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GEOLOGY OF THE BEGGS AREA, OKMULGEE COUNTY, OKLAHOMA

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GEOLOGY OF THE BEGGS AREA, OKMULGEE COUNTY, OKLAHOMA

CHAPTER I

INTRODUCTION

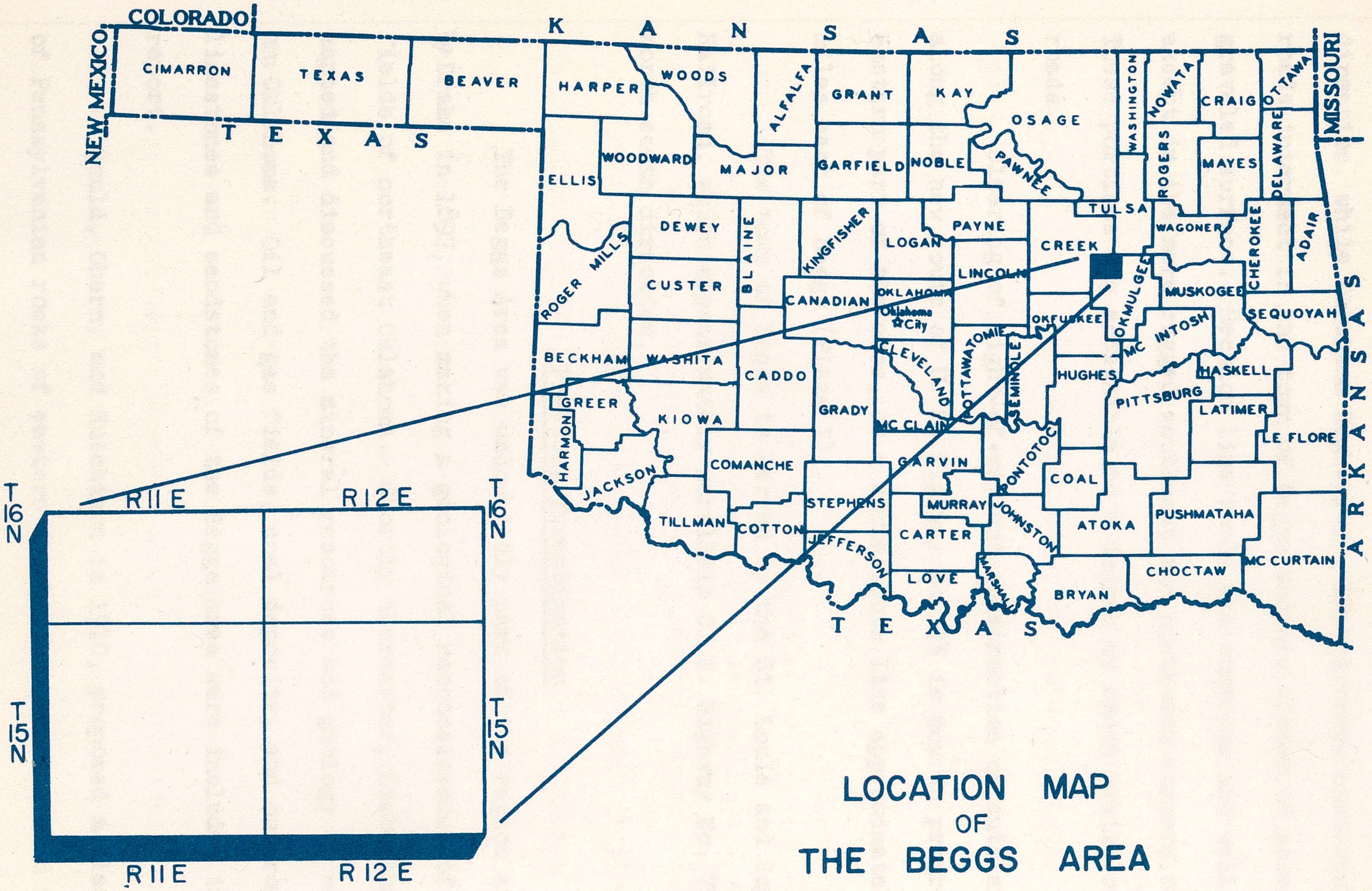
Scope and Purpose

This report concerns a study of the rocks of middle Pennsylvanian age that crop out in the Beggs Area of Okmulgee County.

The primary purposes of this investigation were to prepare a geologic map of the outcropping formations and to study the lithologic character, thickness, distribution and faunal content of these rocks. The resulting data will be used in a report on the geology of Okmulgee County by the Oklahoma Geological Survey.

Location

The Beggs Area is situated in the extreme northwest portion of Okmulgee County and was named after the town of Beggs, located therein. The area includes T. 15 N., Rs. 11 and 12 E., the south one-half of T. 16 N., R. 11 E. and the south one-half of T. 16 N., R. 12 E., in all, a total of 108 square miles (Fig. 1). The area is bounded on the west by Creek County and on the north by Creek and Tulsa Counties. The southern boundary is the south line of T. 15 N., and the eastern boundary is the east line of R. 12 E.



LOCATION MAP
OF
THE BEGGS AREA

FIGURE 1

U. S Highway No. 75 traverses the area in a north-south direction, while Oklahoma Highway No. 16 traverses east-west. These roads intersect in the town of Beggs and are either of paved or graveled surface. Section line roads are numerous and well maintained except in the more rugged southeast and northwest corners of the area. These portions are accessible to a degree by ranch trails or oil lease roads.

Clearing of right-of-way and construction of cuts and fills along the new route of U. S. Highway No. 75 is now in progress in the eastern part of the area, on a north-south line approximately three miles east of Beggs (Plate I).

The town of Beggs is served by the St. Louis and San Francisco Railroad, which approximately parallels U. S. Highway No. 75, in a north-south direction.

Previous Investigation

The Beggs Area was undoubtedly part of the region examined by Drake in 1897, when making a geological reconnaissance of the coal fields of northeast Oklahoma. Shortly thereafter, Siebenthal (1907) mapped and discussed the mineral resources and geology of northeastern Oklahoma. Oil and gas fields, coal deposits, and outcrops of limestones and sandstones of the Beggs Area were included in that report.

Gould, Ohern, and Hutchison in 1910, proposed a classification of Pennsylvanian rocks of eastern Oklahoma, which included rocks of the Beggs Area. Brief descriptions of the surface and subsurface geology, structure, and oil and gas development of Okmulgee County was presented by Clark and Bauer in 1921. Subsequently, references to Okmulgee County have appeared in several publications of the Oklahoma Geological Survey, and in professional journals and papers.

Considerable mapping of a large part of eastern Oklahoma, including the Beggs Area, was done by Malcolm C. Oakes from 1947 through 1950 during the preparation of the Geologic Map of Oklahoma (Miser, 1954). Mapping was not intended to be in detail, but rather to have wide-spread coverage. As a result, correlations throughout northeast Oklahoma were improved.

Present Investigation

Prior to commencement of actual field work, minor preparations were necessary. A field map consisting of four township plats was constructed using airplane photographs (1941 flight) furnished by the Oklahoma Geological Survey, with a scale of 3.1 inches to the mile. As the network of section line roads was extensive, most section corners were marked and little adjustment was required. By means of stereoscopic study, the drainage, road system, section corners and cultural features were traced to transparent acetate overlays and later transferred to the field map. In addition, various geologic features, such as alluvial material, traceable beds, and faults were marked on the overlays. Numerous published sources relating to similar geology of adjacent areas were studied before attempting any field work.

Field investigation was started in May, 1956 and completed in

August, 1956. Airplane photographs were taken into the field where interpretations were checked and corrected whenever necessary. The final data were transferred daily to the field map. The first unit mapped was the Checkerboard limestone, because of its continuity and importance as geologic unit. Upon completion of the mapping of the Checkerboard, the formations were mapped in descending geologic order from the Nellie Bly outcrops in the northwest through the Wewoka outcrops in the southeast. Lithologies were noted and described and where possible, detailed stratigraphic sections were measured with the aid of hand-level, steel tape, alidade, or aneroid barometer. Rock samples for laboratory testing were collected of selected rock units at selected localities. Also, coal samples were collected for the Oklahoma Geological Survey for research studies.

In most localities, the dip is about one degree and was not considered in the measurement of stratigraphic sections. It was used, however, in computing the thicknesses of sections along alidade traverses. In all, about twenty miles of alidade traverse was made for determining formation thicknesses. Several days also were spent in similar work with the aneroid barometer.

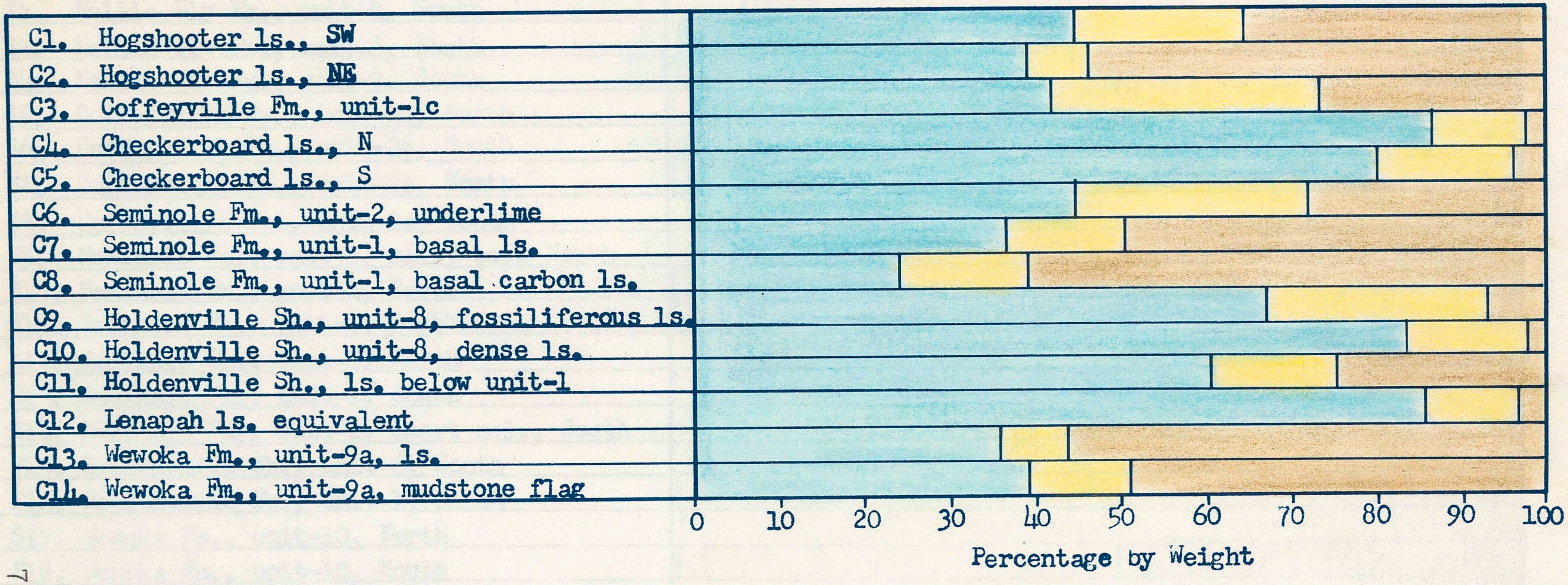
Laboratory procedure consisted of testing the rock samples collected in the field. Carbonate rocks were tested for insoluble residues, and sandstones were subjected to mechanical sieve analysis in addition to the insoluble residue test. The sieve test of sandstones was useful in determining lithologic changes in the rock units crossing the area. The results of these tests are given in the discussion of each unit as well as being listed as tables in Appendix C, and presented diagrammatically in Figures 2 and 3.

Upon returning from the field, a base map was constructed using the same scale as the field map. Information was readily transferred from the field map to the base map. A diagrammatic composite section was constructed from measured and computed sections.

Geography

The Beggs Area is located in the Sandstone Hills physiographic province of Oklahoma (Snider, 1917, p. 80). Outcropping rocks are largely alternating sandstones and shales, which dip about one degree to the west-northwest. As a result of differential weathering, the more resistant sandstone beds form steep escarpments to the east and gentle "dip slope" surfaces to the west. Some of the sandstones are of considerable thickness and are sufficiently resistant to produce rugged hills while broad lowlands or flats are produced in the thick shales between the sandstones. Rugged, hilly topography is found in the northwest and southeast with a northeast-southwest trending valley between. The hills to the northwest are supported largely by sandstones of the Coffeyville and Nellie Bly formations, with the highest elevations in that part being capped by limestones of the Hogshooter formation. Rock units of the lower Coffeyville formation through the Holdenville shale form the lowland valley, and sandstones of the Wewoka formation cap the hills in the southeast.

