in a single bed, weathers light medium brown	1.0	14.2
Limestone, dark gray, finely crystalline, phosphatic, weathers light grayish brown and smoothly	0.3	13.2
Covered	0.3	12.9
Shale, and limestone, changing laterally into each other: Shale, dark gray-brown, calcareous, silty, irregularly bedded, weathers very light grayish brown; limestone, dark gray-brown, finely crystalline, somewhat silty, weathers smoothly and very light grayish brown	1.8	12.6
Limestone, dark gray, finely crystalline, phosphatic, silty, somewhat cross-bedded, weathers fairly smoothly and light grayish brown with some yellow	0.3	10.8
Limestone, medium gray with some brown, coarsely crystalline, some dense spots, *Agassizocrinus* abundant, thin-bedded, weathers roughly and medium gray	0.5	10.5
Limestone, medium gray-brown, medium crystalline, with dense spots to oolitic, fossiliferous, thin-bedded, weathers medium brown to medium or light blue-gray	0.5	10.0
Limestone, medium brown-gray to dark brown-gray, finely to medium crystalline, silty, cross-bedded, massive, weathers dark brown-gray and with leached, silty, protruding lines marking the cross-bedding	2.1	9.5
Shale, medium green, calcareous, a few irregular calcareous nodules at top, somewhat fissile, weathers medium green; near top contains several beds (up to .15 foot thick) of limestone, black, dense, phosphatic, weathers light gray, often yellowish, and smoothly	7.4	4.9
Limestone, dark medium gray, fine to medium crystalline, shaly, in a single bed, weathers smoothly and light blue-gray with light brown streaks	0.8	2.5
Limestone, dark medium gray with some brown, medium crystalline, somewhat silty, cherty in places, bed of abundant *Agassizocrinus* in lower part, medium-bedded, weathers medium brown and roughly	0.9	1.7
Covered	0.4	0.8
Limestone, dark medium brown to medium blue-gray, finely to medium crystalline, rather silty (especially at base), phosphatic nodules, fossiliferous, *Pleurodictyum* sp., *Agassizocrinus* (rare), in a single bed, weathers light bluish brown and smoothly	0.4	0.4
Moorefield:		
Bayou Manard member:		
Limestone, black, ranging from very finely crystalline to finely crystalline, some larger crystals, shaly, weathers light blue-brown	0.4	14.3
Shale, dark medium brown, calcareous, near top changes laterally into limestone, silty, somewhat platy, weathers medium brown to medium gray-brown; limestone is dark brown-gray, silty, weathers light medium brown	1.5	13.9
Limestone, dark medium gray, medium to coarsely crystalline, becomes silty and thin-bedded toward top, weathers smoothly and medium brown to medium blue-gray	0.9	12.4

Shale, brown-black to medium gray-brown, calcareous, silty, platy, weathers light gray-brown to light brown, rather roughly and with outer surfaces leached	2.0	11.5
Limestone, medium to dark medium gray, medium to finely crystalline, irregular phosphatic beds, weathers medium to light brown	0.7	9.5
Shale, medium brown, bluish, calcareous, silty, abundant *Leiorhynchus carboniferum*, very platy, weathers light brown and smoothly	2.9	8.8
Limestone, medium gray with black phosphatic pebbles, medium crystalline, very phosphatic (including small gastropods replaced by phosphate), blends into lower bed, weathers roughly and light brown..	0.2	5.9
Limestone, dark gray, finely crystalline, silty, especially in upper portion, weathers light brown and smoothly and approaches a leached siltstone in upper part	0.6	5.7
Poorly exposed: Shale, black-brown, calcareous, large phosphatic pebbles, silty, quite platy, weathers in irregular patches of brown and gray and fairly smoothly	1.3	5.1
Limestone, medium brown-gray, varies from shaly limestone to limy shale, abundant *Leiorhynchus carboniferum*, some phosphatic pebbles, shaly limestone phase irregularly bedded, weathers with irregular patches of brown and gray, and rather smoothly except for fossils and phosphatic pebbles....	0.4	3.8
Limestone, dark gray, finely crystalline, phosphatic pebbles, weathers light gray and somewhat roughly..	0.3	3.4
Poorly exposed: Shale, dark brown, silty, irregularly platy, calcareous, weathers light gray and brown....	3.1	3.1
"Boone":		
Limestone, medium dark gray, finely crystalline, hard, crinoid stems, small chert masses, massive, weathers light gray and smoothly		
Base not exposed.		

23. PARTIAL SECTION—BUCKSKIN HOLLOW

Near Center of North Line, NE¼ NW¼ of Section 31, T. 13 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hale:		
Pitkin:		
Limestone, medium gray-brown, finely crystalline, oolitic, massive- to medium-bedded, weathers medium gray and fairly smoothly	5.4	18.9
Limestone, dark gray-brown, dense to finley crystalline, fossiliferous in places, bedding planes irregular, massive, weathers medium gray and rubbly..	6.7	13.5
Covered	2.1	6.8
Limestone, black, finely crystalline, massive, weathers gray and fairly smoothly	4.4	4.7
Limestone, medium brown and dark gray, finely crystalline, with a great many coarser crystals, very fossiliferous, crinoid stems very abundant, trilobites, others, upper contact gradational in a single bed	0.3	0.3
Probable Base of Pitkin (Covered below)		

24. PARTIAL SECTION—BUCKSKIN HOLLOW
NW¼ NW¼ NE¼ of Section 31, T. 13 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Bloyd:		
Hale:		
Limestone, dark brownish gray, finely crystalline, very oolitic, sandy (medium grains,) thin-bedded, weathers brown	1.6	28.7
Covered	2.3	27.1
Limestone, dark brownish gray, finely crystalline, oolitic, medium- to thin-bedded, weathering not known	1.5	24.8
Limestone, dark brownish gray, finely crystalline, oolitic, somewhat sandy (medium grains), in a single bed, weathers medium gray	2.4	22.9
Limestone, dark brown-gray, with some orange spots, finely to coarsely crystalline, often intermixed, crinoidal, in a single bed, weathering not known	0.7	20.5
Covered	0.2	19.8
Limestone, and sandstone, intergrading: Limestone, dark medium brownish gray with earthy orange spots, coarsely crystalline, crinoidal, sandy (medium grains), weathers rottenly, color not known; sandstone, light brown, medium-grained, calcareous, weathers medium brown and fairly smoothly	0.7	19.6
Limestone, medium to dark brownish gray or dark gray, some earthy orange spots, finely crystalline, somewhat oolitic, sandy (medium grains), bedding obscure but probably medium-bedded, weathers medium brownish gray, fairly smoothly, and tends to be rotten	4.2	18.9
Limestone, medium to dark brownish gray or dark gray, some earthy spots, medium crystalline with both coarse and fine spots, sandy (medium grains), very sandy toward base, very crinoidal, bryozoans, large ammonoid cephalopods, bedding planes generally obscure, massive to thin-bedded, weathers medium brown to gray, fairly smoothly, oftentimes rottenly	9.0	14.7
Sandstone, light to medium brown or grayish brown, medium-grained, calcareous, in places has large calcite crystals, rarely sandy limestones occur, sandstone is fossiliferous in places, probably cross-bedded on large scale, upper contact may be cross-bed, massive, weathers medium brown and has some pits in upper portion; sandy limestone is grayish brown and medium-grained	5.7	5.7
Pitkin limestone (only upper few feet exposed)		

25. MEASURED SECTION NEAR QUALLS,
Section 2, T. 14 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Chattanooga:		
Shale, black, fissile, iron stains, with basal Sylamore sandstone member	22.0	22.0

Sallisaw:		
Sandstone, brown, medium-grained, chert fragments at base	0.7	0.7
St. Clair:		
Limestone, gray, weathering knobby, bedding planes poorly developed, considerable silica replacement in parts, upper portion has some dolomite and chert	8.0	10.3
Dolomite, buff, weathering smooth, some silica	1.3	2.3
Limestone, gray, limonite-stained, dolomitic and siliceous in part, siliceous oolite development in lower 6 inches	1.0	1.0
Sylvan:		
Shale, greenish-buff, platy, concretionary	31.0	31.0

26. MEASURED SECTION UP TRAIL TO ROAD.
Southwest Corner of Section 21, T. 14 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, brown, thin-bedded, shaly, to top of hill	18.0	18.0
Bloyd:		
Shale, bluish, poorly exposed	2.5	66.0
Limestone, medium crystalline, resistant, conglomeratic	1.0	63.5
Shale, bluish-gray, containing bed of highly fossiliferous shaly lime, abundant corals, bryozoa, and crinoid stems	5.0	62.5
Limestone, weathering granular, with shale breaks	3.0	57.5
poorly exposed	2.0	54.5
Covered	1.0	52.5
Limestone, brown calcite in a dense matrix, crinoidal	1.0	51.5
Shale, greenish-blue	2.0	50.5
Limestone, light gray, coarsely crystalline in upper part, fossiliferous	7.0	48.5
Covered	2.0	41.5
Limestone, blue, medium crystalline becoming finer near top	0.5	39.5
Limestone, gray-white, dense	5.0	39.0
Limestone, sandy, iron stained, thin-bedded, some shale breaks	4.0	34.0
Limestone, unevenly bedded, poorly exposed	5.0	30.0
Covered	5.0	25.0
Shale, poorly exposed	2.0	20.0
Limestone, basal part sandy	5.0	18.0
Limestone, very sandy, iron-stained, weathers cross-bedded and pitted, glauconitic zone present in upper part	13.0	13.0
Shale, grayish-green, poorly exposed		
Hale:		
Limestone, coarsely crystalline, iron-stained, some sand grains	1.0	24.7
Covered	1.0	23.7
Sandstone, fine grained, calcareous, limonite-stained	3.0	22.7
Limestone, coarsely crystalline, crinoidal, traces of glauconite	0.2	19.7
Covered	6.0	19.5
Limestone, gray, white calcite, mostly fine textured becoming more coarsely crystalline at top, crinoidal, some shale poorly exposed	7.0	13.5
Covered	5.0	6.5
Sandstone, medium-grained, calcareous	1.5	1.5

27. MEASURED SECTION IN DEEP GULCH PARALLELING THE SEQUOYAH-CHEROKEE COUNTY BOUNDARY
Section 36, T. 14 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Pitkin:		
Limestone, blue gray, coarsely crystalline, *Archimedes* present	31.0	31.0
Fayetteville:		
Shale, black, platy, iron-stained, grading up into buff colored soil	4.5	58.0
Shale (black) and thin limestone beds, limestone becoming more prominent in upper portion. Some of the limestone stringers contain abundant fossils	18.5	53.5
Limestone, blue, mostly fine-grained, iron-stained, overlain by six inches of dense limestone highly fossiliferous, abundant *Linoproductus ovatus* and *Diaphragmus cestriensis*	1.0	35.0
Shale, bluish buff, silty, with thin inter-bedded silty limestone which appears to be lenticular	6.0	34.0
Covered, probably shale, abundant limestone blocks	11.0	28.0
Shale, black with thin irregularly bedded limestone beds	3.0	17.0
Shale, black, concretionary, upper portion has one foot bed of dense limestone	2.0	14.0
Covered, probably shale	12.0	12.0
Moorefield:		
Limestone, dark gray, shaly, Base covered to river	23.5	23.5

28. MEASURED SECTION IN SIGNBOARD CREEK 150 YARDS EAST OF THE ROAD CROSSING THE CREEK
Section 5, T. 14 N., R. 22 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Fayetteville:		
Shale, black, fissile, dense blue limestone beds	12.5	12.5
Hindsville:		
Limestone, generally massive-bedded, weathering smooth, upper portion limonite-spotted and oolitic	4.5	17.7
Covered, probably shale	1.0	13.2
Limestone, blue to gray, coarsely crystalline, limonite spotted, somewhat finer grained in upper portion. The upper eight inches has abundant *Diaphragmus cestriensis* and central portion contains profuse crinoid stems	4.0	12.2
Covered, probably shale	1.0	8.2
Limestone, gray, fine to medium crystalline, mostly thin bedded, weathers cross-bedded, fossiliferous	2.0	7.2
Limestone, blue-gray, conglomeratic, well rounded chert pebbles up to three inches across	1.0	5.2
Covered interval containing one four-inch bed of limestone, gray crystalline, with some small well rounded pebbles near top	4.2	4.2
Boone:		
Chert, blue-white, exposed	12.0	12.0

29. PARTIAL SECTION OF THE TYNER
Section 32, T. 14 N., R. 22 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Fite:		
Limestone, blue-white, sublithographic	6.5	6.5
Tyner:		
Limestone, buff, alternating streaks of white and gray, dolomitic, base has some silica	1.5	8.4
Limestone, blue, dense, grades into a buff limestone above	1.0	6.9
Limestone, dark blue, lithographic, calcite streaks, fractures conchoidal, thin shale break	0.4	4.9
Sandstone, buff, slightly calcareous, friable	1.1	5.5
Limestone, buff, granular, some silica	0.4	4.4
Limestone, buff, dolomitic, thin shale parting near center	3.0	4.0
Limestone, blue, fine grained, somewhat granular	1.0	1.0
Base of exposure.		

30. MEASURED SECTION OF ST. CLAIR
Section 32, T. 14 N., R. 22 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Chattanooga:		
Shale, black, fissile with basal Sylamore sandstone member	45.0	45.0
St. Clair:		
Limestone, gray-white, medium crystalline, pink crinoidal, poorly exposed	3.5	23.0
Limestone, gray, finely crystalline, weathers smooth, pink crinoid stems	4.0	19.5
Covered	2.0	15.5
Limestone, pink calcite replacing crinoid stems, coarsely crystalline, weathers pitted and rough	2.0	13.5
Limestone, gray, finely crystalline, massive-bedded and pink crinoidal in upper part	3.5	11.5
Limestone, light blue, dense, weathers pitted	3.0	8.0
Limestone, blue with stringers of chert 4-6 inches thick, lower portion silty and weathering buff	5.0	5.0
Sylvan:		
Shale, buff, silty	21.5	21.5

31. MEASURED SECTION IN BIG RAVINE
Section 36, T. 14 N., R. 21 E., Paralleling County Line

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, brown, massive, to top of hill	44.0	44.0
Bloyd:		
Limestone, gray-blue, medium crystalline, crinoidal, weathering granular, limestone blocks slumped obscuring shale intervals	32.0	63.5
Limestone, blue, dense, thin-bedded	2.0	31.5

Limestone, brownish white, iron-stained, upper part finely crystalline, lower part more granular and cross-bedded	3.0	29.5
Covered	6.5	26.5
Limestone, greenish cast, finely crystalline, thin shale partings	1.5	20.0
Covered, probably shale	2.0	18.5
Limestone, grayish-white, granular fossiliferous, somewhat iron-stained	1.5	16.5
Covered	7.0	15.0
Shale, buff-blue	3.0	8.0
Sandstone, brown, fine-grained, calcareous, iron-stained	1.0	5.0
Limestone, blue, resistant, coarsely crystalline, crinoid stems	4.0	4.0
Hale:		
Limestone, gray, medium crystalline, more granular at base, shale breaks of undetermined thickness	22.0	45.0
Limestone, gray-brown, coarse grained, weathers silty, some shale breaks	17.0	23.0
Sandstone, brown, calcareous, cross-bedded, iron stained, upper part pitted, conglomeratic at base	6.0	6.0
Pitkin:		
Limestone, gray-blue, fossiliferous, abundant *Archimedes*	27.0	27.0
Fayetteville:		
Shale, black, thin blue limestone stringers	58.0	58.0
Moorefield:		
Limestone, gray, massive bedded, shaly, base covered	23.5	23.5

32. EAST SIDE OF BUCKHORN MOUNTAIN

Northeast ¼ of Section 36, T. 14 N., R. 22 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Covered, sandstone rubble	45.0	179.0
Sandstone, mottled grayish brown, carbonaecous streaks, thin-bedded	10.8	134.0
Sandstone, greenish light brown, fine grains, micaceous, weathers platy dark brown	12.0	123.2
Sandstone, light brown, micaceous, massive, weathers iron-stained buff	48.0	111.2
Sandstone, greenish gray, argillaceous, highly micaceous, carbonaceous zones, weathers platy greenish brown	16.0	63.2
Covered, sandstone rubble	14.0	47.2
Sandstone, brown, iron-stained, massive, weathers reddish brown	11.2	33.2
Sandstone, dark greenish gray, argillaceous, glauconitic, carbonaceous	22.0	22.0
Bloyd:		
Covered, probably shale with limestone stringers	24.0	142.7
Limestone, gray, sublithographic, weathers rubbly, buff stained, gray	6.0	112.7
Covered, probably shale	5.0	107.2
Limestone, dark gray, medium crystalline, fossiliferous, thin-bedded	6.2	102.2
Covered, probably shale	7.0	96.0
Shale, brownish gray, silty	4.2	89.0

Limestone, blue gray, coarsely crystalline, oolitic, crinoidal	1.0	84.8
Shale, blue gray, fissile	4.0	83.8
Limestone, purple gray, silty, with irregular and rounded green argillaceous siltstone pebbles (intraformational conglomerate)	.5	79.8
Shale, blue gray, fissile	8.5	79.3
Limestone, light gray, finely crystalline, fossiliferous, weathers into smooth buff colored blocks	5.0	70.8
Limestone, light gray, coquinal	1.2	65.8
Limestone, gray, sublithographic, thin-bedded, weathers smooth buff	4.8	64.6
Limestone, gray, coarsely crystalline, brown, iron spots, massive	11.0	59.8
Covered, probably shale	10.5	48.8
Shale, greenish gray, fissile	4.0	38.3
Covered, probably shale	5.0	34.3
Limestone, dark gray, dense, carbonaceous, glauconitic, iron spots, crinoidal, massive	5.5	28.5
Limestone, gray, fine crystalline, fossiliferous	5.5	23.0
Covered, probably shale	4.0	17.5
Shale, greenish gray, fissile	10.0	13.5
Covered, probably shale	3.5	3.5
Hale:		
Limestone, gray, dense, sandy, weathers with sandy gray brown surface	.5	50.6
Sandstone, brown, calcareous, weathers dark brown and honeycombed	.8	50.1
Limestone, gray, coarsely crystalline, sandy	1.0	49.3
Limestone, brownish gray, very sandy, weathers reddish brown, fluted	7.5	48.3
Partially covered, brown argillaceous siltstone	3.0	40.8
Siltstone, brown, argillaceous platy	5.8	37.8
Limestone, grayish brown, sandy, fossiliferous, weathers honeycombed brown	2.5	32.0
Limestone, gray, medium crystalline, sandy, massive	6.0	30.5
Limestone, gray, coquinal, sandy, weathers rubbly, brown-stained, gray	4.5	24.5
Limestone, gray, medium crystalline, slightly sandy, fossiliferous	1.8	20.0
Sandstone, brownish green, calcareous, argillaceous, weathers fluted brown	1.5	18.2
Limestone, brownish gray, coarsely crystalline, very sandy, massive	3.8	16.7
Limestone, gray, coarsely crystalline, thin-bedded, fossiliferous	1.8	12.9
Limestone, gray, medium crystalline, sandy, fossiliferous, massive, weathers rubbly, brown-stained, gray	5.5	11.1
Limestone, brownish gray, coarsely crystalline, very sandy, massive	2.8	5.6
Sandstone, brown, calcareous, argillaceous, platy, weathers reddish brown	1.5	2.8
Limestone, gray, medium crystalline, somewhat oolitic	.8	1.3
Siltstone, greenish gray, calcareous, argillaceous	.5	.5
(continued on west side of Buckhorn Mountain, SE¼ Section 27, T. 14 N., R. 22 E.)		
Pitkin:		
Limestone, gray, medium crystalline, crinoidal, weathers rubbly gray	2.0	10.0
Covered, probably limestone	5.0	8.0

Limestone, gray, finely crystalline, thin irregular beds, thin shale partings	3.0	3.0
Fayetteville:		
Mostly covered, black shales and thin, dark gray, sublithographic limestones	12.0	12.0
Hindsville:		
Covered, probably limestone	3.0	20.6
Limestone, gray, finely crystalline, containing *Agassizocrinus*	5.0	17.6
Limestone, gray, coarsely crystalline, carbonaceous, crinoidal, massive	9.2	12.6
Limestone, light gray, finely crystalline, silty, jointed	1.2	3.4
Limestone, gray, coarsely crystalline, crinoidal carbonaceous	1.0	2.2
Limestone, dark gray, medium crystalline, containing large well rounded, chert conglomerate, *Agassizocrinus*	1.2	1.2
Moorefield:		
Limestone, gray, oolitic, containing many small subangular and rounded chert pebbles	1.0	26.6
Limestone, brownish gray, very silty, weathers with brown silty zones	1.2	25.6
Limestone, gray, coarsely crystalline, carbonaceous, contains small chert pebbles	2.5	24.4
Limestone, dark gray, carbonaceous, argillaceous fossiliferous, *Leiorhynchus*, weathers platy brown	1.2	21.9
Limestone, dark gray, finely crystalline, carbonaceous, silty, thin-bedded	4.0	20.7
Limestone, blue-black, dense, siliceous, glauconitic, 4-8" beds with bright blue irregular chertified zones, bedding and fracture patterns similar to chert	3.0	16.7
Limestone, dark gray, argillaceous, thin-bedded, containing subangular chert fragments	3.6	13.7
Limestone, blue-gray, dense, highly silicified, glauconitic, conchoidal fracture, weathers "punky" brown	1.0	10.1
Limestone, dark gray, glauconitic, argillaceous, fossiliferous, *Leiorhynchus*, platy	6.6	9.1
Limestone, gray, dense, silty, crinoidal	1.2	2.5
Limestone, dark gray, coarsely crystalline, carbonaceous, crinoidal	.8	1.3
Limestone, dark gray, finely crystalline, glauconitic, silty, black carbonaceous spots, *Leiorhynchus*	.5	.5
Boone:		
Keokuk and Reeds Spring cherts and limestones	Not measured.	

33. ELK CREEK

Sections 5 and 8, T. 14 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Covered, sandstone rubble	10.0	120.7
Sandstone, reddish brown, medium-grained massive	14.0	110.7
Covered, sandstone rubble	21.0	96.7
Sandstone, buff, micaceous, black carbonaceous zones; weathers platy	58.0	75.7
Sandstone, light gray, highly micaceous	3.2	17.7

Sandstone, greenish gray, argillaceous, platy	4.0	14.5
Siltstone, dark brownish-black, carbonaceous, argillaceous, calcareous, thin and moderately massive	10.5	10.5
Bloyd:		
Covered, probably shale	18.0	143.2
Shale, gray, fissile	6.0	125.2
Limestone, gray brown, very sandy, fossiliferous,	.8	119.2
Covered, probably shale	4.0	118.4
Limestone, gray, coarsely crystalline, glauconitic, crinoidal, massive	2.0	114.4
Limestone, light gray, medium crystalline, fossiliferous, *Composita*, *Spirifer*, *Dictyoclostus*, massive	5.2	112.4
Shale, dark gray, carbonaceous, with argillaceous limestone zones	8.0	107.2
Siltstone, gray, argillaceous, calcareous, glauconitic, weathers platy dark brown	5.5	99.2
Shale, dark gray, highly carbonaceous	17.0	93.7
Covered, probably shale	4.0	76.7
Limestone, gray, finely crystalline, fossiliferous, *Dictyoclostus*, weathers buff-stained gray	3.5	72.7
Shale, gray green, fissile	3.0	69.2
Limestone, dark gray, sublithographic, conchoidal fracture	1.5	66.2
Poorly exposed, some greenish gray shale evident	21.0	64.7
Shale, gray, fissile, with thin blue gray limestone stringers	4.0	43.7
Limestone, gray, medium crystalline, crinoidal	.5	39.7
Shale, partially covered, contains some thin gray limestone stringers	5.0	39.2
Limestone, dark gray, medium crystalline brown iron-spotted, fossiliferous, massive	4.5	34.2
Limestone, greenish gray, coarsely crystalline, highly glauconitic, crinoidal, massive	9.0	29.7
Limestone, light gray, medium crystalline, with argillaceous glauconitic zones, weathers platy, greenish gray	2.2	20.7
Limestone, gray, medium crystalline, very oolitic	2.0	18.5
Shale, blue gray, fissile	6.0	16.5
Limestone, gray, coarsely crystalline, crinoidal, massive	4.5	10.5
Shale, blue gray, fissile, containing thin, irregular beds of dark gray limestones	6.0	6.0
Hale:		
Limestone, gray, coarsely crystalline, sandy, weathers fluted brown	1.0	43.8
Limestone, light gray, coarsely crystalline, crinoidal, slightly sandy, massive	3.0	42.7
Limestone, dark gray, dense, silty, weathers fluted brown	1.5	39.7
Siltstone, green, calcareous, glauconitic, argillaceous, weathers platy gray green	3.0	38.2
Limestone, dark gray, finely crystalline, silty, weathers fluted brown	1.0	35.2
Shale, gray brown, sandy	.5	34.2
Limestone, light gray, coarsely crystalline, slightly sandy, crinoidal	3.0	33.7
Limestone, light brownish gray, sandy, weathers honeycombed brown	9.5	30.7
Limestone, gray, medium crystalline, very fossiliferous, sandy, thin-bedded	3.0	21.2

Limestone, light gray, coarsely crystalline, sandy, massive, weathers fluted	10.2	18.2
Shale, brownish gray, sandy	1.0	8.0
Sandstone, brown, gray argillaceous zones, weathers honeycombed reddish brown	1.5	7.0
Shale, dark brownish gray, very sandy, weathers iron stained reddish brown	3.0	5.5
Limestone, gray, medium crystalline, sandy, oolitic	.5	2.5
Limestone, light gray, coarsely crystalline, glauconitic, with reworked limestone pebbles at base	2.0	2.0
Pitkin:		
Limestone, gray, medium crystalline, oolitic	1.0	24.8
Limestone, blue-gray, finely crystalline, crinoidal, massive	5.2	23.8
Limestone, dark gray, sublithographic, thin-bedded, black shale partings	4.8	18.6
Limestone, dark gray, medium crystalline, petroliferous, phosphatic nodules on surface	3.8	13.8
Limestone, gray, sublithographic	1.0	10.0
Shale, dark gray, fissile	1.0	9.0
Limestone, dark gray, sublithographic, conchoidal fracture, upper part massive and lower part thin-bedded with black shale partings, fossiliferous	8.0	8.0
Fayetteville:		
Mostly covered, black shale with thin smooth, blocky, dark gray, sublithographic limestone stringers	5.0	16.0
Limestone, gray, sublithographic, fossiliferous, *Archimedes*	1.0	11.0
Covered, probably black shale with thin limestone beds	8.0	10.0
Shale, black, fissile	2.0	2.0
Hindsville:		
Limestone, dark gray, medium crystalline, carbonaceous, crinoidal, massive	4.0	21.9
Limestone, grey, sugary texture, silicious, massive	2.0	17.9
Limestone, light gray, medium crystalline, carbonaceous, crinoidal, thin-bedded	3.5	15.9
Limestone, gray, coarsely crystalline, carbonaceous, fossiliferous, *Diaphragmus*	4.2	12.4
Limestone, dark gray, medium crystalline, carbonaceous, crinoidal, thin-bedded	1.0	8.2
Limestone, gray, coarsely crystalline, carbonaceous, glauconitic, fossiliferous, *Agassizocrinus*, thin bedded	5.2	7.2
Limestone, gray, medium crystalline, thin-bedded, containing occasional subrounded and angular chert fragments	2.0	2.0
Boone:		
Keokuk and Reeds Spring chert and limestone	Not measured.	

34. SOUTH SIDE OF BEAVER MOUNTAIN
East Center Section 25, T. 14 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Mostly covered, thin, platy, argillaceous, siltstone and brown sandstone beds	160.0	160.0
Bloyd:		
Mostly covered, poorly exposed green shale intervals	12.0	158.0
Limestone, light gray, sublithographic, thin-bedded, shale partings	12.5	146.0

Shale, greenish gray, fissile, with limonite concretions	9.0	133.5
Limestone, gray, coarse crystalline crinoidal, iron spotted	1.5	124.5
Shale, greenish, gray, fissile	4.0	123.0
Limestone, dark gray, medium crystalline, crinoidal	1.8	119.0
Shale, blue gray, fissile, with dense gray limestone stringers	11.0	117.2
Limestone, dark gray, medium crystalline, sandy, fossiliferous, massive	4.5	106.2
Shale, blue gray, fissile	16.0	101.7
Limestone, gray, fine crystalline, glauconitic zones, thin uneven bedding, weathers knobby, light gray	8.2	85.7
Shale, poorly exposed, blue gray	15.0	77.5
Limestone, gray, coarse, glauconitic, thin-bedded at top and massive at base, weathers brown stained gray	17.8	62.5
Mostly covered, primarily blue gray shale with thin irregular limestone stringers	16.0	44.7
Limestone, dark gray, medium to fine crystalline, fossiliferous, iron-spotted, weathers rubbly, brown stained gray	18.5	28.5
Limestone, gray, coarse crystalline, crinoidal, glauconitic	1.0	10.2
Limestone, gray, medium crystalline, oolitic, slightly glauconitic, weathers gray with brown and black splotches	3.2	9.2
Shale, greenish gray, fissile	6.0	6.0
Hale:		
Limestone, gray, sandy, weathers gray with brown sandy zones	6.0	58.1
Limestone, grayish tan, very sandy, oolitic, weathers sandy brown and platy	4.0	52.1
Sandstone, reddish brown, calcareous, weathers honeycombed, dark brown	1.2	48.1
Limestone, gray, dense, sandy	.8	46.9
Sandstone, gray, calcareous, weathers brown and platy	1.8	46.1
Limestone, gray, coarse crystalline, glauconitic, slightly sandy, fossiliferous, weathers crinoidal gray	2.2	44.3
Limestone, greenish-gray, medium crystalline, glauconitic, fossiliferous, sandy	5.0	42.1
Sandstone, brownish-gray, calcareous, argillaceous, weathers rubbly, rusty brown	2.8	37.1
Limestone, gray, medium crystalline, crinoidal, slightly sandy	2.0	34.3
Limestone, gray, medium crystalline, glauconitic, sandy, weathers sandy, brown-fluted	3.5	32.3
Sandstone, reddish brown, medium-grained, calcareous, weathers honeycombed, dark brown	21.0	28.8
Siltstone, greenish-gray, argillaceous, with thin conglomeratic zone at base containing subangular limestone and calcareous sandstone pebbles	.5	7.8
Limestone, gray, coarse crystalline, slightly sandy	2.0	7.3
Limestone, brownish gray, medium crystalline, sandy, massive, weathers gray with brown, sandy fluted zones	2.8	5.3
Sandstone, brown, calcareous, weathers brown, fluted	2.0	2.5
Conglomerate, dark greenish gray, argillaceous, contains sandy limonitic pebbles and phosphate nodules	.5	.5

Pitkin:		
Limestone, gray, medium crystalline, oolitic, crinoidal, weathers granular	2.5	19.2
Limestone, dark blue gray, dense, with large black siliceous concretions, numerous *Archimedes*	6.0	16.7
Limestone, gray, coarsely crystalline, slightly oolitic, crinoidal, fossiliferous, *Diaphragmus*	5.0	10.7
Limestone, dark gray, sublithographic, thin rubbly beds with black shale partings	2.0	5.7
Limestone, dark gray, medium crystalline, crinoidal, weathers gray with brown stains	1.5	3.7
Limestone, dark gray, sublithographic, thin irregular bedding with black shale partings, *Archimedes*	2.2	2.2
Fayetteville:		
Limestone and shales, black, fissile, shales, dark gray, sublithographic, blocky, thin, smooth buff weathering limestone beds	6.0	24.5
Shale, black fissile	4.0	17.5
Limestone, gray, fine crystalline, fossiliferous, *Composita, Stenoscisma, Diaphragmus*, with 1-2" black phosphatic zone on surface	2.5	15.5
Partially covered, black shales and gray, sublithographic limestones	11.0	13.0
Shale, black, fissile	2.0	2.0
Hindsville:		
Limestone, dark gray, fine crystalline, fossiliferous, *Diaphragmus, Athyris, Camarotoechia*	1.5	32.5
Limestone, gray, dense, silty, *Agassizocrinus*, weathers silty, light brown	1.0	31.0
Limestone, gray, coarsely crystalline, iron-spotted, carbonaceous, crinoidal, thin-bedded	3.5	30.0
Limestone, gray, medium crystalline, slightly glauconitic, fossiliferous, massive, weathers rubbly gray	5.0	26.5
Limestone, grayish tan, silty, thin-bedded, weathers brown, silty, platy	10.5	21.5
Limestone, dark gray, coarsely crystalline, silty, *Agassizocrinus*, weathers gray with brown silty zones	3.0	11.0
Limestone, grayish tan, fine crystalline, silty, *Agassizocrinus*, weathers gray with brown silty zones	2.8	8.0
Limestone, gray, coarsely crystalline, crinoidal, fossiliferous, *Orthotetes, Dielasma*, massive, chert conglomerate at base	5.2	5.2
(continued into Hastings Hollow, SE Section 25 and NE Section 36, T. 14 N., R. 23 E.)		
Keokuk:		
Chert, light gray to white and buff stained, irregular masses with no distinct bedding planes, contains rare thin irregular zones of gray, finely crystalline limestone	96.0	96.0
Reeds Spring:		
Chert, blue gray, thin-bedded, contains thin, dense, light gray limestone beds	49.0	49.0
St. Joe:		
Limestone, gray, sublithographic, containing rounded, green glauconitic, limestone pebbles	.5	5.3
Shale, pearly green, highly glauconitic, pyritic, containing glauconitic, finely crystalline, limestone fragments	1.8	4.8

Limestone, greenish gray, medium to fine crystalline, glauconitic, highly fossiliferous, weathers rubbly green	3.0	3.0
Chattanooga:		
Shale, black carbonaceous, pyritic, blocky and jointed, weathers brown stained gray, fissile	18.0	18.0
Sylamore:		
Sandstone, dark brown, calcareous, friable, subangular clear sand grains, petroliferous	.5	17.7
Sandstone, light gray, rounded to subangular, black carbonaceous zones, contains tiny black phosphatic nodules	4.6	17.2
Sandstone, gray, calcareous, friable, slightly glauconitic, phosphatic nodules	2.8	12.6
Sandstone, light brown, calcareous, red iron-stained spots, phosphatic	.5	9.8
Siltstone, gray, argillaceous, black, carbonaceous, weathers brownish gray and pitted	.5	9.3
Sandstone, grayish tan, calcareous, phosphatic, friable, thin-bedded	4.0	8.8
Sandstone, light brown, subangular to rounded, slightly calcareous, phosphatic, massive, weathers mottled reddish brown	4.8	4.8
St. Clair:		
Limestone, light pink, coarsely crystalline, massive, weathers light gray	5.0	17.3
Limestone, light grayish tan, fine to medium crystalline, black mottling, weathers dark gray and occasionally platy	6.8	12.3
Limestone, pink flesh colored, coarsely crystalline, calcite veinlets, weathers light gray with segregated jointing	5.5	5.5

35. HAMLIN HOLLOW SECTION
Southwest ¼ of Section 7, T. 14 N., R. 24 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Bloyd:		
Consists predominantly of medium to coarsely crystalline dark limestone with lesser amounts of dark gray shales	154.0	154.0
Hale:		
Limestone and sandy limestone, dark gray, massive, sandy in lower portions, sand content decreases upward, large amounts iron staining, locally weathers into bedded effect	98.0	98.0
Pitkin:		
Limestone, dark bluish, gray medium crystalline, locally appears to weather out in long splintry fragments. Seven feet from top is 1 inch bed of black chert, very smooth and iron-stained	9.5	19.5
Limestone, rubbly, considerable shale present, abundant *Archimedes*	4.0	10.0
Covered section, estimated thickness	6.0	6.0
Fayetteville:		
Lower portion black shale, upper equally divided between light bluish gray limestone and black fissile shale	28.0	28.0

Hindsville:		
Limestone, thick, massive, fine to medium crystalline, extremely hard but locally crumbly. Sparingly fossiliferous with occasional *Archimedes* on weathered surface	9.3	9.3
Keokuk:		
Irregular masses of light gray chert and limestone	129.0	129.0

36. SECTION NORTH OF "LEAD MINE"
Southwest ¼ of Section 11, T. 14 N., R. 24 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Reddish brown thin-bedded sandstone and variegated platy shale	194.0	194.0
Bloyd:		
Limestone, very hard, dark bluish gray, abundance of *Pentremites*, coarsely crystalline, interbedded with thin layers of dark gray thinly laminated crumbly shale	55.0	145.0
Shale, light gray to greenish gray, thin, platy, poorly exposed	50.0	90.0
Limestone, dark bluish gray, medium crystalline, hard, very fossiliferous, interbedded with medium gray, thinly laminated shale	40.0	40.0
Hale:		
Rust-colored sandstone, grading into light gray medium crystalline, crinoidal limestone	63.0	63.0

37. SOUTH SIDE OF ROAD AT BEAVER PASS
Northwest ¼ of Section 12, T. 14 N., R. 24 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Bloyd:		
Dark gray medium crystalline limestone with lesser amounts of shale	156.0	156.0
Hale:		
Sandstone, massive limy, steel gray on fresh surface, numerous small limonitic stains. Sand grains are slightly frosted, rather small, well rounded and cemented	51.0	62.7
Shale, black, thinly laminated, locally sandy, often has a purple hue	11.7	11.7
Pitkin:		
Bluish gray dense and light gray crinoidal limestone, with small shale section	12.0	12.0

38 ALONG STREAM IN SE¼ Sec. 22, T. 14 N., R. 24 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hale:		
Pitted sandstone and light gray limestone grading laterally and vertically into each other	60.0	60.0