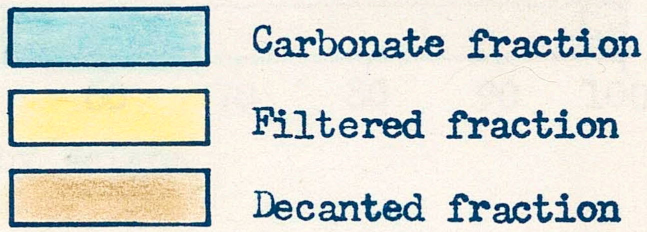
Locally, throughout the valley between the hilly sectors can be found minor ridges ranging in relief from a few feet to about 100 feet. These escarpments are upheld by thin, lenticular limestones



INSOLUBLE RESIDUE ANALYSES DIAGRAM

OF

CARBONATE ROCK UNITS

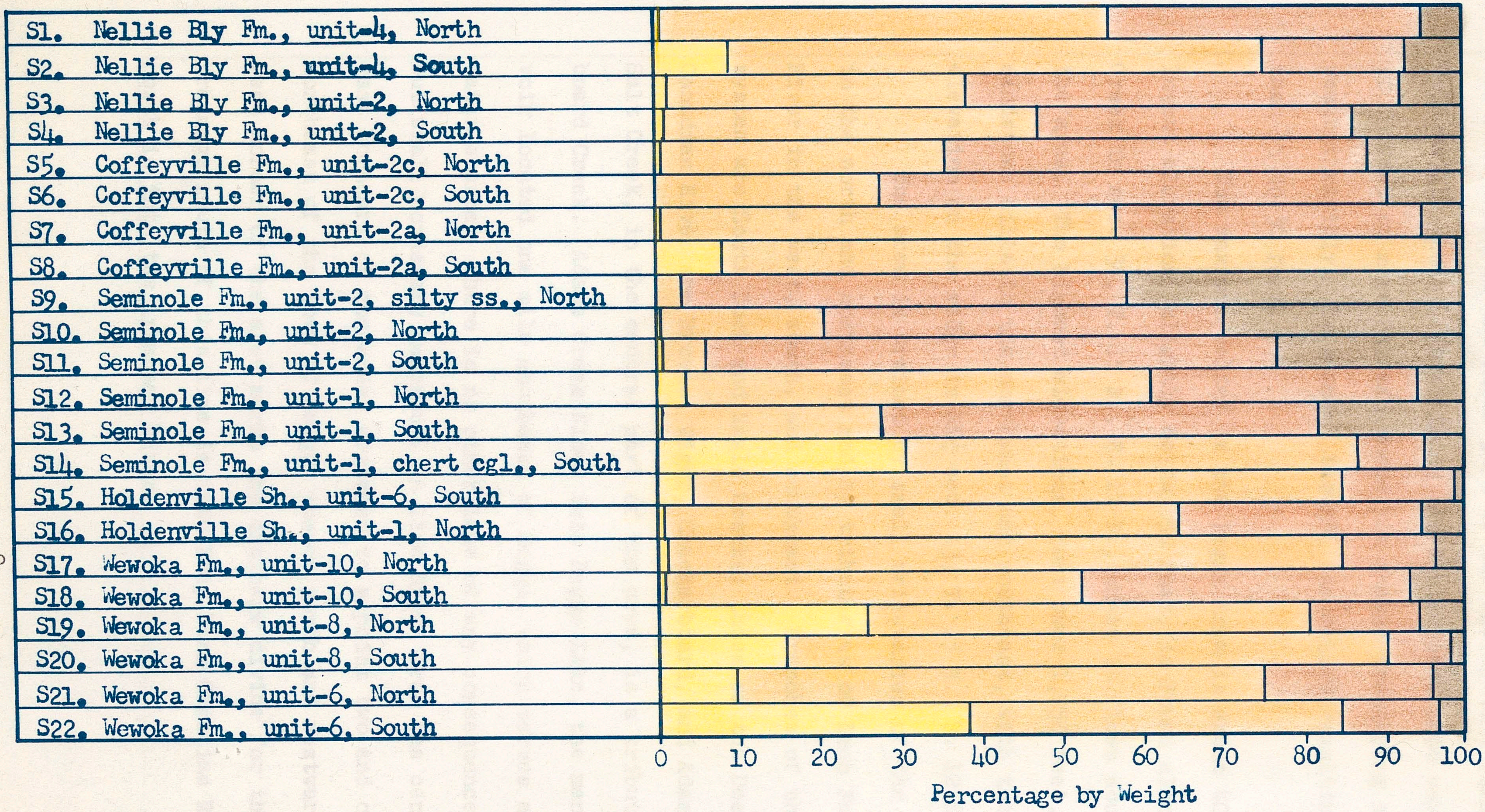


THE BEGGS AREA

OKMULGEE COUNTY, OKLAHOMA

GLEN C. LUFF, 1956

FIGURE 2



>.250	coarser sand
.250<.125	fine sand
.125<.062	very fine sand
<.062	silt

MECHANICAL SIEVE ANALYSES DIAGRAM

OF

SANDSTONE ROCK UNITS

THE BEGGS AREA

OKMULGEE COUNTY, OKLAHOMA

FIGURE 3

GLEN C. LUFF, 1956

and sandstones in the lower part of the Coffeyville formation through Holdenville shale. These thin, lenticular rock beds may form ridges of 75 feet or more relief, where the shales underlying are thick and weather rapidly. In general though, the relief resulting is not more than 15 to 30 feet.

The maximum relief in the Beggs Area is about 400 feet. The lowest elevation, slightly below 650 feet, is found along Checkerboard Creek in sec. 34, T. 15 N., R. 11 E., where it flows southward out of the area. The highest elevations, just over 1,050 feet, are in the sandstone hills in the northwest and southeast, with the maximum elevation on the ridge in SE$\frac{1}{4}$ sec. 13, T. 15 N., R. 12 E.

The area is drained by small tributaries of the Arkansas River in the north and northeast and by tributaries of Deep Fork Canadian River in the west, south, and southeast. Branches of the Arkansas system are South Duck and Eagle Creeks; those of the Deep Fork Canadian River are Browns, Tiger, Checkerboard, and Adams Creeks. Salt Creek, in the central part of the area, is a tributary of Checkerboard Creek. Adams Creek flows into Beggs Lake, the man-made reservoir located one mile southeast of Beggs, which serves as that town's water source. There is no other lake of any consequence in the area, but small ponds are numerous. A line drawn from the center of the east boundary of the area, westward to a point two and one-half miles northeast of the town of Beggs, thence north and westward to the northwest corner of the area marks the drainage divide for the area. Drainage south of this line is into Deep Fork Canadian River and that north is into the Arkansas River.

The average regional dip as computed by the three-point method using information derived from alidade and aneroid barometer surveys is in the direction of N. 55° W., at about one degree. Local dips were found to be greater in the southeast, about 90 to 150 feet to the mile, and less in the northwest, about 60 to 90 feet to the mile..

CHAPTER II

STRATIGRAPHY

General Statement

The stratigraphic sequence exposed in the Beggs Area is almost entirely of rocks of the Des Moines and Missouri series of middle and upper Pennsylvanian age. The composite thickness is about 1,400 feet and consists of alternating beds of shale, sandstone, and limestone, in decreasing order of abundance.

Most units, especially sandstones, were found to be continuous throughout the area. Notable exceptions are the lenticular units of the lower Coffeyville and Holdenville formations. Two limestones are continuous; the Hogshooter formation and the Checkerboard limestone. The remaining limestones are either thin lenses or "pocket" beds between two gradational units. Most of the intervening shales are covered and the lithologic character normally can not be accurately determined.

DES MOINES SERIES

The oldest rocks exposed in the area are of late Desmoinesian age. More specifically, they include beds of the Wewoka and Holdenville formations of the Marmaton group, uppermost group in the Des

Moines series.

Rocks of this series crop out in most of the eastern one-half of the area where they strike northeast and dip northwest at about one degree. They are mainly the alternating shales and sandstones of the Wewoka formation and the predominant shale and minor sandstone and limestone lenses of the Holdenville shale. Approximately 600 feet of Desmoinesian rocks are exposed.

The Des Moines series is unconformable with the overlying Missouri series. The strongest evidence for an unconformity is the truncation of several mappable units in the upper part of the Holdenville shale. Possible structural discordance may also be present locally, although direct evidence of this is wanting.

Marmaton Group

Wewoka Formation

Definition. The Wewoka formation was first named by Taff (1901, p. 4) from exposures along Wewoka Creek, near the town of Wewoka in Seminole County. In describing the formation, Taff states:

> Above the Wetumka shale is a succession of massive and, for the most part, friable sandstones and shales, seven in number, in alternating beds 40 to 130 feet thick. These beds together are about 700 feet thick....The separate massive beds composing the formation are of sufficient thickness to be mapped, but on account of the obscurity of the contact lines, due to the friable nature of the beds, it is not possible to accurately distinguish them.

In Hughes County (Weaver, 1954, p. 62), the Wewoka consists of four massive to thin-bedded sandstone units with thick, interbedded and intertonguing shales. The average thickness was given as 680 feet.

Five sandstone and four shale units with four local sandstone tongues or lenses were mapped in Okfuskee County (Ries, 1954, p. 35). The composite thickness is about 750 feet.

In the Beggs Area, also, the Wewoka formation consists of alternating shales and sandstones. It conformably overlies the Wetumka formation (Leitner, 1957, p. 21) and is overlain conformably by the Holdenville shale.

Distribution and thickness. The Wewoka formation crops out in the southeast one-quarter of the area and is easily recognized by the hills it upholds. Outcropping beds in the area do not represent a complete section of the Wewoka as the basal 200 feet of the formation, measured by Leitner (1957), crops out southeast from the southeast corner. It was not possible to measure accurately a complete stratigraphic section in any given locality; however, composite sections indicate a variable thickness of 350 to 450 feet. Most of these sections were measured in cuts along the proposed new highway during its construction, and should be considered with that in mind. It is hoped that in a few years, more accurate measurements may be possible along this highway.

The top of the formation extends from the southeast part of sec. 31, T. 15 N., R. 12 E., northeastward to the northeast part of sec. 24, T. 16 N., R. 12 E. The strike of the Wewoka is N. 36° E. and the regional dip is N. 58° W. at about 110 feet per mile.

Character and subdivisions. The Wewoka formation consists essentially of alternating shales and sandstones. The shales are for the most part, gray-blue, massive, and friable. Sandstones are of variable color, from cream to brown, depending on the iron content, fine- to medium-grained, massive, and locally may grade into siltstones within the same unit. Any attempt to discuss the lithology of each unit individually would appear repetitious and therefore only marked changes and thicknesses will be presented. Units Pwk-1 through Pwk-4, do not appear as continuous units and were mapped largely for correlation with the work of Leitner (1957) to the east, and Miller (1957) to the south. These units will be discussed only briefly.

The contact between the Wewoka formation and the overlying Holdenville shale was mapped as the top of the uppermost sandstone unit of the Wewoka from the south boundary northward, to the center of NW$\frac{1}{4}$ of sec. 15, T. 15 N., R. 12 E., and as the top of the mudstone flag zone, Pwk-10a and Pwk-9a, from that point northward to the northern boundary.

Local dips of units Pwk-2 through Pwk-6 in sec. 35, T. 15 N., R. 12 E. were computed by the three point method and range from 2.5° to 6°. These are believed to be, in part, original dips of deposition.

That part of the formation which crops out in the Beggs Area was divided into ten mappable units. Each consists of a sandstone and an overlying shale, with the exception of units Pwk-1 and Pwk-10. Unit Pwk-1, the oldest mapped, is 33 feet of gray-tan silty shale, as exposed in the southeast corner of sec. 36, T. 15 N., R. 12 E. The underlying sandstone of this unit does not crop out in the area.

Unit Pwk-2 is from 30 to 45 feet thick. The shale member maintains a nearly constant thickness of 22 feet, while the underlying sandstone member ranges from 11 to 25 feet. The unit is thinner in the southern part of the area.

Unit Pwk-3 pinches out as it leaves the area southward and eastward as well. It is about 28 feet thick; 17 feet of sandstone and 11 feet of shale.

Pwk-4 is about 30 feet thick, consisting of 8 feet of sandstone and 22 feet of shale. It crops out in parts of secs. 25, 35, and 36, T. 15 N., R. 12 E., but is not continuous across the area.

The lowest unit continuous across the area is Pwk-5. In secs. 23-27, 34-36, T. 15 N., R. 12 E. it is one of the weaker Wewoka units. In the southern part, it is 30 feet thick, consisting in ascending order, of 8 feet of sandstone, 8 feet of gray-tan, silty shale, which contains worm trails (Fig. 4) and carbonaceous fossil plant remains and 13 feet of gray-blue shale. Not far to the north, however, along the east line of sec. 25, T. 15 N., R. 12 E., the combined shale increases to 75 feet. This may be one indication of the deltaic origin of the Wewoka formation.

Pwk-6 is sufficiently resistant to form several ridges in the extreme southeastern corner. This unit consists of a basal sandstone 12 feet thick; a 60-foot siltstone bed; a second sandstone, 10 feet thick; and an upper bed of gray-blue shale 27 feet thick. As exposed in the center of sec. 35, T. 15 N., R. 12 E., in new road cuts, the basal sandstone is tan to cream, medium- to fine-grained, weathers red-brown, contains fossil brachiopods and plants, and exhibits contorted bedding locally (Fig. 5). In the same road cuts the 60-foot siltstone is gray-tan and is very shaly locally. It contains a few poorly preserved fossils. Another good exposure of this bed, although

Figure 4. Worm trails of unit Pwk-5, SE$\frac{1}{4}$ sec. 35, T. 15 N., R. 12 E.

Figure 5. Contorted bedding of unit Pwk-6, SE$\frac{1}{4}$ sec. 35, T. 15 N., R. 12 E.

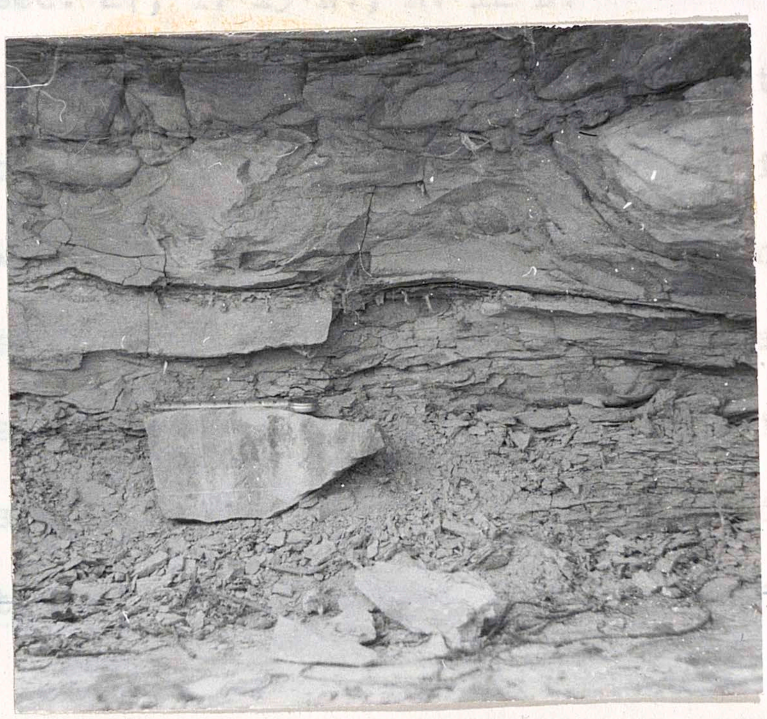


Figure 6. "Dumped" deposits and ripple marks of unit Pwk-7, below dam of Beggs Lake, sec. 32, T. 15 N., R. 12 E.

much more shaly, is in the road cut on Oklahoma Highway No. 16 at the southwest corner of sec. 25, T. 15 N., R. 12 E. The lower sandstone thickens to 24 feet in the northeast corner of sec. 25, where it forms a steep escarpment.

The most extensive ridge-former in the south one-half of the Wewoka outcrop area is unit Pwk-7. This is principally due to the resistant nature of both beds of this unit as compared to that of other units. Pwk-7 consists of from 10 to 34 feet of sandstone and about 10 to 20 feet of silty shale. The sandstone is thicker to the southwest and is composed of several individual beds, some of which show cross-bedding and ripple-marked surfaces (Fig. 6). An excellent exposure of this bed (Measured Section No. 10, Appendix A) may be seen below the dam of Beggs Lake, sec. 32, T. 15 N., R. 12 E. (Fig. 7). This sandstone is also the lowest bed of the Wewoka formation in this area to form extensive "dip slope" surfaces to the northwest. The upper shale bed is locally quite silty, exhibiting cross-bedding and also a few ripple-marked sandstone zones. A good exposure of the shale bed may be seen on Oklahoma Highway No. 16 in the west part of sec. 27, T. 15 N., R. 12 E.

Unit Pwk-8 upholds most of the ridges in the northern one-half of the Wewoka outcrop pattern. It is one of the units (Pwk-7, 8, 9) which form the steep escarpment along the west side of Beggs Lake, sec. 32, T. 15 N., R. 12 E., northeastward to the southeast corner of sec. 15, T. 15 N., R. 12 E. The unit is about 40 feet thick, consisting of 20 feet of shale and 30 feet of sandstone. In the south, the sandstone bed contains 8 feet of interbedded gray-blue shale, that pinches out to the north. North of the alluvium of Eagle Creek in sec. 36, T. 16 N., R. 12 E., the sandstone bed is the uppermost mappable sandstone of the Wewoka formation as units Pwk-9 and Pwk-10 have become the calcareous mudstone flag beds, Pwk-9a and Pwk-10a.

To the south, in sec. 33, T. 15 N., R. 12 E., unit Pwk-9 consists of an upper 4-foot, silty shale and a lower 22-foot, sandstone bed. The sandstone bed locally has an interbedded shale. North of Oklahoma Highway No. 16, extending northeast to the alluvium of Eagle Creek in sec. 2, T. 15 N., R. 12 E., this unit has the typical Wewoka form of an upper shale and a lower sandstone. An exception to this continuity is the disappearance of the sandstone bed in NE$\frac{1}{4}$ of sec. 10, and the NW$\frac{1}{4}$ of sec. 11, T. 15 N., R. 12 E., where it apparently grades into shale facies down-dip, to the northwest. A large dip slope of this sandstone occurs in sec. 15, T. 15 N., R. 12 E. An apparent gradation of the sandstone of Pwk-9, to the mudstone flag bed, Pwk-9a, is indicated by an outcrop of limy sandstone in Eagle Creek, at the center of sec. 2, T. 15 N., R. 12 E. This bed is 2 feet thick, tan, and is characterized by a large Myalina species fossil. North of this outcrop, the sandstone could not be traced and therefore the base of the corresponding mudstone flag zone was mapped. Pwk-9a is a 2-foot zone of calcareous mudstone flags, about 2 inches in thickness and of variable shapes. The flags are, at places, dense, chocolate brown, weather yellow, and are concretionary (Fig. 8). Results of laboratory tests of the aforementioned limy sandstone and of the mudstone flags for carbonate material are listed in Table I, Appendix C.

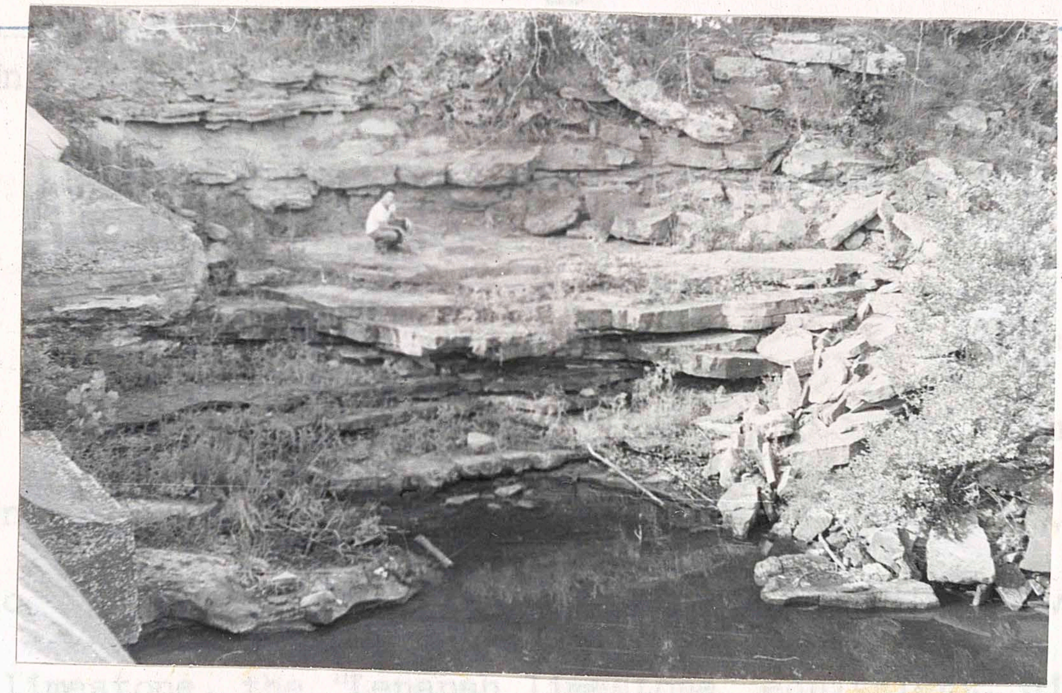


Figure 7. Sandstone sequence of unit Pwk-7 below dam of Beggs Lake, sec. 32, T. 15 N., R. 12 E.

Figure 8. Limy mudstone flags, unit Pwk-9a, SW$\frac{1}{4}$ sec. 25, T. 16 N., R. 12 E.

Unit Pwk-10 is mapped from along U. S. Highway No. 75, south of Beggs, northeast, to the alluvium in sec. 32, T. 15 N., R. 12 E., then as a continuous unit to the center of NW$\frac{1}{4}$ of sec. 15, T. 15 N., R. 12 E. This unit is a 4-foot sandstone bed, which thins northward to 2 feet at the aforementioned termination. At this point, there is an apparent gradation into a calcareous mudstone flag bed, Pwk-10a, similar to that of Pwk-9 into Pwk-9a. The sandstone is overlain by a 2-foot limestone, the "Lenapah limestone" equivalent, discussed later. From this point, northward, to the alluvium of Eagle Creek in sec. 2, T. 15 N., R. 12 E., the sandstone could not be traced and the suspected base of the Pwk-10a bed is mapped as a dashed contact. North of the alluvial material, mudstone flags occur as zones throughout the shale body from the base of the Holdenville to the top of the upper Wewoka sandstone. No distinctive demarcation was noted for each bed and only the base of the flag zone was mapped, Pwk-9a.

Age and correlation. The Wewoka formation is of upper Desmoinesian age. It is equivalent in northeastern Oklahoma, to the Lenapah limestone, the Oologah formation, the Nowata shale, and part of the Labette shale (Oakes, 1952, p. 42).

Paleontology. Fossils have been collected in abundance from the Wewoka formation to the south (Girty, 1915) and southwest (Ries, 1954, pp. 38, 39). In the Beggs Area, however, the Wewoka contains few well preserved fossils. Portions of casts and molds and plant fossils as well as trail and bottom markings were found in some of the sandstones. The following fossils were collected:

Brachiopoda
Linoproductus oklahomae Dunbar and Condra
Marginifera sp.
Gastropoda
steinkerns
Pelecypoda
Myalina sp.
Plantae
Calamites sp.

Detailed sections. For stratigraphic sections including the Wewoka formation, see measured sections numbered 9, 10, 11, 12, 13, Appendix A, and alidade sections numbered 1, 2, 3, Appendix B.

Lenapah Limestone

The Lenapah limestone, as such, is not a mappable unit in the Beggs Area. Several peculiarities of an equivalent horizon are, nevertheless, worthy of discussion.

The Lenapah was mapped as a unit in Tulsa County, to the northeast (Oakes, 1952). Oakes found this limestone, north of the Arkansas River, to be closely related, stratigraphically, to the limy flagstones of the Nowata shale, of which he states (1952, p. 35):

> ....the Nowata contains in the upper part a band of limy flagstones....it is present in the area south of Bird Creek and southward to the south side of Tulsa County. In this southward extension, the band of flagstones is thicker, contains thin fossiliferous limestone flags, locally, and extends up to, and at some places may include, the Lenapah limestone. The author has traced the flags southward into the uppermost part of the Wewoka formation.

As to correlation of the Lenapah limestone-limy flagstone relationship, Oakes further states (1952, p. 41):

> In 1950, incident to field work for the new Geologic Map of Oklahoma, now in preparation, the author traced the band of limy flagstones, previously described as occurring in the upper part of the Nowata shale and extending up to the Lenapah limestone, southward to the southwest part of

sec. 15, T. 15 N., R. 12 E., Okmulgee County, where they merge with the uppermost sandstone of the Wewoka formation. In Okmulgee County, as in southern Tulsa County, the uppermost flags, in many localities at least, are actually thin-bedded, fossiliferous limestone and in all probability represent the Lenapah. For all practical cartographic purposes, then, the Lenapah limestone is equivalent to the uppermost Wewoka beds.

Mapping of units Pwk-9a and Pwk-10a was northward from the gradation locality of the equivalent Wewoka sandstone beds rather than southward as the Lenapah limestone was mapped by Oakes in Tulsa County. Pwk-9a extends into Tulsa County as a continuous flagstone zone. It is believed, however, that Pwk-10a is not continuous northward into Tulsa County as a flagstone unit, but becomes shale in the western part of sec. 24, T. 16 N., R. 12 E. The Wewoka-Holdenville contact, the equivalent Lenapah horizon, therefore, for all practical purposes, was mapped as the uppermost part of the flagstones from the center of NW$\frac{1}{4}$ of sec. 15, T. 15 N., R. 12 E., to the Tulsa County line in sec. 24, T. 16 N., R. 12 E. A definite Lenapah limestone, other than the flagstones, was not detected by field investigation.

At one locality, the center of NW$\frac{1}{4}$ of sec. 15, T. 15 N., R. 12 E., a 2-foot limestone bed does crop out. The areal extent of this outcrop is not more than 500 square feet. This limestone is off-white, with minor iron staining, is very fossiliferous, and overlies the 2-foot sandstone unit, Pwk-10, as previously mentioned. Extensive field investigation in this area failed to reveal another outcrop of this limestone or any bed of similar character.

The occurrence of this unit is similar to that of the limy sandstone gradational facies, previously described, between units Pwk-9 and Pwk-9a.