Pitkin:		
Limestone, very dense, locally oolitic, light blue gray in color, weathers into sharp fluted mass, abundant *Archimedes* on surface	7.1	15.6
Shale. dark brownish gray, platy, grades laterally into shaly lime	1.5	8.5
Limestone, highly crinoidal, light gray, may be either massive or weathers into stair step effect. Crinoid stems shatter into rhombs	7.0	7.0
Fayetteville:		
Shale, thin, black, fissile, few *Archimedes swallovanus*	0.2	15.5
Limestone, light gray, medium crystalline, lacy Bryozoa cover weathered surface	0.2	15.3
Shale, thin, black and fissile	0.1	15.1
Limestone, light gray, medium crystalline, abundant *Chonetes oklahomensis* weathered out on surface	0.1	15.0
Shale, thin, black and fissile	0.1	14.9
Limestone, dark gray, medium to finely crystalline, very rough and irregular yellowish surface covered with lacy type of bryozoans	0.5	14.8
Shale, thin, black and fissile	0.2	14.3
Limestone, irregular yellowish surface with numerous bryozoans weathered out	0.2	14.1
Shale, black and thinly laminated	0.1	13.9
Limestone, argillaceous to sublithographic, fractures into conchoidal plates, generally fossiliferous	0.1	13.8
Shale, black, thin, fissile	0.1	13.7
Limestone, dense argillaceous, dark bluish gray on fresh surface, weathers into round light gray rubbly masses	0.6	13.6
Shale, dark and fissile	0.3	13.0
Limestone, sublithographic, dark bluish gray, very dense, sparingly fossiliferous	0.2	12.7
Shale, black, thinly laminated	0.4	12.5
Limestone, dark gray, dense small amount calcite crystals on freshly fractured surface, rubbly on weathered surface	0.5	12.1
Shale, black, thin, weathers to a dull, coal black and splits into thin fragments	9.8	11.6
Limestone, light gray on weathered surface, small amount iron staining at base. *Archimedes* sp. weathered out on surface	1.8	1.8
Hindsville:		
Dark gray, finely crystalline to dense limestone. Considerable amount of jointing has taken place at this locality	4.2	4.2

39. SECTION SECOND STREAM SOUTH OF LLOYD TIGHE FARM
NW¼ Section 29, NE¼ Section 30, T. 14 N., R. 24 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hindsville:		
Series of alternating limestone and shale	26.0	26.0
Moorefield:		
Covered exposure but believed to be a dark gray thinly laminated shale	8.9	10.3
Limestone, soft, shaly, very dark, appears to be inated chert. Very fossiliferous, weathers gray-light colored oolities set in dark shaly limestone matrix	0.5	1.4

Limestone, black, medium crystalline, semi-platy zone. Highly fossiliferous zone (*Leiorhynchus carboniferum*) three inches above base	0.8	0.9
Conglomerate, well rounded chert pebbles one inch in diameter, well cemented together with black medium crystalline limestone	0.1	0.1
Keokuk:		
Limestone, light brownish, gray, platy (⅛" to ¾") finely crystalline to dense, void of fauna, locally may be slightly silty	5.9	135.0
Limestone, dark gray, chert masses gives a very irregular surface, weathers into a fractured appearance	10.6	129.1
Limestone, light gray, highly crinoidal, weathers into cross-bedded appearance, often slick surface, occasional chert masses entirely surrounded by limestone	18.0	118.5
Limestone, and chert, consists of large irregular light gray to buff colored chert masses surrounded by light gray limestone, upper section often cliff former and erodes into very steep side narrow valleys	100.5	100.5
Reeds Spring:		
Chert, dark bluish-gray, beds range from 2" to 14" in thickness, often contains numerous ¼" dark bands. Corners of beds very sharp and material not easily taken in solution	49.7	49.7
Chattanooga:		
Shale, black, platy, locally pyritic, incompetent bed	7.0	7.0
Sylamore:		
Sandstone, well rounded, medium clear, quartz grains, poorly cemented, friable, locally iron stained, pitted surface	16.0	18.2
Sandstone, unconsolidated, extremely well rounded, clear grains, orangish-clay matrix	0.1	2.2
Shale, dark gray, thinly laminated	0.2	2.1
Sandstone, unconsolidated, orangish-gray, well rounded grains	0.1	1.9
Shale, light gray to orange gray, platy	0.2	1.8
Shale, black, thinly laminated	0.3	1.6
Siltstone, unconsolidated, light orange colored, small amount of clay	0.2	1.3
Shale, coal black, thickly laminated	0.3	1.1
Sandstone, unconsolidated, well rounded, considerable clayey material, orangish yellow in color	0.1	0.8
Sandstone, dark gray, phosphatic nodules, well cemented with calcareous material	0.7	0.7
Sallisaw:		
Chert, light pearl gray, vitreous luster and conchoidal fracture	0.9	0.9
St. Clair:		
Limestone, medium crystalline, pink, coarsely crystalline filled cavities, surrounded by fine flesh colored limestone	0.5	0.5

40. EAST SIDE OF BEAVER MOUNTAIN
Northwest ¼ of Section 30, T. 14 N., R. 24 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Shale, dark red, thinly laminated, interbedded with a number of sandstone beds	42.0	205.0
Sandstone, medium to coarsely crystalline, dark reddish brown, massive, number of *Taonurus* marks	28.0	163.0
Shale, very dark red, platy and slightly silty	22.0	135.0
Siltstone, very thin and platy, well cemented, brown to red, often massive	58.0	113.0
Shale, platy, dark maroon gray	17.0	45.0
Sandstone, medium-grained, reddish brown, fairly well cemented	28.0	28.0
Bloyd:		
Limestone, medium crystalline, dark bluish gray, abundant *Pentremites*, weathers into bedded appearance	33.5	160.5
Shale, thin, platy, locally yellow-stained	50.0	127.0
Limestone, dark gray, slightly rotten, highly crinoidal, weathers into crumbly mass	28.0	77.0
Shale, does not crop out, but lithology inferred from flat bench	16.0	49.0
Limestone, very hard, medium crystalline, light gray, abundance of crinoid stems that weather out to form a rough surface	33.0	33.0
Hale:		
Massive light bluish gray limestone, weathers into a rusty color, grades into highly pitted reddish brown sandstone	67.5	67.5

41. NIGGER HOLLOW STREAM CUT NEAR BRIDGE
Section 12, T. 15 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Fayetteville: (base in water—top covered)		
Shale, black, fissile, weathers iron-stained, 5 feet above stream there is a 0.5 foot limestone, black sublithographic, lens-like bed	20.0	20.0
Hindsville:		
Limestone, blue-gray, coarsely crystalline, unevenly bedded, weathers to rubble; contains numerous brachiopods including *Diaphragmus*, and *Linoproductus ovatus* in zones	3.6	8.6
Limestone, black, lithographic to sublithographic, fossiliferous, weathers light blue-gray, smooth, subcuboidal, in beds 0.5 feet thick separated by thin shale breaks	5.0	5.0
Base covered.		

42. ALONG STREAM CUT
Section 15, T. 15 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Pitkin:		
Limestones, partially covered	50.0	50.0

Fayetteville:		
Shale, black, fissile, mostly covered	53.0	62.5
Limestone, black, lithographic, in beds 0.7 thick, thin conglomerate at top	6.5	9.5
Shale, black fissile, covered	3.0	3.0
Hindsville:		
Limestone, blue-gray to black, fine crystalline, massive *Linoproductus ovatus* zone	2.0	12.0
Limestones, black, lithographic, subcuboidal, 0.2-0.6 feet thick separated by black, calcareous, platy shale	10.0	10.0
Moorefield:		
Covered, probably shale	5.0	21.0
Shale, and black argillaceous limestone grading into each other, *Leiorhynchus*	16.0	16.0
Base covered.		

43. SECTION ALONG HIGHWAY 10, BRAGGS MOUNTAIN

Sections 21-29, T. 15 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, tan to buff, fine-grained at base, locally cross-bedded, trace of coal smut at base	8.0	8.0
Bloyd:		
Sandy shale, brown to tan stain, fine	3.0	57.9
Shale, fissile, grades into sandy beds above	5.0	52.9
Limestone, blue-gray, medium crystalline, weathers brown-gray, crinoidal, fossiliferous	5.5	47.9
Shale, blue-gray, fissile, jointed	8.9	42.4
Limestone, poorly exposed, rubbly, weathers pseudo-cross-bedded; extremely crinoidal, reddish and porous	3.0	33.5
Shale, poorly exposed, brown, fissile, fossiliferous	9.0	30.5
Limestone, blue-gray, very fine crystalline, crinoidal	6.0	21.5
Shale, fine, silty, gray and buff, greenish cast	4.0	15.5
Shale (covered)	3.0	11.5
Limestone, blue-gray, weathers buff, abundant *Pentremites*	3.5	8.5
Shale, poorly exposed, gray-black, fissile	5.0	5.0
Hale:		
Limestone, poorly exposed, blue-gray, medium to fine crystalline, thin-bedded, platy, may include some shale	8.0	57.7
Shale, calcareous, marly, buff, fossiliferous nodules at top, *Composita* and crinoid stems	2.0	49.7
Limestone, brown-gray, few thin shale beds	3.0	47.7
Limestone, brown-gray, coarse to medium crystalline crinoidal, massive in lower portion, locally platy in upper portion	11.0	44.7
Shale, black-gray, fissile, weathers buff, poorly exposed	10.0	33.7
Limestone, brown-gray, fine sandy, weathers to pseudo-crossbeds, upper is platy and crinoidal	8.0	23.7
Shale, black-gray fissile, weathers buff, *Pleurodictyum*	1.5	15.7
Limestone, black-gray, very fine to sublithographic fossils, brachiopods, fenestellids	2.2	14.2
Limestone, light blue-gray, locally very sandy, fine granular crystals, weathers into honeycomb sandy beds	11.5	12.0

Conglomerate at base, 3-6", small flat, rounded pebbles, red and very limy	0.5	0.5
Pitkin:		
Limestone, light blue-gray, fine-crystalline, porous and pseudo-crossbedded, coquina, crinoidal, basal is dense, 2-3' concretionary, upper 3' oolitic, few glauconitic specks, *Archimedes*, porous weathering..	11.0	59.6
Limestone, thin, dark shale, rubbly and crinoidal.....	2.0	48.6
Limestone, blue-gray, dense to crystalline, *Fenestella*, *Diaphragmus*, fossiliferous streaks, fossiliferous pseudo-crossbedded	6.0	46.6
Shale, dark gray, thin concretionary bed at top, nodular, weathers to gray clay	6.0	40.6
Limestone, brown, blue-gray, *Diaphragmus*, fossiliferous	6.0	34.6
Shale (covered)	0.3	28.6
Limestone, blue-gray, medium-crystalline, crossbedded, limonite-stained	4.5	28.3
Shale, dark gray, soft	0.3	23.8
Limestone, light blue-gray to gray, dense, calcite inclusions, conchoidal fracture, fossiliferous oolitic in part, *Pentremites*	17.0	23.5
Limestone, gray, blue-gray, black, lithographic, rubbly, nodular, concave, upper is massive and coarsely crystalline, fossiliferous, *Archimedes*	6.5	6.5
Fayetteville:		
Shale and limestone, blue-gray to black, crystalline to lithographic, fossiliferous, 4" thick beds; shale, black to gray, fissile, in thin beds	7.5	116.6
Limestone, gray-brown, very fine, (*Composita*)	1.2	109.1
Limestone, and shale; limestone is blue-gray to brown, fine to coarsely crystalline, crinoidal, oolitic in part, fossiliferous, thick-bedded, shale, gray, calcareous, rubbly, contains small limestone lenses	13.7	107.9
Shale, black fissile, six to eight thin limestone lenses, black, lithographic to medium coarse crystalline, fossiliferous	36.1	94.2
Shale, gray to dark gray, concretionary	11.1	58.1
Covered	2.0	47.0
Shale, black, fissile, large septarian concretions 2-3 feet across	45.0	45.0
Hindsville:		
Limestone, black, medium crystalline with *Diaphragmus*, *Composita*, *Agassizocrinus*	5.0	5.0
Moorefield:		
Ordnance Plant member:		
Shale, brown, silty, gray, and black, jointed fissile, concretion-like	17.0	55.0
Shale, buff, soft, jointed, calcareous	12.0	38.0
Bayou Manard member:		
Limestone, black, argillaceous, scales off, weathers gray on surface, grades into black, platy, calcareous shales, *Leiorhynchus*, *Spirifer arkansanus*, *Moorefieldella*	24.5	26.0
Limestone, black, dense, lithographic, petroliferous odor	1.5	1.5
Base covered.		

44. COMPOSITE SECTION, MILITARY ROAD, WILDHORSE PRAIRIE
Sections 18 and 19, T. 15 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, reddish-brown, partly covered	36.0	36.0
Bloyd:		
Limestone, gray, medium crystalline, poorly exposed, friable, scaly, glauconitic	12.0	36.8
Shale, laminated, fossiliferous	4.0	24.8
Limestone, dark blue-gray, dense, rubbly, many Bryozoa	3.4	20.8
Shale, brown, rubbly, Bryozoa	1.5	17.4
Limestone, blue-gray, dense, sublithographic	4.9	15.9
Shale, shaly limestone, many corals	4.0	11.0
Limestone, fine to medium, hard, pentremital	3.0	7.0
Limestone, blue-gray, fine, crinoidal	2.0	4.0
Shale, gray, laminated, nodular, iron-stained	2.0	2.0
Hale:		
Limestone, blue-gray, coarse crystalline	2.0	40.8
Shale, laminated, silty, rubbly	6.0	38.8
Limestone, blue-gray, coarse, crinoidal, corals	6.8	32.8
Shale, dark, laminated, rubbly	1.5	26.0
Limestone, fine to dense, gray, crinoidal, glauconitic, fossiliferous	2.5	24.5
Siltstone, gray, banded, sandy, shaly, calcareous	2.0	22.0
Shale, gray, silty, calcareous	0.5	20.0
Limestone, blue-gray, coarse, crinoidal	12.0	19.5
Limestone, blue-gray, shaly, fossiliferous, crinoidal, nodular	1.0	7.5
Limestone, blue, coarse to dense, coquina	6.0	6.5
Shale, gray, brown, iron-stained	0.5	0.5
Pitkin:		
Limestone, gray, weathers white, dense, lithographic, nodular, thin shale breaks, *Archimedes*	6.0	60.0
Limestone, blue-gray, crystalline, covered	18.0	54.0
Limestone, blue-gray, nodular-rubbly	8.0	36.0
Limestone, blue-gray, dense to medium crystalline, crinoidal, fossiliferous	12.0	28.0
Limestone, black, lithographic, nodular	6.0	16.0
Covered	10.0	10.0
Fayetteville:		
Covered, black fissile shale exposed; subcuboidal, lithographic, black limestone; and conglomeratic limestone with small, rounded, black pebbles and cephalopods	88.0	115.7
Limestone, black, lithographic, subcuboidal	3.0	27.7
Shale, black, fissile	0.2	24.7
Limestone, black, bluish, surface fine crystalline	0.9	24.5
Shale, black, fissile	0.7	23.6
Limestone, buff to blue-gray, medium crystalline	0.5	22.9
Shale, brown, fissile, calcareous	0.6	22.4
Limestone, dark, fine crystalline to dense	0.8	21.8
Shale, dark to black, thinly laminated	2.7	21.0
Shale, brown, silty, laminated, iron-stained, concretion-like in upper part	18.3	18.3

Moorefield:		
Limestone, blue-gray, dense to fine crystalline	0.5	33.8
Shale, brown, silty, calcareous, almost a limestone, scales off, forming round concretion-like masses	3.3	33.3
Black argillaceuos limestones and black platy shales, *Leiorhynchus, Moorefieldella, Spirifer arkansanus*	30.0	30.0
Base covered.		

45. SOUTH ROADSIDE, QUALLS DOME AREA
Section 35, T. 15 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Boone:		
Chert, tan to bluish-gray, thin-bedded, lenses of gray, finely crystalline limestone	14.0	14.0
Chattanooga:		
Shale, black, iron-stained, fissile	36.0	38.0
Sandstone, reddish-brown, coarse, conglomeratic, cross-bedded	0.6-2.0	2.0
Sallisaw:		
Sandstone, brown, calcareous, fine-grained, unconformable above and below	0.6-1.1	1.1
St. Clair:		
Limestone, blue, mottled, yellow, fine crystalline dolomitic, cherty, sparsely fossiliferous, weathers silty, coarse calcite veins	2-4.0	4.0
Sylvan:		
Shale, dark green, fissile, weathers to yellow-green clay	36.0	36.0
Fernvale:		
Limestone, pink to salmon red, coarsely crystalline, crinoidal, cliff-forming, fossiliferous	18.0	18.0
Fite:		
Limestone, blue-gray to gray-brown, lithographic, birdseye; contains thin dolomite beds near center	7.0	7.0
Tyner:		
Dolomitic limestone, yellow-brown, weathers silty	12.0	79.5
Sandstone, brown, medium- to fine-grained, calcareous	1.5	67.5
Shale, bright green to blue-green, fissile, weathers ocher	66.0	66.0
Burgen:		
Sandstone, white, fine-grained, loosely cemented, quartz sand, fucoidal, veined near fault zone	72.0	72.0
Cotter:		
Shale, yellow, fissile	0.5	4.5
Dolomite, yellow to blue-gray, dense, weathers silty to powdery	4.0	4.0
Base covered.		

46. ROAD CUT, MILITARY ROAD NORTH FROM QUALLS DOME
Section 35, T. 15 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Red sandstones and black shale	50.0	50.0
Bloyd:		
Shale, poorly exposed, 1-foot limestone bed	6.0	56.9

Limestone, gray-brown, sublithographic, algae knobs..	2.5	50.9
Shale and limestones; brown, silty, fissile, limestone dark, blue-gray, bryozoans	27.5	48.4
Shale and thin limestones; shale, brown, clayey, limestone, dark blue-gray, fine to coarsely crystalline, iron-stained, rubbly, fossiliferous, conglomeratic, *Pentremites*	6.9	20.9
Limestone, gray-brown, lithographic, rubbly	6.0	14.0
Shale, brown, iron-stained, fissile, rubbly; limestone ledges, dark blue-gray, crystalline, fossiliferous, bryozoans	8.0	8.0
Hale:		
Limestone, gray, medium to coarsely crystalline, crinoidal, coquinoid	16.5	26.0
Limestone, dark blue-gray, fine crystalline, sandy crinoidal	6.0	9.5
Sandstone, fine to medium, ferruginous	1.5	3.5
Limestone, blue-gray, sandy, highly leached	1.0	2.0
Conglomerate, sandy, ferruginous, small flat pebbles, fossiliferous	1.0	1.0
Pitkin:		
Limestone, gray to blue-gray, fine crystalline, oolitic, fossiliferous	8.0	36.0
Limestone, blue-gray, coarse crystal masses	6.0	28.0
Limestone, blue-gray, lithographic, *Diaphragmus*, weathers nodular and smooth	6.0	22.0
Limestone, fine to medium crystalline, blue-gray, crinoidal, oolitic, fossiliferous	16.0	16.0
Fayetteville:		
Covered zone containing black, fissile shale and subcuboidal blocks of black lithographic limestone....	11.0	11.0

47. PARTIAL SECTION—ATOKA FORMATION
Section 19, T. 15 N., R. 22 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Covered	4.1	48.2
Sandstone, massive, gray to red, hard, with limonite deposits, weathered surface highly pitted	22.2	44.1
Shale and siltstone, shale, black, interbedded with siltstone, finely laminated, non-fossiliferous	.4	21.9
Sandstone, massive, gray-buff, weathers to a dark brown red color with many solution cavities	4.2	20.4
Sandstone, thin-bedded, limonitic, medium buff-reddish gray	.9	16.2
Sandstone, massive, light gray, hard, medium-grained, weathered highly with solution cavities	4.3	15.3
Shale, black, fissile, interbedded with red siltstone, much secondary iron staining	.8	11.0
Covered	8.1	10.2
Shale, gray to black, fissile, brittle	2.1	2.1
Covered	0.0	0.0
Base of exposure		

48. PARTIAL SECTION, Section 36, T. 15 N., R. 22 E.

Formational Description	Thickness in Feet Of Unit	To Base of Fmtn.
Atoka:		
Covered	22.2	26.2
Sandstone, grayish-red, medium grain size	4.0	4.0
Bloyd:		
Covered, (Shale)	7.0	97.2
Shale, dark blue, flaky with limonite concretions	17.8	90.2
Limestone, dark gray, poorly fossiliferous, finely crystalline	2.5	72.4
Shale, concretionary, blue-gray, fissile	35.0	69.9
Limestone, very hard, dense, dark gray	1.0	34.9
Shale, coral fauna embedded	2.5	33.9
Limestone, and honeycomb reef, limestone dark gray, hard, finely crystalline, replacement by calcium carbonate and calcite	4.1	31.4
Limestone, fossiliferous, hard, medium crystalline, dark blue-gray	5.1	27.3
Shale	12.1	22.2
Shale, dark gray and fissile	10.1	10.1
Hale:		
Covered	8.1	8.1
Base of exposure.		

49. COMPOSITE SECTION ON PRICE RANCH
Section 2, T. 15 N., R. 23 E.

Formational Description	Thickness in Feet Of Unit	To Base of Fmtn.
Bloyd:		
Soil, dark gray with thin limestone cobbles	3.0	38.0
Limestone, gray, coarsely crystalline, very fossiliferous *Composita ovata, Composita wasatchensis, Dictyoclostus morrowensis, Septopora crebipora, Ethelocrinus oklahomensis, Pentremites angustus*, covered	15.0 20.0	35.0 20.0
Hale:		
Soil, very sandy, abundant brown sandstone pebbles and cobbles	5.0	60.0
Limestone, white to buff, limonitic with some calcareous sandstone streaks, large scale crossbedding	25.0	55.0
Limestone, reddish-brown, coarsely crystalline, fossiliferous, *Linoproductus altonensis, Dictyoclostus welleri, Ethelocrinus cf. magister*	28.0	30.0
Conglomerate, blue-gray, argillaceous, calcareous matrix with reddish-gray limestone pebbles and greenish, glauconitic streaks	2.0	2.0
Pitkin:		
Limestone, light blue-gray, coarsely crystalline, buff weathering, fossiliferous, *Archimedes communis, Archimedes swallovana, Pentremites laminatus, Composita subquadrata, Chonetes chesterensis*	10.0	25.0
Limestone, gray, dull, finely crystalline	10.0	15.0
Limestone, purple-blue, very coarsely crystalline, reddish weathering, fossiliferous, *Chonetes chesterensis, Eumeteria pitkinensis, Orthotetes kaskaskiensis, Diaphragmus cestriensis, Stenoscisma cestriensis, Platyceras subrotundum, Archimedes communis, Triplophyllum spinulosum, Septopora cestriensis*	5.0	5.0

Fayetteville:		
Covered	20.0	54.0
Shale, dark blue-gray, soft, platy, evenly bedded, ovate ironstone concretions, fossiliferous, *Leda vaseyana Allorisma walkeri, Gastrioceras richardsonianum, Michelinoceras wapanuckense*	10.0	34.0
Limestone, black, hard, concoidal fracture, smooth, whitish weathering, few brachiopods filled with calcite crystals, no identifiable specimens	1.5	24.0
Shale, dark gray, fissile	2.5	22.5
Covered	6.0	20.0
Shale, black, hard, fissile	14.0	14.0
Hindsville:		
Limestone, blue-gray, coarsely crystalline, fossiliferous, *Camerotoechia purduei* var. *laxa, Cliothyridina sublamellosa, Spirifer increbesens, Diaphragmus cestriensis, Linoproductus ovatus, Marginifera adairensis, Composita subquadrata, Eumetria verneuiliana, Agassizocrinus*	5.0	7.0
Covered	2.0	2.0
Moorefield:		
Ordnance Plant member:		
Siltstone, greenish-gray, fossiliferous, *Leiorhynchus carboniferum, Camarotoechia purduei* var. *laxa*	3.0	14.0
Shale, dark gray to black, micaceous	1.0	11.0
Limestone, blue-black, oil odor on fresh break, fossiliferous,*Spirifer moorefieldianus, Moorefieldella eurekensis*	10.0	10.0
Keokuk:		
Limestone, blue-gray, medium crystalline, fossiliferous, *Brachythyris suborbicularis, Spirifer mortonanus*	3.0	208.0
Chert, white to buff, iron-stained	1.0	205.0
Limestone, gray, coarsely crystalline, fossiliferous, *Spiriferella neglecta, Spirifer mortonanus*	10.0	204.0
Limestone, oolitic, light gray to white, massive-bedded	15.0	194.0
Limestone, light blue, whitish weathering, hard, medium crystalline	4.0	179.0
Chert, white to buff, massive-bedded, fractured fossiliferous, *Spirifer logani, Dictyoclostus crawfordsvillensis, "Productus" mesialis*	175.0	175.0
Reeds Spring:		
Limestone, and chert, interbedded thin, gray to blue, fine to medium crystalline limestones and white to blue, sparingly fossiliferous cherts	70.0	70.0
St. Joe:		
Limestones and shales, gray, very porous, fossiliferous, coarsely crystalline limestones with some gray-green shales, horn-corals, exposure partially covered with debris	20.0	20.0
Chattanooga:		
Shale, greenish, platy, soft, possibly glauconitic	1.5	24.0
Shale, black, fissile to platy, hard yellow stain on beding planes, abundant pyrite nodules, base not exposed	22.5	22.5
Alluvium		
Stream gravel and soil.		

50. SECTION SOUTH OF SCHOOLHOUSE
Section 7, T. 15 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Moorefield:		
Limestone, dark gray, fine to medium crystalline, abundant fossils	4.2	13.4
Limestone, dark gray, medium crystalline, thin-bedded, fossiliferous	.7	7.7
Limestone, dark gray, coarsely crystalline, bedded, fossiliferous	4.3	8.5
Limestone, gray, finely crystalline, thin-bedded from one-eighth to two inches	1.1	4.2
Limestone, greenish-gray, massive, finely to medium crystalline, weathered surface spotted	1.2	3.1
Limestone, gray, minute calcite crystals, even-bedded, niche out in bank by weathering	.4	1.9
Limestone, light gray, medium to coarsely crystalline, calcite crystals, greenish specks resembling glauconite	1.5	1.5
Boone:		
Chert, light gray, massive, conchoidal fracture, uneven upper surface	4.8	4.8
Base of exposure.		

51. SECTION ON LYONS MOUNTAIN
Sections 34 and 35, T. 15 N., R. 24 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandy soil and brown sandstone rubble	14.0	54.0
Sandstone, brown to buff, fine grained, thin-bedded	20.0	40.0
Siltstone, thin-bedded, light buff	12.0	20.0
Sandstone, brown to reddish-brown, medium-grained, limonitic	8.0	8.0
Bloyd:		
Covered, evidence of dark gray shale	62.0	102.0
Shale, gray, soft, thick, uneven-bedded	15.0	40.0
Limestone, massive, blue-gray, coarse-grained, fossiliferous, *Michelinia scopulosa, Zaphrentis gibsoni, Pentremites augustus, Pentremites rusticus, Ethelocrinus oklahomensis, Composita wasatchensis, Spirifer rockymontanus*	5.0	25.0
Shale, gray, soft, thick-bedded	10.0	20.0
Limestone, gray, coarsely crystalline, buff weathering, fossiliferous with an abundance of *Michelinia scopulosa, Zaphrentis gibsoni, and Pentremites augustus*	10.0	10.0
Hale		
Limestone, sandy, limonitic, cross-bedded, light gray to buff	12.0	54.0
Sandstone, calcareous, buff to gray, cross-bedded coarse grained	18.0	42.0
Sandstone, pitted, buff, with white and reddish purple streaks, medium-grained, fossilized plant remains	20.0	24.0
Conglomerate, bluish-gray, argillaceous matrix with coarse reddish sand and limestone pebbles some ironstone concretions	4.0	4.0

Pitkin:		
Limestone, blue-gray, finely crystalline, fossiliferous *Archimedes communis, Eumetria costata*	15.0	57.0
Covered, Hale debris	20.0	42.0
Limestone, dark gray, finely crystalline, abundance of *Archimedes communis* and *Archimedes swallovana*	12.0	22.0
Limestone, light blue, coarsely crystalline, fossiliferous *Archimedes communis, Archimedes swallovana, Eumetria pitkinensis*	10.0	10.0
Fayetteville:		
Shale, blue-gray, platy, soft, limonitic concretions, fossiliferous, *Leda vaseyana, Gastrioceras richardsonianum*	17.0	38.0
Shale, blue-black to black, fissile	21.0	21.0
Hindsville:		
Limestone, light gray, coarsely crystalline, fossiliferous, *Composita subquadrata, Diaphragmus cestriensis Dielasma shumardanum, Eumetria verneuiliana, Marginifera adairensis, Torynifera setigera, Spirifer leidyi*	12.0	22.0
Shale, gray, soft, with some light yellow drip-stone nodules	2.0	10.0
Limestone, blue-gray, coarsely crystalline, fossiliferous, *Spirifer increbesens, Marginifera adairensis,* and an abundance of *Agassizocrinus*	8.0	8.0
Moorefield:		
Ordnance Plant member:		
Covered	5.0	10.5
Shale, black, micaceous, platy, fossiliferous, a few crushed Spirifers	2.0	5.5
Siltstone, buff, fossiliferous, *Echinochonchus sp., Leiorhynchus carboniferum, Aviculopecten batesvillensis*	3.5	3.5
Bayou Manard member		
Covered	8.0	16.0
Limestone, coarsely crystalline, dark gray	2.0	8.0
Limestone, dark, blue-black, finely crystalline, oil odor, fossiliferous, *Leiorhynchus carboniferum, Moorefieldella eurekensis*	6.0	6.0
Boone:		
Chert, white to buff, badly fractured, rotten	7.0	7.0

52. STILWELL MOUNTAIN SECTION

Northwest ¼ of Section 12 and Southwest ¼ of Section 1, T. 15 N., R. 25 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Covered, sandstone rubble	17.0	117.0
Sandstone, yellow-brown, fine-grained, weathers dark gray	10.0	100.0
Covered	24.0	90.0
Sandstone, light brown, fine-grained, friable, heavily limonite stained, beds average 4″ in thickness	18.0	66.0
Covered, obscured by sandstone rubble	48.0	48.0
Bloyd:		
Shale, greenish-yellow, platy	18.0	176.0
Limestone, blue-gray, medium to finely crystalline, hard, weathers orange-brown, crinoidal	24.0	158.8
Covered, and blue-green shale	38.0	134.8
Limestone, brown, coarsely crystalline, slightly sandy, weathers to a dark gray-brown	18.0	96.8

Shale, blue-green and platy	11.0	78.8
Limestone, blue-gray, medium to finely crystalline, weathers brown, very fossiliferous, hard	0.9	67.8
Covered, limestone rubble not in place	15.0	66.9
Limestone, blue-gray, finely crystalline, weathers dark gray	0.8	51.9
Covered, some blue-green shale	6.0	51.1
Limestone, blue-gray, finely crystalline, weathers to light brown	1.1	45.1
Covered, some blue-green shale	13.0	44.0
Limestone, light gray, fine-grained, weathers to light gray-tan, hard	1.0	31.0
Shale, bluish-green and platy	30.0	30.0
Hale:		
Sandstone, dark brown, fine-grained, very rotten and friable, weathers to dark grayish-brown	1.0	76.6
Covered	6.0	75.6
Sandstone, dark brown, fine-grained, weathers to dark brown	4.0	69.6
Limestone, blue-gray, medium to finely crystalline, very sandy, hard, weathers to dark brown	14.0	65.6
Sandstone, light gray, fine-grained, calcareous, typical Hale weathering, exposed as a bluff	49.0	51.6
Conglomerate, dark shaly matrix with blue limestone and reddish-brown sandstone cobbles averaging 1″ to 3″ in diameter	2.6	2.6
Pitkin:		
Limestone, dark gray, fine to medium crystalline, very hard, crinoidal	0.3	32.7
Shale, black, weathers dark gray	0.7	32.4
Limestone, blue-gray, medium to finely crystalline, fossiliferous, weathers to light gray, very rotten and rubbly appearance	12.0	31.7
Covered, limestone rubble	19.7	19.7
Fayetteville:		
Shale, black, chunky, somewhat fissile, weathers blue-black and breaks in 6″ thick blocks. Many ironstone concretions in upper 20 feet	60.0	60.0
Hindsville:		
Limestone, blue-gray, finely crystalline, unfossiliferous	2.0	29.5
Limestone, medium gray, finely crystalline, weathers white	10.0	27.5
Limestone, light gray, medium to coarsely crystalline, hard, weathers light gray	15.7	17.5
Shale, completely weathered to a greenish-yellow shale, discontinuous limestone stringers, both shale and limestone fossiliferous	1.8	1.8
Moorefield:		
Ordnance Plant member:		
Limestone, blue-gray, weathers to a gray-brown, finely crystalline, "Moorefield" fauna	1.0	8.0
Siltstone, greenish-brown, platy and blocky, fossiliferous, *Leiorhynchus*, *Aviculopecten*, *Orbiculoidea*, and *Allorisma*	5.0	7.0
Lindsey Bridge member:		
Limestone, blue-gray, medium to coarsely crystalline, contains small angular chert fragments and dissem- brown and rough with crinoid stems and chert protruding, exposure thins to 6″ in 100′ along the outcrop	2.0	2.0

Keokuk:
Chert, buff to white with dark mottling, to base of exposure

53. GOAT MOUNTAIN SECTION

Southwest ¼ of Sec. 8 and Southeast ¼ of Sec. 7, T. 15 N., R. 25 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Bloyd:		
Covered to top of hill	12.0	42.0
Limestone, light blue-gray, fossiliferous (*Pentremites*). Weathers to a light gray, thin-bedded	24.0	30.0
Shale, bluish green, poorly exposed	6.0	6.0
Hale:		
Limestone, blue-gray, changing laterally and vertically into a brown calcareous sandstone. Upper five feet is very rotten	24.0	67.0
Sandstone, calcareous at base, grades upward to a reddish brown medium to fine grained sandstone. The lower calcareous part has parallel horizontal flutings and pittings	43.0	43.0
Pitkin:		
Shale, black, fissile	0.9	54.1
Limestone, medium blue-gray, medium to coarsely crystalline. Heavily limonite stained and many fossil fragments. Weathers to a dark gray	1.7	53.2
Shale, black, calcareous	1.0	51.5
Limestone, medium blue-gray, lithographic. Weathers to a very light gray. Hard but weathers to a fractured, rubbly appearance	2.5	50.5
Limestone, brownish gray, medium crystalline. Massive-bedded	18.0	48.0
Covered	30.0	30.0
Fayetteville:		
Shale, black, chunky, poorly exposed, spring at contact of the overlying Pitkin formation	71.0	71.0
Hindsville:		
Limestone, medium blue-gray, medium to finely crystalline, heavily limonite stained. Near-coquina of spirifers and *Camarotoechia*	14.0	19.0
Limestone, dark blue-gray, very coarsely crystalline, fossiliferous	5.0	5.0
Moorefield:		
Ordnance Plant member:		
Siltstone, greenish yellow and blocky, very abundantly fossiliferous, *Leiorhynchus*	2.0	27.1
Bayou Manard member:		
Limestone, dark blue-gray coarsely crystalline. Weathers brown and in 2″ beds	1.3	25.1
Limestone, dark blue-gray, finely crystalline, massive bedded, weathers to a gray brown	1.3	23.8
Limestone, gray, finely crystalline argillaceous, platy, weathers to a buff-brown	1.0	22.5
Limestone, medium blue-gray, coarsely crystalline, weathers to a dark gray. Beds average 4″ in thickness	3.5	21.5
Limestone, medium blue-gray, finely crystalline, argillaceous, platy limestone. Weathers to a dark gray-		

brown. Occasional 4″ bed of blue medium crystalline limestone	18.0	18.0
Keokuk:		
Chert, buff to white with dark mottling to base of exposure		

54. NORTH DOUBLE HEAD MOUNTAIN SECTION
Northeast ¼ of Section 23, T. 15 N., R. 25 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Covered, rubble consisting of thin-bedded yellowish-brown, fine-grained sandstone	52.5	52.5
Bloyd:		
Covered	6.0	225.0
Limestone, light brownish-gray, medium to coarsely crystalline, weathers to an orange-brown, somewhat rubbly	12.0	219.0
Shale, greenish-yellow, poorly exposed	75.0	207.0
Limestone, dark blue-gray, medium to coarsely crystalline, very hard, weathers to a gray-brown, crinoidal	30.0	132.0
Covered, traces of blue-green shale	42.0	102.0
Limestone, dark blue-gray, very coarsely crystalline, very fossiliferous and is rotten appearing, weathers rough, *Michelinia*	30.0	60.0
Limestone, medium blue-gray, medium to finely crystalline, very hard and crinoidal, weathers orange-brown	6.0	30.0
Covered, some shale indications	24.0	24.0
Hale:		
Sandstone, yellow-brown, medium- to fine-grained. Weathers reddish brown, calcareous, outcrop forms a continuous bluff	72.0	74.0
Conglomerate, blue-gray fine-grained limestone cobbles in a black shaly matrix	2.0	2.0
Pitkin:		
Covered	24.0	54.0
Limestone, blue-gray and limonite-stained, coarsely crystalline, very rubbly and crinoidal, weathers rough and to a light gray	12.0	30.0
Limestone, dark blue, cryptocrystalline, weathers knobby and smooth	18.0	18.0
Fayetteville:		
Shale, black, chunky, weathers into blocks 3″ thick. Limonite concretions in upper zone	78.0	78.0
Hindsville:		
Limestone, medium blue-gray, medium to coarsely crystalline, very hard, weathers to a yellow-brown, *Diaphragmus* and *Agassizocrinus*	4.0	16.0
Limestone, very dark blue-gray, medium to finely crystalline, weathers to a dark gray, *Echinoconchus*	12.0	12.0
Moorefield:		
Ordnance Plant member:		
Siltstone, greenish-yellow, and chunky, weathers to a green-brown, very abundantly fossiliferous, *Leiorhynchus*, and *Aviculopecten*	5.0	8.3

Lindsey Bridge member:		
Limestone, light blue gray, finely crystalline, very hard, contains small angular chert fragments, fossiliferous	3.3	3.3
Keokuk:		
Limestone, light blue gray, medium to finely crystalline, very crinoidal, contains Keokuk fauna	2.0	2.0
Chert, white to buff with dark mottling to base of exposure		