Paleontology. The outcrop in sec. 15, T. 15 N., R. 12 E. yielded excellent fossil specimens. Several of those collected and identified are:

- Anthozoa
  - *Lophophyllidium* sp.
  - *Pleurodictyum eugeneae* White
- Crinoidea
  - columnals
  - basal plates
- Brachiopoda
  - *Chonetes granulifer* Owen
  - *Cleiothyridina orbicularis* (McChesney)
  - *Echinoconchus semipunctatus* (Shepard)
  - *Leiorhynchus rockymontanum* (Marcou)
  - *Neospirifer dunbari* King
- Pelecypoda
  - *Nuculopsis girtyi* Schenck
- Gastropoda
  - *Amphiscapha catilloide* (Conrad)
  - *Worthenia tabulata* (Conrad)

Holdenville Shale

Definition. The Holdenville shale was described by Taff (1901, p. 4) as a friable blue clay shale, 250 feet in thickness, with local thin beds of shelly limestone and shaly calcareous sandstone in the upper part. The Holdenville, in the type area near Holdenville, Hughes County, Oklahoma, is conformable with the underlying Wewoka formation and is overlapped by the Seminole formation above (Morgan, 1924, p. 103).

In the Beggs Area, the Holdenville, uppermost Desmoinesian age, rests conformably upon the Wewoka formation below and is unconformable with the superjacent Seminole formation of the Missouri series. It is principally a shale containing locally prominent, lenticular sandstone and limestone units.

<u>Distribution and thickness</u>. The Holdenville is shown on the geologic map (Plate I) as a continuous outcrop extending from southwest of Beggs, northeasterly, into Tulsa County. The average width of the outcrop is about two miles. Thicknesses computed by alidade (alidade sections 1 and 3, Appendix B), indicate the formation to range from about 200 feet in the south to approximately 260 feet in the north. The Holdenville strikes N. 32° E.; its regional dip is N. 58° W. at about 90 feet per mile.

<u>Character and subdivisions</u>. The Holdenville is a gray-blue, fissile shale, which varies little in character throughout the formation. It is one of the formational units forming the lowlands between the "Wewoka" hills and the "Coffeyville-Nellie Bly" hills. Thin lenticular sandstone and limestone units of the middle and upper part of the formation form steep escarpments and dip slopes locally because of their resistance to erosion and the nonresistance of the underlying shales.

The base of the Holdenville, as previously discussed, was mapped as the top of the uppermost Wewoka sandstone from the south boundary, north, to the center of $NW\frac{1}{4}$ of sec. 15, T. 15 N., R. 12 E., and then as the top of the limy mudstone flags, from that point northward to Tulsa County in sec. 24, T. 16 N., R. 12 E. The top of the formation was mapped as the Des Moines-Missouri unconformity, discussed later, which in most places is considered as the base of the lower sandstone bed of the overlying Seminole formation.

Eight lenticular beds were mapped within the Holdenville shale. Six are sandstones, one is a limestone, and one exhibits a facies change from sandstone to limestone from south to north. The lowest of these units mapped, Phd-1, is a buff, fine-grained sandstone, extending from the southeast corner of sec. 4, T. 15 N., R. 12 E., northeastward, into Tulsa County in sec. 24, T. 16 N., R. 12 E. It thickens from a few feet at its southern extremity, directly below Phd-2, to about 12 feet going northward. It becomes separated by an increasingly thicker shale interval from Phd-2, in its northward trend. A steep escarpment locally as much as 70 feet high is held up by this sandstone.

A thin, 4-inch, red-brown, fossiliferous limestone crops out occasionally about 30 feet below unit Phd-1. This bed was not mapped. An insoluble residue test showed it to be about 60 per cent carbonate material. It contains many unidentified brachiopods, gastropods, and crinoid columnals.

Phd-2 is also a buff, fine-grained sandstone. It was mapped from below unit Phd-3, in the center of sec. 16, T. 15 N., R. 12 E., northward to the northern boundary. A dip slope of this bed is found along the northern part of its outcrop. Thickness of this unit is from 3 to 10 feet.

Unit Phd-3 is the most continuous unit of the Holdenville mapped. It is shown on the geologic map as extending from the center of NW$\frac{1}{4}$ of sec. 29, T. 15 N., R. 12 E., into Tulsa County in sec. 22, T. 16 N., R. 12 E. The unit is a 3 to 5-foot sandstone bed extending from sec. 29 to the north part of sec. 16, T. 15 N., R. 12 E., where it crops out as a sandy limestone. From sec. 16 northward to the county line, the unit is a 3-foot, limy flagstone bed. Although similar to the limy mudstone flags at the base of the formation in weathered-yellow appearance, they are limestone flags in the true sense. A fresh surface reveals a gray-blue, dense limestone. Phd-3 forms a large dip slope as much as one mile wide along the length of its outcrop.

Phd-4, a sandstone bed, was mapped from below unit Phd-7, in the east part of sec. 19, T. 15 N., R. 12 E., north, to SW$\frac{1}{4}$ of sec. 33, T. 16 N., R. 12 E., where it is truncated by the unconformity at the top of the formation. Its thickness increases from about a foot at its south extremity to 12 feet before truncation. A large dip slope of this unit occurs in and adjacent to sec. 17, T. 15 N., R. 12 E.

Units Phd-5 and Phd-6 are thin sandstone lenses cropping out only in sec. 31, T. 15 N., R. 12 E. They are relatively unimportant in occurrence except in forming a slight slope break and are two of the three sandstones that form the escarpment in the western half of that section.

The upper sandstone of this escarpment is unit Phd-7. It is a continuous unit from the southwest corner of sec. 31, T. 15 N., R. 12 E., to the north part of sec. 19, of the same township, where it grades into thin-bedded, ripple marked siltstones (Fig. 9), before becoming shale. Phd-7 forms the large escarpment in Beggs and the long dip slope extending west from the town.

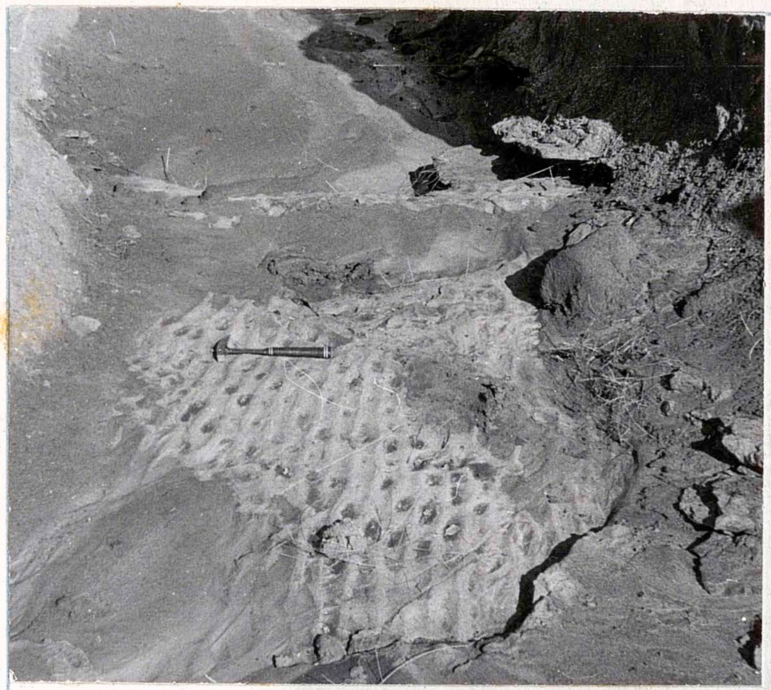


Figure 9. Ripple marks in siltstone of unit Phd-7, NE$\frac{1}{4}$ sec. 19, T. 15 N., R. 12 E.

A 3-foot limestone crops out at the base of Phd-7, one city block north of Oklahoma Highway No. 16, in Beggs. It is a gray, crystalline limestone, below, with the upper 8 inches dull brown and dense. The bed could not be traced either north or south from this outcrop. It may possibly represent a facies change between either unit Phd-5 or Phd-6 and unit Phd-4, although no evidence to support this statement was uncovered by field investigation.

The only continuously mappable limestone bed of the Holdenville is unit Phd-8. This bed is unique in that it crops out near the base of the Missouri series. It extends from sec. 25, T. 15 N., R. 11 E., to the point of its disappearance in NW$\frac{1}{4}$ of sec. 19, T. 15 N., R. 12 E. The limestone is readily traceable in sec. 25 up to its southern limit as mapped; at that point, exposures are few. The contact was not traceable, also, in most of sec. 19. This limestone consists of two beds. The lower member is about 3 feet thick, gray-blue, and dense, becoming a light chocolate brown, dense limestone near the top. The upper member is a thin, 3 to 5-inch, gray-tan, fossiliferous limestone.

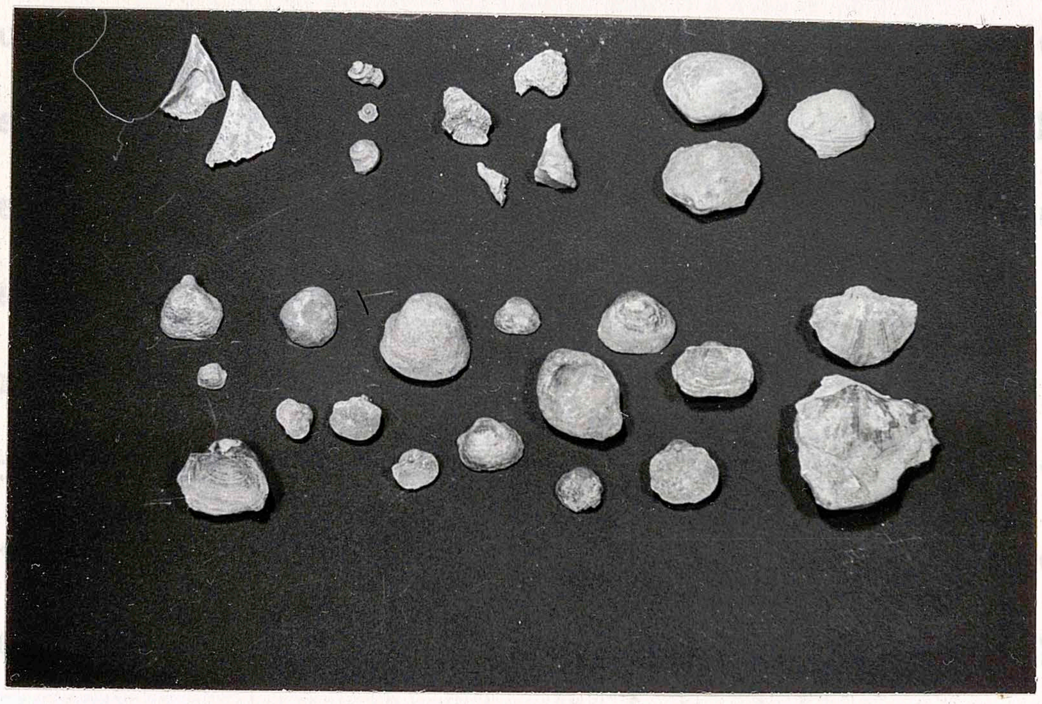


Figure 10. Representative fauna of unit Phd-8; pelecypods, gastropods, corals, brachiopods; NE$\frac{1}{4}$ sec. 24, T. 15 N., R. 11 E.

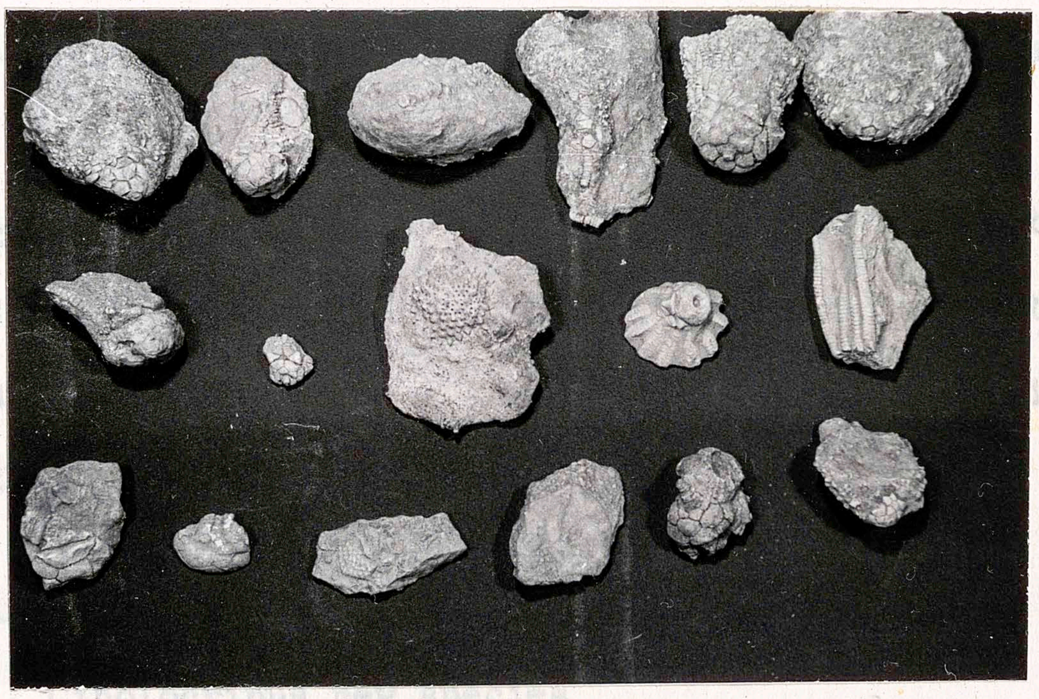


Figure 11. Representative crinoid specimens of unit Phd-8, NE$\frac{1}{4}$ sec. 24, T. 15 N., R. 11 E.

Both limestones weather yellow.

The upper zone of this unit proved to be extremely fossiliferous. Its outcrop in the creek in NE$\frac{1}{4}$ of sec. 24, T. 15 N., R. 11 E., yields a variety of fossils. These included corals, Bryozoa, crinoids, brachiopods, pelecypods, and gastropods (Fig. 10). Of special interest are the unusual number of excellent crinoid specimens collected (Fig. 11). From about 65 individual crowns or parts of crowns to date, 11 new species have been identified, which so far have not been named. Some of the specimens were so weathered as to reveal basal plates, calyx structure, and arms. Two showed tegmen structure. The collection was presented to the Oklahoma Geological Survey for classification and study.

Age and correlation. The Holdenville shale is uppermost Desmoinesian age. It is correlated with shale of patchy occurrence northward in Oklahoma, heretofore mapped as Memorial shale (Oakes, 1952, p. 47).

Paleontology. A variety of fossils are representative of the Holdenville shale in the Beggs Area. Most of those collected, however, are from outcrops of unit Phd-8. The following were identified:

Anthozoa
- Lophophyllidium sp.
- Pleurodictyum eugeneae White

Crinoidea
- Aatocrinus new species
- Cibolocrinus new species
- Delocrinus new species
- Ethelocrinus related to E. magnus Strimple
- Ethelocrinus sp.
- Haertocrinus new species
- Malaiocrinus cf. M. azygous Strimple
- Perimestocrinus new species (?)
- Plaxocrinus cf. P. tumulosus Strimple

Polusocrinus new species
Stellarocrinus new species (?)
Texacrinus new species (?)

Bryozoa
Bascomella sp.
ramose types
fenestrate types

Brachiopoda
Composita subtilita (Hall)
Derbyia cymbula Hall and Clarke
Juresania nebrascensis (Owen)
Linoproductus prattenianus (Norwood and Pratten)
Neospirifer dunbari King

Pelecypoda
Aviculopecten occidentalis (Shumard)
Myalina subquadrata Shumard
Myalina sp.

Gastropoda
Trepospira depressa (Cox)
Worthenia tabulata (Conrad)

Cephalopoda
Gastrioceras excelsum (Meek)

Plantae
Calamites sp.

Detailed sections. For stratigraphic sections including the Holdenville shale, see measured sections numbered 6, 7, Appendix A, and alidade sections 1, 3, Appendix B.

MISSOURI SERIES

The Missouri series is separated from the underlying Des Moines series by an unconformity, mentioned previously. Rocks of this series, which crop out in the western one-half of the area, are of the Skiatook group, lower Missourian in age. More specifically, they include the Seminole formation, Checkerboard limestone, Coffeyville formation, Hogshooter formation, and the lower part of the Nellie Bly formation. These formations consist of alternating shales, sandstones, and limestones, in order of predominance.

The strike of the beds is about N. 30° E., with a regional dip of N. 60° W., at about 90 feet per mile. Between 800 to 900 feet of Missourian rocks are exposed.

Skiatook Group

Seminole Formation

Definition. According to Oakes (1952, p. 48), the name Seminole formation has been extended into northeast Oklahoma and applied to the shale and sandstone unit lying above the unconformity at the base of the Missouri series and below the base of the Checkerboard limestone. Taff (1901, p. 4) defined the lower limit of the Seminole formation, in Seminole County, as a chert conglomerate, and Morgan (1924, pp. 109-112), in the Stonewall quadrangle, placed the upper limit as the base of the DeNay limestone, near age equivalence with the Checkerboard limestone.

In the Beggs Area, the Seminole formation lies above the unconformity at the top of the Holdenville and is conformable with the overlying Checkerboard limestone. It consists of alternating sandstones and shales, with a few thin coals appearing locally throughout the shales and lower part of the sandstones.

Distribution and thickness. The Seminole formation crops out as a band of variable width, from one to two miles, from the central portion of the southern boundary in T. 15 N., R. 11 E., northward to its exit from the area in secs. 20 and 21, T. 16 N., R. 12 E. The formation varies in thickness from about 110 feet in the south to about 190 feet in the north. These thicknesses were computed by alidade methods (alidade sections numbered 1, 3, Appendix B). The strike of

Seminole beds also is changeable from N. 35° E. in the south to N. 15° E in the north, presumably, as a result of channeling throughout the formation. The regional dip is to the west-northwest at about 90 feet per mile.

Character and subdivisions. In the Beggs Area, the Seminole formation is divided into two distinct units; Ps-1, consisting of a basal sandstone bed with an overlying shale, and Ps-2, consisting of another sandy zone with a superjacent shale. The sandstones, and consequently the corresponding shales, are not of uniform thickness throughout the area because of considerable channeling not only at the base of the formation, but also in the upper sandy zone. Dip slopes of both sandstones are common, but those formed by the lower sandstone are more prevalent.

Unit Ps-1 is basically separated into two units; a lower sandstone and an overlying shale. Two shaly carbonaceous sequences were located directly below the basal sandstone, but as these are not more than 10 feet in thickness and do not occur continuously beneath this bed, they shall be considered as part of Ps-1. These sequences apparently are a result of channel fillings upon the unconformity surface. Their descriptions are listed as measured sections numbered 3, 19, Appendix A. Figure 12 is illustrative of one of these zones.

Two "limestones" occurring in the zone in $SW\frac{1}{4}$ of sec. 25, T. 15 N., R. 11 E., were examined for insoluble residue. Although, possessing a limy appearance, their carbonate percentage was found to be low.

The sandstone of Ps-1, varies not only in thickness, but in character as well. As exposed at the southwest corner of sec. 35, T. 15 N., R. 11 E., it is thin-bedded, gray-tan, shaly and contains a few poorly preserved fossils. To the east, an outlier of the sandstone is located in secs. 25, 26, 35, 36, T. 15 N., R. 11 E. This erosional remnant contains resistant chert conglomerate material interbedded in the basal part of the sandstone. Chert fragments, up to one-quarter-inch in diameter, have a chalky texture, are angular, and are presumed to be tripolitic chert. These fragments appear as interbedded zones throughout the main body of sandstone, which is buff, fine-grained, and friable. An insoluble residue test showed about 32 per cent carbonate material and 62 per cent decanted material. Examination of the residue showed a considerable number of chert fragments, leading to the conclusion that the carbonate is present as a cementing agent. A few plant fossils are present within the chert zones.

Results of the sieve test indicated that this basal sandstone becomes finer-grained from south to north. Thickness of this bed is quite varied; from 10 to 35 feet and undoubtedly it attains greater thicknesses, although none were evident. This unit, both sandstone and shale, thins considerably in secs. 7, 18, T. 15 N., R. 12 E. This is readily apparent from examination of the geologic map (Plate I) although it could not be measured in the field. This thinning may be a result of a thinner section being deposited over a pre-Missourian structure. Farther to the north, in a road cut at the center of the west line of sec. 28, T. 16 N., R. 12 E., the basal part of this sandstone is exposed, clearing showing "dumped" deposits characteristic of this bed (Fig. 13).

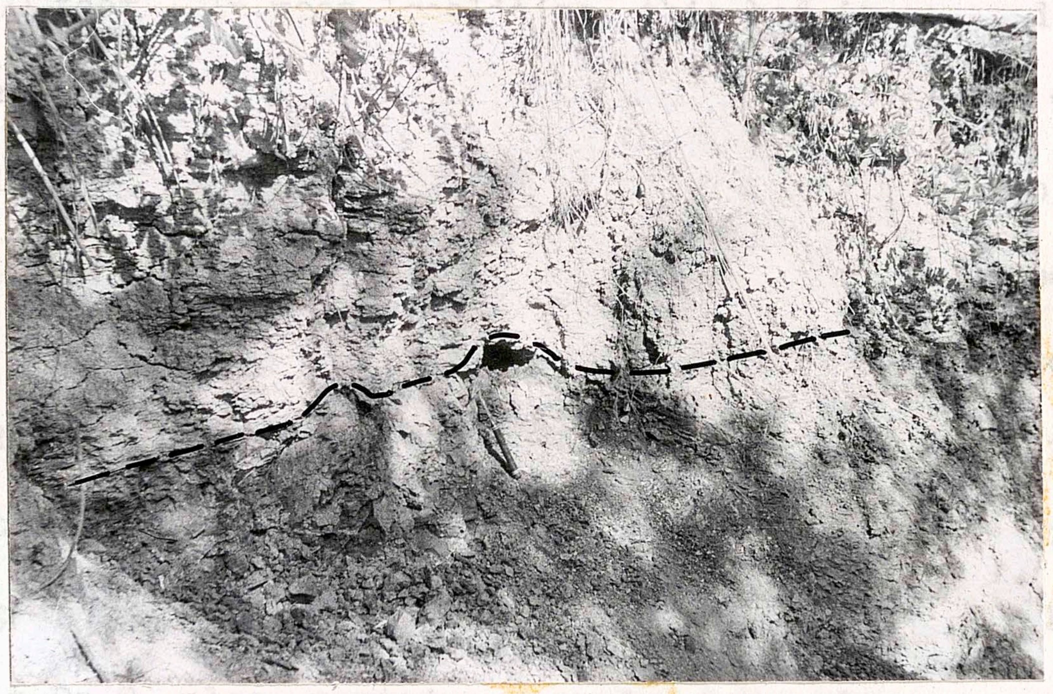


Figure 12. Unconformity (dashed line) between the Seminole and Holdenville, thin coal found along contact; center of east line, sec. 29, T. 16 N., R. 12 E.

Figure 13. "Dumped" ungraded deposits of basal sandstone of Seminole formation; center of west line, sec. 28, T. 16 N., R. 12 E.

The overlying shale also varies in thickness, from a few feet to about 100 feet. In most localities, this bed is covered and an accurate description cannot be given. Oakes (1952) mapped the Dawson coal in Tulsa County. This coal seam was not found to crop out in the Beggs Area, and therefore a southern extension was not mapped. Abandoned coal strip pits surrounding the southeast corner of sec. 12, T. 15 N., R. 11 E., could represent the south extremity of the Dawson coal, but this is based strictly on their stratigraphic position. Minute fragments of coal were recovered from ant hills at this locality.

Unit Ps-2, also, contains a sandy zone and a corresponding overlying shale. The lower sandy zone consists of a single sandstone bed from the southern boundary to about sec. 13, T. 15 N., R. 11 E. From that point northward, the sandy zone is comprised of several thin-bedded sandstones, silty shales, and a few thin-bedded calcareous sandstones. The southern sandstone apparently is characterized by a facies change to a very fine-grained, silty sandstone. A complete exposure of this transition from south to north is lacking. One of the few good exposures of the southern part of this sandstone bed, south of the aforementioned locality, may be seen cropping out in Salt Creek, east-central part of sec. 23, T. 15 N., R. 11 E. (Fig. 14). Thicker sections of the sandstone zone are exposed in the northern part of the area.

Excellent exposures of several beds of Ps-2, in the north, may be seen along South Duck Creek, in NE$\frac{1}{4}$ of sec. 30, T. 16 N., R. 12 E. (Figs. 15 and 16). Dips of 4 to 6 degrees were measured of the two thin calcareous sandstones in Figure 16. These are considered in part

Figure 14. Outcrop of unit Ps-2 in Salt Creek, center E$\frac{1}{2}$ sec. 23, T. 15 N., R. 11 E.

Figure 15. Outcrop of micaceous, silty sandstone member of unit Ps-2 on South Duck Creek, SW$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 30, T. 16 N., R. 12 E.

original dips and in part a reflection of subsurface structure to the east and south. Thicknesses of the sandstone of unit Ps-2 range from a few feet to as much as 40 feet. Again, this variation in thickness is believed a result of channeling, although it is not as marked as it is at the base of the formation.

A persistent coal bed, thickness of one to 2 feet, was mapped from the north, out of Creek County, south to NW$\frac{1}{4}$ of sec. 13, T. 15 N., R. 11 E., where it pinches out. This bed was previously mapped by Oakes (1952, p. 53) as cropping out near Mounds cemetery, one-half mile north of the area in Creek County. The coal occurs in the lower part of the upper sandstone. The interval between it and the Checkerboard limestone at the top of the formation, becomes less from north to south until at the point mentioned in sec. 13, it is but a few feet. Several exposures of this coal are marked on the geologic map (Plate I). An excellent section may be seen in the east creek bank in southwest corner of sec. 12, T. 15 N., R. 11 E. (Fig. 17). Exposed at this place are an upper sandstone, pinching out to the south, the underlying coal, a gray underclay, and a reddish, conglomeratic, fossiliferous underline. An insoluble residue test of the under lime indicated 45 per cent carbonate material.

Age and correlationThe Seminole is of early Missourian age. In the Beggs Area, it is essentially equivalent to the Seminole formation of the type locality, even though the upper limit, the Checkerboard limestone, cannot be mapped to that point (Oakes, 1952, p. 54).

Figure 16. Thin calcareous sandstones of unit Ps-2 in South Duck Creek, SW$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 30, T. 16 N., R. 12 E.