55. WEST STILWELL MOUNTAIN SECTION
Southwest ¼ of Sec. 28 and Northwest ¼ of Sec. 33, T. 16 N., R. 25 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, yellow-brown, poorly exposed	7.0	7.0
Bloyd:		
Limestone, dark blue-gray, medium- to fine-grained, weathers to an orange-brown, very crinoidal	4.0	139.0
Shale, blue-green with limonite concretions	12.0	135.0
Limestone, dark blue-gray, finely crystalline, weathers brown and crinoidal	12.0	123.0
Shale, blue-green, occasional limonite concretion	15.0	111.0
Limestone, blue-gray, finely crystalline with black limestone inclusions, very hard, weathers to an orange-brown. Very large crinoid stems are weathered out	1.0	96.0
Covered	6.0	95.0
Limestone, dark blue-gray, finely crystalline, weathers to a dark orange-brown	5.0	89.0
Covered	21.0	84.0
Limestone, blue-gray, coarsely crystalline, very crinoidal, weathers to a dark orange-brown	3.0	63.0
Covered, poorly exposed blue-green shales	30.0	60.0
Limestone, medium gray, sublithographic with dark limestone inclusions. Weathers to a dark orange-brown	13.0	30.0
Covered	17.0	17.0
Hale:		
Limestone, blue-gray, coarsely crystalline and rotten. Weathers to a gray-black. Beds average one foot in thickness with one inch shale intervals between beds. Outcrop is a gentle slope above the Hale bluff	12.0	72.0
Limestone, light blue-gray on fresh and weathered surfaces, very sandy exposure is an almost vertical bluff, parallel horizontal flutings begin 23' above the base	60.0	60.0
Pitkin:		
Covered, large sandstone and limestone blocks obscuring exposure	24.0	36.0
Limestone, dark blue-gray, medium to coarsely crystalline, weathers to an orange-brown, crinoidal	12.0	12.0
Fayetteville:		
Shale, black, chunky. Upper 18' contains many limonite concretions. Large spring issuing from Pitkin-Fayetteville contact	51.0	51.0
Hindsville:		
Limestone, blue-gray, finely to coarsely crystalline, weathers to a dark gray	27.0	37.5

Limestone, light blue-gray, weathers to a bluff-yellow, medium to finely crystalline, *Agassizocrinus* zone.....	6.0	10.5
Limestone, blue-gray, finley crystalline, weathers buff	2.5	4.5
Shale, yellow-green and weathers to yellowish soil, unfossiliferous	2.0	2.0
Moorefield:		
Lindsey Bridge member:		
Limestone, medium blue-gray, medium to coarsely crystalline, small angular chert pebbles disseminated throughout	2.0	2.0
Keokuk:		
Chert, buff to white with dark mottling, to base of exposure		

56. DAHLONEGAH MOUNTAIN SECTION

South Half of Sec. 29 and Southeast ¼ of Sec. 30, T. 15 N., R. 25 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Covered	8.0	108.0
Sandstone, cream yellow and fine-grained, weathers to gray-brown, heavily limonite-stained, massive-bedded	11.0	100.0
Covered	24.0	89.0
Siltstone, yellowish-green, thin-bedded, weathers to a gray-brown	17.0	65.0
Covered	24.0	48.0
Sandstone, orange-yellow, fine-grained, friable, massive-bedded, weathers to a dark brown, hard on outer surface but soft inside	24.0	24.0
Bloyd:		
Covered	72.0	167.5
Limestone, blue-gray, finely crystalline, weathers orange-brown, very crinoidal on weathered surfaces..	2.0	95.5
Covered	7.0	93.5
Limestone, blue-gray, finely crystalline, weathers to an orange-brown	0.5	86.5
Covered	12.0	86.0
Limestone, blue-gray, coarsely crystalline, fossiliferous, *Dictyoclostus morrowensis*	1.0	74.0
Shale, blue-green, poorly exposed	12.0	73.0
Limestone, dark blue-gray, coarsely crystalline, weathers to a dark gray, abundant crinoid stems and a few *Pentremites*	1.0	61.0
Shale, blue-green, poorly exposed	60.0	60.0
Hale:		
Sandstone, light brown, very calcareous, medium to coarsely crystalline, deeply weathered	78.0	78.0
Pitkin:		
Limestone, dark blue-gray, medium to coarsely crystalline, fractured and rubbly appearing; weathers a light blue-gray, upper 5' is medium blue-gray, very coarsely crystalline and crinoidal	32.0	32.0
Fayetteville:		
Shale, black, chunky, poorly exposed	60.0	60.0
Hindsville:		
Limestone, blue-gray, medium to finely crystalline, massive-bedded, *Agassizocrinus* abundant and large..	12.0	24.4

Shale, greenish-yellow, blocky, weathers to yellow-brown soil	4.2	12.4
Limestone, medium blue-gray, medium to coarsely crystalline, very hard, *Agassizocrinus* abundant	3.7	8.2
Shale, greenish-yellow with five inch bed of limestone 2′ above base	4.5	4.5
Moorefield:		
Ordnance Plant member:		
Siltstone, black, calcareous, very thin-bedded, weathers to reddish-yellow soil, *Leiorhynchus* and *Aviculopecten* abundant in lower zone, unfossiliferous in upper	12.0	25.0
Bayou Manard member:		
Limestone, light blue-gray, finely crystalline, very fossiliferous	7.0	13.0
Limestone, black, fine-grained argillaceous, weathers gray brown, very large *Echinoconchus*	6.0	6.0
Keokuk:		
Chert, buff to white with dark mottling, to base of exposure		

57. WELCH MOUNTAIN SECTION
North Half of Section 33, T. 15 N., R. 25 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Covered, yellow sandstone float obscuring exposure	33.0	43.0
Sandstone, yellow-brown, fine-grained massive-bedded, weathers to a dark reddish-brown	3.0	10.0
Covered	7.0	7.0
Bloyd:		
Limestone, blue-gray, medium to coarsely crystalline, weathers to an orange-brown and platy	7.0	123.0
Covered	48.0	116.0
Limestone, blue-gray, medium to coarsely crystalline, weathers to an orange-brown, very crinoidal	10.0	68.0
Covered	18.0	58.0
Limestone, brownish-gray, medium to coarsely crystalline, thin-bedded, weathers to an orange-brown	10.0	40.0
Covered, blue-green shales poorly exposed	17.0	30.0
Limestone, gray-brown, medium to coarsely crystalline, weathers to a blue-gray, hard, very crinoidal	2.0	13.0
Covered	11.0	11.0
Hale:		
Limestone, brownish-gray, medium to coarsely crystalline, weathers to a blue-gray, very crinoidal	2.0	45.0
Covered	3.0	43.0
Limestone, light gray, medium to finely crystalline, very sandy and deeply pitted, weathers to a dark blue-gray	7.0	40.0
Covered	15.0	33.0
Limestone, medium blue-gray, very coarsely crystalline, weathers platy and thin-bedded, very crinoidal, grades upward to a darker blue	18.0	18.0
Pitkin:		
Limestone, light brown, very coarsely crystalline, rubbly and very rotten, limonite stained, massive-bedded, upper zone becomes harder and less stained. Poorly exposed in lower part	25.0	25.0

Fayetteville:		
Shale, black, chunky, poorly exposed	30.0	30.0
Hindsville:		
Limestone, medium blue-gray, medium to coarsely crystalline, very hard, *Agassizocrinus* on lower beds, *Archimedes* on uppermost bed	18.0	19.9
Shale, greenish-yellow, silty, one inch beds of blue-gray medium crystalline limestone beds interfingering. This is the uppermost shaly zone found in the quarry on U. S. Highway 59, 8 miles south of Stilwell	1.9	1.9
Moorefield:		
Ordnance Plant member:		
Limestone, blue-gray, medium to coarsely crystalline, contains Moorefield fauna	6.8	30.1
Limestone, blue-gray, very finely crystalline and has green shale streaks, abundant *Leiorhynchus* and *Aviculopecten*	2.0	23.3
Shale, blue-green, very calcareous, chunky appearing, pyrite flakes	0.3	21.3
Lindsey Bridge member:		
Limestone, dark blue-gray, medium to coarsely crystalline	1.1	21.0
Shale, dark blue-green	0.7	19.9
Limestone, dark blue-gray, medium to coarsely crystalline	0.8	19.2
Shale, greenish-yellow, hard, very calcareous, platy, limestone fingers, pyrite flakes	2.0	18.4
Limestone, dark blue, medium to coarsely crystalline, very hard contains *Linoproductus*	7.5	16.4
Shale, greenish blue, calcareous, hard, unfossiliferous, chunky and blocky appearing	0.8	8.9
Limestone, dark blue-gray, finely crystalline, very hard, unfossiliferous, conchoidal fracture	8.1	8.1
Keokuk:		
Chert, white to buff with dark mottling, floors the quarry in one place		

58. SOUTH DOUBLE HEAD MOUNTAIN SECTION
Southwest ¼ of Section 35, T. 15 N., R. 25 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Siltstone, yellow-tan, weathers to a reddish-brown and is platy in appearance	2.0	68.0
Covered	18.0	66.0
Siltstone, yellowish-tan, weathers to a light brown, very thin bedded	3.0	48.0
Covered by large sandstone blocks	45.0	45.0
Bloyd:		
Limestone, brownish-gray, fine to medium crystalline, crinoidal, weathers to an orange-brown, beds average 4′ in thickness	31.0	192.0
Covered, some greenish-yellow shale	36.0	161.0
Limestone, medium blue-gray, finely crystalline, weathers gray-brown, becomes rubbly in upper zone..	36.0	125.0
Covered, traces of blue-green shale	24.0	89.0
Limestone, light blue-gray, medium to coarsely crystalline, very crinoidal, very rubbly in upper zone....	28.0	65.0
Covered	37.0	37.0

Hale:		
Covered	37.0	71.0
Limestone, medium blue-gray, medium to very coarsely crystalline, weathers blue-gray, very crinoidal	4.0	34.0
Sandstone, light brown, very coarsely crystalline, calcareous, and rotten, heavily limonite stained, typical Hale weathering	18.0	30.0
Covered	12.0	12.0
Pitkin:		
Limestone, brown to tan, sublithographic, very hard, weathers to a near white	6.0	31.0
Limestone, brownish-gray, medium to finely crystalline, hard, very crinoidal, weathers to a medium blue-gray	25.0	25.0
Fayetteville:		
Shale, black and chunky	42.0	42.0
Hindsville:		
Limestone, dark blue-black, medium to coarsely crystalline, very hard weathers to a brownish-gray, *Agassizocrinus* abundant 12′ from the base, upper 10′ is much finer in grain size	30.0	30.0
Moorefield:		
Ordnance Plant member:		
Sitlstone, greenish-yellow, weathers to a yellow-tan, very fossiliferous, *Leiorhynchus* and *Aviculopecten*..	5.0	21.0
Lindsey Bridge member:		
Limestone, light blue-gray, medium to coarsely crystalline, angular to subrounded chert fragments disseminated throughout, fossiliferous in part, weathers to a gray-brown	10.0	16.0
Bayou Manard member:		
Limestone, dark blue-gray, fine grained, argillaceous, and platy, very fossiliferous, weathers to a gray brown	6.0	6.0
Keokuk:		
Chert, white to buff with dark mottling, to base of exposure		

59. NORTHEAST SPUR OF MUSKRAT MOUNTAIN
Sections 1 and 2, T. 15 N., R. 26 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Covered to top of hill.		
Hale:		
Sandstone, cream to buff, weathers ferruginous, hard, massive	30.0	30.0
Pitkin:		
Limestone, medium gray, dense, lithographic, rubbly, *Linoproductus ovatus*	18.0	18.0
Fayetteville:		
Covered (Includes base of Pitkin)	20.0	184.0
Sandstone, interbedded, fine-grained, buff to tan, hard, ripple marked, sandstone, and dark greenish, thin-bedded, platy shales	8.0	164.0
Shale, fissile to platy, gray-green, few limonite concretions	30.0	156.0
Covered	78.0	126.0

Shale, black, carbonaceous, platy, weathers into small benches 6 inches high and wide, gives jointed appearance	48.0	48.0
Hindsville:		
Limestone, coarsely crystalline, fossiliferous, medium gray, hard, *Agassizocrinus conicus* in abundance	11.0	23.0
Limestone, blue-gray, medium crystalline, very hard, petroliferous odor	12.0	12.0
Covered		

60. NORTHWEST SPUR OF MUSKRAT MOUNTAIN
Section 17, T. 15 N., R. 26 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Covered to top of hill.		
Hale:		
Sandstone, reddish brown, coarse, massive, fluted and cavernous, calcareous	20.0	20.0
Pitkin:		
Limestone, silty, black, fine-grained	6.0	29.8
Shale, black, platy, small nodules and thin stringers of limestone	1.0	23.8
Limestone, rubbly, gray, fossiliferous in zones, dense, cherty locally, *Linoproductus ovatus, Archimedes*	22.8	22.8
Fayetteville:		
Covered (Includes the base of the Pitkin)	36.0	102.0
Shale, black, platy, carbonaceous, grades upward into more greenish, fissile variety	66.0	66.0
Hindsville:		
Limestone, gray, crystalline, hard, petroliferous odor, massive-bedded, *Diaphragmus cestriensis, Dictyoclostus inflatus*	21.5	21.5
Moorefield:		
Covered (Includes pieces of Moorefield float)	2.0	20.0
Lindsey Bridge member:		
Limestone, dark gray, coarsely crystalline, thin-bedded	6.0	18.0
Limestone, silty, fine-grained, light gray, contains small angular chert fragments	12.0	12.0
Boone:		
Chert, cream to white, weathers reddish to orange	5.0	5.0
Covered		

61. SOUTH SIDE OF SALLY BULL HOLLOW
Section 33, T. 15 N., R. 26 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Covered		
Hindsville:		
Limestone, finely crystalline to granular, medium blue-gray, rubbly weathering	1.5	26.9
Limestone, finely crystalline to dense, light blue-gray, weathers smooth	1.5	25.4
Limestone, thin-bedded, limonitic, finely crystalline, *Agassizocrinus conicus*	1.0	23.9
Shale, brownish green, thin and platy	0.5	22.0
Limestone, dense to lithographic, dark blue-black to bluish-white	1.8	22.4

Limestone, dark blue-gray, medium crystalline, very hard, relatively unfossiliferous	2.0	20.6
Limestone, thin-bedded, coarsely crystalline, blue-gray..	2.5	18.6
Limestone, coarsely crystalline, light gray, *Agassizocrinus conicus* plentiful	1.8	16.1
Limestone, coarsely crystalline (granular), crinoid stems of pure calcite, rotten	0.5	14.3
Limestone, hard, blue-gray, *Agassizocrinus conicus*	1.8	13.8
Limestone, hard, dense to finely crystalline, medium gray	0.8	12.0
Shale, weathers bluish-brown, calcareous, platy	1.2	11.2
Limestone, light to medium gray, coarsely crystalline, *Agassizocrinus conicus*	4.0	10.0
Limestone and shale, interbedded brownish, thin limestones and dark blue-black shales, *Agassizocrinus conicus* found in limestones	5.0	6.0
Moorefield:		
Ordnance Plant member:		
Siltstone and shale, calcareous, hard, brownish in color, abundant *Leiorhynchus carboniferum*	1.0	1.0
Boone:		
Limestone, blue-gray, medium crystalline, hard, *Linoproductus ovatus*	6.0	36.0
Chert, white to creamy, weathers orange, characteristically in angular pieces	30.0	30.0
Covered		

62. SOUTH END OF ROSS MOUNTAIN
Section 1, T. 14 N., R. 26 E., and
Sections 35 and 36, T. 15 N., R. 26 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Covered	42.0	183.5
Sandstone, massive to thin-bedded, light brown to tan in color, weathers ferruginous, coarse-grained	24.0	141.5
Covered	94.0	117.5
Sandstone, fine-grained, thin-bedded, light brown to buff weathering to reddish brown	5.5	23.5
Covered, with shale indications	18.0	18.0
Bloyd:		
Limestone, medium gray, hard, fossiliferous, beds one-half foot thick	3.0	139.0
Covered with greenish-gray shale	27.0	136.0
Limestone, finely crystalline, medium to light gray, fossiliferous, crinoidal, weathers to a thin-bedded appearance, rotten on surface	2.0	109.0
Covered	18.0	107.0
Limestone, dark gray, limonitic, dense, with *Pentremites*	1.0	89.0
Covered, with limestone float	24.0	88.0
Limestone, dark blue-gray weathering to brown, hard, fine to medium crystalline, *Pentremites* abundant	1.0	64.0
Covered, with shale indications	18.0	63.0
Limestone, light gray, medium crystalline, hard, weathers dark gray, *Michelinia scopulosa* on surface..	3.0	45.0
Covered	36.0	42.0
Limestone, dense, hard, blue-gray, fossiliferous	6.0	6.0

Hale:		
Sandstone, thin-bedded, fine-grained, interbedded with gray, fissile, shales	21.0	136.0
Limestone, arenaceous, hard, medium crystalline, light gray, surface weathers smooth, *Michelinia scopulosa*..	24.0	114.0
Sandstone, fluted, weathers from brown to buff, coarse grained, cross-bedded	42.0	90.0
Covered	18.0	48.0
Sandstone, fine-grained, calcareous, weathers brown from a buff to cream, massive	30.0	30.0
Pitkin:		
Limestone, rubbly, finely crystalline, light gray, *Archimedes* abundant on weathered bedding planes	32.0	48.0
Covered	16.0	16.0
Fayetteville:		
Covered	14.0	136.0
Sandstone, hard, massive-bedded, buff, laminated	4.0	122.0
Siltstone and shale, dark, greenish-gray, shales, intercalated with brownish, fine-grained, siltstones	6.0	118.0
Shale, dark blue-gray, fissile	20.0	112.0
Covered	50.0	92.0
Shale, black, carbonaceous, weathers to large black plates, layers from 3 to 6 inches thick	42.0	42.0
Hindsville:		
Limestone, coarsely crystalline, blue-black, petroliferous odor	3.0	5.3
Shale, green, silty, plastic	0.8	2.3
Limestone, blue-gray, weathers white, lithographic	0.5	1.5
Limestone, hard, blue-gray, dense to finely crystalline, few fossils	1.0	1.0
Covered		

63. MUSKRAT MOUNTAIN
Sections 28 and 29, T. 15 N., R. 26 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:	21.0	75.0
Covered	24.0	54.0
Sandstone, hard, massive, weathers from buff to brown	30.0	30.0
Covered		
Bloyd:	48.0	176.9
Covered	3.0	128.9
Limestone, blue-gray, weathers brown, dense, massive..	39.0	125.9
Covered	18.0	86.9
Limestone and shale	6.0	68.9
Limestone, brown, fossiliferous, weathers platy, *Pentremites*	18.0	62.9
Shale, gray-green, fissile	8.0	44.9
Limestone, dense, dark blue, *Pentremites* weathered out on surface	4.0	36.9
Shale, gray-green, very fissile	17.9	32.9
Limestone, light gray to brown, hard, medium crystalline	3.0	15.0
Shale, blue-gray to brown, platy	12.0	12.0
Limestone, blue-gray, hard, fossiliferous, orange, crinoid stems		
Hale:	24.0	101.0
Covered	24.0	77.0
Sandstone, flaggy, beds 1" to 1' thick, brown in color..		

Sandstone, calcareous, massive-bedded, fluted weathering	47.0	53.0
Shale, black with phosphatic pebbles	6.0	6.0
Pitkin:		
Limestone, blue-gray rubbly, medium crystalline to lithographic, *Linoproductus ovatus*	20.0	26.0
Covered	6.0	6.0
Fayetteville:		
Covered	12.0	102.0
Sandstone, buff to cream colored, 6" to 1' beds, hard	6.0	90.0
Interbedded siltstones, shales and sandstones, with each bed only a few inches thick	12.0	84.0
Covered	6.0	72.0
Shale, gray-green, platy	12.0	66.0
Covered	30.0	54.0
Shale, black, carbonaceous, blocky	24.0	24.0
Hindsville:		
Limestone, hard, blue, few fossils	6.8	28.9
Shale, brownish green, compact, blocky	2.8	22.1
Limestone, hard, medium to coarsely crystalline, blue-gray	5.0	19.3
Shale, gray-green, blocky	2.5	14.3
Limestone, fossiliferous, hard, blue-gray	1.3	11.8
Shale, dark green, plastic, non-fossiliferous	1.5	9.0
Limestone, hard, dense, blue-gray, unfossiliferous	1.0	9.0
Covered	8.0	8.0
Boone:		
Chert, not measured.		

64. SECTION ALONG WEST SIDE OF FORT GIBSON DAM
Northeast ¼ Section 13, T. 16 N., R. 19 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Siltstone, buff-brown, upper portion thin-bedded and iron-stained, lower part massive and streaked black	16.0	16.0
Bloyd:		
Shale, bluish-gray, calcareous, weathers iron-stained	3.3	39.5
Limestone, light gray, silty, locally sandy, weathers iron-stained	9.5	36.2
Covered	12.5	26.7
Limestone, blue-gray, fine crystalline with finer crystalline nodules within, weathers fluted and crinoidal, several shale breaks	10.5	14.2
Shale, gray, bryozoans abundant	2.0	3.7
Limestone, blue-gray, fine crystalline, weathers crinoidal, fossiliferous	0.7	1.7
Shale, dark gray to black with greenish cast, fissile, bryozoans	1.0	1.0
Hale:		
Limestone, gray to brown, fine crystalline, massive, fluting and crinoidal weathering	19.7	47.1
Limestone, gray, fine crystalline, knobbly, shale partings, pinches out laterally	0.5	27.4
Limestone, reddish-brown to gray brown, medium to coarse crystalline, pink calcite masses, weathers buff and fluted, iron stained, crinoidal	20.2	26.9

Shale, gray to black, fissile, calcareous, thickness varies laterally	4.7	6.7
Limestone, hematitic and concretionary, conglomeratic appearance, shale breaks, great lateral variation in thickness, 6.0 feet in one place	2.0	2.0
Pitkin:		
Limestone, gray, finely crystalline, oolitic	9.5	9.5
Base covered		

65. SECTION TAKEN ALONG TRIBUTARY OF RANGER CREEK IN CORNERS OF Section 7, 8, 17, 18, T. 16 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Fayetteville:		
Shale, blue-black, with interbedded blue-black lithographic limestones and septarian concretions	12.0	38.0
Covered, probably shale	26.0	26.0
Hindsville:		
Limestone, lower portion medium to coarse crystalline, bluish-gray, upper part, fine to sublithographic, brownish-gray, weathers bluish	12.0	12.0
Moorefield:		
Ordnance Plant member:		
Covered	16.5	26.8
Siltstone, calcareous, dark brown to light brownish-gray, weathers blocky and platy in middle portions, shaly in lower and upper parts, unfossiliferous	6.0	10.3
Lindsey Bridge member:		
Limestone, light gray to brown, medium to coarse crystalline, abundant chert pebbles, bed characterized by large amounts of small brachiopods on weathered surface and calcite layers which are limonitic streaked	2.1	4.3
Bayou Manard member:		
Limestone, brownish-gray, medium to fine crystalline limestone. Lower part is massive, upper portion weathers into an argillaceous limestone, fossiliferous, containing *Moorefieldella eurekensis* and *Leiorhynchus carboniferum*	2.2	2.2
Base of exposure.		

66. SECTION ALONG ROAD CUT ON EAST SIDE OF FORT GIBSON DAM Sections 7 and 18, T. 16 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, very coarse, containing fossil trees, sandstone is white where not stained and is sub-angular to sub-rounded, uneven bedding	6.4	178.3
Sandstone, conglomeratic at base, sand grains up to 5 mm., gravel to 1 cm., pebbles to 3″	1.3	171.9
Shale, gray, thinly laminated, limonitic stains	1.1	170.6
Mudstones, gray-white on weathered surface, highly stained by limonite, uneven bedding, upper part highly concretionary with limonitic rectangular concretions	5.5	169.5

Sandstone, shaly, gray, fine-grained, worm-like fossil zone at base, beds vary from 1″ to 3″ and platy, whole section is limonitic-stained buff and weathers to a white	5.6	164.0
Sandstone, very fine-grained, uneven bedded, limonitic concretions throughout in rectangular shapes	35.2	157.4
Sandstone, fine-grained, massive, blocky, highly ferruginous	4.1	122.2
Sandstone, shaly, containing concretions with matrix of fossils, weathers platy, calcareous thicker bedding at base	20.3	118.1
Shale, sandy with dark ferruginous sand at base	11.1	97.8
Sandstone, dark, ferruginous, platy, uneven bedding, iron-stained	17.0	86.7
Sandstone, medium-grained, blocky-bedded, ferruginous	5.6	69.7
Shale, greenish	0.9	64.1
Sandstone, buff to cream colored, medium-grained, weathers blocky, banded, ripple marked, iron-stained	2.1	63.2
Shale, gray, weathers to a light mottled clay, concretions	3.2	61.1
Sandstone, very fine-grained, weathers buff	2.1	57.9
Shale, gray, platy	0.2	55.8
Sandstone, fine-grained, weathers buff	0.3	55.6
Shale, black, grades into sandstone above, rubbly weathering, uneven bedding, streaked black	1.0	55.3
Ironstone concretionary layer — red concretions spherical 1″ to 3″ in diameter—grades into shale above	0.4	54.3
Sandstone, medium-grained, iron concretions	0.8	53.9
Shale, gray, sandy, unevenly bedded	0.6	53.1
Sandstone, argillaceous, streaked black, fine-grained	1.3	52.5
Ironstone concretions, red	0.3	51.2
Shale, gray, silty, highly concretionary, concretions columnar or wheel shaped, rubbly, uneven bedded, streaked black	5.4	50.9
Sandstone, medium-grained, ferruginous, grades into shale at top, block, massive, buff on surface, grayish on fresh breaks, shaly and iron-stained near base	3.0	45.5
Shale, blue-black, iron-stained near top, ¼″ sandstone breaks near base	2.1	42.5
Sandstone, medium-grained, shaly especially in center, uneven bedded, iron-stained	2.1	40.4
Shale, black, weathers light gray, sandstone ledges 2″ to 3″ thick 1′ from top, ferruginous, 1″ concretionary bed	2.3	38.3
Siltstone, blue-gray, massive, blocky, cross-bedded, cavernous, light buff on weathering, iron-stained, streaked black	16.2	36.0
Shale, black, weathers gray, iron-stained	0.4	19.8
Shale, calcareous, blue-gray, contains dense lenses of calcareous sandstone	6.2	19.4
Siltstone, calcareous, yellow-brown, blue-gray at base	1.9	13.2
Shale, blue-gray, black streaked, concretionary, top 5″ a black thinly laminated shale, lower portion a shaly, calcareous sandstone	1.1	11.3
Siltstone, blue-gray, shale partings, weathers iron-stained, zones of porous weathering, pure to sandy, cross-bedded	10.2	10.2
Bloyd:		
Shale, black to steel-blue with numerous lenses of fossiliferous limestone varying from 1″ to more than		

2', weathers iron-stained, the shale is thinly laminated and breaks up into long, thin fragments, fractures in conchoidal almost concretion-like flattened oblate spheriods, very fossiliferous, lower limestone lenses thickens and thins rapidly, limestone is dense, hard, blue-gray	9.5	33.1
Limestone, dense, fossiliferous, blue-gray, varies in thickness laterally	3.5	23.6
Shale, gray to black, calcareous, uneven-bedded, nodular with calcite knobs, fossiliferous, grades laterally into limestone, has concretionary red hematitic bed near base, colonial corals	1.1	20.1
Limestone, blue-gray, weathers whitish, medium crystalline, *Pentremites*	1.0	19.0
Shale, black, calcareous, as above	0.6	17.1
Limestone, as above, with shale breaks	4.1	16.5
Limestone, gray, very knobular or concretionary, numerous shale breaks, shale gray-green	5.0	12.4
Limestone, blue-gray, fine crystalline, fossiliferous, massive, numerous shale breaks average one half inch, uneven-bedded, central portion contains black nodular limestone	7.0	7.4
Shale, black, thinly laminated, calcareous	0.4	0.4
Hale:		
Limestone, light gray to brown, coarsely crystalline, massive, pitted, about 2' from top there is oolitic section followed by a pistachio green section, no lateral extension of oolite, greenish shale near center, conglomeratic bed missing at base, thin shale parting only	30.6	30.6
Pitkin:		
Limestone, gray, medium crystalline, uneven-bedded, weathers rubbly, many shale partings, coarse calcite crystals	17.4	39.2
Limestone, lithographic to sublithographic, nodular, brown, *Pentremites, Archimedes*	2.8	21.8
Covered	13.0	19.0
Limestone, dark blue-gray, lithographic to sublithographic, knobular, shale partings	6.0	6.0
Fayetteville:		
Limestones and shales, interbedded, limestones black lithographic to sublithographic, vary in thickness up to 1', shales, dark fissile, up to 1.5' in thickness, limestones nodular in places, fossiliferous throughout	15.3	18.5
Limestone, dense, brown, nodular, lithographic	3.2	3.2
Base of exposure.		

67. WEAVER QUARRY SECTION

Southwest ¼ of Section 15, T. 16 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of F'mtn.
Bloyd:		
Limestone, irregularly bedded, medium to coarse blue-gray, weathers crinoidal and fluted	6.0	28.6
Covered, probably shale	3.0	22.6
Limestone, blue-gray, medium-grained	0.5	19.6
Limestone, knobby, rubbly, shale partings	2.0	19.1

Limestone, blue-gray, with interbedded dark fissile shale	6.0	17.1
Shale, gray, stained reddish-brown, lenses of sandy, knobby, limestone	0.5	11.1
Shale, blue, limonitic stained	1.0	10.6
Limestone, blue-gray, locally silty, several shale breaks	5.6	9.6
Siltstone, calcareous, glauconitic, greenish cast, streaked black, weathers nodular	4.0	4.0
Hale:		
Limestone, brown, medium to fine crystalline, shale breaks	15.0	37.5
Shale, greenish cast, lenses of nodular limestones	0.5	22.5
Limestone, medium to fine crystalline, fossiliferous, colors from light to dark brown, thin shale beds	20.0	22.0
Conglomerate, phosphatic pebbles, reddish in color	2.0	2.0
Pitkin:		
Limestone, blue-gray, dense, fine-crystalline to sub-lithographic, oolitic in basal sections	14.0	14.0
Base of exposure.		

68. SECTION TAKEN ALONG ROAD BETWEEN Sections 5, 6, 7, 8, T. 16 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hale:		
Limestone, brown, fine-grained, sandy	0.5	38.6
Limestone, light brown to gray, medium crystalline, sandy	3.3	38.1
Limestone, light blue-gray	3.0	34.8
Limestone, bluish, grading upward into gray oolitic limestone, sandy, the lower portion becomes coarser and less sandy, crinoidal weathering	16.5	31.8
Covered, probably shale	4.3	15.3
Limestone, bluish-black, sandy	0.7	11.0
Covered, probably shale	0.2	10.3
Conglomerate, pitted, ferruginous, limestone pebbles	1.0	10.1
Shale, brownish-gray, calcareous	3.1	9.1
Conglomerate, pitted, ferruginous, limestone pebbles, ¾″ in diameter	6.0	6.0
Pitkin:		
Limestone, black, weathers rubbly, bluish on weathered surface	5.0	5.0
Fayetteville:		
Shale, black fissile	20.0	26.0
Covered, probably shale	6.0	6.0
Hindsville:		
Limestone, gray, highly fossiliferous, bluish, smooth lithographic beds in upper portions	6.0	6.0
Moorefield:		
Covered	36.0	39.5
Limestone, light gray, coarse, coquina-like, crinoidal, crinoid stems measure 1 to 2 inches in diameter	3.5	3.5
Base of exposure.		

69. NORTH SLOPE OF MOUNTAIN BORDERING LINDER VALLEY
Section 15, T. 16 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Covered, sandy, tree-covered soil	8.0	24.0
Sandstone, tan, medium-grained, hard, massive-bedded	16.0	16.0
Bloyd:		
Covered	2.0	63.0
Limestone, gray to light blue, hard, massive, fossiliferous, finely crystalline, weathers rough on surface	22.0	61.0
Shale, blue, brittle	4.0	39.0
Siltstone, buff, coarse, porous, iron-stained on bedding surfaces, beds 2 and 3 inches thick	8.0	35.0
Siltstone, same as above except it is thin, platy, more shaly	12.0	27.0
Limestone, blue-gray, finely crystalline, fossiliferous, large calcite masses in fractures	4.0	15.0
Shale, soft, gray	4.0	11.0
Limestone, lithographic, light blue	2.0	7.0
Shale, light blue, friable, covered	5.0	5.0
Hale:		
Limestone, gray, massive, coarsely crystalline, granular, iron-stained, contains disseminated specks of iron, crinoidal	9.0	32.0
Covered	4.0	23.0
Limestone, same as top zone, contains *Striatopora oklahomenis* in shale parting near top	19.0	19.0
Pitkin:		
Limestone, poorly exposed, coarsely crystalline, fossiliferous, contains *Archimedes* and *Pentremites*	24.0	24.0
Covered to base of hill		

70. TAHLEQUAH CREEK BED, ONE MILE SOUTH OF TAHLEQUAH
Section 4, T. 16 N., R. 22 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hindsville:		
Covered interval in stream bed.		
Limestone, blue-gray, coarsely crystalline, highly fossiliferous, weathers rough and gray, bedded by strata 8 to 10 inches thick	4.0	4.0
Moorefield:		
Ordnance Plant member:		
Siltstone, yellow, platy, soft and streaked with thin fissile black shale	0.5	4.0
Siltstone, yellow, soft, concretionary, thin-bedded, weathers rapidly to a clayey soil	3.5	3.5
Bayou Manard member:		
Limestone, finely crystalline, blue to black color, jointed into rectangular blocks, weathers very smooth and to a light blue on the surface	2.0	14.0
Shale, dark gray, soft and calcareous	0.2	12.0
Limestone, dark blue, argillaceous, fine crystalline	3.0	11.8
Limestone, dark, dense, fine crystalline, interbedded with argillaceous, shaly to platy beds less than one		

foot thick. Abundant *Griffithides pustulosus* in basal layer	8.8	8.8
Tahlequah member:		
Limestone, dark gray, medium crystalline, glauconitic or green-specked, bedded in layers 6 to 8 inches thick, unfossiliferous	4.0	9.0
Limestone, gray, medium to coarsely crystalline, crinoidal, interbedded with light gray brittle chert	5.0	5.0
Keokuk:		
Chert, white, massive, and spicular	2.0	14.0
Chert and limestone partially covered to base of exposure	12.0	12.0
Base of exposure.		

71. ILLINOIS RIVER SOUTH BLUFF (CORNSHELL MOUNTAIN)
Southeast ¼ of Section 25, T. 16 N., R. 22 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Keokuk:		
Chert, chalky white to creamy gray, iron-stained, fossiliferous, massive, shatters to small angular fragments with conchoidal fractures, inclusions of drusy quartz, with occasional lens gray-blue, fine limestone	50.0	50.0
Reeds Spring:		
Chert, thin-bedded, nodular, gray-white, with some dark zones interbedded, resistant bluff former, fossils very rare	171.0	171.0
Chattanooga:		
Clay, greenish black to yellow with small pebbles of black shale	0.2	7.6
Shale, black, brittle, carbonaceous	1.5	7.4
Shale, buff, silty, streaked dark	0.5	5.9
Shale, black, carbonaceous, brittle, often iron-stained to red in seams	4.2	5.4
Sandstone, black, fine-grained, slightly calcareous (Sylamore ?)	0.6	0.6
Sylvan:		
Shale, light brown to buff color, silty, hard, blocky and unevenly bedded. Many stringers of brown quartzitic sandstone of one to three inches thickness occur locally in the lower half	33.0	33.0
Fernvale:		
Limestone, lead gray, massive, coarsely crystalline; crinoidal, cliff former, weathers crumbly and pitted with gray color. Abundant *Lepidocyclus laddi*	14.0	14.0
Fite:		
Limestone, dense, powder-blue, lithographic, non-fossiliferous, flecked with calcite crystals giving birds-eye appearance. Massive beds of four inches to three feet, cliff forming	11.6	15.0
Dolomite, very sandy, yellow to brown color with thin dark streaks	1.4	3.4
Limestone, same as upper zone	2.0	2.0
Tyner:		
Dolomite, sandy, yellow, finely crystalline, slabby and evenly bedded	1.5	75.0
Dolomitic limestone, yellow to brown, silty with granular appearance	1.2	73.5

Dolomite, same as the first zone	1.8	72.3
Sandstone, dolomitic and limy, rounded quartz grains fairly coarse, dark to black color, shiny on fracture..	0.7	70.5
Dolomite, yellow, silty, granular, slabby	5.0	69.8
Shale, bright blue, soft, gritty	0.4	64.8
Dolomite, pink, soft	0.4	64.4
Shale, green to greenish-blue, soft and thinly laminated	14.0	64.0
Sandstone, pink, saccharoidal	0.3	50.0
Shale, green, soft, weathers to mucky yellow clay	3.0	49.7
Covered to river level, base not exposed	46.7	

72. PARKHILL MOUNTAIN SECTIONS ALONG HIGHWAY 10 TWO MILES SOUTH OF JUNCTION WITH U. S. HIGHWAY 62

Sections 27-28, T. 16 N., R. 22 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Covered, clay and shale soil, sandy	15.0	35.0
Sandstone, thin-bedded, medium-grained, shaly and brown in color	3.0	20.0
Sandstone, reddish brown, medium-grained, iron-stained, very hard	3.0	17.0
Sandstone, buff, thin-bedded, medium- to fine-grained, slightly cross bedded	10.0	14.0
Sandstone, thin and shaly at top, shaly at bottom, buff to gray	4.0	4.0
Bloyd:		
Shale, buff with greenish hue, weathers buff, silty texture, fissile, limonite concretions	19.5	79.0
Shale, thin, fissile, soft, buff to bluish gray in color	4.4	59.5
Limestone, blue, rubbly, stained yellowish-brown on surface	0.6	55.1
Shale, blue-gray, soft	0.2	54.5
Limestone, sublithographic, blue, uneven to rubbly, contains small calcite vugs, discontinuous shale	4.1	54.3
Shale, yellow-brown, thin limestone lens	2.6	50.2
Siltstone, buff with greenish hue, weathers buff or tan, fissile	21.0	57.6
Limestone, hard, blue, fine crystalline and shaly at top	2.5	36.6
Siltstone, buff, fissile, thin-bedded	3.1	34.1
Shale, bluish color, thin, fissile, soft, fossil fragments..	6.0	31.0
Limestone, blue, medium crystalline to sublithographic in zones, weathers buff on surface, fossiliferous, shale bed included	5.9	25.0
Shale, pale blue, fissile, soft with thin discontinuous limestone layers	10.8	19.1
Limestone, brittle, fossiliferous stained reddish brown on surface with layer of concretionary iron-stained shale at base	5.0	8.8
Shale, soft, gray, friable	3.8	3.8
Hale:		
Sandstone, calcareous, heavily iron-stained, earthy red color, pitted and cavernous	1.2	36.0
Shale, light blue, friable, iron-stained	3.4	34.8
Limestone, blue, fine crystalline, sandy and clayey, irregular with discontinuous hard shales	3.2	30.4
Shale, blue-gray, weathers buff, friable	0.5	27.2

Limestone, gray or light blue, coarsely crystalline crinoidal, extremely hard, massive-bedded with thin discontinuous shale partings containing abundant *Striatopora oklahomensis*	10.0	26.7
Shale, soft, friable, yellowish, weathers buff with blue hue	2.5	16.7
Limestone, same as thick layer above, contains *Pentremites angustus*, weathers fluted and slightly cross-bedded	14.2	14.2
Pitkin:		
Limestone, series of fine crystalline to sublithographic layers with shale partings, uneven to rubbly surface weathered smooth, fossiliferous	6.0	30.0
Limestone, blue sublithographic, conchoidal fracture, *Archimedes*	0.5	24.0
Covered interval of poorly exposed limestones and shales	12.0	23.5
Limestone, blue, sublithographic, jointed, *Archimedes* and *Pentremites*	2.0	11.5
Covered to estimated base of formation	9.5	9.5
Fayetteville:		
Covered interval from estimated base of Pitkin formation	20.0	35.0
Shale, black, carbonaceous, fissile, splintery and concretionary in zones	15.0	15.0
Hindsville:		
Limestone, dark blue, sublithographic, calcite masses, *Diaphragmus cestriensis*	1.0	1.0
Base covered.		