Figure 17. Cyclical sequence of marine and non-marine sediments of unit Ps-2; sandstone, coal, underclay, underlime; SW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 12, T. 15 N., R. 11 E.

Paleontology. The following fossils of the Seminole formation were collected and identified:

Bryozoa
    ramose type
Brachiopoda
    Dictyoclostus sp.
    Neospirifer dunbari King
Pelecypoda
    Aviculopecten occidentalis (Shumard)
    Cypricardinia sp.
    Myalina sp.
Gastropoda
    steinkerns
Plantae
    Calamites sp.
    Pecopteris sp.
    Sphenopteris sp.

Detailed sections. Stratigraphic sections showing the Seminole are measured sections numbered 3, 5, 7, 19, 20, Appendix A, and alidade sections numbered 1, 3, Appendix B.

Checkerboard Limestone

Definition. The Checkerboard limestone first appeared in print in 1910 (Gould, Ohern, and Hutchison, map). Other early references include those by Hutchison (1911, p. 157) and Smith (1912, p. 41). In 1917, the Checkerboard limestone was mentioned by name by Fath and Emery (1917, p. 370) as follows:

> Two outcrops of the Checkerboard lime, a bed which is about two feet thick, where noted by writers along Flat Rock Creek (name later changed to Checkerboard Creek) at the west side of the area described in this report. These exposures are in sec. 22, T. 15 N., R. 11 E. - one in and north of the road at the south side of this section and a short distance west of the creek, and the other in the creek bed at old "Checkerboard Crossing" near the east-west quarter line of the section.

Gould (1925, p. 72), in giving the first actual description of the Checkerboard limestone designated its type locality.

> The Checkerboard limestone member of the Coffeyville formation lies near the base of the formation. It is $2\frac{1}{2}$ to 3 feet thick, fine-grained and fossiliferous; bluish-white on fresh surfaces but becomes yellowish-white on weathered surfaces. In bare areas the limestone presents a "checkerboard" appearance, due to solution channels along joints, which occur in two sets, the one crossing the other. From this characteristic feature the limestone was for years known as the "Checkerboard lime", but the geographic locality which is here designated as its type locality is the exposures on Checkerboard Creek in T. 15 N., R. 11 E. A good exposure may be seen at "Checkerboard Crossing" of the creek, near the east-west quarter line of sec. 22, T. 15 N., R. 11 E.

The Checkerboard limestone was a member of the Coffeyville formation until it was raised to the rank of formation in 1937 (Moore, Newell, Dott, and Borden, 1937, p. 40).

In the Beggs Area at the type locality (Fig. 18), the Checkerboard lies above the Seminole formation and below the Coffeyville formation. It is conformable both above and below.

Figure 18. Outcrop of Checkerboard limestone at the type locality; blocks and "checkerboard" joint pattern; NW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 22, T. 15 N., R. 11 E.

Distribution and thickness. The Checkerboard is shown on the "Geologic Map of Oklahoma" (Miser, 1954) as extending from the latitude of Okmulgee north to the Kansas line.

In the Beggs Area, the Checkerboard extends as a nearly continuous mappable unit, from the southern boundary in sec. 33, T. 15 N., R. 11 E., northeastward, to the north boundary in sec. 20, T. 16 N., R. 12 E. It is a single bed of limestone about 2 feet thick. The bed strikes N. 30° E. and dips N. 60° W. at about 90 feet per mile.

Character. The Checkerboard is gray-blue, fossiliferous, and massive, and exhibits a "checkerboard" block pattern in weathering (Fig. 18). On fresh surfaces, it varies in color from a bluish-white to a dark blue, but weathers to a yellow color which seems to be peculiar to the Checkerboard only in this area.

The "checkerboard" joint pattern, nearly at right angles, breaks the bed into large blocks. One set of joint cracks strikes north-south; and the other set, about N. 70° W. This pattern was found consistently at several exposures in the area.

The Checkerboard limestone does not crop out as a well-exposed bed, but more commonly forms escarpments and dip slopes. Some of the criteria described by Oakes (1952, pp. 55, 56) are useful in this area also for finding exposures of the Checkerboard. It forms the first escarpment and corresponding dip slope above the upper sandy zone in the Seminole formation. It is overlain by the lowermost part of the Coffeyville formation, which contains about 6 or more feet of black shale near the base, with small, black, rounded, phosphatic nodules. The nodules are resistant to weathering and remain on the surface. A difference in soil is also noted from that of the clayey Coffeyville beds to that of the sandy, silty beds of the Seminole.

Several thin sandy limestone lenses in the lower Coffeyville formation and thin limy sandstones in the upper Seminole formation could possibly be confused with the Checkerboard limestone. The peculiar "checkerboard" joint pattern may be present in these beds, but because of the distinct yellow weathering color, high carbonate content, and abundance of fossils, the Checkerboard should be easily recognized.

Insoluble residue tests indicated the Checkerboard to consist of 80 to 90 per cent carbonate and from 11 to 18 per cent filtered material. Microscopic examination of residues showed principally gray to light brown clay and minor traces of silt and very fine quartz sand grains. A good show of comparatively large fragments of pyrite was also found. The carbonate percentage was found to increase from south to north. Strikingly enough, however, the abundance of fossils was noticed to decrease in the same direction, so that from sec. 31, T. 16 N., R. 12 E., northward, very few fossils were observed.

Good exposures of the Checkerboard are numerous in the area. They have been noted and marked on the geologic map (Plate I) as openings in the line, Pcb. An excellent exposure, of course, is that at the type locality, "Checkerboard Crossing", previously mentioned in sec. 22, T. 15 N., R. 11 E. The bed crops out in the stream for approximately 200 feet upstream. The oddity of this outcrop is that it has been called a "highway of an ancient civilization" by some of the local inhabitants.

Age and correlation. The Checkerboard limestone is of lower

Missourian age. It is approximately the same age as the DeNay limestone of central Oklahoma, but their outcrops are not continuous (Ries, 1954, p. 56).

Paleontology. The Checkerboard is very fossiliferous in the southern two-thirds of its outcrop area. Some fossils were noted in rock samples collected from northern outcrops, while abundant specimens characterize the southern outcrops. Only a few specimens were collected, however, as most of the fossils weather into fragments. The following were identified:

Crinoidea
  columnals
Brachiopoda
  Derbyia crassa (Meek and Hayden)
  Marginifera muricatina Dunbar and Condra
  Marginifera sp.
  unidentified specimens
Pelecypoda
  unidentified specimens

Detailed sections. For stratigraphic sections including the Checkerboard, see measured sections numbered 3, 5, 20, Appendix A, and alidade sections numbered 1, 3, Appendix B.

Coffeyville Formation

Definition. The Coffeyville formation was first described by Schrader and Haworth (1905, p. 448), from outcrops in the vicinity of Coffeyville, Kansas. In the type area, the Coffeyville is conformable with the Checkerboard, below, and the Hogshooter (Dennis) formation, above.

In the Beggs Area, the Coffeyville is a sandstone-shale sequence occurring between the same two limits: the Checkerboard limestone (below) and the Hogshooter formation (above). It is conformable with both.

Distribution and thickness. The Coffeyville formation is shown on the "Geologic Map of Oklahoma" (Miser, 1954) as extending from the southwestern part of Okfuskee County, northward, into Kansas. From the southwest corner of the Beggs Area, the Coffeyville crops out in a northeasterly trending band approximately five miles wide to Creek County in the north-central part of the area. The thickness of the Coffeyville ranges from about 450 to about 500 feet. These figures do not represent a complete section at any one locality, but are a composite of many measured and computed sections. The general strike of the formation is N. 30° E., and the dip is N. 60° W. at about 90 feet per mile.

Character and subdivisions. The Coffeyville in this area has been subdivided into three major parts: a lower shale unit, a middle sandstone unit, and an upper shale unit. Six lenticular beds, descriptions to follow, were mapped in the lower shale and four sandstone-siltstone units comprise the middle zone. The upper shale zone was mapped as one unit.

The lower shale unit is approximately 250 feet thick. It is predominantly a black to gray-blue, fissile shale becoming a gray-tan, silty shale adjacent to the lenticular beds. At the base of the formation, and just above the Checkerboard limestone, is a black, fissile shale, 6 feet or more thick, containing small, black, rounded phosphatic nodules, previously mentioned. A definite thickness between this zone and the first lenticular unit in the lower Coffeyville cannot be given because the first unit is not always the same bed throughout the area, and also because the intervening shale increases in thickness from south to north.

Lenticular unit Pcf-1a, is probably a sandstone about 3 feet thick. No exposures of this bed were found to crop out in the area. It is present as a dip slope from the east-central part of sec. 11, T. 15 N., R. 11 E., northward, to the west-central part of sec. 19, T. 16 N., R. 12 E.

Unit Pcf-1b extends from the center of the south line of sec. 22, T. 15 N., R. 11 E., northward to the southwest part of sec. 24, T. 16 N., R. 11 E. It is a gray-tan sandy limestone a few inches thick in the south becoming a sandstone about 4 feet thick in the north. An excellent exposure of this bed may be seen in the creek, east of the bridge, center of the west line of sec. 14, T. 15 N., R. 11 E. One of the small faults cutting this unit at that exposure is shown in Figure 19.

Unit Pcf-1c is also a sandy limestone which becomes a sandstone to the north. It has a thickness of about 4 feet. It was mapped from the alluvium of Tiger Creek in NE$\frac{1}{4}$ of sec. 28, T. 15 N., R. 11 E., northward to the center of sec. 3, T. 15 N., R. 11 E. An excellent outcrop may be seen in the west bank of Tiger Creek, 1/8 mile from the north line of sec. 28, T. 15 N., R. 11 E. (Fig. 20). At this point, units Pcf-1c and Pcf-1d are in direct contact, but northward from that location, the two units are separated by a shale of increasing thickness. Pcf-1c has the same "checkerboard" jointing as the Checkerboard limestone and consequently, weathers into large blocks. An insoluble residue test yielded 42.35 per cent carbonate and 47.65 per cent insoluble material; the residue was largely clay and mud.

A coal seam crops out between Pcf-1c and Pcf-1d, in Tiger Creek in the N$\frac{1}{4}$ of sec. 21, T. 15 N., R. 11 E. It is exposed in the east creek bank on the north section line where it is a few inches thick and was intermittently traced southward for one-quarter mile to an exposure of 4 feet. No exposures were found south of this point.

Pcf-1d is a 3 foot sandstone mapped from the western part of sec. 33, T. 15 N., R. 11 E., northward, to the western portion of sec. 10, T. 15 N., R. 11 E. It is a gray-tan, fine-grained sandstone. An outcrop of this bed has been discussed under Pcf-1c.

Unit Pcf-1e was mapped from the center of the south line of sec. 32, T. 15 N., R. 11 E., northward, to the center of the east line of sec. 20, T. 15 N., R. 11 E. It is a sandstone lense which is about 20 feet thick in the south of the area, and rapidly pinches out by its northern limit. An usual outcrop is seen just north of the south boundary road in sec. 32; within a very small area, strikes varying from north-south to east-west and dips of from one degree to as great as 20 degrees were noted (Fig. 21). These are believed to be a result of slumping due to rapid weathering of the underlying shales.

Sandstone lense Pcf-1f, forms a dip slope in secs. 30, 31, T. 15 N., R. 11 E. No good exposures were found for measurements, but the bed is estimated to be not more than 4 feet thick.

A series of thin, interbedded, silty limestone stringers was observed in the road cut on the steep hill along the north line, NW$\frac{1}{4}$ of sec. 3, T. 15 N., R. 11 E. This section occurs about 28 feet below

Figure 19. Minor fault cutting unit Pcf-lb in Checkerboard Creek; center of west line, sec. 14, T. 15 N., R. 11 E.

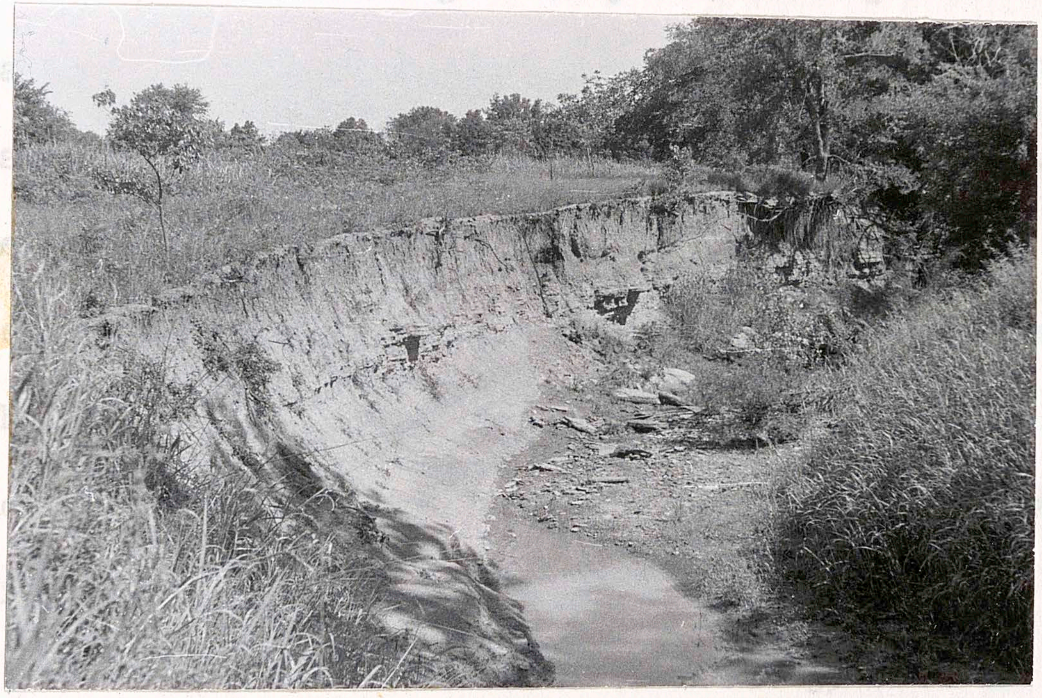


Figure 20. Outcrop of units Pcf-lc and Pcf-ld on Tiger Creek; N$\frac{1}{2}$ sec. 28, T. 15 N., R. 11 E.

Figure 21. Unusual strikes and dips of unit Pcf-le; center of south line, sec. 32, T. 15 N., R. 11 E.

the sandstone of unit Pcf-2a. A few minor shaly limestones and thin-bedded sandstones are also present locally in the lower shale unit, but are not significant.

The middle sandy zone has been further subdivided into four mappable units. Each consists of a sandstone and an overlying shaly siltstone. Units Pcf-2a, Pcf-2c, and Pcf-2d are continuous across the area, while Pcf-2b crops out for only a short distance. The total thickness of this zone is 160 feet. Sandstones are buff to brown, fine-grained, friable and generally form escarpments or support hilly topography. The corresponding shaly siltstones of these units are gray-tan and locally are of sufficient resistance to also form minor escarpments. The lowest escarpment of this sandy zone is conspicuous as it is the first one occurring west of the lowlands of the central part of the area. It extends from sec. 30, T. 15 N., R. 11 E., northeastward to sec. 23, T. 16 N., R. 12 E. Prominent outcrops of the sandstones are found all along this ridge.

Unit Pcf-2a consists of about 35 feet of sandstone and between 35 to 55 feet of siltstone. The variable thickness of the siltstone is due to the occurrence of the lenticular unit Pcf-2b. Unit Pcf-2b was mapped from the north-central part of sec. 20, T. 15 N., R. 11 E. northward to the northeast part of sec. 8, T. 15 N., R. 11 E. It is composed of 10 feet of sandstone and 12 feet of siltstone. Pcf-2c has 24 feet of sandstone and 32 feet of siltstone. The upper unit of this zone is formed by 18 feet of sandstone and about 30 feet of siltstone. The beds of this unit form the grassy slopes in the upper Coffeyville outcrop.

Unit Pcf-3 is a gray to blue shale, 30 to 50 feet thick. In most localities it is covered so that a complete section was not seen. It was mapped as a single unit.

Age and correlation. The Coffeyville formation is of lower Missourian age. It is equivalent to the lower part of the Francis formation in south-central Oklahoma (Ries, 1954, p. 60). The Coffeyville has also been found to be equivalent to the rocks of the interval between the Checkerboard limestone and the Dennis formation, in Kansas.

Paleontology. Very few fossils were observed in this formation. The following were collected:

Brachiopoda
- unidentified specimens

Pelecypoda
- *Aviculopecten occidentalis* (Shumard)
- *Myalina* sp.

Gastropoda
- unidentified specimens

Detailed sections. Stratigraphic sections including the Coffeyville are measured sections numbered 1, 4, 5, 8, 15, 16, 17, 18, Appendix A and alidade sections numbered 1, 3, Appendix B.

Hogshooter Formation

Definition. The Hogshooter formation was first mapped by Adams (1903, pp. 62, 63) as the lower Drum limestone. The formation was named by Ohern (1910, pp. 28,29) from exposures along Hogshooter Creek, Washington County, Oklahoma. He described the unit as essentially a single bed of limestone, massive to the north, but thin-bedded and argillaceous to the south.

In the Beggs Area also, the Hogshooter is essentially a single bed of limestone, but quite sandy as well as argillaceous.

Distribution and thickness. The Hogshooter extends from the west part of sec. 6, T. 15 N., R. 11 E., northward along the ridge of the "Nellie Bly" hills, to the county line in sec. 20, T. 16 N., R. 11 E. Several outliers of Hogshooter are hillcaps in secs. 21, 28 and 29, T. 16 N., R. 11 E. Sandstone debris covers most of the outcrop throughout the area, so that only a few exposures were found. Thicknesses at these locations range from a few inches to as much as 11 feet.

Character and subdivisions. The Hogshooter has been subdivided into two members to the north; the Winterset and the Lost City (Oakes, 1952, p. 60-62). In the Beggs Area, however, the Hogshooter appears to be represented only by the Winterset member. As good outcrops are lacking, it is possible that more than the Winterset is present, although field investigation failed to reveal but one.

Only two exposures of sufficient character as to be described were located. In the southeast face of the escarpment in NW$\frac{1}{4}$ of sec. 32, T. 16 N., R. 11 E., the Hogshooter crops out in a gully as a thin, chalky-white, silty limestone of about 8 inches thickness. The Hogshooter also caps the hill on the south line of sec. 21, T. 16 N., R. 11 E. It crops out at several places around the top of the hill and is about 11 feet thick. The lower part of the unit, as exposed, is about 10.5 feet of off-white, shaly, fucoidal limestone stringers, which grade into a red-brown, sandy limestone near the top. A 6-inch bed of blue-gray, sandy, fossiliferous limestone overlies the lower bed.

It weathers to a red-brown.

A few other exposures were found along the Hogshooter outcrop but normally they were almost unidentifiable due to the fact that the carbonate material had been dissolved, leaving a sandstone residue.

Insoluble residue tests of the better samples of Hogshooter limestone collected showed 40 to 45 per cent carbonate material and 35 to 50 per cent decanted material. Particles varying in size from that of very fine sand to clay were noted in the residues.

Age and correlation. The Hogshooter is equivalent to the Dennis formation of Kansas and to the middle part of the Francis formation of south-central Oklahoma (Oakes, 1952, p. 64).

Paleontology. The following poorly preserved fossils of the Hogshooter formation were collected:

Crinoidea
- columnals
- plates

Brachiopoda
- unidentified specimens

Detailed sections. For measured sections including the Hogshooter formation, see sections numbered 16, 17, Appendix A.

Nellie Bly Formation

Definition. Gould (1925, p. 74) quoted Ohern (unpublished manuscript) as naming the Nellie Bly formation from exposures along Nellie Bly Creek, Washington County, Oklahoma. Gould gave the following original description:

> Alternating shales and hard, gray sandstones....from a few feet on the Kansas line to 200 feet in southeastern Osage County....Rests on the Hogshooter limestone and is overlain by the Dewey limestone.

In the Beggs Area, only the lower part of the Nellie Bly formation crops out. It consists of alternating shales and sandstones, and is conformable with the underlying Hogshooter formation.

Distribution and thickness. Gould (1925, p. 74) states that the Nellie Bly "enters Oklahoma in northwestern Nowata County and extends southwest across Nowata, Washington, southeastern Osage, and Creek Counties as far as northern Okfuskee".

The Nellie Bly crops out in the extreme northwest part of the Beggs Area, having a total areal coverage of not more than 4 square miles. It is recognizable by the rugged hills that form its outcrop belt in that area. It was not possible to measure a complete section at any one locality, but composite sections indicate that about 180 feet of the lower Nellie Bly is exposed in the area.

Character and subdivisions. The Nellie Bly in this area is divided into four mappable units, each consisting of a sandstone and an overlying shale. The sandstones are buff to brown, fine to very fine-grained, friable, and weather dark brown. Locally, they show ripple marks and large weathering cavities (Figs. 22 and 23). The corresponding shales are covered throughout the area by slumped debris, but weather to a silty soil.

Unit Pnb-1 is from 50 to 60 feet thick, consisting of a basal 3-foot sandstone and the remainder shale. The sandstone rests conformably on the Hogshooter formation. Unit Pnb-2 is composed of 13 feet of sandstone and 22 feet of overlying shale. Pnb-3 has 6 feet of sandstone and 65 feet of superjacent shale. Pnb-4 is exposed only along the western boundary as a sandstone and a locally thin, overlying shale that caps two hills: one in sec. 6, T. 15 N., R. 11 E., and the other in sec. 19, T. 16 N., R. 11 E. The sandstone was measured as 6 feet and the maximum shale exposed is estimated to be 10 feet.

Figure 22. Ripple-marked base of sandstone of unit Pnb-2; NW$\frac{1}{4}$ sec. 32, T. 16 N., R. 11 E.

Figure 23. Weathering cavities of sandstone of unit Pnb-2, NW$\frac{1}{4}$ sec. 32, T. 16 N., R. 11 E.

Results of sieve analysis of each of these two sandstones indicate that both become finer-grained from south to north (Table III, Appendix C).

Good exposures of the sandstones may be seen along the escarpments they form. An excellent one may be seen at the outcrop of unit Pnb-2, on the north line in NW$\frac{1}{4}$ of sec. 19, T. 16 N., R. 11 E. (Fig. 24).

Age and correlation. The Nellie Bly is approximately equivalent to the Cherryvale shale of Kansas and to the upper half of the Francis formation in south-central Oklahoma (Oakes, 1952, p. 57).

Paleontology. Only a few poorly preserved crinoid columnals and plates were discovered in the sandstones of the Nellie Bly.

Detailed sections. For measured sections including the Nellie Bly, see sections numbered 2, 14, 16, 17, Appendix A.

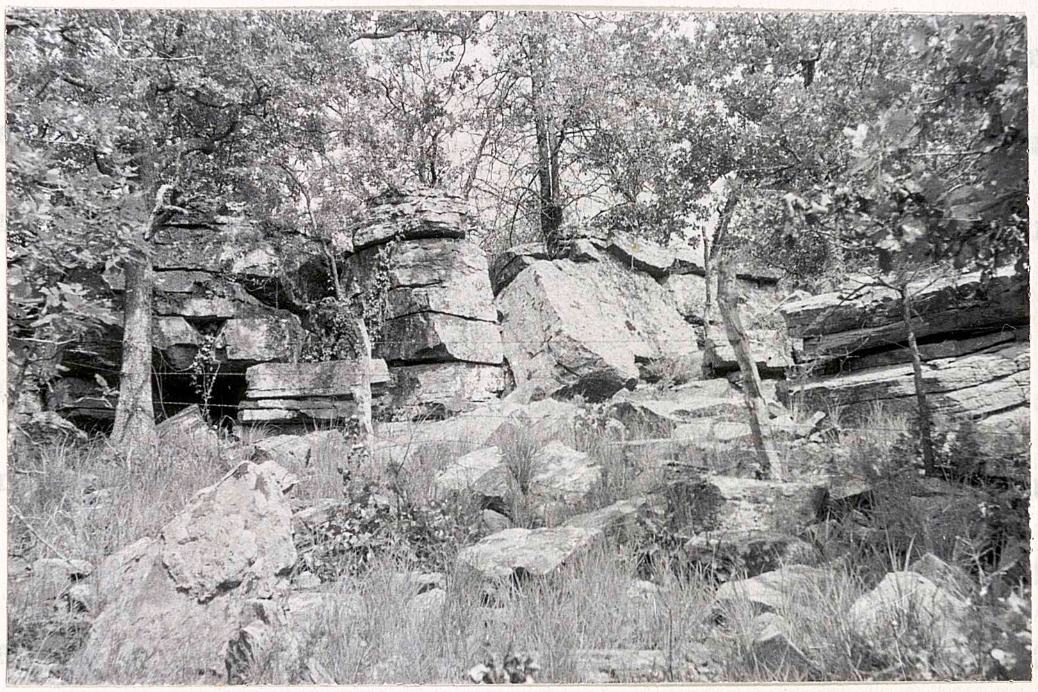


Figure 24. Sandstone escarpment of unit Pnb-2; north line, NW$\frac{1}{4}$ sec. 19, T. 16 N., R. 11 E.

Figure 25. Alluvial deposits on Tiger Creek; sec. 21, T. 15 N., R. 11 E.

Quaternary Deposits

Quaternary deposits, as mapped in the Beggs Area, consist entirely of alluvium of the flood plains of the larger streams. It is, for the most part, sand, silt, and clay, with minor amounts of gravel.

The Quaternary has been mapped along all major creeks of the area and along some of the larger tributaries. Thicknesses at most places are 5 to 15 feet, but may be greater. As much as 25 feet of alluvial material is known to occur along Tiger Creek, sec. 21, T. 15 N., R. 11 E. (Fig. 25).

CHAPTER III

HISTORICAL GEOLOGY

The Pennsylvanian system in northeast Oklahoma represents a series of transgressions and regressions of shallow seas on a stable shelf, resulting in cyclical deposition of marine and non-marine sediments. As deposition occurred on a nearly featureless surface, slight variations of either the sea or continent caused extensive changes in extent and minor changes in depth of the Pennsylvanian sea, and consequently varied sedimentation. The alternating series of clastics, sandstones and shales, with limestones and coals indicate typical shallow water and deltaic environments in which the shore-line fluctuated and depth varies as the lands rose southward (Gould, 1927, p. 44). There was, however, a gradual retreat of the Pennsylvanian seas, westward, as the land masses rose in the south and southeast (Gould, 1927, p. 36).