73. NORTH SLOPE OF HILL ONE MILE SOUTH OF SEQUOYAH INDIAN SCHOOL ON U. S. HIGHWAY 62

Section 29, T. 16 N., R. 22 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Bloyd:		
Limestone, blue, finely crystalline, massive, fossiliferous	3.0	20.0
Covered interval with a few poorly exposed limestone outcrops	17.0	17.0
Hale:		
Limestone, sandy, coarse, reddish color with purple streaks, iron-stained, pitted	2.5	38.0
Shale, poorly exposed, buff, soft	1.0	35.5
Limestone, gray, coarsely crystalline, massive-bedded, hard, crinoidal	14.0	34.5
Covered	4.0	20.5
Limestone, drab gray, coarsely crystalline, fossiliferous, hard, weathers rough and fluted on surface, massive-bedded with shale partings, contains ferrouginous specks	16.5	16.5
Pitkin:		
Covered	3.0	26.0
Limestone, dark gray, finely crystalline with sublithographic zones and shale partings, irregular, fossiliferous	2.0	23.0
Limestone, very coarse, dark blue to light gray, iron stained in places	8.0	21.0

Limestone, poorly exposed, shaly, with rubbly, clay covered cobbles	13.0	13.0
Fayetteville:		
Shale, black, carbonaceous, fissile, with thin layers of gypsum near top	36.0	36.0
Hindsville:		
Limestone gray sublithographic, bedded unevenly, fractured	3.0	44.0
Limestone, coarse, granular, dark gray, evenly bedded in layers 10 to 18 inches thick, calcified crinoids	20.0	41.0
Limestone, thinly-bedded, shale partings, dark blue and fossiliferous, *Agassizocrinus* zone 8 feet above base, abundant *Composita subquadrata* in basal layer	21.0	21.0
Moorefield:		
Ordnance Plant member:		
Shale, yellow, soft, friable, full of phosphatic shell fragments	0.2	6.0
Shale, soft buff mixed with brittle black shale	0.5	5.8
Shale, yellow, soft, friable	0.4	5.3
Siltstone, buff, argillaceous, thin and shaly, weathers to clay soil, grades laterally into black, fissile shale similar to Fayetteville	4.9	4.9
Base of exposure:		
(Covered to Keokuk 100 yards downstream.		
Covered interval thickness estimated 12 feet		

74. WAUHILLAU AREA
Center of Section 2, T. 16 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Reeds Spring:		
Chert, gray-white, interbedded with gray, dense, thin, silicified limestone. Chert beds average about 8" thick and limestone 2". Covered above	25.0	25.0
Chattanooga:		
Shale black, hard, slaty, with abundant pyrite nodules, weathers iron-stained	30.0	30.0
Sylamore member:		
Sandstone, gray, fine to medium, hard, with rounded phosphate nodules which weather white	0.3	1.8
Sandstone, brown, medium, soft, friable, petroliferous	0.7	1.5
Sandstone, gray to brown, fine to medium, hard, massive with phosphate nodules, weathers brown to gray. Base of exposure	0.8	0.8

75. EAST SIDE OF OUTLIER
Southeast ¼ of Section 3, T. 16 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Fayetteville:		
Shale, very poorly exposed as black shale wash. Outlier is covered by Boone chert wash from upthrown side of fault. Top of hill	50.0	50.0
Hindsville:		
Limestone, black, medium-textured, fossiliferous, iron-stained, weathers pink and gray, petroliferous odor, bedding up to 2 feet	8.0	51.0

Covered	3.0	43.0
Limestone, gray, dense, platy, silty, weathers blocky and gray	4.0	40.0
Limestone, light gray, dense, rubbly	4.0	36.0
Limestone, gray to black, medium crinoidal, iron-stained, petroliferous odor, massive	6.0	32.0
Limestone, light gray, fine silty, weathers blocky	2.0	26.0
Limestone, gray to black, medium-textured, fossiliferous, weathers rotten and gray, petroliferous odor, bedding from 6 to 12 inches	12.0	24.0
Limestone, gray, fine, dense, silty, rubbly, weathers light gray and smooth	8.0	12.0
Limestone, gray-black, medium to dense, massive, highly fossiliferous with *Linoproductus ovatus*. Believed to be base although covered	4.0	4.0
(Taken along road in NE section 3)		
Hindsville:		
Limestone, gray, medium, highly fossiliferous with *Marginifera adairensis, Agassizocrinus, Spirifer leidyi*	2.0	2.5
Marl, buff, fossiliferous, with small limestone nodules	0.5	0.5
Moorefield:		
Ordnance Plant member:		
Shale, buff, silty, fissile	0.5	11.0
Shale, black, fissile	1.0	10.5
Shale, buff, silty, fissile	9.5	9.5
Bayou Manard member:		
Limestone, gray to black, fine, platy, silty with abundant *Leiorhynchus carboniferum*	5.5	6.0
Limestone, gray to black, medium, silty, friable with abundant chert pebbles	0.5	0.5
Keokuk:		
Limestone gray, dense, siliceous, knobby intermingled with white chert to base of creek	6.0	6.0

76. SOUTH OF WELLING
Southeast ¼ of Section 7, T. 16 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hindsville:		
Limestone, gray to brown, fine to medium texture, well jointed, consisting of residual blocks on top of hill	2.7	17.5
Limestone, gray, dense, fine	0.7	14.8
Limestone, gray to black, medium to coarse, massive, iron-stained, weathering rotten	2.3	14.1
Limestone, gray to black, sublithographic, rubbly, weathering white to buff	1.9	11.8
Limestone, gray to buff, medium, oolitic, weathering rotten	0.7	9.9
Limestone, gray to black, medium-crystalline, rotten	1.3	9.2
Limestone, gray, dense, thin-bedded	2.4	7.9
Limestone, gray, fine, thin-bedded, fossiliferous, rubbly, weathers light buff	2.0	5.5
Limestone, gray, fine to medium texture, highly fossiliferous, weathering knobby on top	1.2	3.5
Limestone, black, medium-crystalline, petroliferous, massive	2.0	2.3
Limestone, fine, silty	0.3	0.3

Moorefield:		
Ordnance Plant member:		
Shale, brown, silty	0.5	17.4
Shale, black, fissile	0.9	16.9
Shale, brown to buff, silty, friable with occasional black, dense, limestone septaria, weathering light buff, measuring up to 10 inches in diameter	16.0	16.0
Lindsey Bridge member:		
Limestone, black, medium, platy, with rounded to subangular, white to reddish brown chert pebbles	0.2	4.8
Limestone, black, dense, with conchoidal fracture, variable in thickness	0.7	4.6
Limestone, black, fine, shaly	0.9	3.9
Limestone, gray to black, medium to coarse, crinoidal, massive with 2 to 6 inch chert pebble zone at base	3.0	3.0
Bayou Manard member:		
Limestone, brown, shaly	0.9	11.8
Limestone, gray to black, fine, silty, platy, grading downward to more massive, dense, well-jointed limestone, weathers blue, base of exposure	10.9	10.9

77. WAUHILLAU CLUB OUTLIER

Northeast ¼ of Section 9, T. 16 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Fayetteville:		
Shale, black, poorly exposed as black shale wash to top of hill	50.0	50.0
Hindsville:		
Limestone	40.0	40.0
Moorefield:		
Ordnance Plant member:		
Shale, buff, silty, fissile	0.9	14.2
Shale, black, fissile	1.0	13.3
Shale, buff, silty, fissile	12.3	12.3
Bayou Manard member:		
Limestone, black, dense, platy, silty, weathers blue-gray and buff	5.8	5.8
Keokuk:		
Limestone, gray-black, dense, knobby, typical, weathers light blue-gray, intermixed with white chert masses	4.0	44.0
Chert, reddish-white, massive, some intermixed limestone to bottom of creek	40.0	40.0

78. PRICHARD'S HOLLOW

Southeast ¼ of Section 9, T. 16 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Reeds Spring:		
Chert and limestone, interbedded. Covered above	20.0	20.0
Chattanooga:		
Shale, black, hard, slaty, well jointed	46.7	46.7
Sylamore member:		
Sandstone, gray to brown, hard to friable, some calcareous, some with small phosphate nodules, extremely variable. Exposed in creek floor	2.0	2.0

79. North Center Section 10, T. 16 N., R. 23 E.

Formational Description	Thickness in Feet Of Unit	To Base of Fmtn.
Reeds Spring:		
Chert, gray to white, interbedded with gray, dense, thin, siliceous limestone. Covered above	40.0	40.0
St. Joe:		
Limestone, gray, some greenish-gray, fine, crinoidal, coarsely disseminated pyrite, and interbedded with thin green fissile shale. Limestones are medium-bedded	3.8	4.9
Shale, gray-green, well consolidated	0.3	1.1
Limestone, gray, medium, crinoidal, coarsely disseminated pyrite	0.8	0.8
Chattanooga:		
Shale, black, hard, slaty, abundant pyrite. Base of exposure	24.0	24.0

80. NORTH BLUFF OF DEEP HOLLOW
Southwest ¼ of Section 17, T. 16 N., R. 23 E.

Formational Description	Thickness in Feet Of Unit	To Base of Fmtn.
Reeds Spring:		
Chert, gray to white, exposed as residual talus to top of hill	80.0	80.0
Chattanooga:		
Shale, black, slaty, pyrite particles, streaked with iron-stain	33.0	33.0
Fernvale:		
Limestone, gray, coarse, massive, abundant *Lepidocyclus laddi*	13.9	13.9
Fite:		
Limestone, blue-white to gray, sublithographic, non-fossiliferous, weathers smooth and light gray, slabby with definite bedding ranging from 6 inches to 4 feet	12.2	16.6
Dolomite, buff, massive, sandy, weathering brown to reddish, has dark bands throughout	2.7	4.4
Limestone, gray, sublithographic, non-fossiliferous, massive	1.7	1.7
Tyner:		
Upper member:		
Dolomite, brown-yellow, massive, with resistant jointing	5.0	10.0
Sandstone, black, coarse	0.3	5.0
Dolomite, tan, sandy	0.4	4.7
Dolomite, tan to black, coarse, sandy	1.5	4.3
Dolomite, brown-yellow, medium, sandy	1.5	2.0
Dolomite, pink, sandy	1.3	1.3
Middle member:		
Shale, deep blue-green, silty	0.5	17.9
Shale, green, soft, friable	14.0	17.4
Dolomite, brown, thin-bedded, sandy	2.0	3.4
Shale, green	0.5	1.4
Dolomite, pink, medium, base of exposure covered	0.9	0.9

81. BOY SCOUT CAMP
North Central Section 19, T. 16 N., R. 23 E.

Formational Description	Thickness in Feet Of Unit	To Base of Fmtn.
Hale:		
Sandstone, poorly exposed, brown, fine to medium, thin-bedded, top of hill	10.0	44.4
Limestone, gray, medium, crinoidal, iron-stained, weathers brown	2.0	34.4
Limestone, gray-brown, medium, sandy	2.0	32.4
Limestone, gray, dense	2.0	30.4
Shale, green-brown-gray, silty, interbedded with gray silty limestone	4.0	28.4
Limestone, gray, fine, dense, massive, some silty	10.0	24.4
Limestone, gray-brown medium, massive, slightly iron-stained	14.0	14.4
Conglomerate, red to brown, pitted, sandy, calcareous, typical	0.4	0.4
Pitkin:		
Limestone, black, dense, some coarsely crinoidal, fractures blocky, with *Archimedes* and *Linoproductus ovatus*	8.0	14.0
Covered	6.0	6.0
Fayetteville:		
Shale, black, fissile with abundant black, dense, limestone septaria, base covered	30.0	30.0

82. SMALL OUTLIER ONE-FOURTH MILE SOUTH OF BOY SCOUT CAMP
West Central Section 19, T. 16 N., R. 23 E.

Formational Description	Thickness in Feet Of Unit	To Base of Fmtn.
Hale:		
Limestone, gray-brown, fine to medium, massive, some iron-stained to top of bluff	10.0	16.0
Covered	6.0	6.0
Pitkin:		
Limestone, gray, dense, blocky, made up largely of *Linoproductus ovatus*	4.9	16.8
Covered	2.0	11.9
Limestone, black, medium, iron-stained, sometimes coarsely crinoidal	0.5	9.9
Covered rubbly zone	7.0	9.4
Limestone, gray, dense knobular	1.6	2.4
Limestone, black, fine, platy, iron-stained	0.3	0.8
Marl, buff, granular, limy	0.5	0.5
Fayetteville:		
Shale, black, poorly exposed to alluvium	30.0	30.0

83. DEEP HOLLOW SECTION
100 YARDS EAST OF ROAD ONE MILE SOUTH OF WELLING BRIDGE
Northwest Corner of Section 20, T. 16 N., R. 23 E.

Formational Description	Thickness in Feet Of Unit	To Base of Fmtn.
Keokuk:		
Chert, massive-bedded, white or gray, often stained		

red or brown, fossiliferous, and very brittle. Exposure forms slopes of angular fragmental chert talus, sometimes tripolitic or porous	68.0	68.0
Reeds Spring:		
Chert, white or light gray with few thin dark layers, knobby and nodular thin beds, dense, and non-fossiliferous	178.0	178.0
Chattanooga:		
Shale, black, carbonaceous, brittle, with angular concretionary structure, jointed into rectangular blocks approximately 3 by 5 feet, stained red, especially along joint seams	20.0	33.0
Shale, same as above but containing abundant pyrite as streaks between layers and as nodular lumps up to ½ inch in diameter	8.0	13.0
Shale, same as upper layer, free of pyrite but showing cone-in-cone structure	5.0	5.0
Fernvale:		
Limestone, gray, massive, coarsely crystalline, crinoidal, weathers crumbly and pitted, a bluff former. Abundant *Lepidocyclus laddi*	13.7	13.7
Fite:		
Limestone, gray-blue, lithographic, dense, brittle, with calcite crystals forming birdseye structure. Bedded in layers of 4 to 24 inches	12.3	12.3
Tyner:		
Dolomite, massive, sandy and granular, tan brown color with dark streaks, weathers yellowing	5.0	28.0
Sandstone, coarse, black, calcareous, soft	0.3	23.0
Dolomite, same as upper layer	2.3	22.7
Sandstone, coarse, dark dolomitic, rounded quartz grains	1.5	19.3
Dolomite, same as upper layer	1.5	17.8
Dolomite, pinkish tan, silty, slabby and even bedded..	1.4	16.3
Shale, bright blue-green, soft, silty	0.5	14.9
Shale, green, fine clayey, interbedded thin dolomite stringers	12.0	14.4
Dolomite, yellow, slabby	1.5	2.4
Shale, soft, friable, pale green	0.2	0.9
Sandstone, coarse, rounded quartz grains, pink, rough surface	0.5	0.7
Shale, soft, friable, blue	0.2	0.2
Remaining thickness unknown and unexposed.		

84. Southeast ¼ of Section 28, T. 16 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hindsville:		
Limestone, gray, medium, massive, weathers iron-stained and blocky, covered above	12.0	29.3
Limestone, gray, dense rubbly zone	8.0	17.3
Limestone, gray, medium, massive, weathers rotten	4.0	9.3
Limestone, gray, fine to medium, silty, rotten, rubbly, weathering buff and light gray, highly fossiliferous..	5.0	5.3
Marl, buff, highly fossiliferous with small limestone nodules	0.3	0.3
Moorefield:		
Ordnance Plant member:		
Shale, buff, silty, fissile	0.3	5.5

Shale, black, fissile	1.0	5.2
Shale, black and buff, silty, fissile	4.0	4.2
Siltstone, buff, friable	0.2	0.2
Bayou Manard member:		
Limestone, black to buff, platy, silty	0.5	0.5
Keokuk:		
Limestone, blue-gray, dense, knobby. Ghert and limestone below mostly covered	4.0	4.0

85. SUGAR MOUNTAIN

Northwest ¼ of Section 28, T. 16 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Covered, brown, residual, sandstone blocks on top of hill	10.0	42.0
Sandstone, brown, hard, fine, even-bedded	12.0	32.0
Covered	20.0	20.0
Bloyd:		
Limestone, gray-brown, dense, massive	6.0	110.5
Covered	70.0	104.5
Limestone, gray-brown, dense, massive	0.5	34.5
Covered	6.0	34.0
Limestone, gray, dense, massive	2.0	28.0
Shale, blue-gray-green, fissile	4.0	26.0
Limestone, gray, dense, massive	2.0	22.0
Covered	20.0	20.0
Hale:		
Limestone, gray-brown, coarse, iron-stained, massive, sandy	20.0	50.0
Covered	12.0	30.0
Limestone, gray-brown, medium, iron-stained, massive	6.0	18.0
Covered	12.0	12.0
Pitkin:		
Limestone; gray, medium to coarse, massive, blocky	8.0	18.0
Covered	6.0	10.0
Limestone, gray to black, dense, massive, weathers buff, coarsely crinoidal, with *Archimedes*	4.0	4.0
Fayetteville:		
Covered, evidence of black shale wash	30.0	30.0
Hindsville:		
Limestone, gray to black, dense, exposed as rubbly zone	4.0	27.0
Limestone, gray to black, medium to coarse, massive, poorly exposed	8.0	23.0
Covered	15.0	15.0
Moorefield:		
Ordnance Plant member:		
Shale, buff, silty, fissile, covered below	6.0	6.0

86. EAST SIDE SUGAR MOUNTAIN

Southeast ¼ of Section 28, T. 16 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Unmeasured section of Atoka, Hale, Pitkin, and Fayetteville due to slump covered hillside.		
Hindsville:		
Limestone, dark gray, compact, massive beds one to two feet thick	12.0	22.0

Limestone, darker, more thinly bedded, highly fossiliferous, shale partings	4.0	10.0
Covered	3.0	6.0
Limestone, dark gray to black, coarsely crystalline, beds 0.5″ thick separated by soft crumbly argillaceous shale, abundant *"Marginifera" adairensis*	3.0	3.0
Moorefield:		
Ordnance Plant member:		
Siltstone, yellow, thinly-bedded	1.0	6.0
Covered	5.0	5.0
Bayou Manard member:		
Limestone, dark blue, massive, smooth-bedded, argillaceous, shale partings, *Leiorhynchus carboniferum*	5.0	5.0
Limestone, with large rounded chert pebbles	1.0	1.0
Base of exposure on Keokuk chert		

87. HORSESHOE BEND OF ILLINOIS RIVER
Sections 30 and 31, T. 16 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Keokuk:		
Limestone, gray, massive, interbedded with weathered chert, very fossiliferous, *Spirifer logani* fauna	50.0	50.0
Reeds Spring:		
Limestone, dark, thin-bedded, carrying much dark colored chert, sparsely fossiliferous	165.0	165.0
Chattanooga:		
Shale, black, pyritic, cone-in-cone structure common, slaty	8.0	8.0
Sylvan:		
Shale, greenish, buff, silty, concretionary	29.2	29.2
Fernvale:		
Limestone, gray to pinkish, coarsely crystalline, massive	13.7	13.7
Fite:		
Limestone, buff, dense, sublithographic, massive	0.9	16.7
Sandstone, buff, medium, friable, calcareous	0.2	15.8
Limestone, gray to buff, sublithographic, weathers blue-white and smooth, slabby	10.3	15.6
Dolomite, buff, fine, massive, sandy	3.7	5.3
Limestone, gray to buff, dense, sublithographic, weathers blue-white and smooth	1.6	1.6
Tyner:		
Upper member:		
Limestone, buff, fine, very hard, massive, dolomitic	2.8	10.8
Covered	4.0	8.0
Limestone, buff, fine, very hard, massive, dolomitic	4.0	4.0
Middle member:		
Shale, buff to green, some silty, calcareous	13.7	38.8
Shale, dark blue-green, fissile	0.5	25.1
Dolomite, buff, fine, friable, massive, very sandy	1.2	24.6
Shale, green to blue, silty, some calcareous	4.8	23.4
Dolomite, buff, fine, massive, sandy	1.0	18.6
Shale, green fissile	3.7	17.6
Dolomite, buff, fine, massive, sandy	2.5	13.9
Shale, blue-green, fissile	1.2	11.4
Dolomite, buff, fine, massive, sandy	2.2	10.2
Shale, blue, green	3.0	8.0
Sandstone, buff, fine, hard but friable, dolomitic	2.7	5.0

Shale, green, silty, friable	1.3	2.3
Sandstone, buff, fine, hard, thin-bedded, covered to alluvium 20 feet below	1.0	1.0

88. SMALL OUTLIER WEST OF SUGAR MOUNTAIN
Southeast ¼ of Section 32, T. 16 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hindsville:		
Limestone, gray, medium, rubbly, fossiliferous, covered above	2.0	9.2
Covered, probably shale (questionably Hindsville)	6.0	7.2
Limestone, gray-black, fine, silty, platy (questionably Hindsville)	0.2	1.2
Limestone, gray, medium, fossiliferous (questionably Hindsville)	0.5	1.0
Limestone, gray to black, fine to medium, silty, platy with small chert pebbles and ironstone fragments (questionably Hindsville)	0.5	0.5
Moorefield:		
Tahlequah member:		
Limestone, gray to buff, fine to medium, massive with glauconite, coarsely disseminated throughout. Upper contact questionable due to high initial dip of overlying bed which gives a peculiar "exfoliated" appearance	12.0	12.0
Keokuk:		
"Short Creek" member:		
Limestone, gray-white, finely oolitic to medium to coarsely crystalline, massive. Thickness indefinite due to gentle slope. Contacts estimated	8.0	8.0
Chert, white to reddish white, exposed as float to base of hill		

89. WEST SIDE OF SUGAR MOUNTAIN
Southwest ¼ of Section 33, T. 16 N., R. 23 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, covered to top of hill with brown to red, fine to medium, loose blocks	13.7	27.7
Sandstone, brown, some red, ferruginous, hard, massive, exposed in a bluff	14.0	14.0
Bloyd:		
Covered, probably shale	19.0	102.5
Limestone, gray, dense, sucrosic, massive, weathers gray-buff and smooth	4.0	83.5
Covered	55.5	79.5
Limestone, gray, fine, platy	4.0	24.0
Limestone, gray, medium texture, dense, massive, fossiliferous, *Pentremites*, weathers brown to gray	2.0	20.0
Covered	18.0	18.0
Hale:		
Limestone, brown, fine, platy, silty	1.0	43.0
Limestone, gray-brown, medium, heavy-bedded	12.0	42.0
Sandstone, brown to red, fine to medium, massive	6.0	30.0
Covered	12.0	24.0

Limestone, dark gray, medium, massive, sandy, weathers brown	8.0	12.0
Limestone, dark gray, fine, coarsely crinoidal, massive	4.0	4.0
Fayetteville:		
Shale, black, exposed as float with few black sublithographic septaria	18.0	18.0
Hindsville:		
Limestone, gray, fine, silty, platy, jointed, massive	6.0	22.0
Covered	6.0	16.0
Limestone, poorly exposed, rubbly zone	10.0	10.0
Moorefield:		
Tahlequah member:		
Limestone, gray to buff, medium coarse, massive, with specks of glauconite coarsely disseminated throughout, contacts not exposed	12.0	12.0
Keokuk:		
"Short Creek" member:		
Limestone, white to gray, massive, fine to medium oolitic, crystalline, poorly exposed	8.0	8.0
Chert, consists of white to reddish-white chert float to base of hill	10.0	10.0

90. SPADE MOUNTAIN
North Central Section 2, T. 16 N., R. 24 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, brown, fine, hard, massive, loose blocks on top of north side of hill	2.0	2.0
Bloyd:		
Limestone, blue-gray, fine to medium, platy, fossiliferous, crinoidal, questionably correlated by Moore with the Kessler of Arkansas	3.0	145.0
Shale, gray-green to buff, fissile, with limonite concretions, poorly exposed with possible thin limestone members	35.0	142.0
Limestone, gray, fine to medium, platy	3.0	107.0
Shale, blue-green, fissile, poorly exposed	5.0	104.0
Limestone, gray, medium to coarse, rubbly, fossiliferous	4.0	99.0
Shale, blue-gray, fissile, limonite concretions, poorly exposed	10.0	95.0
Limestone, gray to brown, fine to medium, platy, weathers iron-stain brown	2.0	85.0
Covered	20.0	83.0
Limestone, gray to buff, medium, locally coarse, massive, weathers brown and platy	3.0	63.0
Shale, gray, fissile, poorly exposed	8.0	60.0
Limestone, gray to buff, medium to coarse, crinoidal, massive, weathers iron-stained brown	4.0	52.0
Shale, gray, fissile, with limonite concretions	7.0	48.0
Limestone, gray, medium to coarse, massive, crinoidal	4.0	41.0
Shale, gray, fissile	8.0	37.0
Limestone, brown to gray, sandy, *Pentremites*	3.0	29.0
Shale, gray, fissile, poorly exposed	6.0	26.0
Limestone, gray, to brown, fine to medium, thin-bedded, poorly exposed	10.0	20.0
Limestone, gray, dense, massive, weathers smooth and light blue	4.0	10.0

Limestone, gray, fine to coarse, massive, weathers smooth and coarsely crinoidal	6.0	6.0
Hale:		
Sandstone, gray, medium, weathers red to brown pitted, friable	10.0	99.5
Covered, abundant red to brown, pitted sandstone float	87.5	89.5
Shale, green	2.0	2.0
Hindsville:		
Limestone, black to gray, fine to coarse, predominantly massive, some thin-bedded, base covered	26.0	26.0
Moorefield:		
Covered, brown silty soil typical of upper shale member	10.0	10.0
Boone:		
Chert, white to reddish white float, to base of exposure	70.0	70.0

91. SPADE MOUNTAIN
Southeast ¼ of Section 11, T. 16 N., R. 24 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hale:		
Sandstone, brown, fine to medium, massive, fluted, ferruginous, weathers reddish brown, top of hill....	11.7	42.9
(Underlying section of Hale exposed as cliff)		
Sandstone, brown to reddish, sometimes almost white, fine to medium, some calcareous, ferruginous, massive, fluted, weathering reddish brown	20.5	31.2
Limestone, gray, dense, massive, slightly silty	6.0	10.7
Sandstone, gray to brown, rotten, ferruginous, massive, highly calcareous, weathers brown and pitted, grades downward into the underlying conglomerate	3.5	4.7
Conglomerate, red to gray, fossiliferous, sandy, calcareous, weathers pitted and rough	1.2	1.2
Fayetteville:		
Shale, black	0.2	12.9
Covered, probably shale	12.7	12.7
Hindsville:		
Limestone, gray, fine to medium, some iron-stained, sometimes highly fossiliferous, weathers rotten, poorly exposed	10.0	24.0
Covered	10.0	14.0
Limestone, gray, dense, massive, iron-stained. Covered below	4.0	4.0

92. SOUTH OUTLIER OF SPADE MOUNTAIN TAKEN ON HIGHWAY 51
Section 14, T. 16 N. R. 24 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hale:		
Sandstone, red to brown, fine to medium, massive, some calcareous. Exposed as high residual blocks on south part of outlier	12.0	52.0
Covered with sandstone slump	40.0	40.0

Fayetteville:		
Shale, black, fissile, with ironstone concretions, poorly exposed	45.0	45.0
Hindsville:		
Limestone, gray, dense, massive, argillaceous	2.6	26.5
Limestone, gray-buff, dense, massive	3.2	23.9
Limestone, gray-black, medium, iron-stained, crinoidal, massive	4.3	20.7
Limestone, gray-black, dense, sublithographic, massive	3.2	16.4
Limestone, black, medium, massive	3.0	13.2
Shale, black, fissile	2.5	10.2
Limestone, gray, medium, massive, weathers iron-stained and rotten	3.0	7.7
Limestone, gray, dense, massive	4.0	4.7
Marl, buff with small limestone nodules, fossiliferous..	0.7	0.7
Moorefield:		
Ordnance Plant member:		
Shale, buff, silty	5.6	6.6
Shale, black, fissile	1.0	1.0
Covered below		

93. SMALL OUTLIER
Northeast ¼ of Section 17, T. 16 N., R. 24 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hale:		
Sandstone, red, fine, massive, residual blocks	1.0	9.5
Limestone, brown, medium to fine, limonite-stained, massive, sandy	2.5	8.5
Covered, typical Hale conglomerate float	6.0	6.0
Fayetteville:		
Shale, black, poorly exposed as black shale wash	35.0	35.0
Hindsville:		
Limestone, gray, medium, massive	6.0	26.8
Limestone, poorly exposed rubbly zone	15.0	20.0
Limestone, gray to black, medium, massive, fossiliferous (*Agassizocrinus*)	5.0	5.8
Marl, buff, fossiliferous with small limestone nodules scattered throughout	0.8	0.8
Moorefield:		
Ordnance Plant member:		
Shale, buff, silty, fissile	5.2	28.2
Shale, black, fissile	8.0	23.0
Shale, buff, silty	15.0	15.0
Bayou Manard member:		
Limestone, gray, fine, silty, platy	0.8	4.8
Covered	4.0	4.0
Tahlequah member:		
Limestone, gray, dense, slightly glauconitic, poorly exposed	1.0	1.0
Keokuk:		
Short Creek member:		
Limestone, white to gray, oolitic, massive. Base unexposed. Contacts unexposed	4.0	4.0

94. ROAD NEAR WAUHILLAU
Center of Section 19, T. 16 N., R. 24 E.

Formational Description	Thickness in Feet Of Unit	To Base of Fmtn.
Hale:		
Sandstone, brown, fine, massive, poorly exposed and badly slumped on top of hill	20.5	95.4
Sandstone, brown, fine, thin-bedded to massive, interbedded yellow buff, fissile shale, poorly exposed	27.3	74.9
Shale, gray-green, hard,	11.6	47.6
Sandstone, brown, fine, massive, to thin-bedded, interbedded with buff to dark shales, poorly exposed	36.0	36.0
Fayetteville:		
Shale, black, fissile, jointed, well exposed in ditch, base unexposed	40.0	40.0

95. CANEY CREEK
Northwest ¼ of Section 30, T. 16 N., R. 24 E.

Formational Description	Thickness in Feet Of Unit	To Base of Fmtn.
Hale:		
Limestone, gray, medium to coarsely crystalline, even bedded, well jointed, sandy, iron-stained, weathers brown	6.3	56.2
Limestone, black, dense, sucrosic, poorly exposed	2.0	49.9
Covered	4.0	47.9
Sandstone, brown, fine, hard, calcareous	2.0	43.9
Sandstone, brown to gray, fine, calcareous, badly slumped	6.0	41.9
Limestone, gray-brown, fine to medium, massive, locally thin-bedded, sandy, weathers brown	15.0	35.9
Sandstone, brown, fine, massive, calcareous, weathers pitted and fluted	6.0	20.9
Sandstone, brown, fine, slabby	2.8	14.9
Limestone, brown, finely oolitic and pitted with some coarse calcite masses	0.3	12.1
Sandstone, brown to gray, fine- to medium-grained, massive to locally thin-bedded	11.0	11.8
Conglomerate, brown, pitted, with sandy calcareous matrix, contains worn fossils and rounded phosphate (?) nodules	0.8	0.8
Pitkin:		
Limestone, blue-gray, fine to medium, massive, many coarse crinoid stems and *Archimedes*	3.3	28.1
Covered	7.0	24.8
Limestone, gray, dense, massive, blocky	4.8	17.8
Marl, poorly exposed, buff, small limestone nodules, some blue-gray shale	6.0	13.0
Limestone, black, rubbly, poorly exposed	3.0	7.0
Limestone, gray to black, dense, massive, well jointed, weathers brown, *Archimedes*	4.0	4.0
Fayetteville:		
Covered	20.0	26.0
Shale, black, fissile, well jointed to creek bed	6.0	6.0

96. COON MOUNTAIN

Southeast ¼ of Section 35 and SW ¼ Section 36, T. 16 N., R. 24 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Bloyd:		
Limestone, gray to black, medium, some thin-bedded, weathers brown to gray	5.0	96.0
Shale, blue-gray, fissile, limonite concretions	6.0	91.0
Limestone, gray, fine, to medium, weathers brown	5.0	85.0
Covered	7.0	80.0
Limestone, gray, dense, weathers buff to blue	4.0	73.0
Covered	6.0	69.0
Shale, blue-gray, fissile with limonite concretions	10.0	63.0
Covered, probably shale	4.0	53.0
Limestone, blue-gray, fine, dense, jointed, massive, weathers smooth	5.0	49.0
Covered	5.0	44.0
Shale, blue-gray, fissile, limonite concretions	3.0	39.0
Limestone, blue-gray, fine, dense, massive, weathers smooth and buff	10.0	36.0
Shale, blue-gray, fissile with limonite concretions	8.0	26.0
Limestone, blue-gray, medium to coarse, fossiliferous	3.0	18.0
Covered	10.0	15.0
Limestone, gray to brown, medium, platy	5.0	5.0
Hale:		
Sandstone, brown to red, pitted, thin-bedded	6.0	72.7
Covered	30.0	66.7
Sandstone, brown to red to yellow, fine, friable, pitted	30.0	36.7
Limestone, gray, medium, massive, changing facies locally to red to brown to gray, medium, massive, pitted, friable some calcareous sandstone	6.0	6.7
Conglomerate, variable in thickness, red to brown, limonite and jasperoid pebbles, coarse, calcareous, sandy matrix, weathers red and pitted	0.7	0.7
Pitkin:		
(Exposure badly slumped)		
Limestone, gray, coarsely crinoidal, *Archimedes*, massive, weathers rough and yellow-buff	3.3	21.3
Limestone, gray, medium, massive, weathers rotten	5.6	18.0
Limestone, gray, medium, platy	0.5	12.4
Limestone, gray-black, medium, crinoidal, massive, iron-stained	4.2	11.9
Limestone, gray, dense, blocky	2.0	7.7
Covered, probably shale	3.0	5.7
Limestone, gray, dense, massive	1.2	2.7
Limestone, black, dense, massive	1.5	1.5
Fayetteville:		
Shale, black, poorly exposed as black shale float	60.0	60.0
Hindsville:		
Limestone, gray, fine, silty, platy	0.6	20.1
Limestone, gray to black, fine to medium, some iron-stained	4.0	19.5
Limestone, gray, medium, coarsely crinoidal, massive	4.0	15.5
Limestone, gray, dense, silty, platy	3.0	11.5
Limestone, gray to black, dense, massive	2.0	8.5
Limestone, gray-black, medium to coarse, with *Agassizocrinus*	0.4	6.5
Limestone, gray-black, dense, massive	1.0	6.1

Limestone, gray-black, fine, thin-bedded to platy, weathers buff	1.4	5.1
Limestone, gray, medium, massive with *Agassizocrinus*	1.0	3.7
Limestone, gray, medium, crinoidal	0.7	2.7
Marl, buff, fossiliferous with small limestone pebbles	2.0	2.0
Moorefield:		
Ordnance Plant member:		
Limestone, variable in thickness, gray, fine, silty grading into siltstone below	0.5	11.5
Siltstone, yellow buff, massive, variable in thickness..	1.0	11.0
Siltstone, buff, thin-bedded to platy. Base covered.....	10.0	10.0
Bayou Manard member:		
Limestone, gray to black, fine, silty, platy	4.0	7.0
Limestone, black, dense, massive, well-jointed. Base covered	3.0	3.0

97. SOUTH END OF BUGGER MOUNTAIN
Section 27, T. 16 N., R. 26 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hale:		
Sandstone, typical fluted weathering and cross-bedding, coarse-grained, weathers reddish brown, no fossils observed	54.0	73.0
Shale, gray to green blocky shale	19.0	19.0
Pitkin:		
Limestone, gray to medium gray, finely crystalline to dense, weathers light gray and rubbly, *Archimedes*..	19.2	19.2
Fayetteville:		
Covered (includes the base of Pitkin)	42.0	162.0
Sandstone, massive- to thin-bedded, hard, laminated, light brown to buff, forms bench on hillside	18.0	120.0
Covered	18.0	102.0
Shale, gray-green, limonite concretions, fissile or platy	30.0	84.0
Covered	24.0	54.0
Shale, black, very platy, carbonaceous, jointed, weathers out in small steps	30.0	30.0
Hindsville:		
Limestone, largely crystalline, gray, massive, fossiliferous	3.0	22.5
Limestone, dense, lithographic, weathers dark blue-gray to white	1.0	19.5
Limestone, medium to coarsely crystalline, gray, hard, fossiliferous, rough surface, *Agassizocrinus, Diaphragmus cestriensis*	18.5	18.5
Moorefield:		
Ordnance Plant member:		
Siltstone, calcareous, hard, brownish-yellow, very fossiliferous with *Leiorhynchus carboniferum, Sphenotus meslerianus, Camarotoechia purduei* and *Orbiculoidea newberryi* var. *marshallensis*	1.5	6.0
Shale, dark brownish green, platy and very fossiliferous	3.5	4.5
Siltstone, fine-grained, hard calcareous, dark brown....	1.0	1.0
Lindsey Bridge member:		
Limestone, blue gray, coarsely crystalline, very hard and relatively unfossiliferous	4.2	5.0

Limestone, coarsely crystalline, blue gray, petroliferous odor, small angular chert pebbles weathered out on surface	0.8	0.8
Bayou Manard member:		
Limestone, hard, blue gray, fine to coarsely crystalline, unfossiliferous	5.0	32.1
Limestone, silty, gray-green, weathers platy	0.3	27.1
Chert and limestone, hard, light gray, largely crystalline, sparingly fossiliferous limestone interbedded with tripolitic, nodular, cherty limestone which weathers soft and brown	17.8	26.8
Limestone, dense, medium to light gray, unfossiliferous, very hard, weathers to a smooth surface	9.0	9.0
Boone:		
Limestone and chert, beds 2 to 4 inches thick, gray, crystalline, very hard limestone; brown, tripolitic chert, weathers to "cotton-rock"	1.5	16.0
Limestone, medium to coarsely crystalline, glauconitic, blue-gray, petroliferous odor, hard	14.5	14.5
Covered		

98. SECTION TAKEN ALONG TOWNSHIP LINE BETWEEN T. 16 N., AND T. 17 N., R. 19 E. Section 3 of T. 16 N., and Section 33 of T. 17 N.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Covered	3.0	138.0
Limestone, and sandstone, upper beds are dark blue-gray limestone, which grade into buff sandstone	2.0	135.0
Shale, dark, bluish-gray, fissile, with black-streaked very thin limestone beds, grades into a silty shale at top	13.0	133.0
Limestone, blue-gray, medium to coarsely crystalline, weathers limonitic and crinoidal	2.0	120.0
Shale, dark, bluish-gray, fissile	0.5	188.0
Limestone, blue-gray, dense to very finely crystalline, massive	6.0	117.5
Shale, dark gray with intercalated argillaceous limestone concretionary layers, poorly exposed	60.0	111.5
Limestone, reddish-brown, sandy, dense, weathers to a brown and white fine-grained sandstone	9.5	51.5
Covered	40.0	42.0
Sandstone, weathers red-brown to gray, fine-grained	2.0	2.0
Base covered.		

99. COMPOSITE SECTION UP HILL AT EAST END OF HIGHWAY 51 BRIDGE
Sections 22 and 27, T. 17 N., R. 19 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Covered, loose blocks of buff to reddish sandstone, estimated	5.0	80.6
Limestone, buff, black-streaked, cherty, spicular, weathers to a siliceous, porous rock containing profuse microscopic shells	14.0	75.6

Sandstone, buff to greenish-gray to gray, fine-grained, hard	3.0	61.6
Shale, gray to black, contains many thin iron-stone concretionary beds; the concretions are argillaceous and sideritic and weather to oxide in concentric layers about the center	10.0	58.6
Ironstone, variegated, weathers to oxide in buff, to red and brown bands	0.3	48.6
Sandstone, and siltstone, brown to dark gray, calcareous, glauconitic, and shaly	0.8	48.3
Shale, dark gray to greenish-gray, contains concretions, argillaceous, sideritic; shales are fossiliferous, *Chonetes, Lindstroemella, Orbiculoidea*	5.0	47.5
Covered	9.0	42.5
Sandstone, dark gray, fine-grained, black argillaceous streaks	2.5	33.5
Shale, dark gray to black, contains clay iron-stone concretions, intercalated with shale-streaked, iron-stained, thin-bedded siltstones	9.5	31.0
Sandstone, and siltstone, greenish-gray to dark gray, weathers flaggy	15.0	21.5
Sandstone, greenish-buff-gray, fine-grained, intercalated with thin, black shaly streaks, and black-streaked silty layers	6.5	6.5
Bloyd:		
Limestone, gray to brown-gray, fine to medium-crystalline, productid brachiopods	7.5	54.6
Limestone, greenish to bluish-gray, fine to medium crystalline, weathers thin-bedded	3.3	47.1
Limestone, gray-blue, dense to finely crystalline	2.0	43.8
Limestone, gray, dense, hard	3.0	41.8
Covered	8.0	38.8
Limestone, purplish-gray, dense	3.0	30.8
Limestone, purple, finely crystalline, extremely fossiliferous	1.0	27.8
Shale, green, soft	1.5	26.8
Limestone, purple, finely crystalline	2.0	25.3
Covered	2.0	23.3
Limestone, gray, dense	2.5	21.3
Limestone, gray-blue, dense	1.3	18.8
Shale, dark gray to black, and limestone, gray to dark gray, lithographic, extremely fossiliferous, with fenestellids and other bryozoans, thin-bedded	11.0	17.5
Limestone, blue-gray, fine to medium crystalline, medium-bedded	6.0	6.5
Shale, greenish-gray, soft, pyritic, iron-stained	0.5	0.5
Hale:		
Limestone, gray to slightly greenish-gray, dense, to finely crystalline, heavily iron-stained on surface, thin greenish-gray shale break 10 feet below contact	25.0	25.0
Base covered.		

100. COMPOSITE SECTION UP HILL ON BOUNDARY OF Sections 9 and 16, T. 17 N., R. 19 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, light buff-tan, iron-stained in spots, cross-bedded	6.0	20.8
Conglomerate, coarse chert pebbles	4.8	14.8
Covered, probably conglomerate and sandstone	10.0	10.0

Bloyd:		
Limestone, and shale, limestone is brownish blue-gray to blue, hard, dense to finely crystalline, to dark gray, abundant Bryozoa, shaly; shale, dark gray to greenish-buff, very poorly exposed	18.0	24.5
Limestone, gray, dense to finely crystalline, spotted iron stained	6.5	6.5
Hale:		
Limestone, white to gray, medium to coarsely crystalline to granular	5.0	37.3
Limestone, light gray, fine to medium crystalline to granular and oolitic in part, weathers slightly sandy	3.0	32.3
Limestone, light gray, spotted iron stain, coarsely crystalline, hard	2.0	29.3
Covered	3.3	27.3
Limestone, reddish-gray to grayish-brown, medium to coarsely crystalline, thin-bedded, weathers buff to brown to red	5.0	24.0
Limestone, light gray, dense to finely crystalline, heavily pitted and pockmarked on weathered surface, weathers to a greenish-streaked sand with argillaceous pockets	2.0	19.0
Limestone, varies from a light gray, medium crystalline, sandy limestone, to a reddish-tan, yellow stained, limy sandstone, to a buff-brown, iron-stained, sandstone, massive-bedded, weathers pitted and cross-bedded, has occasional small, flat, gray-blue and dove gray limestone pebble conglomerate at the base	17.0	17.0
Pitkin:		
Limestone, gray, sublithographic to lithographic, massive, hard, passing upward into a light gray, sandy, limestone which contains numerous brachiopods and gastropods	6.0	20.7
Limestone, gray, oolitic in part	0.5	14.7
Limestone, gray, extremely oolitic with very fine oolites, massive-bedded	6.0	14.2
Limestone, brownish-gray, finely crystalline, calcite	1.5	8.2
Limestone, light gray, very finely oolitic, to finely crystalline	1.7	6.7
Limestone, gray, finely crystalline to oolitic, massive-bedded	5.0	5.0
Base covered.		

101. SECTION TAKEN UP HILL BETWEEN T. 17 N., AND T. 18 N., R. 20 E. Section 6 of T. 17 N., and Section 31 of T. 18 N.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Covered, large coarse sandstone and grit boulders	20.0	25.0
Sandstone, red to buff-brown, medium-grained	5.0	5.0
Morrow:		
Covered	5.0	63.1
Limestone, blue-gray, dense to medium crystalline, weathers buff-brown and thin-bedded	0.7	58.1
Limestone, light gray to brown-gray, dense to finely crystalline, weathers blue on surface	0.7	57.4
Covered	1.0	56.7
Limestone, light gray, dense, to medium crystalline, slightly oolitic	2.3	55.7
Covered	2.5	53.4

Limestone, light gray, fine to medium crystalline reddish-brown stained	2.1	50.9
Limestone, gray, dense, hard	0.3	48.8
Limestone, blue to brown-gray, dense to medium crystalline, thin to medium-bedded	10.0	48.5
Covered	4.0	38.5
Limestone, gray to brownish-gray, medium crystalline, thin-bedded	1.5	34.5
Limestone, gray, medium to coarsely granular	0.5	33.0
Limestone, gray, sublithographic with larger calcite crystals, thin-bedded	2.0	32.5
Limestone, gray, fine to medium crystalline, weathers flaggy	1.0	30.5
Limestone, brownish to greenish-gray, finely granular to slightly oolitic, weathers crumbly	2.5	29.5
Limestone, gray, spotted iron-stained, coarse crystals in a lithographic matrix, hard	0.5	27.0
Covered	5.0	26.5
Limestone, varies from gray-brown very finely oolitic, to blue-gray, finely crystalline, very hard, slightly oolitic, fossiliferous, *Composita*, "*Productus*," *Rhynchopora*, *Gastrioceras*, *Platyceras*	5.0	21.5
Limestone, blue-gray to gray, dense, weathers reddish-brown, thin-bedded	1.5	16.5
Limestone, buff to brown, to bluish-gray, fine to medium crystalline	1.5	15.0
Covered	2.0	13.5
Limestone, gray to brownish-gray, fine to medium crystalline, poorly exposed	2.5	11.5
Limestone, gray to reddish-gray stained, dense to finely crystalline	2.5	9.0
Covered	0.5	6.5
Limestone, dark gray-blue, extremely oolitic with very fine oolites	0.2	6.0
Limestone, light gray, sublithographic to granular	0.7	5.8
Covered	0.8	5.1
Limestone, brown, granular	1.3	4.3
Conglomerate, reddish to purplish-gray, contains blue-gray flat, smooth limestone pebbles, and red sandstone pebbles	1.5	3.0
Conglomerate, brown to blue-gray, limestone	0.2	1.5
Limestone, reddish, medium crystalline	0.8	1.3
Sandstone, buff to reddish-purple	0.5	0.5
Pitkin:		
Covered, limestone rubble, dove-gray, smooth	10.0	42.7
Limestone, gray, brown-gray, lithographic	2.0	32.7
Covered	2.0	30.7
Limestone, gray, reddish-stained, sublithographic, very hard, crinoidal, massive-bedded, forms cliff	7.0	28.7
Limestone, gray, sublithographic to medium-crystalline, hard, slight petroliferous odor	2.5	21.7
Limestone, light to darker gray, lithographic to finely crystalline, oolitic in part	0.8	19.2
Limestone, gray, coarse crystals in a lithographic matrix, weathers granular	2.0	18.6
Covered, limestone rubble, gray to brownish-gray, lithographic, oolitic	16.6	16.6
Fayetteville:		
Covered, black fissile shale and dark gray, lithographic limestone rubble	5.0	55.3
Covered, occasional black fissile shales	10.0	50.3
Limestone, gray lithographic, hard	0.3	40.3

Covered, several limestone beds poorly exposed, gray, sublithographic, crinoidal	30.0	40.0
Shale, black, fissile, and limestone concretions, dark gray, lithographic, some septarian	5.0	10.0
Shale, black, fissile	5.0	5.0
Hindsville:		
Limestone, gray, lithographic, smooth, weathers blocky and white to light gray	0.6	24.7
Limestone, dark gray, sublithographic, one bed	2.0	24.1
Limestone, gray, oolitic, petroliferous odor, very fossiliferous, *Diaphragmus*, *Linoproductus*	1.2	22.1
Limestone, dark gray, sublithographic to dense, petroliferous odor, two beds	2.2	20.9
Limestone, gray, sublithographic passing downward into oolitic limestone with a petroliferous odor, weathers gray-white and smooth	3.0	18.7
Limestone, gray, sublithographic to finely crystalline to oolitic	1.0	15.7
Limestone, gray lithographic, contains productid brachiopods	0.7	14.7
Limestone, gray, varies from very finely oolitic at top to more dense and less oolitic in lower beds	4.0	14.0
Limestone, gray, buff-stained in spots, fine to medium crystalline, thin-bedded	1.3	10.0
Limestone, brownish-gray to gray, sublithographic to finely crystalline, silty, hard, thin-bedded, weathers buff to brown, some layers fossiliferous with brachiopods	3.7	8.7
Covered, gray, lithographic limestone blocks	3.0	5.0
Limestone, light gray to gray, oolitic to medium crystalline, *Agassizocrinus*, two beds	2.0	2.0
Base covered.		

102. COMPOSITE SECTION FROM CREEK UP HILL
East Half of Section 9, T. 17 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hale:		
Covered, to approximate base of Bloyd, (estimate)	30.0	45.2
Limestone, light gray, sublithographic, crinoidal, crumbly, forms bluff	8.2	15.2
Limestone, gray, medium crystalline, crinoidal, hard, iron-stained, thin- to medium-bedded, conglomeratic at base with pebbles of Pitkin lithology	7.0	7.0
Pitkin:		
Limestone, gray, sublithographic to finely crystalline, weathers granular to sucrosic in irregular beds	2.8	15.6
Limestone, gray, sublithographic to oolitic in part, poorly exposed	3.8	12.8
Limestone, gray, sublithographic to lithographic, weathers orange-spotted, one bed	4.0	9.0
Limestone, gray, lithographic, rubbly, thin- to medium-bedded, *Diaphragmus*, *Linoproductus*	5.0	5.0
Fayetteville:		
Shale, black, fissile, dark gray lithographic limestone rubble near the top, and septarian concretions near the base	55.0	55.0
Hindsville:		
Limestone, sublithographic to dense, slightly oolitic in part, petroliferous odor, one bed	2.5	33.0

Limestone, gray, dense, petroliferous odor	5.0	30.5
Limestone, gray, finely oolitic, strong petroliferous odor	2.0	25.5
Limestone, gray, lithographic, hard, poorly exposed	3.0	23.5
Limestone, gray, finely crystalline	5.0	20.5
Limestone, gray, dense, thin-bedded, poorly exposed	5.0	15.5
Limestone, gray, oolitic, poorly exposed	10.0	10.5
Limestone, gray, oolitic, petroliferous odor, one bed	0.5	0.5
Moorefield:		
Ordnance Plant member:		
Covered, probably shales (estimated)	3.0	33.9
Shale, black, fissile, and dark gray to black silty shales and siltstones	3.3	30.9
Limestone, blue-centered, weathers buff on surface, silty and fossiliferous, *Leiorhynchus*, *Moorefieldella*	1.0	27.6
Siltstone, grayish-buff, calcareous, poorly exposed	2.0	26.6
Covered, estimated	20.0	24.6
Limestone, blue-centered, weathers gray-buff on surface, hard, silty	0.6	4.6
Siltstones, dark gray, calcareous, interbedded, finely crystalline, silty, thin-bedded, unit weathers shaly	4.0	4.0
Lindsey Bridge member:		
Limestone, grayish-blue, finely crystalline, conglomeratic in part with chert pebbles of various sizes	0.7	0.7
Base covered		

103. COMPOSITE SECTION ON HILL
North Half of Section 18, T. 17 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hale:		
Limestone, reddish-gray to gray, medium to coarsely crystalline, thin-bedded, poorly exposed	30.0	30.6
Limestone, buff-brown to gray, coarsely crystalline, sandy has black pebble-like inclusions, weathers crumbly	0.6	0.6
Pitkin:		
Limestone, light gray, finely and extremely oolitic, weathers gray-blue and crumbly, one bed	3.8	49.9
Limestone, gray, dense	0.8	46.1
Limestone, blue-gray, iron-stained, dense to finely crystalline, oolitic in part	5.0	45.3
Limestone, gray, dense to finely crystalline, sandy and reddish in part, *Archimedes*	0.7	40.3
Covered	4.3	39.6
Limestone, blue-gray to black, lithographic, with shale partings, rubbly	5.0	35.3
Limestone, dove-gray, lithographic to finely crystalline, one bed	0.7	30.3
Covered	1.3	29.6
Limestone, gray, lithographic to densely crystalline, crinoidal, spotted iron-stained	5.0	28.3
Limestone, gray, lithographic, rubbly, irregularly bedded, *Linoproductus ovatus*	0.8	23.3
Covered, lithographic limestone rubble	7.5	22.5
Limestone, gray, fine to medium crystalline, oolitic in part	1.0	15.0
Covered	0.8	14.0
Limestone, brown-gray with slight purple cast, extremely oolitic in part, weathers pitted and sandy	0.7	13.2

Covered, lithographic limestone rubble	10.5	12.5
Limestone gray, to bluish-gray, lithographic, passing upward into gray, oolitic, iron-stained, sandy limestone	2.0	2.0
Fayetteville:		
Covered	7.5	62.5
Covered, limestone rubble, gray to black lithographic concretions, and sideritic septarian concretions	25.0	55.0
Covered	5.0	30.0
Limestone, bluish-gray, sublithographic, *Archimedes*	0.5	25.0
Covered	4.5	24.5
Shale, dark gray to black, fissile	20.0	20.0
Hindsville:		
Limestone, gray, oolitic, petroliferous odor	2.0	22.0
Limestone, gray, medium crystalline, petroliferous odor	0.5	20.0
Covered	3.2	19.5
Limestone, gray, medium crystalline, crinoidal, oolitic in part	1.3	16.3
Limestone, gray, lithographic rubble, poorly exposed	2.0	15.0
Limestone, brownish-gray to gray, fine to medium crystalline, thin-bedded, oily smell	3.0	13.0
Limestone, gray, fine to medium crystalline, slightly oolitic in part very fossiliferous, poorly exposed	5.0	10.0
Limestone, dark gray, sublithographic to lithographic, thin-bedded, weathers white and smooth, poorly exposed	4.0	5.0
Limestone, gray, medium to coarsely crystalline, passes downward into finely crystalline, has one inch cherty layer at base, *Agassizocrinus*	1.0	1.0
Moorefield:		
Ordnance Plant member:		
Shale, black fissile	2.0	32.0
Shale, buff-brown, soft to fissile	5.0	30.0
Covered, probably silt and shaly silt	5.0	25.0
Siltstone, brown-buff, black-streaked, calcareous, weathers shaly	15.0	20.0
Covered, estimated	5.0	5.0
Lindsey Bridge member:		
Limestone, gray, extremely oolitic with fine white oolites, chert conglomerate in part	3.0	3.5
Limestone, blue-gray, coarsely oolitic, almost coquinal with *Composita laevis*	0.5	0.5
Bayou Manard member:		
Limestone, buff-gray, silty, fossiliferous	0.5	19.3
Limestone, buff-gray, silty in part	3.5	18.8
Limestone, light gray, silty	0.6	15.3
Covered	3.0	14.7
Limestone, light gray, finely crystalline, weathers earthy, rough and buff-brown	2.0	11.7
Limestone, brownish-gray to darker gray, silty	2.0	9.7
Limestone, dark gray, silty, weathers shaly and platy, extremely fossiliferous, *Leiorhynchus*, *Moorefieldella*	1.2	7.7
Covered	2.0	6.5
Limestone, gray, dense, micaceous, silty	1.0	4.5
Covered, estimated	3.5	3.5
Keokuk:		
Chert, white, massive, not measured.		

104. COMPOSITE SECTION ALONG ROAD
Between Sections 25 and 26, T. 17 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Covered, sandy soil, buff-brown, hard, thin sandstone beds, estimated	15.0	15.0
Bloyd:		
Limestone, gray-blue, dense to sublithographic, to finely crystalline in part, weathers flaggy	5.0	65.6
Limestone, blue-gray, sublithographic, hard	1.0	60.6
Covered	1.0	59.6
Limestone blue-gray, lithographic to sublithographic, thin to medium-bedded	3.0	58.6
Limestone, gray, sublithographic, weathers yellow-gray and rubbly, poorly exposed	8.0	55.6
Limestone, bluish to brownish-gray, lithographic	0.8	47.6
Shale, buff-gray to dark gray, weathers soft	1.5	46.8
Limestone, blue-gray, sublithographic, weathers buff	0.3	45.3
Shale, buff, soft	0.3	45.0
Limestone, blue-gray, sublithographic	0.3	44.7
Shale, olive-buff, weathers soft and clay-like, contains brachiopods	4.0	44.4
Covered, greenish-gray, silty limestone, poorly exposed at top	5.0	40.4
Limestone, gray, lithographic to finely crystalline, weathers granular and flaggy, contains numerous Echinoid spines and plates	4.0	35.4
Limestone, gray, orange spotted, dense matrix containing larger calcite crystals	1.0	31.4
Limestone, gray, dense, weathers flaggy	3.5	30.4
Covered	1.5	26.9
Limestone, blue-gray, finely crystalline	2.5	25.4
Limestone, gray, brown spotted, fine to medium granular, to oolitic in part, weathers flaggy	3.5	22.9
Limestone greenish to bluish-gray, finely crystalline	1.5	19.4
Covered, estimated	8.0	17.9
Limestone, blue-gray, medium crystalline	0.7	9.9
Limestone, gray-blue, lithographic to dense	2.0	9.2
Shale, dark gray to black, calcareous and limestone, dark gray, argillaceous, weathers soft and crumbly, profuse bryozoans	5.5	7.2
Limestone, blue, sublithographic, extremely oolitic, hard, weathers buff-blue and blocky, *Aulopora*, *Pentremites*, *Echinocrinus*, *Michelinia*, and *Striatopora*	1.7	1.7
Hale:		
Limestone, gray-blue, thin-bedded, medium crystalline, iron-stained around edges	0.5	22.5
Limestone, gray, medium to coarsely crystalline, iron-stained, poorly exposed	4.5	22.0
Limestone, light brownish-gray, medium crystalline, fossiliferous	2.5	17.5
Limestone, light gray to blue-gray, lithographic to finely crystalline, weathers flaggy	5.0	15.0
Limestone, light gray, fine to medium crystalline, weathers flaggy, thin- to medium-bedded	5.0	10.0
Limestone, light gray to gray, lithographic to dense, to very finely oolitic to granular, conglomeratic at the base	5.0	5.0

Pitkin:		
Limestone, light gray to blue-gray, extremely oolitic, medium-bedded	4.6	25.7
Limestone, gray, sublithographic, iron-stained	1.0	21.1
Limestone, blue-gray extremely oolitic with very fine oolites	0.7	20.1
Covered	0.8	19.4
Limestone gray-blue sublithographic, thin-bedded, rubbly, *Pentremites*, *Archimedes*, (unit is a small reef structure and varies greatly in thickness.) maximum thickness	3.0	18.6
Limestone, blue-gray, and gray, lithographic to sublithographic, rubbly, profuse *Archimedes* well preserved	5.0	15.6
Limestone, gray-blue, sublithographic	1.0	10.6
Limestone, and shale partings, limestone is gray-blue to gray, lithographic, weathers buff, shale, black, fissile	2.3	9.6
Shale, black fissile	2.5	7.3
Limestone, blue-gray, lithographic to dense	0.4	4.8
Limestone, brown to blue-gray, dense to finely crystalline, black shale partings	2.3	4.4
Limestone, blue-gray and gray, sublithographic to dense, iron-stained	2.1	2.1
Fayetteville:		
Shale, black, fissile, with intercalated beds of limestone, blue-gray, lithographic, crinoidal, weathers buff-gray, lithographic, crinoidal, weathers buff-gray and rubbly	4.0	54.3
Limestone, blue-gray, sublithographic, contains orange calcitic spots and streaks	0.7	50.3
Shale, black fissile, intercalated with limestone blue-gray, sublithographic, thin-bedded, crinoidal, weathers buff-gray, *Archimedes* and *Fenestrellina*, estimated	5.0	49.6
Limestone, blue-gray, lithographic, crinoidal, thin to medium-bedded, weathers brownish-gray	4.8	44.6
Shale, dark gray to black, soft, weathers brown	1.2	39.8
Limestone, blue-centered, brownish-gray around edges, lithographic hard, weathers buff	0.5	38.6
Shale, dark gray to black, soft	1.0	38.1
Limestone, gray, and blue-gray, lithographic	0.8	37.1
Shale, dark gray, weathers brown, intercalated with limestone, blue-gray, lithographic to sublithographic, weathers brown, gray, thin concretionary-bedded	3.0	36.3
Limestone, blue-gray, lithographic, streaked with orange and smoky calcite veins	0.5	33.3
Shale, black fissile	6.5	32.8
Limestone, gray-blue, sublithographic, *Archimedes*	1.3	26.3
Shale, black, fissile, septarian concretions, dark gray, lithographic, sideritic, orange and smoky calcite and siderite crystals as "cementing" material	4.0	25.0
Limestone, dark gray, lithographic, sideritic	1.0	21.0
Shale, black, fissile	17.5	20.0
Covered, (probably shales as above)	2.5	2.5
Hindsville:		
Covered, (probably limestone)	5.0	18.0
Limestone, gray, lithographic to medium crystalline, poorly exposed	1.5	13.0
Limestone, brownish to bluish-gray, dense	1.5	11.5
Limestone, gray fine to medium crystalline	0.8	10.0

Limestone, light brownish-gray, silty, weathers buff-brown and fluted, extremely fossiliferous, *Diaphragmus, Linoproductus*	2.0	9.2
Limestone, gray finely crystalline matrix with medium to coarse olive-brown crystals	0.5	7.2
Limestone, gray, to dark gray, lithographic to finely crystalline	1.0	6.7
Covered	0.7	5.7
Limestone, gray lithographic, rubbly	4.0	5.0
Limestone, gray, medium crystalline, *Linoproductus, Agassizocrinus*	1.0	1.0
Moorefield:		
Ordnance Plant member:		
Shale, black, soft to fissile	0.6	1.2
Shale brown-buff, soft	0.6	0.6
Keokuk:		
Chert, white massive, poorly exposed		
Base covered.		

105. COMPOSITE SECTION ALONG HIGHWAY 51
Sections 25 and 36, T. 17 N. R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hale:		
Limestone, reddish-gray to light gray, fine to medium to coarsely crystalline, thin- to medium-bedded, very poorly exposed	30.0	31.0
Limestone, gray, medium crystalline, locally conglomeratic and ferruginous, weathers reddish-gray, one bed	1.0	1.0
Pitkin:		
Limestone, gray, lithographic, weathers buff and rubbly, black shale partings and lenses of blue-gray granular limestone, *Archimedes*	6.3	20.7
Limestone, blue-gray, sublithographic, weathers buff, *Archimedes, Diaphragmus, Orthotetes, Pentremites*, maximum thickness	2.0	14.4
Shale, black, soft to fissile, contains a thin, irregular bed of limestone, gray, lithographic	3.0	12.4
Limestone, blue-gray, oolitic	0.7	9.4
Shale, black	0.5	8.7
Limestone, brown-gray to gray, fine to medium crystalline, weathers buff-gray, *Archimedes*	2.7	8.2
Limestone, gray, sublithographic to finely crystalline	1.0	5.5
Limestone, dove-gray, lithographic, crinoidal, irregularly thin-bedded	3.0	4.5
Limestone, dove-gray, lithographic to medium crystalline, petroliferous odor, weathers thin and rubbly, *Archimedes*, black shale partings	1.5	1.5
Fayetteville:		
Covered, probable shale	4.0	20.1
Shale, dark gray to black, soft, and concretionary beds of limestone, dark gray, lithographic, weathers buff to white on surface	5.0	16.1
Shale, dark gray to black, fissile	6.0	11.1
Limestone, gray, finely crystalline, petroliferous odor, and shale partings	3.6	5.1
Shale, black fissile	1.5	1.5
Base covered		

106. SECTION ALONG ROAD CUT, Between Sections 5 and 6, T. 17 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Covered, greenish to brownish, iron-stained, sandstone and siltstone exposed near base	40.0	40.0
Bloyd:		
Limestone, crinoidal, weathers to a sandstone	5.0	41.0
Limestone, brown, sandy, thin- to medium-bedded	5.0	36.0
Limestone, blue-gray, dense, weathers brown and sandy	0.7	31.0
Sandstone, olive-green, fine-grained, weathers brown	0.7	30.3
Shale, dark gray to black, soft, poorly exposed	5.0	29.6
Limestone, gray, dense to finely crystalline, thin, irregularly-bedded, rubbly	7.6	24.6
Covered	6.5	17.0
Limestone, blue-gray, dense, very fossiliferous, echinoid spines, *Pentremites*	0.5	10.5
Covered	10.0	10.0
Hale:		
Limestone, green-gray to gray, fine to medium crystalline, hard, thin-bedded	3.0	46.3
Limestone, blue-gray, dense, green, argillaceous pockets, weathers rubbly and shaly at top	1.9	43.3
Limestone, gray, dense, massive	9.0	41.4
Limestone, gray, medium crystalline, crinoidal	1.0	32.4
Covered	8.0	31.4
Limestone, blue, weathers brown, dense	0.2	23.4
Shale, dark gray	1.0	23.2
Limestone, gray, medium crystalline, reddish-stained, massive, *Composita*, "*Productus*", "*Pustula*"	10.0	22.2
Limestone, gray, reddish-stained, very finely oolitic, oolites are small and white	2.2	12.2
Sandstone, buff, limonite-stained, calcareous	3.0	10.0
Limestone, light gray, weathers brown, oolitic	3.0	7.0
Covered	2.5	4.0
Limestone, gray, medium to coarsely granular, reddish-stained	0.5	1.5
Conglomerate, chert and limestone pebbles, smooth ferruginous, limonite and phosphatic nodules	1.0	1.0
Pitkin:		
Limestone, blue-gray, medium crystalline, weathers brown	1.2	13.6
Limestone, gray, dense to finely crystalline, crinoidal, oolitic at the top	1.7	12.4
Limestone, dove-gray, lithographic, oolitic in part	1.2	10.7
Limestone, dove-gray, lithographic, iron-stained at top	1.7	9.5
Covered	2.3	7.8
Limestone, dark gray, sublithographic to lithographic, rubbly with black shale partings, profusely crinoidal, and bryozoan, *Archimedes*	5.5	5.5
Fayetteville:		
Covered, probably shale	2.5	7.5
Shale, dark gray to black, and limestone concretionary beds and concretions	5.0	5.0
Base covered.		

107. BLOYD, HALE, PITKIN, AND FAYETTEVILLE FORMATIONS ON NORTH SIDE OF OUTLIER, Southwest Corner of Section 25, T. 17 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, slump, bed rock covered, top eroded	21.0	21.0
Bloyd:		
Limestone, massive, dark blue, medium crystalline, weathers pitted	2.0	52.7
Limestone, massive, dark gray, coarsely crystalline, fossiliferous, weathers into rotten plates	3.6	50.7
Limestone, same as above	5.6	47.1
Slump, with small exposures of fine, yellow thin-bedded, siltstone	16.8	41.5
Limestone, massive, buff coarsely crystalline, iron stained, crinoidal, abundant gastropods poorly exposed	2.0	24.7
Covered, apparently a shale break	3.0	22.7
Limestone, massive, light gray, coarsely crystalline, weathers rough, limonitic	2.5	19.7
Limestone, massive, blue-gray, fine to medium crystalline, contains veins of calcite, weathers smooth and pitted	1.0	17.2
Covered, apparently a shale break	1.0	16.2
Limestone, massive blue-gray, coarsely crystalline, fossiliferous, abundant sponge spicules, weathers pitted	2.3	15.2
Covered, apparently a shale break	.8	12.9
Limestone, blue-gray, coarsely crystalline, fossiliferous	.7	12.1
Limestone, same as above, average thickness of bedding is .4 feet	4.9	11.4
Limestone, thin-bedded, light gray, coarsely crystalline, crinoidal, sponge spicules, large branching type bryozoans, *Pentremites* in lower units, weathers crumbly, limonitic	3.5	6.5
Covered, apparently a shale break	3.0	3.0
Hale:		
Limestone, massive, dark blue, coarsely crystalline, crinoidal, limonitic-stained	0.7	19.1
Limestone dark blue, medium crystalline, crinoidal, weathers cross-bedded, lowest unit fractures blocky and has knobby surface. Average thickness of bedding is .7 feet	2.3	18.4
Limestone, blue-gray medium crystalline, silty, weathers rubbly	0.7	18.1
Covered, apparently a shale break	1.1	15.4
Limestone, massive, light gray, dense, medium crystalline, smooth surfaced, poorly exposed	1.5	14.3
Limestone, massive, light gray, coarsely crystalline, weathers thin-bedded and fluted, abundant *Pentremites rusticus*, large crinoid plates. Average thickness of bedding is .6 feet	6.1	12.6
Shale, yellowish buff, sandy, thin-bedded, contains well-rounded pebbles of phosphate, and weathers cavernous	1.5	6.7
Limestone, massive, buff, iron-stained, coarsely crystalline, weathers fluted and thin-bedded, contains abundant *Polypora magna*	2.9	5.2

Limestone, massive, blue-gray, finely crystalline, weathers blocky and smooth surfaced, poorly exposed	1.5	2.3
Limestone, massive, blue-black, medium crystalline, crinoidal, subcuboidal fracture, contains black calcite	0.8	0.8
Pitkin:		
Limestone, massive, light blue-gray, lithographic, rectangular jointing	0.6	36.5
Limestone, thin-bedded, blue-gray, coarsely crystalline, very fossiliferous, abundant productids and *Archimedes*, average thickness of bedding 4 inches..	3.0	35.9
Limestone, massive, light gray, sublithographic, dolomitic appearance, weathers into subcuboidal blocks, 2 beds	1.1	32.9
Limestone, massive, light gray, sublithographic, matrix includes large amount of calcite	2.0	31.8
Slump, rubble of black, siliceous sublithographic limestone, containing *Pentremites godoni*	12.0	29.8
Limestone, massive, blue-black, oolitic, weathers iron-stained and blocky	1.7	17.8
Covered	1.0	16.1
Limestone, massive, blue-black, sublithographic, jointed, poorly exposed	1.0	15.1
Covered	5.7	14.1
Limestone, massive, dark gray, coarsely crystalline, crinoidal, limonitic nodules up to 5 inches in diameter on surface, abundant *Pentremites* and *Archimedes*	2.4	8.4
Limestone, rubbly, black, lithographic, interbedded with very thin beds of black shale	3.5	6.0
Limestone, massive, dark blue, dense, medium to finely crystalline, contains abundant *Pentremites* and crinoid fragments, average thickness of beds 10 inches	2.5	2.5
Fayetteville:		
Shale and limestone, shale is black, fissile, and contains abundant *Chonetes oklahomensis*. Average bed is 5 inches thick. Limestone is lenticular, black, lithographic. Average thickness of beds is 4 inches..	13.0	41.1
Limestone, thin-bedded, dark gray, medium crystalline, contains phosphatic fossils, weathers limonitic	0.8	28.1
Shale, black, fissile, weathers brown	0.7	27.3
Limestone, massive, dark blue-gray, dense, fine to medium crystalline, slightly oolitic, very fossiliferous, limonitic nodules on weathered surface	2.6	26.6
Covered, abundant black shale float. Thickness estimated	24.0	24.0
Hindsville:		
Limestone, massive, dark gray, sublithographic, subcuboidal fracture, weathers light blue. Base covered	2.0	2.0

108. SECTION ALONG EAST FLANK OF BARON GRABEN
Section 25, T. 17 N., R. 25 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Covered		
Hindsville:		
Limestone, gray, crystalline, thin-bedded, forms bench around hillside	5.5	16.5
Covered	4.0	11.0

Limestone, gray, thin-bedded, fossiliferous with *Agassizocrinus, Diaphragmus cestriensis*, crystalline..	5.0	7.0
Covered	2.0	2.0
Moorefield:		
Bayou Manard member:		
Limestone, gray, finely crystalline, contains brown, nodular chert "stringers," weathers gray	2.5	29.5
Limestone, gray, weathers brownish-gray, finely crystalline, thin-bedded to platy	1.0	27.0
Covered	0.5	26.0
Limestone, gray, light gray weathering, finely crystalline, hard, nodular chert in lower 8", unfossliferous..	1.5	25.5
Limestone, black, weathers gray, finely crystalline, hard, massively bedded, petroliferous	8.0	24.0
Covered	2.0	16.0
Limestone, dark gray, thin-bedded, finely crystalline, brownish-gray weathering	0.5	14.0
Covered	1.0	13.5
Limestone, gray, sublithographic, hard, massively bedded, thin platy 2" bed near middle of sequence, unfossiliferous	5.0	12.5
Limestone, gray, argillaceous, platy, petroliferous, gray weathering	1.5	7.5
Limestone, black, weathers gray, lithographic, bituminous odor, jointed, brown chert nodules near bottom	3.5	6.0
Covered	2.5	2.5
"Boone":		
Chert, gray to white, massive, iron-stained		

109. SECTION AT NORTH END OF WALKINGSTICK MOUNTAIN
Section 33, T. 17 N., R. 25 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hale:		
Sandstone, brown, medium-grained, fluted surface, massive unfossiliferous, weathers reddish-brown, alternating dark and light bands, not thought to be lamination, provides large amount of float, noncalcareous	33.5	38.5
Limestone, gray-brown, granular, jasperoid-like particles, fossiliferous with abundant crinoid and small brachiopod fragments, rubbly	5.0	5.0
Fayetteville:		
Covered, mapped as Wedington sandstone and Fayetteville shale	123.0	123.0
Hindsville:		
Limestone, gray, weathers brownish-gray, crystalline, rather thin-bedded, crinoidal, limonitic, *Agassizocrinus* abundant, forms bench around hillside, lies unconformably on Boone surface	11.0	11.0
"Boone":		
Chert, buff, pitted, angular surface		

110. SECTION ALONG BARREN FORK CREEK
Section 26, T. 17 N., R. 25 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Covered		
Hindsville:		

Limestone, dark gray, massive, weathers light gray, crystalline, crinoidal, fossiliferous with *Agassizocrinus* sp., *Linoproductus ovatus*, and *Spirifer increbescens*	5.5	5.5
Moorefield:		
Ordnance Plant member:		
Siltstone, brown, weathers brown, same fossils as siltstone below, shaly weathering	0.8	9.1
Limestone, dark gray, silty to finely crystalline, brownish-gray weathering, hard, fossiliferous with abundant *Leiorhynchus carboniferum* and *Echinoconchus alternatus*	1.0	8.3
Covered	1.0	7.3
Limestone, brown, silty, contains same fossils as siltstone below, weathers brown, rubbly weathered surface, may be slumped slightly	1.3	6.3
Siltstone, brown, platy weathering, brown-weathered surface, calcareous, abundantly fossiliferous with *Allorisma walkeri*, *Leiorhynchus carboniferum*, *Aviculopecten batesvillenis*, and *Spirifer increbescens*	4.5	5.0
Limestone, black, weathers brown, thin-bedded, lithographic, platy, unfossiliferous	0.5	0.5
Lindsey Bridge member:		
Limestone, gray, medium crystalline, thin-bedded, weathers gray, contains angular reddish brown chert fragments, fossiliferous with *Linoproductus ovatus*, *Spirifer increbescens*, and *Diaphragmus cestriensis*, crinoidal	2.2	6.2
Covered	2.0	4.0
Limestone, gray, brownish-gray weathering, massively bedded, rough crinoidal surface, contains angular chert fragments	2.0	2.0
Bayou Manard member:		
Covered	2.0	22.0
Limestone, gray, massive, hard, thin shaly partings between thicker limestone beds, contains weathered chert nodules and "stringers", finely crystalline, light gray weathering, fossiliferous with *Linoproductus ovatus* and *Spirifer increbescens*	14.0	20.0
Covered	6.0	6.0
"Boone":		
Chert, white to gray, with large amount of iron staining, highly fractured, unmeasured		

111. BIG HOLLOW CREEK
Sections 1, 2 and 11, T. 18 N., R. 19 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, buff or yellow brown, medium to coarse quartz sandstone, very crumbly Siltstone, light greenish and buff green, has dark gray streaks, thin layered	15.0 to 40.0	15.0 to 40.0
Morrow:		
Limestone, purplish blue to gray, dense, weathers buff with greenish cast	0.3	84.7
Limestone, bluish brown, conglomeratic, weathers shaly in places	0.5 to 0.7	84.4
Limestone, dark gray blue, dense, weathers brownish..	0.7	83.8

Limestone, blue gray to buff, finely crystalline, bottom and center part weathers to a dark calcareous shale	3.3	83.1
Limestone, blue to gray, dense, hard	1.0	79.8
Covered: Limestones, reddish gray and reddish weathering	9.0	78.8
Limestone, brownish gray, finely crystalline, weathers thin-bedded and irregular	0.8	69.8
Limestone, gray, finely crystalline	0.5	69.0
Limestone, gray, dense, fossiliferous, weathers buff	1.3	68.5
Limestone, poorly exposed, gray, dense, pentremital, *Pentremites rusticus, Hustedia miseri, Hustedia brentwoodensis, Recticulariina campestris*	3.7	67.2
Limestone light gray, granular, weathers coarse and very granular	3.0	63.5
Limestone, brown gray to reddish gray, medium crystalline, iron-stained	0.8	60.5
Covered, contains green gray limestone with green argillaceous pockets, contains profuse zone of *Caninia torquia*	1.8	59.7
Limestone, gray, dense to finely crystalline, slightly oolitic	0.7	57.9
Limestone, gray, coarsely crystalline, slightly oolitic	2.8	57.2
Limestone, gray, medium crystalline with larger calcite crystals	7.0	54.4
Limestone, gray, coarsely granular	5.0	47.4
Limestone, gray, medium to coarsely granular, iron-stained, grades upward into gray dense to finely crystalline limestone, pitted in places	15.0	42.4
Covered	5.0	27.4
Limestone, very light gray, medium crystalline approaching granular	2.5	22.4
Covered	7.5	19.9
Limestone, gray, finely crystalline	0.7	12.4
Limestone, gray, medium to coarsely crystalline	3.0	11.7
Limestone, gray, finely crystalline with larger calcite crystals	3.0	8.7
Limestone, red, sandy, cross-bedded, fine, medium and coarse crystalline, sparsely conglomeratic, has argillaceous pebbles, limestone pebbles, sandy pebbles, weathers to sand, varies from 15″ to 24″	1.3 to 2.0	5.7
Shale parting, dark thin, varies from 1″ to 4″, conglomeratic, flat limestone pebbles, sand pebbles, iron stained, mostly flat pebbles, very ferruginous	0.1 to 0.3	0.3
Pitkin:		
Limestone, gray, fine to medium crystalline, shows weathered surface	0.5 to 0.7	20.0
Limestone, light gray, irregularly bedded with calcareous and fossiliferous shale partings throughout, thin-bedded, *Archimedes*, varies 10″ to 18″	0.8 to 1.5	19.4
Limestone, bluish gray, dense to sublithographic, irregularly bedded, very rough surface, profuse *Archimedes, Archimedes intermedius*, bryozoans	1.2 to 1.5	18.3
Shale parting, varies ½″ to 1″	0.04 to 0.08	16.9
Limestone, dark bluish gray, fine to medium crystalline irregular layer 2″ to 4″	0.2 to 0.3	16.8

Shale, dark gray, calcareous, paper thin calcite layers..	0.3 to 0.5	16.5
Limestone, dark gray, sublithographic, large calcite crystals, 3″ to 8″, fossiliferous, bryozoans and *Dielasma formosum, Chonetes chesterensis, Myalina* sp., crinoidal, lense shaped; bottom half is a gray limy siltstone	0.3 to 0.7	16.1
Shale, black, soft, weathers bluish at bottom is lense shaped dark gray to black shaly limestone 12″ to 14″ exposed	1.0 to 1.2	15.6
Covered	14.5	14.5
Fayetteville:		
Covered	15.0	70.0
Black shales, poorly exposed	10.0	55.0
Shale, black, fissile	20.0	45.0
Shale black, fissile, with dark gray lithographic septarian limestone concretions that weather light grayish blue	5.0	25.0
Shale, black, near base is a 10″ bed of dark gray to black lithographic septarian concretions	5.0	20.0
Shale, black, fissile	10.0	15.0
Shale, black, fissile, with big blue septarian concretions that weather gray to buff	5.0	5.0
Hindsville:		
Limestone, gray, sublithographic, pyritic, weathers blocky and sort of rubbly, weathers bluish gray	2.7	36.3
Limestone, blue gray, lithographic, breaks in pieces when hit, buff iron-stain on top, *Archimedes*, bryozoans, *Diaphragmus cestriensis, "Marginifera" adairensis, Torynifera setigera, Composita trinuclea, Linoproductus ovatus, Allorisma walkeri*	0.7	33.6
Limestone, gray, dense to sublithographic, weathers buff gray and rubbly, varies from 4″ to 8″	0.3 to 0.7	32.9
Limestone, gray to brownish gray, oolitic, weathers thin, uneven and rough, highly fossiliferous, a profuse zone of productids	3.5	32.4
Limestone, gray, varies sublithographic to finely crystalline, iron-stained, yellowish cast, contains productids, *Archimedes* and crinoid stems, weathers rubbly and crinoidal, weathers buff gray	0.7	28.9
Limestone, brownish gray, very oolitic, weathers granular upper part of dove gray sublithographic limestone	1.2	28.2
Limestone, gray, varies from oolitic to finely crystalline, to sublithographic and to medium crystalline limestone, weathers gray	3.0	27.0
Limestone, bluish gray, lithographic weathers buff gray toward top, middle part weathers light grayish blue lower part is a bluish gray sublithographic limestone, calcite streaks, weathers slightly crinoidal, whole sequence weathers rubbly	5.0	24.0
Limestone, gray, oolitic to finely crystalline, weathers buff and finely crinoidal	0.3	19.0
Limestone, light gray, dense, hard, dolomitic, slightly micaceous, weathers buff and thin-bedded	3.0	18.7
Limestone, buff gray, sublithographic to dense to finely crystalline, thin, irregularly bedded, rubbly weathering, upper part is fossiliferous, brachiopods, *Archimedes*. Lower portion varies from finely crystalline		

to sublithographic, contains bryozoans, *Archimedes*, *Eumetria pitkinensis*, *Torynifera* ? sp., yellow and buff stained, thin calcite streaks, rubbly beds	4.5	15.7
Limestone, gray to brownish gray, medium crystalline, contains *Paladin mucronatus*	0.5	11.2
Limestone, bluish gray, finely crystalline	0.8	10.7
Limestone, brownish gray, to gray, medium crystalline, with larger calcite crystals, oolitic in places, irregularly bedded, numerous productids, shale partings, varies 9″ to 12″	0.8 to 1.0	9.9
Limestone, blue gray, medium crystalline, slightly glauconitic, varies to gray medium granular, thin shale parting 12″ down; 2′ exposed	2.0	9.0
Covered: est. 5′, probably limestone	5.0	7.0
Limestone gray, medium granular, oolitic	0.5	2.0
Limestone, gray, fine to medium crystalline	1.0	1.5
Limestone, buff to gray, fine to medium crystalline, bluish gray cast, fossiliferous, brachiopods, weathers buff, small *Agassizocrinus* in this bed	0.5	0.5
Moorefield:		
Ordnance Plant member:		
Shales, black, fissile, with a dark gray to black thicker soft shale	1.0 to 2.0	29.7
Shales, black and buff	4.0	28.2
Covered: Siltstones probably, within it is a darker gray but lighter streaked siltstone	10.8	24.2
Siltstone, gray, calcareous, weathers buff	0.4	13.4
Siltstone, buff gray, calcareous, weathers buff and thin	1.8	13.0
Siltstone, buff gray, calcareous	0.8	11.2
Siltstone, buff brown, several ¼″ to ¾″ layers, has blue gray centered limestone concretions, concretions weather buff and silty on edges, siltstone is compacted around the concretion	4.0	10.4
Siltstone, buff gray, calcareous, upper 6″; middle part 8″ to 10″ of gray brown siltstone weathered in paper thin layers; lower part is buff gray calcareous siltstone, 4″ to 8″ and weathers like middle part..	2.0	6.4
Siltstone, gray, brown, paper thin-bedded weathering..	1.0	4.4
Siltstone, gray weathers buff gray and thin-layered....	1.5	3.4
Siltstone, brownish gray, shaly, weathers shaly	0.5	1.9
Siltstone, smoky or dark gray, calcareous, shaly, weathers dark gray	1.4	1.4
Lindsey Bridge member:		
Limestone, gray, oolitic, slightly conglomeratic	0.2 to 0.3	5.0
Limestone, grayish to brown gray, massive, cross-bedded, finely conglomeratic with few large chert pebbles, the fine pebbles appear concentrated in certain areas, oolitic, sucrosic weathering. Bottom 4″ to 5″ in contact with the argillaceous limestone member is a light gray dense to finely crystalline dolomitic limestone, brown to blue gray, 0″ to 2″ dolomitic and cherty layer in the upper ⅓ of the bottom 4″ or 5″; last 4″ or 5″ varies from a gray dense to sublithographic, dolomitic and cherty limestone, in other places it is dense to finely crystalline. The bottom is covered with curved rounded masses, also brachiopods, horn corals, finely crinoidal on bottom surface, appears as one massive bed, *Aviculopecten batesvillensis*, *Spirifer martiniformis*	4.7	4.7

Bayou Manard member:		
Limestone, gray, dense, brittle, fossiliferous, *Leiorhynchus carboniferum*, *Leiorhynchus carboniferum* var. *polypleurum*, *Echinocoelia levicula*, *Triplophylum* sp. ?, weathering seems to be its important character.....	1.7	14.2
Limestone, gradational from above, gray, dense, silty, weathers almost same as above but more irregular; upper 17″ is more massive and more calcareous, weathers light bluish gray, has lighter blue mottling peculiar to Moorefield; lower part is more silty and weathers light blue and platy	5.0	12.5
Siltstone, dark brownish gray, calcareous, gradational from above, weathers slightly massive to platy.....	2.0	7.5
Siltstone, dark gray to black, calcareous, weathers light blue, fossiliferous	2.5	5.5
Limestone, gray, dense, silty, appears darker and more silty toward base, massive pieces spawl off, *Dictyoclostus scitulus*, exposed	0.5	3.0
Covered, probably continuation of same bed	2.5	2.5
Keokuk:		
Chert, white and massive, gray chert and fine to dense buff gray dolomitic limestone together, weathers buff; uneven surface at top of Keokuk	38.0	38.0
Reeds Spring:		
Limestone, and chert, rough and uneven-bedded; chert is brown and white on a brownish gray background; limestones are dense gray weather sort of blue gray; brown and gray blue chert and buff gray cherty limestone; darker chert is in the lower part; estimated exposed	20.0	20.0

112. WEST SIDE OF HILL
Sections 4 and 9, T. 18 N., R. 19 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, white, fine-grained, pinkish tinge, becomes more pinkish and brown spotted at the top	13.0	43.0
Covered, sandstone grit, red, coarse	30.0	30.0
Morrow:		
Limestone, brownish gray, varies from dense to sublithographic in places, weathers white to gray and smooth, very crinoidal, weathers crumbly in crinoidal part	4.0	44.7
Limestone, gray, very coarse, granular, iron-stained, badly weathered	0.3	40.7
Limestone, medium crystalline, iron-stained, weathers granular	3.0	40.4
Limestone, brownish gray, oolitic and granular.....	1.5	37.4
Limestone, gray, dense, massive, iron-stained	4.8	35.9
Limestone, gray dense to finely crystalline, sandy, weathers to a buff sand, poorly exposed	5.0	31.1
Limestone, blue-gray, limonite-stained, some thin beds..	5.0	26.1
Limestone, gray, finely crystalline, sandy, weathers sandy	10.0	21.1
Limestone, greenish gray, dense to finely crystalline, cross-bedded, fossiliferous, weathers buff, sandy, limonite spotted, more highly weathered at the contact	10.9	11.1

Shale, greenish gray, stringers of gray sublithographic limestone with limestone pebbles	0.0 to 0.3	0.0 to 0.3
Pitkin:		
Limestone, gray, varies from sublithographic to finley crystalline, oolitic in spots, iron-stained	3.2	21.7
Limestone, gray, dense to sublithographic, iron-stained in spots, has larger calcite crystals	0.8	18.5
Limestone, poorly exposed, dark gray limestone pieces, weathers light gray to white, limestone, gray, dense, oolitic, weathers gray; limestone, gray dense, iron-stained in places	3.0	17.7
Limestone, gray, granular, highly crinoidal, fossiliferous, iron-stained, weathers flaggy forms bluf	3.8	14.7
Limestone, blue-gray, dense to finely crystalline, hard, slightly iron-stained, abundant *Archimedes*, weathers crinoidal, forms part of bluff	0.5	10.9
Limestone, gray, orange and white calcite crystals dense to sublithographic, *Diaphragmus cestriensis*, weathers white to gray and "chunky", part of bluff	2.8	10.4
Limestone, gray blue, medium to coarsely crystalline, abundant *Archimedes*, weathers brown, thin-bedded, crinoidal	0.7	7.6
Limestone, gray, lithographic, slightly iron-stained	0.3	6.9
Covered: poorly exposed limestones; limestone, gray, lithographic, weathers white to gray; limestone, gray, finely crystalline, dense limestone irregularly distributed through it, fossiliferous, weathers crinoidal	4.0	6.6
Limestone, gray blue to blue gray to gray, numerous veinlets of slightly orange and colorless calcite and smoky colored siderite, weathers smooth, grayish brown, silty, and concretionary	1.0	2.6
Limestone, blue to gray, fine to medium crystalline, *Archimedes* and horn corals, weathers crinoidal	0.6	1.6
Limestone, gray blue to blue gray to gray, numerous veinlets of slightly orange and colorless calcite and smoky colored siderite, weathers smooth, grayish brown, silty, and concretionary; black fairly hard slightly silty shale in this lower part	1.0	1.0
Fayetteville:		
Shale, black fissile	4.0	67.1
Limestone, gray to blue gray, greenish cast in places, varies sublithographic to dense, hard, fossiliferous, *Archimedes*, crinoid stems, weathers buff to gray and crinoidal, *Diaphragmus cestriensis*	1.0	63.1
Shale, black, fissile	5.0	62.1
Shale, black, fissile, limestone, blue gray and brownish gray, finely crystalline, *Pentremites*, *Archimedes*, fenestellid bryozoans, *Spirifer increbescens*, weathers buff to gray and crinoidal with bryozoans covering surface	5.0	57.1
Covered: black fissile shale and limestone rubble	26.0	52.1
Limestone, gray blue, dense to finely crystalline, highly fossiliferous, *Pentremites*, *Archimedes* with big fronds, *Reticulariina spinosa*, *Torynifera setigera*, *Pentremites pyriformis*, gastropods, weathers buff to gray because of iron staining	1.0 to 1.2	26.1
Covered: toward bottom is about 1 foot of poorly exposed blue to gray blue thin-bedded finely crystalline		

limestone, *Diaphragmus cestriensis Reticularlina spinosa, Torynifera setigera*, weathers buff to gray and slightly crinoidal	5.0	25.0
Covered: shale	10.0	20.0
Covered: 10 feet estimated to contact with Hindsville limestone	10.0	10.0
Hindsville:		
Limestone, blue gray, finely crystalline, *Archimedes*,		

113. YONKERS HILL
Southeast Corner of Section 10, T. 18 N., R. 19 E.

Formational Description	Thickness in Feet Of Unit	To Base of Fmtn.
Atoka:		
Sand, iron-stained, very fine; sand, white to buff, very fine, thin-bedded, estimated	25.0	30.0
Covered, green sandy siltstone and fine white sandstone that weathers buff	5.0	5.0
Morrow:		
Limestone, gray, dense to sublithographic, iron-stained green argillaceous lenses, weathers gray and slightly smooth	0.8	65.5
Limestone, gray varies to bluish gray, dense to finely crystalline, iron-stained in places, crinoid stems, *Pentremites angustus, Pentremites rusticus,,* weathers gray, thin to massive	5.0	64.7
Limestone, greenish to bluish gray, fine to medium crystalline, thin-bedded, very fossiliferous, crinoid stems, bryozoans, spines and plates, *Pentremites angustus, Pentremites rusticus*, poorly exposed; also greenish gray sublithographic limestone that weathers rubbly	3.0	59.7
Covered	1.5	56.7
Limestone, poorly exposed, at top is a medium to coarse crystalline bluish gray limestone, greenish cast to greenish limestone; crinoidal gray finely crystalline limestone	5.0	55.2
Covered	5.0	50.2
Limestone, gray, iron-stained and greenish stained, medium crystalline, weathers rough	2.5	45.2
Limestone, greenish gray, medium crystalline, very crinoidal, *Ethelocrinus* cf., *magister*, "*Hydreionocrinus*" sp., *Delocrinus sp., weathers buff*	0.7	42.7
Limestone, gray, and greenish gray, finely crystalline, weathers crinoidal	1.2	42.0
Limestone, gray, greenish cast, varies finely crystalline to sublithographic, slightly iron-stained	2.5	40.8
Limestone, gray, brown-stained, sublithographic	0.8	38.3
Limestone, dove gray to slightly brownish gray, greenish cast, varies finely crystalline to sublithographic, weathers rubbly and thin-bedded, weathers light gray with bluish mottled areas on surface	6.0	37.5
Limestone, gray, fine to medium crystalline, crinoidal, calcite crinoid stems, iron-stained, *Michelinia scopulosa, Condrathyris perplexa*, weathers crinoidal and thin-bedded	2.5	31.5
Limestone, gray, finely crystalline to sublithographic, iron stained, some greenish argillaceous material, weathers thin	2.0	29.0
Shale parting, gray, very thin and irregular	0.0 to 0.3	27.0

Limestone, gray varies to buff-gray, iron-stained, slightly oolitic, highly irregularly bedded	3.0	26.8
Limestone, gray buff, coarsely crystalline, iron-stained in spots, fossiliferous	1.3	23.8
Sand, buff brown, calcareous, iron-stained	0.3	22.5
Limestone, light gray to brownish gray, medium crystalline, reddish brown-stained, weathers finely crinoidal, weathers rough and brown	2.5	22.2
Limestone, gray, oolitic glauconitic, sandy, weathers sandy and greenish 6″ exposed	0.5	19.7
Covered	1.5	19.2
Limestone, greenish to buff and gray, finely crystalline, hard, sandy, weathers to a sand	0.5	17.7
Limestone, gray, fine to medium crystalline, sandy, same as below but is oolitic and less weathered and has greenish argillaceous lenses	3.3	17.2
Limestone, gray, light gray and reddish, fine to medium crystalline, sandy, glauconitic, weathers thin; buff to reddish brown sand, top 3 feet weathers cross-bedded	5.5	13.9
Limestone, red to buff, dense hard, sandy	0.5	8.4
Limestone, reddish, very thin, weathers shaly and sandy, appears as a shale parting	0.2	7.9
Limestone, buff to reddish, medium crystalline, sandy, limonite spotted, few limonite concretions	0.3 to 0.5	7.7
Limestone, light gray, medium to coarse granular, iron stained in streaks	0.5	7.3
Limestone, buff-brown, finely crystalline, sandy, highly iron stained, weathers to a thin-bedded brown fine sand; shale parting 6″ from top	6.0	6.8
Limestone, gray to blue buff, sandy, contains some limestone centered limonite concretions, weathers rust colored	0.3	0.8
Shale, dark gray, calcareous, contains limestone centered concretions with limonite layers around them	0.5	0.5
Pitkin:		
Limestone, dull gray blue, shaly, weathers buff, exfoliates	1.0	27.5
Limestone, poorly exposed, gray, sublithographic, uneven bedded, *Archimedes*, weathers buff	3.0	26.5
Limestone, gray to dark gray, oolitic, contains *Pentremites*, bryozoans, *Girtyella indianensis*, weathers crinoidal, irregular and rough	1.8	23.5
Limestone, varies brownish gray to blue gray, partially to very oolitic, spirifers, weathers light blue to gray	2.0	21.7
Shale parting, soft dark gray to black iron-stained shale	0.6	19.7
Limestone, brown gray to blue gray, sublithographic, to finely crystalline	3.3	19.1
Limestone, gray to blue gray, sublithographic, *Archimedes swallovana*, *Composita subquadrata*, bryozoans, iron-stained in places; weathers irregular and uneven, weathers buff gray and crinoidal, one and one-half feet exposed	1.5	15.8
Covered, some gray sublithographic to dense limestone exposed	5.5	14.3
Limestone, oolitic, iron-stained	1.5	8.8
Covered	1.8	7.3
Limestone, blue gray, dense, iron-stained, oolitic in places, few crinoid stems, one and one-half feet exposed	1.5	5.5

Covered	4.0	4.0
Fayetteville:		
Shale, black fissile	15.0	65.0
Shale, black fissile and rubbly gray sublithographic limestone	5.0	50.0
Shale, black; limestone poorly exposed	5.0	45.0
Shale, black; limestone rubble	10.0	40.0
Shale, black; large septarian concretions at top	5.0	30.0
Shale, black; septarian concretions	5.0	25.0
Shale, black; septarian concretions	5.0	20.0
Shale, black	5.0	15.0
Shale, black; gray dense to finely crystalline fossiliferous limestone	5.0	10.0
Covered; possibly black shale	5.0	5.0
Covered; 30.0 feet to base of hill.		

114. MEASURED SECTION—ALONG FLAT ROCK CREEK
Section 18, T. 18 N., R. 19 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Morrow:		
Limestone, brownish-gray, conglomeratic, coarse crystalline, iron-stained, at contact.		
Pitkin:		
Limestone, gray to brown gray, iron-stained, finely crystalline, oolitic; below poorly exposed is a limestone, gray, dense to extremely oolitic	4.0	39.0
Limestone, gray, medium crystalline, oolitic, iron-stained, poorly exposed	5.0	35.0
Limestone, 1′ to 2′ beds; top is gray dense limestone and gray extremely oolitic limestones; dense gray oolitic bed with greenish cast; blue gray finely crystalline oolitic limestone	5.0	30.0
Limestone gray, dense, some varies to crystalline, uneven bedded, iron-stained, weathers crinoidal	5.0	25.0
Covered: limestone	5.0	20.0
Shales, black, fissile	5.0	15.0
Limestone, gray, finely crystalline, oolitic	4.0	11.0
Limestone, gray, lithographic varies to finely crystalline in areas, massive, iron-stained in places	5.0	6.0
Limestone, gray, lithographic, 1′ exposed, weathers rubbly and light bluish gray and gray	1.0	1.0
Alluvium:		
Covered below.		

115. MEASURED SECTION—SOUTHEAST CORNER
Section 28, T. 18 N., R. 19 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, poorly exposed	5.0	55.0
Sandstone, brown, pinkish cast, siliceous in places	5.0	50.0
Sandstone, brown, fine	5.0	45.0
Covered: probably limonite-stained sandstone	5.0	40.0
Sandstone, red, poorly exposed	10.0	35.0
Sandstone, iron-stained	10.0	25.0
Sandstone, whitish, stained dull green with some iron-stained spots	5.0	15.0

Sandstone, white, stained brown	5.0	10.0
Sandstone, red- and yellow-stained, fine to medium, some very hard, poorly exposed	5.0	5.0
Morrow:		
Covered:	10.0	62.5
Covered: top is limestone, gray, lithographic, hard, weathers smooth and buff	5.0	52.5
Covered: limestone, gray blue, finely crystalline, hard, massive, weathers smooth except for crinoid stems; below is siltstone, yellowish green	5.0	47.5
Covered: limestone, gray blue, dense to finely crystalline, thin-bedded, hard, bryozoans, weathers brown and crinoidal	5.0	42.5
Limestone, bluish gray, slightly granular, medium grained	1.2	37.5
Limestone, gray brown or buff, finely crystalline, crinoidal	1.0 to 1.2	36.3
Limestone, blue gray, finely crystalline, massive, 21 inches exposed	1.8	35.2
Covered:	1.0	33.4
Covered: limestone, bluish gray, dense, one foot at top—may not be in place	10.0	27.4
Limestone, reddish brown and gray, medium crystalline, crinoidal, weathers sandy	1.3	22.4
Limestone, reddish brown and gray, fine to medium crystalline, weathers greenish gray and sandy	0.3	21.1
Covered:	1.2	20.8
Limestone, brown and gray, medium crystalline, sandy, light greenish argillaceous lenses	2.0	19.6
Limestone, light gray, fine and medium crystalline, thin-bedded, sandy, iron-stained, weathers brown and sandy	5.0	17.6
Sandstone, light gray and brown spotted, fine-grained, pock-marked, massive bed	3.0	12.6
Limestone, light gray, fine to medium crystalline, brown and buff stained spots, crinoidal in places, slightly pitted, weathers brownish and thin-bedded	5.0	9.6
Limestone, gray, weathered in sandy streaks and to a buff brown color	0.5	4.5
Sandstone, buff to brown, calcareous, iron-stained	0.3 to 0.5	4.1
Sandstone, greenish and brown, fine, pitted and pock-marked, varies from 12 to 18 inches lower part is a light gray, sandy, conglomeratic limestone, contains dark calcite crystals, small pebbles, and brachiopods, grades into the sandstone above	2.7	3.7
Limestone, conglomeratic, rounded and subrounded pebbles, pebbles ranging up to size of a hen's egg were found, some of pebbles were Pitkin	1.0	1.0
Pitkin:		
Limestone, light gray, weathers brownish gray and sandy	1.3 to 0.0	37.0
Limestone, buff gray, 0″ to 12″ lensing bed	0.0 to 1.0	37.0
Limestone, blue gray, finely crystalline, weathers rubbly at base	1.2 to 2.3	36.0
Limestone, gray, dense to finely crystalline, crinoidal and fossiliferous in lower part, *Archimedes*, thin-bedded	2.0	33.7

Limestone, gray, lithographic, rubbly weathering, about 2″ beds, *Archimedes*	2.0	31.7
Limestones: poorly exposed; limestone, gray blue, fossiliferous; other limestone poorly exposed; limestone, gray blue, dense to sublithographic, very fossiliferous, *Diaphragmus cestriensis, Paladin mucronatus,* beds are thin	1.5	29.7
Limestones: limestone, rubbly weathering; limestone blue gray, lithographic, weathers buff and gray; shale, black, is probably at the bottom but is poorly exposed	2.5	28.2
Limestone, gray blue, sublithographic	0.5	25.7
Limestone, blue gray, iron-stained, highly crinoidal	2.0	25.2
Covered:	0.7	23.2
Limestone, blue gray, dense, iron-stained in places	0.7	22.5
Limestone, blue gray, dense to lithographic, fossiliferous, calcite streaks, iron-stained	20.0	20.0
Fayetteville:		
Covered: limestone gray blue and gray, lithographic and sublithographic, smooth, calcite and siderite veinlets, weathers, light gray; limestone, gray, lithographic to crystalline, hard fenestellid bryozoans in abundance, weathers finely crinoidal, *Archimedes,* both beds not over 8″ each; crinoidal bed carries *Spirifer* sp.	5.0	5.5
Limestone, gray, lithographic, concretionary bed, contains orange calcite deposits, weathers buff	0.5	0.5

116. COMPOSITE SECTION—ALONG GRAND RIVER
Section 29, T. 18 N., R. 19 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone; estimated 10 feet	10.0	73.0
Shale and Limestone: interbedded shales and dark gray lithographic limestone; limestone are thin and weather out in blocks or as rubbly material	13.0	63.0
Sandstone, brown and buff, fine-grained, calcareous cement, slightly greenish in places; also medium-grained sand, less brown in color; limonite-stained, large scale cross-bedding, highly weathered	40.0	50.0
Siltstone, slightly bluish green, thin-bedded; 10 feet exposed down to the alluvium	10.0	10.0

117. MEASURED SECTION—NORTHWEST LIMB OF FOLD
Sections 31 and 36, T. 18 N., Rs. 19 and 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Reeds Spring:		
Chert, limestone and cherty limestone make up Reeds Spring; at contact, chert, blue centered with brown edges, waxy and smooth on broken surface; exposed in branch and along Clear Creek.		
St. Joe:		
Limestone, light blue to gray, lithographic, system of joints; long set—N. 30° W. short set—N. 68° E. Dip—7½° N., 75° W.	0.5	17.1

Limestone, gray medium to finely crystalline and brownish gray, coarsely crystalline, crinoidal. One of lower beds is highly crinoidal, contains some fossils, spirifers. Dip changes upstream to 9° W. Long system of joints: N. 30° W., thin-bedded, varies from 2″ - 12″	4.0	16.6
Covered: estimated 4 feet	4.0	12.6
Shale, highly weathered	3.3	8.6
Limestone, greenish, medium to finely crystalline, argillaceous, weathers shaly; also greenish highly weathered argillaceous, dolomitic limestone that weathers shaly. All looks like shale on the weathered slope, highly fossiliferous with corals, bryozoans, gastropods, brachiopods, crinoid stems and possible crinoid bulb	4.0	5.3
Limestone, gray, sublithographic, Dip 10° to 12° S. 80° W.	1.3	1.3
Chattanooga: Shale, black, fissile, heavy, pyritic, estimated 30′	30.0	30.0
Sylamore: Sand, gray brown, very hard, fine siliceous	0.5	0.5
Tyner: Shale, green, bentonitic, exposed at top of fold		

118. MAYES-CHEROKEE COUNTY LINE
Section 5, T. 18 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka: Sandstone (caps hill), not measured.		
Morrow: Limestone, brownish gray, limonite-stained, crystalline, oolitic, weathered in irregular layers, not measured.		
Sandstone, reddish brown, calcareous, hard, not measured.		
Pitkin: Limestone, brownish gray, medium crystalline, fossiliferous, not measured.		
Fayetteville: Shale, black, fissile, with a light gray sublithographic limestone toward the top	34.0	34.0
Hindsville: Limestone, brownish-gray, fine to medium crystalline, poorly exposed	5.0	24.9
Limestone, gray, oolitic, fossiliferous	4.0	19.9
Limestone, brownish gray, medium crystalline, fossiliferous	1.0	15.9
Limestone, light gray, oolitic, fossiliferous, bryozoans	3.0	14.9
Limestone, gray, dense to crystalline, poorly exposed	2.0	11.9
Covered, limestone, light gray, coarsely crystalline; oolitic and fossiliferous at top	5.0	9.9
Covered, limestone, limonite-stained	2.0	4.9
Limestone, highly fossiliferous	1.0	2.9
Limestone, grayish, limonite-stained, coarsely crystalline	1.0	1.9
Limestone, brownish gray, medium crystalline, fossiliferous, small trilobites, oolitic, *Agassizocrinus* on weathered surface, forms first bluff	0.9	0.9

Moorefield:		
Ordnance Plant member:		
Shale, black, fissile, probably includes this five feet and a little below, poorly exposed	5.0	30.3
Covered, siltstone, dark gray to black, shaly, highly weathered, poorly exposed	5.0	25.3
Covered, siltstone, dark gray, brownish on weathered surface	5.0	20.3
Covered	10.0	15.3
Limestone, grayish-brown, shaly, weathers platy and looks like shale, weathers brown	1.5	5.3
Limestone, bluish gray, shaly, weathers in small platy layers, top 3 inches are more dense and not weathered as much but has begun to weather the same as below	0.9	3.8
Limestone, brownish gray, dense, shaly; weathers a dirty light gray	0.5	2.9
Limestone, blue-gray, shaly, dense, weathers dirty light gray and smooth on surface	0.4	2.4
Siltstone, brownish gray, calcareous, shaly weathers plate-like or in thin sheets; badly weathered	2.0	2.0
Keokuk:		
Chert, white, exposed below in creek		

119. MEASURED SECTION—HILL ON BOUNDARY
Section 6, T. 17 N. and Section 31, T. 18 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Covered, large sandstone grit boulders (grains up to ½″)	20.0	25.0
Sandstone, red, to buff brown, medium-grained	5.0	5.0
Morrow:		
Covered	5.0	63.1
Limestone, blue-gray, buff-brown stained, dense with larger calcite crystals, weathers thin-bedded	0.7	58.1
Limestone, light gray to brown gray, dense to finely crystalline, weathers blue on surface, one bed exposed	0.7	57.4
Covered	1.0	56.7
Limestone, light gray, dense to medium crystalline slightly oolitic	2.3	55.7
Covered	2.5	53.4
Limestone, light gray, finely crystalline, reddish and brownish stained	2.1	50.9
Limestone, gray, hard, dense to sublithographic, exposed	0.3	48.8
Limestone, very poorly exposed, varies from blue gray to brown gray, thin-bedded, finely crystalline at top and middle, to brown and blue gray, more massive, dense limestone at base	10.0	48.5
Covered	4.0	38.5
Limestone, gray to brownish gray, medium crystalline in a dense matrix, thin (2″ - 4″)	1.5	34.5
Limestone, gray, medium to coarsely granular	0.5	33.0
Limestone, gray sublithographic with few larger calcite crystals, thin-bedded	2.0	32.5
Limestone, gray, fine to medium crystalline, flaggy weathering	1.0	30.5

Limestone, brownish to greenish gray, finely granular to slightly oolitic, weathers crumbly	2.5	29.5
Limestone, gray, reddish stained in spots, hard sublithographic with larger crinoid-calcite crystals, one bed exposed	0.5	27.0
Limestone, poorly exposed, varies from grayish brown, very finely oolitic to blue gray, very hard, finely crystalline, partially oolitic, very fossiliferous with brachiopods and gastropods	5.0	21.5
Limestone, blue gray to gray, dense, reddish, and brownish weathered, thin-bedded	1.5	16.5
Limestone, buff to brown to bluish gray, green-spotted, fine to medium crystalline, exposed	1.5	15.0
Covered:	2.0	13.5
Limestone, poorly exposed, gray to brownish gray, finely to medium crystalline	2.5	11.5
Limestone, gray to reddish stained blue gray, dense to finely crystalline	2.5	9.0
Covered:	0.5	6.5
Limestone, dark blue gray, extremely oolitic with very fine oolites, one bed	0.2	6.0
Limestone, light gray, sublithographic to granular	0.7	5.8
Covered	0.8	5.1
Limestone, brown, granular, weathered	1.3	4.3
Conglomerate, reddish to purplish gray, has dark blue and blue gray flat smooth limestone pebbles and red sandstone pebbles	1.5	3.0
Conglomerate, brown to blue gray, dense, limestone	0.2	1.5
Limestone, reddish, medium crystalline	0.8	1.3
Sandstone, buff to reddish purple, very slightly calcareous	0.5	0.5
Pitkin:		
Covered, limestone rubble, dove gray, smooth, contains *Archimedes*	10.0	42.7
Limestone, gray, brown gray, lithographic	2.0	32.7
Covered	2.0	30.7
Limestone, gray, reddish-stained, sublithographic, very hard, crinoidal, crinoids appear as white circles, massive-bedded (forms cliff)	7.0	28.7
Limestone, gray sublithographic to medium crystalline, hard	2.5	21.7
Limestone, poorly exposed, light to darker gray, lithographic to finely crystalline, partially oolitic	0.8	19.2
Limestone, poorly exposed, gray, larger (coarse) crystals in a sublithographic matrix, weathers granular	2.0	18.6
Covered	1.0	16.6
Limestone, poorly exposed	0.6	15.6
Covered, gray, lithographic to sublithographic limestone rubble	5.0	15.0
Covered	5.0	10.0
Covered, brown, extremely oolitic, limestone rubble	5.0	5.0
Fayetteville:		
Covered, dark gray, lithographic to sublithographic, limestone rubble, and black fissile shale	5.0	55.3
Covered: occasional shales, black fissile	10.0	50.3
Limestone, poorly exposed, gray hard sublithographic	0.3	40.3
Covered: few limestones exposed, gray, sublithographic and crinoidal	30.0	40.0
Limestone and shale poorly exposed, gray to dark gray, lithographic, septarian concretions in black, fissile shale	5.0	10.0
Shale, black fissile	5.0	5.0

Hindsville:		
Limestone, gray, lithographic, smooth, weathers blocky and gray to white, one bed	0.6	24.7
Limestone, darker gray, sublithographic, one bed	2.0	24.1
Limestone, gray, oolitic, extremely fossiliferous (Productids) more oolitic near base	1.2	22.1
Limestone dark gray, sublithographic to dense, two beds	2.2	20.9
Limestone, gray, varies from lithographic in upper part to oolitic in lower, weathers gray to white and smooth	3.0	18.7
Limestone, gray, variable lithology, sublithographic, oolitic, fine crystalline and hard	1.0	15.7
Limestone, gray, lithographic and sublithographic, contains some productid-type brachiopods	0.7	14.7
Limestone, gray, varies from very finely oolitic in top beds to more dense and less oolitic in lower beds, hard, 4 beds	4.0	14.0
Limestone, gray, buff stained in spots, fine to medium crystalline, thin-bedded	1.3	10.0
Limestone, brownish gray to gray, sublithographic to finely crystalline, silty, hard, thin-bedded, weathers buff to brown, some layers contain many brachiopods	3.7	8.7
Covered, gray, lithographic, sublithographic, limestone blocks on surface	3.0	5.0
Limestone, light to medium gray, oolitic to medium crystalline, weathered surface covered with *Agassizocrinus*, two beds exposed,	2.0	2.0

120. HADLEY MOUNTAIN
Sections 6 and 7, T. 18 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, buff, fine-grained, brown-specked, hard. 10 feet estimated	10.0	17.0
Siltstone, buff, very sandy, iron-stained, weathers in fine shaly layers	7.0	7.0
Morrow:		
Covered	5.0	84.9
Limestone, blue gray, finely crystalline, abundant *Pentremites*, some cover	5.0	79.9
Limestone, blue, dense, oolitic, brachiopods	1.0	74.9
Limestone, blue gray, dense, fossiliferous	1.3	73.9
Limestone, blue gray, very oolitic, fossiliferous, crinoidal, *Pentremites* at the top, poorly exposed	5.0	72.6
Covered	10.0	67.6
Limestone, gray, fine to dense, fossiliferous, *Pentremites*, weathers crinoidal. Some covered and poorly exposed limestone, medium even crystalline, limonite stained, massive, weathers bluish gray	6.5	57.6
Limestone, gray, fine-crystalline, massive, limonite stained, weathers smooth and bluish gray on surface, contains big branching coral about 1 foot long with ½″ limbs	8.0	51.1
Limestone, limonite specked, weathers crinoidal, corals, branching bryozoans, spines and other bryozoans, mostly covered	5.0	43.1

Limestone, hard, fine, limonite-stained; 8″ gray limonite specked limestone, buff and reddish colored fine to medium crystalline, hard limestone	5.0	38.1
Limestone, blue-gray to buff, limonite-stained, thin-bedded, varies finely crystalline to coarsely crystalline, weathers uneven and sandy	5.0	33.1
Limestone, blue-gray to buff, limonite-stained, thin-bedded, *Spirifer* sp.	1.5	28.1
Limestone, greenish gray, medium crystalline, crinoidal, weathers cross-bedded, corals, *Michelina scopulosa*....	3.5	26.6
Limestone, dark gray, medium crystalline, some green material that may be glauconite, brachiopods	1.0	23.1
Limestone, gray, limonite specked, coarsely crystalline, larger calcite crystals, corals, crinoid stems on weathered surface, forms steps	3.0	22.1
Limestone, brownish gray, coarsely crystalline, crinoidal, abundant corals	2.0	19.1
Limestone, dark gray, fossiliferous, covered with bryozoans and corals, 1½″ bed, weathers light gray and buff, *Cladochonus fragilis*	0.1	17.1
Limestone, blue gray, fine-medium crystalline, fossiliferous, very hard, forms steps up slope, weathers crinoidal, weathers in beds 6″ to 12″, crinoidal and contains many corals	3.9	17.0
Limestone, blue, medium crystalline, very hard, fossiliferous, sublithographic greenish gray portions..	1.0	13.1
Covered; some limestone, hard, gray, medium, sandy, iron stained, large calcite crystals, weathers to pitted sand	2.5	12.1
Limestone, reddish-stained, sandy, greenish cast	0.5	9.6
Limestone, gray, fine to dense, very hard, sandy, weathers to red sand	0.5	9.1
Siltstone, black-streaked, limonite-stained, slightly calcareous, badly weathered, ferruginous, small flat pebbles	0.5	8.6
Limestone, conglomerate, 5″ bed, all kinds of pebbles, ferruginous, small flat pebbles	0.4	8.1
Sand, light buff, slightly stained, contains fossils, more calcareous than below hard, contains small pebbles, varies to limestone	0.5	7.7
Sand, buff, calcareous, weathers in thin layers, calcite crystals in sand matrix	2.3	7.2
Limestone, gray buff, iron-stained, conglomeratic, small flat pebbles, hard, weathers into 2″ to 5″ beds..	1.0	4.9
Limestone, buff, very sandy, weathers cross-bedded, weathers knobby or fluted, also reddish in color, some gray	2.3	3.9
Limestone, extremely limonite-stained, thin, irregular bedded, coarsely crystalline, some finer red sandy limestone	0.7	1.6
Conglomerate, limestone matrix, many different pebbles	0.9	0.9
Pitkin:		
Shale, black, some black lithographic limestone	6.0	8.3
Limestone, blue-gray, finely crystalline to sublithographic in places, weathers rough and buff, contains abundant *Archimedes*, fragments of a crinoid, and blastoid; one massive bed which weathers to form 3 distinct zones with changes in lithology	2.3	2.3
Fayetteville:		
Shale, black fissile	5.0	35.0
Shale, black fissile	5.0	30.0

Shale, black fissile	5.0	25.0
Shale, black fissile, iron-stained, pelecypod imprints, dark gray to black, iron-stained on weathered surface. Black on unweathered surface, occasional limonite concretions	5.0	20.0
Covered, black shale at top	5.0	15.0
Covered, probably shale	10.0	10.0
Hindsville:		
Covered	9.2	11.7
Limestone, brownish gray, medium crystalline, fossiliferous, contains small trilobites, *Paladin mucronatus* (Girty)	0.8	2.5
Limestone, brownish gray, medium crystalline, *Agassizocrinus*	0.7	1.7
Limestone, blue-gray, coarse crystalline, weathers crinoidal, more bluish on the weathered surface	0.4	1.0
Limestone, lower 2″ brownish gray with finely disseminated calcite crystals, rest is gray fine to medium crystalline, brownish on weathered surface, *Agassizocrinus*, calcite crystals	0.6	0.6
Moorefield:		
Ordnance Plant member:		
Siltstone, buff, exposed in small cut along north side of road		

121. ALONG ROAD ON NORTH SIDE
Section 8, T. 18 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hindsville:		
Limestone, blue-gray, fine to medium crystalline, highly fossiliferous, weathers crinoidal, *Agassizocrinus* sp., exposed	3.0	3.0
Moorefield:		
Ordnance Plant member:		
Shale, soft, black	0.8	11.8
Shale, buff, poorly exposed and highly weathered	5.0	11.0
Siltstone, dull grayish brown, calcareous, dark streaks that make it appear finely laminated	0.5	6.0
Shale, black	1.0	5.5
Limestone, blue dense to sublithographic, silty, badly weathered, weathers buff, concretionary and shaly	1.5	4.5
Limestone, light buff gray, silty, weathers buff yellow	1.0	3.0
Siltstone, buff highly weathered, weathers concretionary and shaly	2.0	2.0
Covered to top of Keokuk chert.		

122. ROAD UP ROACH MOUNTAIN
Sections 17 and 18, T. 18 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, sandstone wash toward bottom, 20′ to 40′ estimated exposed	20.0 to 40.0	20.0 to 40.0
Morrow:		
Limestone, light greenish gray to gray-brown, finely crystalline, not as massive as beds below, covered above	5.0	43.0

Limestone, gray, orange and red stained, very dense, also gray dense to sublithographic limestone, hard and massive beds	5.0	38.0
Limestone, light gray, dense to finely crystalline, massive- to thin-bedded, forms small bluff	8.0	33.0
Limestone, poorly exposed	5.0	25.0
Limestone, greenish gray, limonite-stained, dense limestone, almost all covered	5.0	20.0
Limestone, light gray, sublithographic to lithographic..	3.0	15.0
Limestone, light blue gray, dense to finely crystalline, horn corals, crinoid stems, ½″ weathered band on outer surface of rock	2.0	12.0
Limestone, light blue gray, dense and sublithographic, thin, contains brachiopods	5.0	10.0
Limestone, greenish gray, limonite-stained, fine to medium crystalline, becomes more coarsely crystalline in upper part, sandy, conglomeratic with few small pebbles in lower one foot	5.0	5.0
Pitkin:		
Limestone, gray, limonite stains, finely crystalline, crinoidal, *Archimedes*	3.0	20.0
Limestone, gray, blue-gray and brownish gray, in places limonite-stained, thin, uneven-bedded, calcite edges of crinoid stems on fresh broken surface, *Archimedes*	5.0	17.0
Limestone, blue-gray, finely crystalline, limonite tinge, highly filled with crinoid stems that are gray calcite, highly crinoidal on weathered surface, *Archimedes*..	5.0	12.0
Limestone, dark gray, lithographic, poorly exposed, estimated 2′, weathers rubbly and light blue gray.....	2.0	7.0
Limestone, bluish gray, sublithographic, silty, dolomitic, weathers buff and rubbly	5.0	5.0
Fayetteville:		
Shale, black, fissile	5.0	21.4
Limestone, blue-gray, lithographic, small pockets of calcite, contains bryozoans and a small *Archimedes*; one layer made up almost entirely of brachiopods, fenestellid bryozoans, crinoid stems and *Archimedes*, weathers buff and in places finely crinoidal	1.4	16.4
Shale, black, fissile, with septarian concretions	5.0	15.0
Shale, black, fissile poorly exposed, (1 to 1½′) dark gray to black septarian concretions, contact with Hindsville not observed	10.0	10.0
Hindsville:		
Limestone, exposed below along both sides of road.		

123. EAST SIDE OF ROACH MOUNTAIN
Section 19, T. 18 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, red and buff-stained, fine-grained	20.0	20.0
Morrow:		
Limestone, gray, greenish cast, medium crystalline, weathers finely crinoidal, poorly exposed	3.0	53.5
Limestone, gray, fine to medium crystalline with sublithographic areas, some red spotted varies toward top to a gray to blue-gray medium to coarse crystalline, crinoidal, iron-stained limestone, weathers thin to massive, weathers in blocks and then in thin layers; forms second bluff	14.0	50.5

Covered	5.0	36.5
Limestone, gray to brown gray, fine, medium to coarse crystalline, calcite crinoid stems, buff-stained, weathers finely crinoidal, red and brown-stained gray medium crystalline limestone, thin-bedded, contains bryozoans	5.0	31.5
Limestone, gray, finely crystalline	5.0	26.5
Limestone, light gray to gray, medium to coarse granular, varies to fine to medium crystalline, thin-bedded	5.0	21.5
Limestone, gray-blue, dense to sublithographic, thin-bedded, weathers light gray	5.5	16.5
Limestone, light gray, fine to medium crystalline, thin-bedded, ½″ to 4″, oolitic, crinoidal, iron-stained, calcite crystals, weathers buff brown and crinoidal, forms steps above first Hale cliff	5.0	11.0
Limestone, light gray, fine to medium, larger calcite crystals, sandy, iron-stained, cross-bedded, weathers brown	3.0	6.0
Conglomerate, lower part of above bed	3.0	3.0
Pitkin:		
Limestone, gray-blue, dense, weathers rubbly, varies from 2″ to 4″	0.2 to 0.3	34.3
Limestone, gray, partially iron-stained, extremely oolitic	0.3	31.8
Limestone, gray brown to brownish gray, sublithographic in lower one foot, very hard, varies gray to brownish gray, partially oolitic grading to finely granular with sublithographic portions, weathers crinoidal, *Archimedes*	4.0	31.5
Limestone, gray sublithographic, some finely crystalline, fossiliferous, *Torynifera setigera*	3.0	27.5
Limestone, blue to gray, dense to finely crystalline, unevenly bedded, contains bryozoans, abundant *Archimedes*, *Linoproductus ovatus* (Hall), *Reticulariina spinosa* (Norwood and Pratten), *Composita subquadrata* (Hall), *Archimedes owenanus* (Hall), weathers rubbly, exposed	2.5	24.5
Covered	9.0	22.0
Limestone, dove gray, sublithographic, contains productids, weathers rough and chips off in pieces	3.6	12.0
Limestone, gray, dense to sublithographic, very fossiliferous	0.4	9.4
Limestone, brownish gray, finely crystalline, oolitic, crinoids, productids, abundant *Archimedes*	1.0	9.0
Covered, limestone, gray dense to sublithographic, limestone, brownish to gray, finely crystalline, large crinoid stems, *Archimedes*	5.0	8.0
Limestone, gray, lithographic to finely crystalline, productids and abundant *Archimedes*, weathers light bluish gray, weathers into small fragments that break off	3.0	3.0
Fayetteville:		
Covered	5.8	70.0
Covered, limestone rubble	15.0	65.0
Shale, black, fissile, bed of blue and brown dense limestone, larger calcite crystals, contains fenestellid bryozoans, weathers buff and crinoidal; 4″ to 5″ bed in lower part contains *Archimedes*, septarian concretions in the shale	5.0	50.0
Shale, black, also limestone rubble	10.0	45.0

Shale, black, poorly exposed 7″ to 8″ limestone bed, grayish brown and grayish streaked, grayish portions are sublithographic to finely crystalline, very finely oolitic in brownish portions, very fossiliferous, contains *Archimedes* and other fossils, *Diaphragmus cestriensis*, *Eumetria verneuiliana*, *Archimedes invaginatus*, *Pentremites* sp., *Torynifera setigera*, *Dielasma shumardanum*, *"Dictyoclostus" inflatus*, weathers buff to gray and crinoidal	5.0	35.0
Shales, black, fissile, septarian limestone concretions..	5.0	30.0
Shales, black, fissile	15.0	25.0
Shales, black, fissile; large dark gray to black septarian concretions	5.0	10.0
Shales, black, fissile	5.0	5.0
Hindsville:		
Limestone, gray to blue, lithographic, pyritic, weathers rubbly	3.0	24.8
Limestone, gray, varies to brownish gray, medium crystalline, oolitic, weathers gray; toward top in places varies to a gray sublithographic limestone which weathers to light bluish gray	1.3	21.8
Covered: limestone	0.8	20.5
Limestone, gray, fine to medium crystalline, sparsely oolitic	0.7	19.7
Covered: limestone	0.7	19.0
Limestone, brownish gray, oolitic, varies to gray lithographic	1.0	18.3
Limestone, gray, sparsely oolitic in dense matrix, weathers light bluish gray	1.0	17.3
Limestone, gray, lithographic, weathers rubbly and smooth; poorly exposed	4.0	16.3
Limestone, gray, finely crystalline, varies to brownish gray and partially oolitic	2.0	12.3
Limestone, gray, very dense, silty, weathers buff to yellow, poorly exposed; also buff partially oolitic limestone, crinoids and fenestellid bryozoans, crumbly	3.0	10.3
Limestone, poorly exposed	1.5	7.3
Limestone, slight brownish gray, fossiliferous, oolitic, weathers crinoidal; poorly exposed	0.5	5.8
Limestone gray, lithographic, weathers light gray and rubbly; poorly exposed	3.0	5.3
Limestone, brownish gray, medium crystalline	0.8	2.3
Limestone, gray medium crystalline, highly fossiliferous, profuse productid zone, some bryozoans, large productids	0.8	1.5
Limestone, gray to blue, medium crystalline, calcite deposits, partially oolitic, weathers buff, *Agassizocrinus* sp. concentration	0.7	0.7
Moorefield:		
Ordnance Plant member:		
Shale, black	1.0	34.0
Shale, alternating buff and black	3.0	33.0
Covered: some poorly exposed buff siltstone	30.0	30.0
Lindsey Bridge member:		
Limestone, brown-gray, medium granular to coarse crystalline, has small chert granules and fragments with occasional chert pebbles, weathers sucrosic; top one foot is medium crystalline limestone, fossiliferous, *Aviculopecten batesvillensis* Weller, *Camarotoechia purduei* var. *agrestis* Girty, *Moorefieldella eurekensis* (Walcott), *Leiorhynchus carboniferum*		

Girty, *Dielasma arkansanum* Weller, *Composita trinuclea* (Hall), *Composita acinus* Girty, *Harttina brevilobata* var. *marginalis* Girty	3.5	3.5

124. MEASURED SECTION
Section 30, T. 18 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Keokuk:		
Chert, white; not measured.		
Reeds Spring:		
Limestone, exceptionally cherty.		
Chert, light gray and dark blue; not measured.		
St. Joe:		
Shale, blue to green, weathers brown and gray	0.9	6.2
Limestone, gray dense to finely crystalline, weathers very finely crinoidal	0.4	5.3
Shale, light gray green, calcareous	1.2	4.9
Limestone, brownish gray, dense to finely crystalline, varies to lithographic, massive	1.0	3.7
Limestone, dark brownish gray in places, pyritic, weathers rubbly and finely crinoidal, shale partings, thin-bedded	2.3	2.7
Shale, brownish gray, soft, calcareous	0.4	0.4
Chattanooga:		
Shale, black, fissile, pyritic, varies along creek in amount exposed. 2′ exposed here	2.0	2.0

125. MEASURED SECTION
West Central Part of Section 30, T. 18 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hindsville to Atoka exposed above:		
Moorefield:		
Ordnance Plant member:		
Siltstones and one foot bed of buff dense silty limestones and shales both buff and black, Dip—7 N. 45 W.	10.0	18.0
Covered, buff-gray, massive limestone and siltstone	8.0	8.0
Bayou Manard member:		
Chert, blue, waxy, effervesces slightly with acid	1.3	13.9
Limestone, gray, lithographic, exceptionally cherty, weathers light gray	1.4	12.6
Limestone, brownish gray, dense to sublithographic	0.2	11.2
Limestone dull gray, dense to sublithographic, shaly, weathers shaly or flaggy lower part seems to remain more massive and top part more shaly; breaks up in fine pieces when hit with hammer, very brittle	7.0	11.0
Covered, dark shaly and calcareous siltstone	3.0	4.0
Limestone gray, finely crystalline, glauconitic	1.0	1.0
Keokuk:		
Gray lithographic limestone and gray cherty limestone and white to gray chert exposed.		

126. MEASURED SECTION—NORTH SLOPE OF HILL
Section 31, T. 18 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Moorefield:		
Lindsey Bridge member:		
Limestone, gray, dense to finely crystalline, glauconitic, oolitic, very finely conglomeratic, also contains larger chert pebbles and fragments, fossiliferous, very thin, *Dictyoclostus inflatus* var. *coloradoensis* (Girty), *Moorefieldella eurekensis* (Walcott), *Edmondia crassa* Girty, *Lingula batesvillae*, *Leiorhynchus carboniferum*, Girty, *Aviculopecten batesvillensis* Weller, estimated thickness	0.5	0.5
Bayou Manard member:		
Limestone, blue to gray blue, sublithographic to lithographic, contains cherty limestone. Limestone, dark gray and light gray, silty, has "cherty limestone knobs" that weather buff and earthy. Non-calcareous on weathered surface	4.0	21.8
Covered: Siltstone, dull brown, weathers buff	2.0	13.8
Limestone, bluish-gray, sublithographic, shaly, brittle and "slaty", smooth and massive and "slaty" weathers blue to gray, petroliferous odor	5.0	11.8
Limestone, dull gray, shaly and silty, weathers shaly; sublithographic, horn corals	2.3	6.8
Siltstone, black streaked dirty brown calcareous, weathers shaly, units appear to dip away from Keokuk hill	2.0	4.5
Limestone, gray, varies from finely crystalline to sublithographic, glauconitic, white calcite deposited in cracks, appears to be dipping away from Keokuk hill	2.0	2.5
Covered:	1.0	1.0
Keokuk:		
Chert, light gray, exact contact not observed.		

127. MEASURED SECTION—NORTH CENTRAL PART
Section 31, T. 18 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Reed Springs:		
Chert and limestone, interbedded	80.0	80.0
St. Joe:		
Limestone, gray, poorly exposed	5.0	5.0
Chattanooga:		
Shale, black, fissile, heavy	30.0	30.0
Sylamore:		
Sand, yellow brown and gray, siliceous, very dark and hard in places	0.5	0.5
Tyner:		
Shale, green	1.8	4.6
Sand, yellow brown, dolomitic, silty	2.3	2.8
Shale, green, few inches exposed to creek	0.5	0.5

128. MEASURED SECTION—NORTHWEST CORNER
Section 31, T. 18 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Keokuk:		
Chert, white, brown-spotted	10.0	10.0
Reeds Spring:		
Limestone, cherty limestone, and chert interbedded	90.0	90.0
St. Joe:		
Shale, green to gray	1.7	4.7
Limestone, gray, dense, glauconitic, crinoidal	3.0	3.0
Chattanooga:		
Shale, black, fissile	40.0	40.0
Tyner:		
Shale, green, with thin sandy layers	7.5	42.2
Shale, brown, gray in lower part, calcareous	4.0	34.7
Dolomite, yellow brown, contains green gray limestone concretions	1.7	30.7
Shale, green	5.0	29.0
Dolomite, yellow	0.5	24.0
Shale, green, fissile	6.0	23.5
Shale, green, interbedded with thin layers of white to dark green fine sand	5.0	17.5
Dolomitic sand, or sandy dolomite, brown to yellow brown, some places dark and very sandy, contains cherty limestone nodules	1.6	12.5
Sand, dark, fine grained, very hard	0.7	10.9
Shale, green, sandy, contains odd shaped sand concretions	7.0	10.2
Siltstone, buff, calcareous, with thin layer of fine greenish sand	0.7	3.2
Shale, green, 2.5′ exposed	2.5	2.5

129. MEASURED SECTION—UPPER PART OF STREAM
Southwest ¼ of Section 36, T. 18 N., R. 19 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka through Hindsville above; not measured.		
Moorefield:		
Ordnance Plant member:		
Covered: estimated 7.5 feet	7.5	16.9
Limestone, bluish gray centered, silty; weathers in irregular layers	3.0	9.4
Siltstone	0.5	6.4
Limestone, gray, silty, or limy siltstone; weathers buff and in thin ½″ layers	2.1	5.9
Siltstone, dark, dirty buff, calcareous	0.4	3.8
Limestone, blue, silty	2.1	3.4
Siltstone, dark, calcareous; thin-layered	1.2	1.3
Limestone gray, finely crystalline, grades into siltstone at contact	0.1	0.1
Lindsey Bridge member:		
Limestone, gray, finely crystalline, fine vari-colored chert fragments with occasional larger chert pebbles, in places becomes very conglomeratic, glauconitic, oily odor, contains corals, weathers buff, *Aviculopecten batesvillensis* Weller	4.0	4.0

Bayou Manard member:		
Chert, gray to buff layer, varies 4″ to 8″	0.3	19.5
Chert, 2″ blue and grayish layer	0.2	19.0
Limestone, light gray, hard, dolomitic	1.6	18.8
Chert, 2″ blue and grayish layer	0.2	17.2
Limestone light gray, hard, dolomitic	3.0	17.0
Chert, light blue layer, 2″	0.2	14.0
Limestone, blue gray, lithographic, hard, cherty	0.4	13.8
Chert, blue 2″ layer	0.2	13.4
Limestone, gray, lithographic, hard, cherty; weathers earthy on surface	1.2	13.2
Limestone, buff to gray, dense to lithographic, shaly and silty, fossiliferous, mottled, weathers gray to blue gray	12.0	12.0
Keokuk:		
Chert; exposed.		

130. HINDSVILLE AND MOOREFIELD FORMATIONS ON BLACKBIRD CREEK

Center of the East Half of Section 22, T. 18 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hindsville:		
Limestone, massive, dark gray, sublithographic, barren, weathers mottled light blue, fractures subcuboidal, top eroded	8.6	22.8
Covered	5.0	14.2
Limestone, thin-bedded, blue-black, oolitic, contains abundant *Eumetria vera* and *Diaphragmus cestriensis*, weathers iron-stained and pitted, contains lenses of blue, poorly cemented, calcareous, siltstone which weathers yellow	6.2	9.2
Limestone, massive, dark blue, coarsely crystalline, very fossiliferous, contains abundant *Agassizocrinus*, calcite veins	3.0	3.0
Moorefield:		
Ordnance Plant member:		
Siltstone thin-bedded, dark brown, contains concretions of black, lithographic, limestone, weathers yellow	4.7	4.7
Bayou Manard member:		
Limestone, massive, brownish black, finely crystalline, argillaceous, weathers platy	1.7	5.8
Limestone, thin-bedded, dark buff, dense very argillaceous	3.1	4.1
Limestone, massive, black, finely crystalline, fossiliferous, weathers platy, beds display strong rectangular jointing. Base covered	1.0	1.0

131. ST. JOE AND REEDS SPRING FORMATIONS ON SCARP OF FOURTEEN MILE CREEK FAULT 150 YARDS WEST OF STATE HIGHWAY 82 BRIDGE

Center of Section 26, T. 18 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Keokuk:		
Chert, massive, dull, white to buff, dense, highly fractured. Top eroded, base poorly exposed. Estimated thickness	50.0	50.0

Reeds Spring:		
Chert, and limestone sequence. Chert is thin-bedded, gray-blue, dense, has sub-pearly luster, even-bedded and thinly black-banded near base of formation, lens-like, nodular, while, less lustrous approaching top. Limestone is even-bedded near base, lenticular near top, thin-bedded, light blue, dense, sublithographic, barren	30.5	30.5
St. Joe:		
Shale, greenish-gray, soft, poorly exposed	1.8	6.6
Limestone, massive, gray, mottled black, dense finely crystalline, occasional crinoid fragment	2.3	4.8
Limestone, thin-bedded, gray, mottled black, dense, finely crystalline with occasional crinoid fragment, surfaces of beds are nodular, containing small inclusions of altered pyrite. Average thickness of bedding—2 inches	2.1	2.5
Shale, light gray-green, soft plastic	0.4	0.4
Chattanooga:		
Shale, black, hard, well-jointed, contains both nodular and finely disseminated pyrite, Base covered, base of exposure	4.2	4.2

132. BLOYD AND HALE FORMATIONS ON SOUTH BANK OF FOURTEENMILE CREEK

Center of the West Half of Section 26, T. 18 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Bloyd:		
Limestone, nodular, buff, finely crystalline, arenaceous. Thin yellow, buff siltstone exposed at base, top eroded	2.5	28.2
Covered	22.3	27.7
Limestone, massive, dark blue-gray, siliceous, sparingly fossiliferous	1.2	5.4
Limestone, massive, light gray, coarsely crystalline, iron-stained, very fossiliferous	1.3	4.2
Limestone, lenticular, dark blue-gray, medium crystalline, surface weathers knobby	0.3	2.9
Limestone, massive, dark gray, finely crystalline, weathers iron-stained and has subcuboidal fracture..	1.5	2.6
Covered, siltstone float	1.1	1.1
Hale:		
Limestone, massive, gray, coarsely crystalline, fossiliferous, weathers iron-stained and fluted	0.8	41.5
Limestone, massive, light gray, medium crystalline....	0.8	40.7
Limestone, massive, light gray, coarsely crinoidal, fossiliferous, weathers fluted, thin-bedded, and rough surfaced	12.3	39.9
Limestone massive, light gray, finely crystalline, sparingly fossiliferous	3.6	27.6
Limestone, massive dark blue-gray, fine to coarsely crystalline, contains black calcite, very fossiliferous, weathers iron-stained and nodular	2.0	24.0
Limestone, massive, light gray, fine to medium crystalline, dense	3.0	22.0
Limestone, massive, gray, coarsely crinoidal, contains hematite, lenses of dark gray limestone, weathers fluted and cavernous	12.0	19.0

Limestone, massive, gray, coarsely crinoidal, contains hematite weathers fluted	7.0	7.0
Pitkin:		
Limestone, massive, dark blue, lithographic, fractures subcuboidal, poorly exposed	0.4	0.4
Base of exposure		

133. ATOKA, BLOYD, HALE, PITKIN FORMATIONS ON FACE OF CUESTA

Southwest Corner of Section 35, T. 18 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, yellow, to reddish buff, blocky, friable, top eroded	19.0	19.0
Siltstone, yellow, thinly cross-bedded, calcareous in lower zone	20.1	20.1
Bloyd:		
Limestone and shale. Limestone, massive, black, sublithographic. Shale, black, fissile, thin-bedded	13.7	13.7
Hale:		
Limestone, gray, coarsely crinoidal, with few thin shale partings	25.1	25.1
Pitkin:		
Limestone, massive, gray, medium crystalline	3.0	16.7
Limestone, lenticular, black, lithographic, average thickness of bedding 5 inches, includes partings of black shale	4.0	13.7
Limestone, thin-bedded, black, sublithographic	3.0	9.7
Limestone, thin-bedded, blue-gray, fine to coarsely crystalline, dense. Base covered	6.7	6.7

134. ATOKA, BLOYD, HALE, PITKIN, FAYETTEVILLE, HINDSVILLE, MOOREFIELD, FORMATIONS ON FACE OF OUTLIER ALONG STATE HIGHWAY 82

Center of Section 36, T. 18 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, thin-bedded, yellowish-buff, fine-grained, intensely cross-bedded, badly slumped, estimated thickness	96.0	96.0
Bloyd:		
Limestone, massive, blue, coarsely crystalline, very fossiliferous, weathers platy, contains thin black shale breaks	6.2	21.2
Limestone, massive, gray, coarsely crystalline, weathers platy	3.6	15.0
Covered, apparently a shale partings	2.0	11.4
Limestone, massive, dark blue, coarsely crystalline, very fossiliferous, contains *Myalina orthonota*. Has apparent shale partings	5.6	9.4
Limestone, massive, dark blue, finely crystalline, weathers blocky	2.0	3.8
Limestone, thin-bedded, dark gray, coarsely to medium crystalline, very fossiliferous, contains apparent shale partings	1.8	1.8

Hale:		
Limestone, massive, gray, medium crystalline, dense, weathers platy and fluted	2.0	36.9
Limestone, thin-bedded, light gray, iron-stained, weathers nodular and pitted. Average thickness of bedding 5 inches	5.2	34.9
Limestone, massive, light gray, oolitic, weathers nodular	5.0	29.7
Limestone, massive, light gray, finely crystalline, contains much limonite in nodules and long veins, weathers pitted, fluted and very light gray. Becomes medium crystalline near top	11.3	24.7
Limestone, massive, dark blue, mottled, finely oolitic, contains many calcite stringers, fossiliferous, weathers pitted and light gray	3.0	13.4
Limestone, massive, brownish-gray, coarsely crinoidal, weathers fluted. Grades upward into finely crystalline, gray, dolomitic appearing limestone at top which weathers fluted	8.2	10.4
Limestone, massive, gray, hematite-stained, coarsely crinoidal, weathers fluted	2.2	2.2
Pitkin:		
Limestone, massive, light blue-gray, sublithographic, dolomitic appearing, weathers into subcuboidal blocks	1.3	6.3
Limestone, massive, brownish-gray, coarsely crinoidal, very fossiliferous, contains abundant *Archimedes*, weathers light blue and pitted	0.8	5.0
Limestone, massive, dark blue-gray, very coarsely crinoidal, very dense, weathers into 4 inch beds	3.3	4.2
Limestone, irregularly bedded, black lithographic, weathers nodular and limonitic, includes thin, black shale partings	0.9	0.9
Fayetteville:		
Shale, black, fissile, contains lithographic, black limestone concretions	2.0	34.7
Shale, black, fissile, contains septarian concretions of black, lithographic limestone	2.8	32.7
Covered, appears to be predominantly black shale of Fayetteville, but undoubtedly includes several feet of Hindsville limestones	29.9	29.9
Hindsville:		
Limestone, massive, dark gray, medium to finely crystalline, contains abundant *Agassizocrinus* and veins of calcite. Weathers light blue-gray	1.2	1.2
Moorefield:		
Ordnance Plant member:		
Shale, black, silty, soft, interfingering with yellowish buff, friable siltstone at base of exposure	2.1	9.7
Covered, believed to be siltstone	3.5	7.6
Bayou Manard member:		
Limestone, massive, blue-black, finely crystalline, argillaceous, weathers brown, platy and displays massive rectangular jointing. Contains zones of *Leiorhynchus carboniferum*	4.1	4.1
Base of exposure		

135. ALONG ROAD ONE-HALF MILE EAST OF MURPHY
Section 1, T. 19 N., R. 19 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, buff to reddish-brown, medium-grained, conglomerate bed near top	15.0	15.0
Hale:		
Limestone, buff to brown, fine to coarse crystalline, fossiliferous	30.0	33.0
Conglomerate, reddish-brown, sandy matrix, limestone pebbles	3.0	3.0
Fayetteville:		
Shale, black, soft, fissile	14.0	50.0
Limestone, light gray weathering, blue-black inside, lithographic, conchoidal fracture, in beds from 1" to 1', separated by thin black shale partings	36.0	36.0
Hindsville:		
Limestone, gray, fine to coarse crystalline, platy, fossiliferous	9.6	31.8
Limestone, gray, finely crystalline, oolitic, massive	5.6	22.2
Limestone, gray, coarse, crystalline to sublithographic oolitic	2.6	16.6
Limestone, gray, coarse crystalline massive	3.0	14.0
Limestone, blue-gray, coarse to fine crystalline, in platy beds, contains *Diaphragmus*, *Linoproductus* and *Agassizocrinus* zone	7.6	11.0
Limestone, gray, medium crystalline, calcitic, fossiliferous	2.0	3.4
Limestone, gray, fine to medium crystalline, calcitic, limonitic, fossiliferous	1.4	1.4
Moorefield:		
Ordnance Plant member:		
Covered	1.5	17.1
Siltstone, light brown, thin bedded	2.5	15.6
Shale, gray to black, soft	2.0	13.1
Covered	5.5	11.1
Limestone, light brown, dense, silty, massive, to base of exposure	5.6	5.6

136. GULCH—200 YARDS WEST OF FARMHOUSE
Southwest Part of Section 13, T. 19 N., R. 19 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, orange-red, quartzitic	3.0	3.0
Hale:		
Covered, float is red, fossiliferous, limestone	27.5	66.0
Limestone, gray, weathers platy, well exposed in cliff	22.0	38.5
Limestone, gray-brown, hard, fine limonite, cross-bedded	16.5	16.5
Fayetteville:		
Covered	22.0	55.1
Shale, black, soft, crumbly	11.0	33.1
Covered	5.5	22.1
Limestone, light gray to white, lithographic, concoidal fracture	16.6	16.6

Hindsville:		
Limestone, gray, dense, limonitic, contains *Archimedes*	4.0	28.2
Limestone, gray, sublithographic	1.5	24.2
Limestone, gray, fine to medium crystalline, platy	6.0	22.7
Limestone, gray, massive, fossiliferous, contains *Diaphragmus* and *Linoproductus*	5.6	16.7
Limestone, gray, crystalline, calcitic, oolitic, massive, crinoidal	5.6	11.1
Covered	4.5	5.5
Limestone, gray, fine crystalline	1.0	1.0
Moorefield:		
Ordnance Plant member:		
Siltstone, brown, platy	1.0	17.1
Covered, float is laminated, brown, siltstone	7.0	16.1
Limestone, light brown, silty, fine to dense crystalline	5.6	9.1
Siltstone, brown, shaly, thin-bedded	1.5	3.5
Covered	2.0	2.0
Lindsey Bridge member:		
Limestone, gray, fine, limonitic, cherty	2.5	4.0
Limestone gray, dense, even textured	1.5	1.5
Bayou Manard member:		
Limestone, gray, dense hard, thin-bedded, contains chert at top	2.0	13.2
Siltstone, gray, platy, contains streaks of gray lithographic limestone	5.1	11.2
Shale, olive-yellow	0.5	6.1
Siltstone, gray, very thin bedded, top 3 inches rather massive	1.3	5.6
Limestone, yellow to dark gray, platy, fossiliferous	0.3	4.3
Limestone weathers light gray, dark inside, lithographic, concoidal fracture	2.0	4.0
Shale, gray, platy, in irregular beds	1.5	2.0
Shale, yellow-gray, very soft, contains worm borings	0.5	0.5
Keokuk:		
Chert, white, mottled, mixed with gray, cherty limestone, pitted on top	2.5	2.5

137. CEDAR CREST SECTION: GULLY IN FRONT OF PA LUCASA CABIN AND ALONG HILL ROAD TO SOUTHWEST
Section 24, T. 19 N., R. 19 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, fine to medium-grained, thin-bedded, iron-stained	47.0	47.0
Hale:		
Limestone, brown to blue-gray, fine to medium crystalline, hard	19.5	38.1
Limestone, light gray to brown, medium crystalline, fossiliferous	3.6	18.6
Limestone, blue-gray, fine crystalline, hard, massive	5.5	15.0
Covered	7.5	9.5
Limestone, reddish-brown, fine crystalline, very hard	2.0	2.0
Fayetteville:		
Covered	36.0	56.0
Shale, black, thin-bedded, crumbly	6.5	20.0
Covered, contains huge white-weathering, blue-gray lithographic, limestone boulders	11.0	13.5
Limestone, white weathering, blue-gray inside, lithographic, in four thin beds	2.5	2.5

Hindsville:		
Limestone, blue-gray, finely crystalline, massive, very crinoidal	1.1	21.7
Limestone, blue-gray, dense, contains *Fenestrella* and *Archimedes*	1.0	20.6
Limestone, gray, medium-crystalline calcite and oolitic, massive	1.8	19.6
Covered	1.8	17.8
Limestone, blue-gray, dense to lithographic, contains calcite streaks, 3 inch beds	2.5	16.0
Limestone, blue-gray, medium crystalline, fossiliferous	1.5	13.5
Covered	11.0	12.0
Limestone, gray-brown, medium crystalline, calcitic, contains *Linoproductus*	2.0	2.0
Moorefield:		
Ordnance Plant member:		
Covered	4.0	15.6
Shale, buff, thin-bedded	5.6	11.6
Limestone, brown-gray, dense, contains *Leiorhynchus*	1.5	6.0
Siltstone, brown, thin-bedded, platy	0.2	4.5
Clay, buff-yellow, soft	0.5	4.3
Shale, buff-brown, platy	1.0	3.8
Limestone, buff, dense, massive, conchoidal fracture	0.7	2.8
Siltstone, buff-brown, thin-bedded, individual beds laminated	0.8	2.1
Limestone, light brown, massive, edge of bed weathers concave	0.8	1.3
Siltstone, buff-brown, thin-bedded	0.5	0.5
Covered	5.4	5.4
Bayou Manard member:		
Limestone, blue-gray, in thin irregular beds, conchoidal fracture	4.0	13.2
Shale, buff-gray, limy streaks	2.0	9.2
Limestone, blue-gray, very silty, thin-bedded	3.7	7.2
Limestone, blue-gray, sublithographic, conchoidal fracture	1.5	3.5
Shale, light gray, platy	2.0	2.0
Keokuk:		
Chert, buff, massive, forms base of exposure		

138. HILLSIDE 100 YARDS SOUTHWEST LONE STAR SCHOOL
Near North Line of Section 32, T. 19 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, buff-brown, medium-grained	16.5	16.5
Hale:		
Covered	11.0	57.3
Covered, float is gray-brown limestone	5.5	46.3
Limestone, blue-gray, fine crystalline, massive, hard	5.5	40.8
Limestone, gray-brown, fine crystalline to dense, fossiliferous, weathers fluted	5.5	35.3
Covered	5.5	29.8
Limestone, blue-gray to brown, fine crystalline, fossiliferous, hard	11.0	24.3
Limestone, orange, extremely sandy	0.8	13.3
Limestone, rust-colored, fossiliferous	1.0	12.5
Sandstone, greenish-brown, in thin irregular beds	4.0	11.5
Covered (probably sandstone)	5.5	7.5
Conglomerate, red, calcareous sandstone matrix with limestone pebbles	2.0	2.0

Fayetteville:		
Silt, greenish-yellow	0.5	63.0
Shale, black	35.0	62.5
Shale, black, contains dense black limestone concretions	5.5	27.5
Shale, black, well exposed	11.0	22.0
Covered, probably black shale	11.0	11.0
Hindsville:		
Covered	5.5	35.5
Limestone gray, coarse, platy	5.5	30.0
Covered, float is dense limestone full of *Diaphragmus* and *Linoproductus*	11.0	24.5
Limestone, gray, coarse-crystalline calcite, oolitic, crinoidal	11.0	13.5
Covered	2.5	2.5
Moorefield:		
Ordnance Plant member:		
Covered	2.5	13.5
Siltstone, brown, poorly exposed	5.5	11.0
Covered, float is brown, limy siltstone	5.5	5.5
Lindsey Bridge member:		
Limestone, gray, fine, hard, few fossils	1.8	4.3
Limestone, conglomerate, buff, chert-pebbles	2.5	2.5
Bayou Manard member:		
Limestone, brown-gray fine, glauconitic	3.0	3.0
Keokuk:		
Chert, white, mottled; to base of exposure	5.0	5.0

139. COMPOSITE SECTION AT LOW WATER DAM
Northeast ¼ of Section 14, T. 20 N., R. 19 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Moorefield:		
Ordnance Plant member:		
Limestone, gray, very silty, massive to fissile, abundant *Leiorhynchus carboniferum*, flaggy near top, partially covered at base	24.8	28.6
Limestone, blue-gray, silty, fine to medium, porous, chert fragments, shaly to flaggy, fossiliferous	1.7	3.8
Shale, gray-blue to black, silty, calcareous, fossiliferous zone near middle with *Spirifer arkansanus*	2.1	2.1
Lindsey Bridge member:		
Limestone, gray, medium, massive, shale lamina separates beds, chert fragments, calcarenitic, fossiliferous (mainly fragmental), has sharp to zonal (organic burrowing?) contact with underlying beds	6.5	6.5
Bayou Manard member:		
Limestone, gray, dense, massive, interbedded shale laminae	3.1	23.8
Limestone, gray to dense, black chert as large replaced areas in limestone, base of quarry	2.4	20.7
Covered (section continued to south)	2.0	18.3
Limestone, dark gray, massive to flaggy, partly covered, dense, argillaceous	5.3	16.3
Limestone, dark gray, dense, silty, interbedded tan shale, fossiliferous, covered below	10.7	11.0
Shale, tan, fissile, glauconite and muscovite flakes	0.3	0.3
Boone:		
Chert, white, local limestone areas, fractured, weathers with irregular surface	12.7	12.7

140. PARTIAL SECTION AT GRAND VIEW CABIN SITE
Section 26, T. 20 N., R. 19 E.

Formational Description	Thickness in Feet Of Unit	To Base of Fmtn.
Hale:		
Sandstone, brown to cream on fresh break, medium grained non-calcareous	23.0	23.0
Fayetteville:		
Shale, black, fissile, with occasional limestone concretions	26.0	65.0
Limestone, and shale, alternating, with the limestone 2 to 8 inches thick, gray to blue on fresh break and weathering to cream, cuboidal blocks. The shale beds are ¼ to 2 inches thick, light green to cream brown in color	39.0	39.0
Hindsville and base of exposure.		

141. SECTION AT WEST END OF BRIDGE ACROSS GRAND RIVER ON HIGHWAY 33
West side of Sections 27 and 34, T. 20 N., R. 19 E.

Formational Description	Thickness in Feet Of Unit	To Base of Fmtn.
Hindsville:		
Limestone gray, finely crystalline with streaks of lithographic limestone	5.0	27.8
Limestone, lithographic, gray, thin-bedded	2.5	22.8
Limestone, coarsely crystalline, thick bedded, gray, fossiliferous	4.3	20.3
Limestone, and shale alternating, irregularly bedded. Limestone is coarsely crystalline with sublithographic limestone streaks. Only coarse limestone is fossiliferous	12.0	16.0
(Section continued 100 feet north)		
Limestone, coarsely crystalline, massive, gray, fossiliferous	1.5	4.0
Shale, gray, thin-bedded	0.5	2.5
Limestone, coarsely crystalline, massive, gray, fossiliferous	0.8	2.0
Shale, glauconitic, fossiliferous	0.2	1.2
Limestone, coarsely crystalline, gray, fossiliferous	0.4	1.0
Shale, glauconitic, green, highly fossiliferous	0.6	0.6
Moorefield:		
Ordnance Plant member:		
Shale, fissile, brown and black	2.3	8.3
Shale, black, slightly calcareous, weathers platy	6.0	6.0
River level		

142. SECTION EAST OF LINDSEY BRIDGE
Section 6, T. 20 N., R. 20 E.

Formational Description	Thickness in Feet Of Unit	To Base of Fmtn.
Hindsville:		
Limestone, gray, medium-gray weathering, massively bedded, crystalline, fossiliferous with *Agassizocrinus* and *Diaphragmus cestriensis* in abundance, top of hill	18.0	18.0

Moorefield:		
Ordnance Plant member:		
Siltstone, yellow brown, brownish-gray weathering, alternating massive and platy beds, calcareous, *Leiorhynchus carboniferum*	25.5	25.5
Lindsey Bridge member:		
Limestone, gray, weathers gray, massive, medium crystalline, forms cliff along river, bituminous, unfossiliferous, cherty	12.3	22.8
Limestone, gray, gray weathering, finely crystalline, cross-bedded thin-bedded near top, unfossiliferous..	10.5	10.5
Bayou Manard member:		
Limestone, gray, weathers gray, thin-bedded, with calcareous shale partings	16.0	46.8
Limestone, gray, argillaceous, thin-bedded, shaly weathering, platy float covers surface of areas, unfossiliferous	14.8	30.8
Limestone, gray-blue, dense, massive, large amount of black chert nodules	6.0	16.0
Limestone gray, weathers gray, platy in upper zones, massive in lower zones, dense, black nodular chert "stringers" or bands between beds	4.5	10.0
Limestone, gray, weathers light gray, shaly weathering, dense, *Griffithides pustulosus*	5.5	5.5
Covered to water level; Boone chert knob exposed 80 yards to east.		

143. SECTION ON WEST SIDE OF HILL
Southeast ¼ of Section 31, T. 20 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hale:		
Sandstone calcareous, medium-grained	18.0	18.0
Fayetteville:		
Shale, non-calcareous, black, platy, containing occasional black limestone concretions	39.7	90.2
Limestone, lithographic, gray, massively bedded, fossiliferous	2.0	50.5
Limestone, sublithographic, gray with alternating thin beds of shale, weathers cuboidal	48.5	48.5
Hindsville:		
Limestone, coarsely crystalline, massively bedded, fossiliferous	28.3	28.3
Moorefield:		
Ordnance Plant member:		
Shale, cream-brown	1.5	1.5
Base of exposure:		

144. DEAN FARMHOUSE
Southeast ¼ of Section 29, T. 21 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Moorefield:		
Bayou Manard member:		
Limestone, blue-gray, fine-grained to dense, contains large tripolitic chert nodules which are well rounded and show concentric bands, thick-bedded	2.0	9.0
Limestone, gray fine-grained, argillaceous, platy	0.5	7.0

Limestone, blue-gray, fine-grained to dense, contains tripolitic chert nodules	0.5	6.5
Shale, and limestone, alternating layers (2-10 in.) of gray shale and light gray limestone	3.1	6.0
Limestone, blue-gray, fine-grained to dense, contains tripolitic chert nodules	1.1	2.9
Shale, dark gray, thin-bedded, brittle	0.5	1.8
Limestone, blue-gray, fine-grained to dense, thick bedded	1.3	1.3

Base not exposed.

145. SECTION IN TEST PIT WEST OF BOATMAN
Section 32, T. 21 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Moorefield Formation:		
Ordnance Plant member:		
Top eroded.		
Siltstone, blue-gray, buff to tan on weathered surface, medium bedded	1.0	1.1
Shale, gray, soft	0.1	0.1
Lindsey Bridge member:		
Limestone, light gray, coarsely crystalline, with fine shale partings	3.0	4.0
Limestone, gray-white, fine-grained, powdery, soft	0.5	1.0
Limestone, gray-white, coarsely crystalline, contains fossil fragments	0.5	0.5
Bayou Manard member:		
Clay, reddish brown, sticky	0.4	7.8
Limestone, white, fine-grained, powdery, soft	0.8	3.8
Clay, reddish brown, sticky	1.0	3.0
Limestone, white to gray, fine-grained, powdery, soft..	2.0	2.0

Base of Moorefield not exposed.

146. SECTION ALONG SOUTH BANK OF PRYOR CREEK
Section 33, T. 21 N., R. 19 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hale:		
Top eroded.		
Sandstone, blue-gray, medium-coarse, rounded, bituminous, ferruginous and stained with iron oxide	5.8	5.8
Fayetteville:		
Shale, greenish tan, soft	1.0 (?)	1.0(?)
Hindsville:		
Limestone, gray to light blue, coarsely crystalline, oolitic, fossiliferous zones show calcite replacement. *Agassizocrinnus* zone at base	10.8	10.8
Moorefield:		
Ordnance Plant member:		
Shale, black, platy, thin-bedded	5.8	17.5
Siltstone, gray to white, fine-grained, calcareous, dense	2.8	11.7
Shale, dark gray, platy	3.1	8.9
Siltstone, tan to brown, fine-grained, calcareous, black to dark brown and uneven on weathered surfaces, pelecypod traces common	5.8	5.8

Base not exposed.

147. SECTION OF QUARRY
Northeast ¼ of Section 33, T. 21 N., R. 19 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hindsville:		
Top eroded.		
Limestone, white to gray, coarse-grained fossiliferous, 6-8 inch bedding not prominent. Buff to brown streaks and spots on weathered surfaces	2.9	13.1
Limestone, blue to gray, medium to coarse-grained, tough, 6-8 inch bedding separated by 1-2 inch shale partings; shales blue-black and fissile	2.2	10.2
Limestone, dark gray, coarse-grained, fossiliferous, massive, calcite replacement of large percent of fossils, pyrite traces common, gray-white on weathered surfaces. *Composita* abundant	8.0	8.0
Base of exposure: (*Agassizocrinus* zone.)		

148. SECTION ALONG SULPHUR CREEK
Section 33, T. 21 N., R. 19 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hindsville:		
Top eroded:		
Limestone, gray, medium crystalline, fossiliferous, thin 4-10 inch bedding, abundantly crinoidal and many lacy bryozoans. *Fenestrellina* common	2.5	7.5
Limestone, dull gray to white, coarsely crystalline, massive, very thin shaly streaks, profusely fossiliferous	3.1	5.0
Shale, blue-gray, soft	0.4	1.9
Limestone, dull gray, coarsely crystalline, abundantly fossiliferous	1.5	1.5
Base of exposure.		

149. SECTION ON "TIMBERED HILL"
Northwest ¼ of Section 31, T. 21 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Sandstone, brown, fine-grained, non-calcareous, pitted	8.0	8.0
Hale:		
Limestone, reddish gray, coarsely crystalline, streaked with iron stain, massive, deeply pitted, slumped and weathered, moderately fossiliferous	16.0	16.0
Fayetteville:		
Shale, black, soft, platy, thin-bedded	50.0	127.0
Limestone, blue to gray, dense, slightly calcareous, lithographic, bedding 6-8 inches interbedded with 2-6 inches soft green shale zones. Tan to buff yellow on weathered surfaces, weathers into subcuboidal blocks, very fossiliferous	77.0	77.0
Base of exposure.		

150. SLOPE IN NORTH ROAD CUT
South Side of Section 27, T. 22 N., R. 19 E.

Formational Description	Thickness in Feet Of Unit	To Base of Fmtn.
Fayetteville:		
Limestone, dark gray, sublithographic, massive, hard, weathers into subcoidal blocks and white on surface, on fresh break fractures almost conchoidal, layers separated by 2 or 3 inch dark yellowish-gray shale parting containing abundant *Dictyoclostus inflatus*.....	12.4	15.9
Shale, dark yellowish-gray, thin-bedded, calcareous, contains a few stringers of sublithographic limestone near top, shale covered at base	3.5	3.5

151. SECTION IN STREAM NORTH OF BRIDGE
Southwest ¼ of Section 3, T. 22 N., R. 20 E.

Formational Description	Thickness in Feet Of Unit	To Base of Fmtn.
Hindsville:		
Limestone, dark to light gray, coarse, covered above and below	1.3	2.3
Covered	1.0	1.0
Moorefield:		
Ordnance Plant member:		
Siltstone, gray, calcareous, massive, leached fossils.....	5.0	12.5
Limestone, cream, silty, flaggy to massive, chert.....	7.5	7.5
Lindsey Bridge member:		
Limestone, gray, coarse, chert pebbles abundant, poorly preserved fossils	1.6	8.0
Limestone, fine, silty, gray, flaggy	3.3	6.4
Limestone, gray, medium, cross-bedded, glauconitic, chert pebbles	0.9	3.1
Limestone, gray, fine, silty, flaggy	1.3	2.2
Limestone, gray, fine to medium, flaggy, chert pebbles	0.9	0.9
Bayou Manard member:		
Limestone, gray fine, coarsens near top	10.7	10.7
Boone:		
Limestone, gray, sucrosic, cherty, fractured, chert as nodules, uneven flaggy beds	7.5	7.5

152. WEST SIDE OF GRAND RIVER
Northeast Corner of Section 4, T. 22 N., R. 20 E.

Formational Description	Thickness in Feet Of Unit	To Base of Fmtn.
Moorefield:		
Ordnance Plant member:		
Siltstone, brownish-yellow, very fine-grained, silt and iron oxide, massive soft, light weight "cotton rock" or punkstone	0.9	6.7
Limestone, gray, dense to medium crystalline, silty, platy, slabby to massive, cross-bedded	5.8	5.8
Lindsey Bridge member:		
Limestone, gray, coarsely crystalline, contains brown angular chert fragments, sandy, massive, hard, cross-bedded, some fossils	1.1	11.8

Limestone, light gray, fine-grained, silty, thinly plated to massive, cross-bedded	7.1	10.7
Limestone, gray, coarse-grained, contains brown angular chert fragments, massive, hard, fossiliferous	0.9	3.6
Limestone, gray, dense to finely crystalline, coarsely crystalline 6 inches from top with tiny brown chert fragments, massive, hard	1.8	2.7
Limestone, gray, coarsely crystalline, slightly iron-stained, massive, hard, fossiliferous	0.9	0.9
Bayou Manard member:		
Limestone, gray, medium crystalline, slightly silty, massive, hard, cross-bedded	2.5	11.0
Limestone, gray, dense, to medium crystalline, silty, massive, hard, characterized by dark streaks, few crinoid stems, scattered dark fragments, and cross-bedded in places	2.4	8.5
Limestone, light gray, fine, medium to coarsely crystalline, abundant reddish-brown angular chert fragments, massive, hard, slightly crinoidal and fossiliferous	0.9	6.1
Limestone, light bluish-gray dense to finely crystalline, massive, hard, scattered reddish-brown angular chert fragments and *Dictyoclostus crawfordsvillensis*	1.2	5.2
Limestone, light gray, dense, medium, lenticular bedded, pinches out on knob zone of *Dictyoclostus crawfordsvillensis* at base on flank of arch	.0 to 4.0	4.0
Keokuk:		
Chert, white, massive, highly fractured and jointed, dark brown on weathered surface	3.0	7.0
Interbedded chert and limestone; chert, white, massive, irregularly bedded; limestone, bluish-gray, dense, irregularly bedded, unexposed below water	4.0	4.0

153. NORTH ROAD CUT TO TOP OF BUTTE

Southwest Corner of Section 5 and Southeast Corner of Section 6, T. 22 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka:		
Siltstone, gray, very fine-grained, siliceous cherty, massive, hard, spicular, weathers red and blocky	0.4	0.4
Fayetteville:		
Limestone, dark gray, dense to finely crystalline, very hard, layer acts as cap rock in places, many *Archimedes* sp. and very fossiliferous	0.5	44.0
Shale, light greenish-gray, calcareous, fissile, soft, some stringers of finely crystalline gray limestone	5.3	43.5
Limestone dark gray, mainly fine but also dense to coarsely crystalline, medium-bedded, hard, very fossiliferous, weathers yellowish	0.4	38.2
Shale, light greenish-gray, calcareous, fissile, soft, thin limestone layer at top	2.2	37.8
Limestone, dark gray, sublithographic to finely crystalline, thin bed, hard, weathers light yellowish-green	0.1	35.6
Shale, light greenish-gray, calcareous, fissile soft, weathers light gray	2.1	35.5

Limestone, dark gray, dense to coarsely crystalline massive, hard, very fossiliferous, weathers buff-yellow, zone of *Dictyoclostus inflatus*	0.7	33.4
Shale, light greenish-gray, calcareous, fissile, soft	3.0	32.7
Limestone, dark gray, dense, medium bed, hard, weathers buff-yellow, very fossiliferous, zone of *Dictyoclostus inflatus*	0.4	29.7
Shale, light greenish-gray, calcareous, fissile, soft	6.0	29.3
Limestone, dark gray, sublithographic, medium-bedded, hard, weathers yellowish	0.3	23.3
Shale, light greenish-gray, calcareous, fissile, soft, weathers yellowish	12.0	23.0
Limestone, dark gray, dense to finely crystalline, medium bed, hard, fossils mainly small	0.4	11.0
Shale, greenish-gray, calcareous, fissile, soft, basal three quarters of zone covered but believed to be same as shown 1 mile to north	10.6	10.6

154. WEST SIDE OF STRANG RIVER BRIDGE
North Side of Section 10, T. 22 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hindsville:		
Limestone, (only basal bed exposed), gray coarsely crystalline, massive, hard, very fossiliferous, strong petroliferous odor, zone of *Diaphragmus*	1.2	1.2
Moorefield:		
Ordnance Plant member:		
Siltstone, brown, very fine-grained, massive, soft due to leaching, lightweight "Cotton rock"	0.5	9.2
Limestone, gray to yellowish-brown where weathered, fine to medium crystalline, silty, highly cross-bedded in places	8.7	8.7
Lindsey Bridge member:		
Limestone, gray, coarsely crystalline, angular varicolored chert fragments, oolitic and fossiliferous, massive, hard	0.7	7.9
Limestone, light gray, semi-crystalline, silty, platy, medium hard	4.5	7.2
Limestone, gray, coarsely crystalline, contains a few angular fragments of dark chert, massive, hard	0.6	2.7
Limestone, gray, fine to medium crystalline, massive to thin irregular beds, medium hard	1.5	2.1
Limestone, gray, coarsely crystalline, few angular chert fragments, massive, hard	0.5	0.5
Bayou Manard member:		
Limestone bluish-gray, dense to finely crystalline, irregular beds of whitish-discolored chert, massive, hard	14.0	14.0
Keokuk:		
Limestone, gray, coarsely crystalline, crinoidal, medium irregular bedded	1.0	7.0
Chert, white (if unweathered), massive, hard, fractured and jointed, yellowish, reddish to brownish on weathered surface, base unexposed at water level	6.0	6.0

155. SECTION ON SOUTH EMBANKMENT, BENG CREEK
West Side of Section 10, T. 22 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Moorefield:		
Ordnance Plant member:		
Shale, buff-yellow, thin-bedded, soft, mainly covered..	1.2	12.5
Limestone, gray to yellowish-brown where weathered, finely crystalline, silty, platy where weathered, otherwise slabby to massive, medium hard, mainly covered by debris	11.3	11.3
Lindsey Bridge member:		
Limestone, covered	5.5	9.0
Limestone, mainly covered gray, coarsely to finely crystalline, angular varicolored chert fragments at base, massive to platy, hard to medium hard	3.5	3.5
Bayou Manard member:		
Limestone, light bluish gray, dense to finely crystalline, massive, slabby to platy on weathered surface, medium hard, strong petroliferous odor, few fossils..	16.1	36.0
Limestone, bluish-gray, dense to semi-crystalline, irregular bedded with slightly discolored lenticles of chert, contains knobs of chert similar to baseballs, hard, zone of *Griffithides pustulosus* and *Leiorhynchus carboniferum* near base	19.9	19.9
Keokuk:		
Chert, white to reddish-brown at contact, massive, hard, fractured and jointed, unexposed below creek bottom	8.5	8.5

156. SECTION AT NORTHEAST SIDE OF BENG CREEK BRIDGE
West Side of Section 10, T. 22 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Moorefield:		
Limestone, gray, coarsely crystalline, contains angular fragments of varicolored chert, massive, hard, slightly yellow-stained, oolitic, highly fossiliferous	0.7	8.9
Limestone, light gray, semi-crystalline, massive, (platy where weathered), silty, medium hard, specks of iron-staining where slightly weathered	4.8	8.2
Limestone, gray, coarsely crystalline, contains angular fragments of chert, massive, hard, specks of iron staining	0.6	3.6
Limestone, gray, finely crystalline, massive to thin irregular-bedded, slightly iron-stained	1.3	3.0
Limestone, whitish-gray, very finely crystalline to dense, irregular bedded, soft, contains light whitish-yellow iron stains near weathered surface	1.2	1.7
Limestone, gray, coarsely crystalline, contains angular fragments of varicolored chert, massive, hard, fossiliferous and crinoidal	0.5	0.5
Base of exposure at water level.		

157. NORTH ROAD CUT ON SLOPE EXTENDING EAST TO WEST
Southwest Corner of Section 16, T. 22 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hindsville:		
Limestone, gray, sublithographic with tiny calcite crystals, massive, hard, weathers whitish-yellow, highly variable in thickness throughout area	0.5	13.7
Shale, buff-yellow, calcareous, soft, thin-bedded (mainly covered by wash in road cut)	4.0	13.2
Limestone, gray, dense coarsely to finely crystalline, massive, hard, fossiliferous	1.2	9.0
Limestone, gray, finely to semicrystalline, massive, well-cemented conglomerate with dense gray pebbles	1.5	7.8
Limestone, dense, finely to coarsely crystalline in center, sandy, massive, hard, highly cross-bedded, contains streaks of asphalt	2.6	6.3
Limestone, gray, coarsely crystalline, massive, hard, zone of *Agassizocrinus conicus*, small brachiopods and crinoid stems abundant	1.9	3.7
Shale, buff-yellow, thin bedded, calcareous, soft	1.3	1.8
Limestone, gray, coarsely crystalline, massive, hard, fossiliferous, crinoid stems	0.5	0.5

158. SOUTH ROAD CUT, WEST FLANK SENECA FAULT ZONE
Northwest Corner of Section 21, T. 22 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Atoka and younger Pennsylvanian:		
Sandstone, red to reddish brown, medium to coarse-grained, iron-stained, medium to massive, irregular bedded, hard to friable	unmeasured	unmeasured
Siltstone, gray, fine-grained, medium-bedded, very hard, red and iron-stained on weathered surface, contains some light gray chert	0.4 to 0.5	0.4 to 0.5
Hale:		
Limestone, gray, coarse-grained, very massive, hard, sandy, cross-bedded, has peculiar feature of changing laterally to sandstone in just a few yards, very fossiliferous, zone of *Delocrinus* and *Michelinia*	8.2	39.2
Sandstone, red, medium to coarse-grained, pitted, and fluted, loosely cemented, sub-angular, friable, fossils common as molds and casts, many brachs and spirifers	29.0	31.0
Sandstone, red, medium-grained, friable, loosely cemented, non-fossiliferous	1.1	2.0
Sandstone, yellowish-red, fine-grained, limonitic, pity and fluted, highly weathered, fossils common as molds and casts	0.9	0.9
Fayetteville:		
Shale, black platy, greenish at contact, base unexposed	18.0	18.0

159. SECTION IN RAVINE TO SOUTH OF SPAVINAW CREEK BRIDGE
East Side of Section 16, T. 22 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Keokuk formation:		
Chert, white, yellowish to reddish-brown tripolitic at top, massive-jointed and fractured, fossils common as molds and casts	64.0	64.0
Reeds Spring formation:		
Limestone and chert, gray, blue to buff (darker near base), interbedded, medium hard	132.0	132.0
St. Joe "group":		
Limestone, bluish-gray, dense to finely crystalline, massive, hard, crinoid stems small and abundant	6.0	25.3
Limestone, light gray, dense, cherty and shaly, nodular and laminated on weathered surface	4.0	19.3
Limestone, bluish to buff yellow, dense to finely crystalline, massive- to thin-bedded, shaly and soft, upper massive limestone parted by soft shaly limestone, crinoid stems	11.0	15.3
Limestone, gray, dense to finely crystalline, massive, hard, crinoid stems	3.0	4.3
Shale, green, laminated, calcareous, mainly covered	1.3	1.3
Chattanooga formation:		
Shale, black, slightly iron-stained, platy and fissile, pyritic, cone-in-cone black limestone near center, jointed and fractured	65.3	65.3
Cotter formation:		
Dolomite, white to buff, finely crystalline, hard, massive, some beds appear cherty	25.4	85.1
Dolomitic conglomerate; pebbles and cobbles, gray, dense to semicrystalline, hard, cherty, and dolomitic, elongated parallel to bedding; matrix, white to light gray, slightly sandy, very oolitic, well-cemented, hard, massive	3.4	59.7
Dolomite, white to light gray, lithographic to crystalline, limy, hard, massive, medium- to thin-bedded, nodular weathering surface	30.2	56.3
Dolomite, white to buff, finely crystalline, sandy, hard, massive	12.8	26.1
Dolomite, white, buff to vitreous gray, finely crystalline, sandy with some laminations of yellow chert near base, hard, massive to laminated, basal beds unexposed	13.3	13.3

160. LARGE BLUFF ON NORTHWEST SIDE OF SPAVINAW CREEK
West Side of Section 18, T. 22 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Keokuk formation:		
Chert, white, sometimes mottled, iron-stained, to reddish-brown on weathered surface, massive, fractured and jointed, upper contact unexposed by erosion, fossiliferous	69.0	69.0
Reeds Spring formation:		
Interbedded limestone and chert: chert, white to light gray, layers over 1′ thick at top to 6″ at bottom,		

hard, weathers buff to yellow; limestone, light gray, dense, hard, medium- to thin-bedded at top, weathers dirty	34.7	155.7
Interbedded limestone and chert; chert, light gray to gray, medium-bedded, beds heavier near top, hard; limestone, bluish-gray, dense, medium-bedded, beds thinner near top, hard; zone bluff forming	103.5	121.0
Shale, dark gray, calcareous, splintery, soft, weathers one to four feet back in bluff	0.2 to 0.4	17.5
Interbedded limestone and chert, dark gray to opalescent very fine-grained, flinty, hard; limestone, dark bluish-gray, fine-grained and dense, dolomitic, hard; alternate beds of apparent equal thicknesses, 4 to 6 inches	17.2	17.2

161. SECTION ON BLUFF SOUTHEAST OF ROAD FORK
Northwest Corner of Section 19, T. 22 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
St. Joe "group":		
Limestone, gray, dense to finely crystalline, hard, massive, crinoidal	2.8	18.8
Limestone, (mainly covered with slump), gray to bluish-gray, dense, soft, irregular-bedded and nodular appearing, shaly limestone, slightly cherty near top, crinoidal	11.2	16.0
Limestone, gray, dense to finely crystalline, hard, massive crinoidal	4.2	4.9
Shale, green to yellow, soft, platy, calcareous	0.7	0.7

162. SECTION AT RIVER
Northeast ¼ of Section 33, T. 23 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hindsville:		
Limestone, gray, medium to coarse, silty, cross-bedded, weathered, fossiliferous	2.8	11.1
Limestone, gray to white, medium, laminated, contorted, nodules of limestone, calcarenitic zones, fossiliferous	1.0	8.3
Covered	3.3	7.3
Limestone, gray to white, medium, contorted, silty, laminated	0.3	4.0
Limestone, gray, fine to coarse, calcarenitic, cross-bedded to irregular flaggy beds	1.3	3.7
Limestone, gray to black, fine, laminated to swirly, silty, thins out laterally	0.6	2.4
Limestone, gray, fine to coarse, calcarenitic, irregular flaggy beds	1.7	1.8
Limestone, gray, medium, calcarenitic, nodules of shale, even-bedded	0.1	0.1
Moorefield:		
Ordnance Plant member:		
Limestone, gray, very silty, in massive to flaggy beds, pitted, *Leiorhynchus carboniferum* near top	9.8	15.1
Limestone, gray, silty, flaggy to cross-bedded, some fragmental chert, pitted	5.3	5.3

Lindsey Bridge member:		
Limestone, gray, coarse to medium, calcarenitic, leached and broken fossils, cross-bedded	2.3	2.3
Bayou Manard member:		
Limestone, gray, silty, fine, flaggy to massive, texture coarsens at top, cherty near top	5.5	5.5

163. SECTION IN STREAM
Northeast ¼ of Section 27, T. 23 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hindsville:		
Limestone, gray to cream, contorted, laminated, irregular bedding, silty, finely calcarenitic	1.7	7.4
Limestone, gray, silty, fine to medium, calcarenitic, fossiliferous, green limy shale nodules, shale interbedded	2.5	5.7
Limestone, gray, calcarenitic, compact	2.0	3.2
Covered	1.2	1.2
Moorefield:		
Ordnance Plant member:		
Limestone, gray, silty, fossiliferous, massive, *Leiorhynchus carboniferum* at base	1.3	3.2
Limestone, gray, silty, irregular bedding, some fragmental chert	1.9	1.9
Lindsey Bridge member:		
Limestone, gray, fine, irregular to cross-bedded, chert fragments, leached fossils, bench-former	2.5	2.5
Bayou Manard member:		
Limestone, gray, silty, flaggy to shaly, thinner bedded near top, covered near base	11.0	11.0

164. SECTION IN QUARRY
Southeast ¼ of Section 22, T. 23 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hindsville:		
Limestone, dark gray to black, medium to coarse, silty, calcarenitic, broad banding, cross-bedded to irregular bedding, zones of fine limestone, fossiliferous, overlain by a dense fossiliferous limestone as float	4.1	19.0
Shale, green, silty, fissile, nodules to beds of dense limestone with calcite veinlets	0.9	14.9
Limestone, gray, fine to coarse, calcarenitic, glauconitic, nodules of shale, interbedded fine limestone zones, fragmental micro-chert	2.0	14.0
Shale, green, fissile, silty, nodules of dense limestone, pyritic	3.0	12.0
Limestone, gray to white, silty, contorted, cross-bedded, massive nodules of green shale, fossiliferous	3.0	9.0
Shale, green, fissile, silty limy	0.1	6.0
Limestone, gray to white, silty, contorted, zones of calcarenitic limestone, black shale phenoclasts, thin green shale partings	0.7	5.9
Shale, green, fissile, silty, limy interbeds	0.6	5.2
Limestone, black to white, silty contorted, interbedded green shale, fossiliferous	1.1	4.6

Shale, green, silty interbedded flaggy siltstone	1.0	3.5
Siltstone, gray, contorted, calcareous, interbedded shale, uneven bedding, glauconitic	2.0	2.5
Siltstone, black calcareous, shale as laminae, irregular bedding, forms floor of quarry	0.5	0.5

165. SECTION ALONG ROAD AND IN STREAM
East-line of Section 22, T. 23 N., R. 20 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hindsville:		
Covered, occasional buff siltstone float	12.0	18.6
Siltstone, buff, calcareous, flaggy to massive, laminated, uneven bedding, color has gray cast near top	5.3	6.6
Limestone, gray, medium to coarse, fossiliferous, some clastic chert, shale nodules	1.3	1.3
Moorefield:		
Ordnance Plant member:		
Siltstone, gray, massive to flaggy, banded coloring, rests on middle member in creek	12.0	12.0
Lindsey Bridge member:		
Limestone, gray, fine to medium, calcarenitic, fossiliferous, clastic chert, medium and rounded sand grains, interbedded siltstone	7.7	14.7
Covered	2.0	7.0
Bayou Manard member:		
Limestone, gray, flaggy, medium, nodular chert	5.0	5.0
Boone:		
Limestone, gray, chertified, iron-stained	6.0	6.0

166. SECTION ALONG ROAD AND IN STREAM
West-line of Section 18, T. 23 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hindsville:		
Covered, occasional buff siltstone float	10.8	11.3
Limestone, gray, medium, calcarenitic, green shale nodules, may have interbedded shale and limestone interval below, *Agassizocrinus*	0.5	0.5
Moorefield:		
Ordnance Plant member:		
Limestone, gray, poorly exposed, very silty, green shale nodules	4.5	9.8
Covered	5.3	5.3
Lindsey Bridge member:		
Limestone, gray, fine to coarse, interbedded with nonclastic fine limestone, clastic chert abundant, silty	3.3	3.3
Bayou Manard member:		
Limestone, gray, fine, poorly exposed in road	3.0	15.9
Covered	4.0	12.9
Limestone, gray, fine, with coarser sandy zones, flaggy to cross-bedded, clastic chert	8.9	8.9

167. SECTION IN QUARRY
Southeast ¼ of Section 16, T. 25 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Hindsville:		
Limestone, gray, medium to coarse, calcarenitic, thin shale interbedded, irregular bedding	2.0	22.7
Shale, green, weathered, nodules of dense limestone..	0.7	20.7
Limestone, dark gray, calcarenitic, medium, abundant *Agassizocrinus*	1.0	20.0
Limestone, gray, medium, calcarenitic, thin shale interbedded	1.6	19.0
Limestone, gray, medium, calcarenitic	0.5	17.4
Limestone, gray, medium calcarenitic, thin shale interbedded	0.9	16.9
Limestone, gray, medium, flaggy and irregular bedding abundant *Agassizocrinus*	1.0	16.0
Siltstone gray, high calcareous content, massive, cross-bedded, zones of calcarenite, fossiliferous	3.0	15.0
Limestone, gray to white, medium to coarse, calcarenitic, interbedded fine limestone, nodules of shale and limestone, "conglomerate" development near top, black chert near base	10.6	12.0
Limestone, gray, even textured, medium, chert fragments are microscopic, interbedded green shale laminae	1.4	1.4
Boone:		
Limestone, blue-gray, cherty, massive, saccharoidal....	8.0	8.0

168. INCOMPLETE SECTION OF FAYETTEVILLE TAKEN FROM SOUTHWESTERN SLOPE OF HILL
Northeast ¼ of Section 32, T. 25 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Fayetteville:		
Limestone, brown to tan, gray on fresh surface, thin-bedded, and abundantly fossiliferous	2.0	47.2
Shale, varicolored, calcareous, fissile, and jointed. Several fossiliferous, shaly limestones (0.2′ thick) are interbedded with the shale	45.2	45.2

169. FAYETTEVILLE SECTION TAKEN FROM HILL IN NORTHEAST Section 11, T. 25 N., R. 21 E.

Formational Description	*Thickness in Feet* Of Unit	To Base of Fmtn.
Fayetteville:		
Limestone, buff, platy, profusely fossiliferous, abundant *Archimedes* and other bryozoans	2.3	48.4
Shale, dark gray to black, calcareous, fissile, and soft..	11.4	46.1
Limestone, buff, shaly and platy	0.6	34.7
Shale, varicolored, calcareous, and fissile. Three thin (0.2′) fossiliferous zones	16.4	34.1
Covered, probably shale	17.1	17.7
Limestone, reddish brown, lithographic, cube-weathered, forms base of exposure	0.6	0.6
Base of formation is concealed.		

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