During Desmoinesian time, northeastern Oklahoma was a stable shelf area bounded by the McAlester basin to the south. The hinge line occupied many positions at the southern edge of the shelf, south of the Beggs Area, beyond which the sediments thickened rapidly basinward (Weirich, 1953, p. 2030). The shelf area remained relatively stable, but the basin continued to subside while receiving large amounts of sediments.

The deltaic Wewoka sequence of alternating sandstones and shales was deposited by a re-advancing Marmaton sea. Relatively continuous deposition of the thick section of Holdenville shale followed. Desmoinesian time closed with uplift and extensive stream erosion producing channels that were later filled by the lower sandstones of the Missouri series. Some of the en échelon faulting of late Desmoinesian rocks is believed by some to have occurred at this time (Dott, 1928, p. 62).

In Missourian times, there was a return to quiet deposition after the basal sediments of the Seminole formation were deposited upon the eroded surface. The large areal extent of the Checkerboard limestone and the thick shale section of the lower Coffeyville are indicative of this stability. Withdrawals of the sea in lower Missourian time were slight at first, as suggested by the lenticular beds of the lower Coffeyville, but later the seas became dominantly regressive as indicated by the deposition of the thick sandstone zone of the middle part of the Coffeyville formation. The upper shale of the Coffeyville and the Hogshooter formation represent an encroachment of the seas, again followed by shallower water deposits of the Nellie Bly formation.

Late Pennsylvanian and Permian sediments doubtless covered the area, but have subsequently been removed by erosion.

CHAPTER IV

STRUCTURAL GEOLOGY

The Beggs Area is situated near the eastern margin of the Prairie Plains Homocline. This large structure has an average westerly dip of 90 feet to the mile. As a result, outcropping middle Pennsylvanian strata, with an average strike of N. 30° E., form long parallel bands across the area.

The surface structure of the area is that of a northwestward dipping monocline with subsurface structures being revealed only slightly in the form of terraces and noses (Bosworth, 1920, p. 37). Clark and Bauer (1921, pp. 287-289) state that the variation in structure between surface beds and subsurface rocks is partly due to the increased thickness basinward, to the south, and also because the deeper strata were folded slightly before the younger beds were deposited. Folding was progressing while sediments were being deposited or at intervals throughout lower Pennsylvanian times. Subsurface structures generally are not reflected on the surface.

Several sedimentary structures, such as cross-bedding, lenticularity, varying thicknesses, and facies changes, are characteristic of this section of the Pennsylvanian rocks. In general, the beds cropping out in the area do become thinner and finer-grained from south to north. This is especially true of the sandstone members of the Wewoka formation and the lenticular units of the Holdenville shale and Coffeyville formation.

Faulting is of minor importance as a structural feature in this area. Only a few faults were mapped. No general conclusion can be drawn as to strike of the faults, but there appears to be a northwest-southeast trend, similar to that of the faulting northwest of the area. The displacements of the faults are not measureable, but are estimated to be not more than 10 to 20 feet. "Checkerboard" jointing, previously discussed, also appears to have the same trend directions as that of the few faults mapped.

Peculiarities encountered in measuring the dips of sandstones in the Wewoka formation aroused interest as to the origin of these sediments. Dip components varied from one to 6 degrees within short distances. In addition other characteristics, such as sharp changes in thickness, cross-bedding, interbedded sediments, strike of the beds becoming more easterly from south to north, the upper sandstones grading into shale facies northwestward, and the overall facies change to finer-grained sediments from south to north indicate conditions similar to that of a seaward building of a delta, northwestward. Assuming the Wewoka to be of deltaic origin, many of the erratic dips measured, could be attributed to original dips of deposition.

Possible evidence to corroborate the existence of an unconformity between the Des Moines series and the Missouri series in the Beggs Area is present at several localities along the Seminole-Holdenville contact. These are:

1. Conglomeratic material in the basal Seminole sandstone is found in sec. 36, T. 15 N., R. 11 E.

2. A carbonaceous sequence of rocks is found in SW$\frac{1}{4}$ of sec. 25, T. 15 N., R. 11 E.

3. Unit Phd-8 appears to be a truncated unit, extending only a short distance of two miles northwest of Beggs.

4. Sandstone unit Phd-4 thickens from a thin bed beneath Phd-7 to a 12-foot bed in SW$\frac{1}{4}$ of sec. 33, T. 16 N., R. 12 E., at which point it is apparently truncated.

5. Another carbonaceous deposit is found between two lithologically different shales (Seminole and Holdenville) in the road cut on the east line of sec. 29, T. 16 N., R. 12 E.

Several discontinuous thin limestones are also present directly below the lower Seminole sandstone. This sandstone was found to have a greater thickness locally, which might be due largely to a sandstone lens of the Holdenville shale being directly overlain by the lower Seminole sandstone unit and thereby having the Holdenville unit measured as part of the Seminole formation. No direct evidence was found to support this statement, however.

CHAPTER V

ECONOMIC GEOLOGY

Petroleum and natural gas are the most significant economic products of the Beggs Area. Drilling first began in 1904, but it was not until 1907 that a producing well (gas) was brought in. It was located in sec. 20, T. 16 N., R. 12 E., and was of such capacity as to supply gas to the town of Mounds for ten years. The first oil well was completed in 1908 to the Glenn (Salt) sand at a depth of 1,700 feet. It was drilled in sec. 22, T. 15 N., R. 11 E.

Active development commenced after 1909, with the discovery of deeper production in the Dutcher sands of the Preston pool, immediately to the southeast of the Beggs Area. Approximately 44 wells were drilled in the Beggs pool in 1910 and 1911, some of which flowed 1,000 barrels a day or more (Bosworth, 1920, p. 115). Unfortunately, the pool experienced rapid decline so that by 1914, there remained only a few small pumping wells. Renewed activity again took place during the period from 1918 to 1926 with the discovery of still deeper production from the Wilcox sands in 1918.

Initial production was quite high, being as much as 1,000 to 3,000 barrels a day from some wells (Bosworth, 1920, p. 115). However, most of the older wells have been plugged while the greater number of those remaining are operated from central pumping units and produce but a few barrels daily. Developments in the area, since 1950, have been in the nature of work-over wells. Only recently has the use of formation fracturing revived activity. To date, no water-flood project has been attempted in any of the pools.

Some of the more important pools of the area are the Beggs districts, north and south, surrounding the town of Beggs, and the Pollyanna pool in the central part of the north one-half of T. 15 N., R. 11 E., and the central part of the south one-half of T. 16 N., R. 11 E. Other pools, equally important production-wise, are scattered throughout the area. The principal producing horizons are the Glenn, Dutcher, and Wilcox.

Coal has been produced only on a local scale. Abandoned strip pits, previously mentioned, surround the southeast corner of sec. 12, T. 15 N., R. 11 E. No active production is known.

The unnamed coal seam of the upper Seminole formation is of sufficient thickness and quality for mining, although in a limited quantity. It does not appear to be of commercial value, because of the cost involved in removing the overburden.

The Checkerboard limestone was used as a road material during the years of the Works Project Administration. Abandoned quarries are in secs. 27 and 33, T. 15 N., R. 11 E. The Checkerboard was also used extensively in early drilling operations for derrick foundations and to fill the hole in correcting for crooked drilling. It is not being used at the present time.

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APPENDIX

APPENDIX A

MEASURED STRATIGRAPHIC SECTIONS IN THE BEGGS AREA

Township 15 North

1. Sec. 5, T. 15 N., R. 11 E.; measured from the base of the sandstone outcrop at southeast corner, northwest, to top of ridge.

	Feet
Coffeyville formation	
Unit Pcf-2d	
Sandstone; buff, fine- to medium-grained, weathers brown	16.0
Unit Pcf-2c	
Covered: probably siltstone; shaly	33.0
Sandstone; buff, medium-grained, weathers brown	22.0
Unit Pcf-2a	
Covered: probably siltstone; shaly	55.0
Sandstone; buff, fine-grained, weathers brown	28.0
Unit Pcf-1	
Covered: probably shale; not measured	

2. Sec. 6, T. 15 N., R. 11 E.; measured from trail east of hill in NW$\frac{1}{4}$, west, to top of hill.

Nellie Bly formation	
Unit Pnb-4	
Covered: probably shale; silty, not measured	
Sandstone; buff to rust, medium-grained, friable. . . .	6.0
Unit Pnb-3	
Covered: probably shale; silty	43.0
Sandstone; buff, fine-grained, weathers brown	1.0
Covered: probably shale; silty	18.0
Sandstone; buff, fine-grained, weathers brown	3.0
Unit Pnb-2	
Covered: probably shale; silty	19.0
Sandstone; buff, fine-grained, friable.	12.0
Unit Pnb-1	
Covered: probably shale; silty	11.0
Sandstone; buff, fine-grained, friable.	3.0

	Feet
Covered: probably shale; silty	16.5

3. Sec. 12, T. 15 N., R. 11 E.; measured from base of exposure, 200 feet northeast from the southwest corner, southwest, to the southwest corner.

Checkerboard limestone	
Limestone; gray-blue, fossiliferous, "checkerboard" jointing, weathers yellow	2.0
Seminole formation	
Unit Ps-2	
Shale; gray-tan, sandy, fissile	0.4
Sandstone; buff, fine-grained, even-bedded.	0.5
Shale; gray-tan, silty, even-bedded	4.0
Shale; gray-green, micaceous, silty, weathers tan . . .	4.5
Sandstone; gray-tan, silty, pinches out southward . . .	2.5
Coal; unnamed, not Dawson, plant roots and trunks . . .	0.8
Underclay; gray-green, waxy, few plant remains.	1.2
Underlime; fossiliferous, white nodules in red matrix .	0.3
Shale; gray-green, even-bedded, not measured	

4. Secs. 17, 20, T. 15 N., R. 11 E.; measured from creek bottom, NW$\frac{1}{4}$ sec. 20, north, to top of ridge, SW$\frac{1}{4}$ sec. 17.

Coffeyville formation	
Unit Pcf-2d	
Sandstone; buff, fine- to medium-grained, weathers brown	17.5
Unit Pcf-2c	
Covered: probably siltstone; shaly	30.0
Sandstone; buff, medium-grained, weathers brown	20.0
Unit Pcf-2a	
Covered: probably siltstone; shaly	33.0
Sandstone; buff, fine- to medium-grained, weathers brown	33.0
Unit Pcf-1	
Covered: probably shale; not measured	

5. Sec. 22, T. 15 N., R. 11 E.; measured from base of outcrop at type locality on Checkerboard Creek, NW$\frac{1}{4}$ SE$\frac{1}{4}$, to top of bed.

Coffeyville formation	
Unit Pcf-1	
Covered: probably shale; not measured	
Checkerboard limestone	
Limestone; gray-blue, shaly, fossiliferous, weathers yellow	0.8
Limestone; gray-blue, fossiliferous, weathers yellow. .	1.5
Seminole formation	
Unit Ps-2	
Shale; dark gray, poorly exposed, not measured	

		Feet
6.	Sec. 24, T. 15 N., R. 11 E.; measured from base of outcrop, NE$\frac{1}{4}$, south of creek, in road cut on east road, to top of hill.	
	Holdenville shale	
	Unit Phd-8	
	Limestone; gray-blue, fossiliferous, shaly, weathers yellow	0.5
	Limestone; gray-blue base, chocolate brown top, dense .	3.1
	Shale; gray-blue, calcareous, thin-bedded, not measured	
7.	Sec. 25, T. 15 N., R. 11 E.; measured from creek bottom, SW$\frac{1}{4}$, north, up gully on north side of creek, to top of chert conglomerate sandstone.	
	Seminole formation	
	Unit Ps-1	
	Sandstone; fine- to medium-grained, chert conglomerate interbedded, not measured	
	Shale; gray-green, massive.	6.0
	Limestone; gray-white, fossiliferous.	0.2
	Shale; gray, platy.	0.3
	Limestone; buff, crystalline, interbedded fossil zones.	0.4
	Limestone; gray-blue, carbonaceous, plant fossils . . .	0.1
	Coal; shaly at top, clayey at base.	0.7
	Unconformity (?)	
	Holdenville shale	
	Shale; gray-blue to black, fissile, poorly exposed, not measured	
8.	Sec. 28, T. 15 N., R. 11 E.; measured in west bank of Tiger Creek, at point 1/8 mile south from north line, from creek bed to alluvium at top.	
	Coffeyville formation	
	Unit Pcf-1d	
	Sandstone; tan, medium-grained, even-bedded	2.0
	Unit Pcf-1c	
	Limestone; tan, sandy to silty, fucoidal, few fossils, "checkerboard" jointing	1.5
	Unit Pcf-1	
	Shale; black, fissile, even-bedded, interbedded <u>Myalina</u> fossil zone	4.5
	Shale; black to blue, even-bedded, calcareous, few fossils	1.2
9.	Sec. 25, T. 15 N., R. 12 E.; measured along east line from base of hill, NW$\frac{1}{4}$, to top, in northeast corner.	
	Wewoka formation	

	Feet
Unit Pwk-6	
Sandstone; buff, fine-grained, weathers brown	24.0
Unit Pwk-5	
Covered: probably shale.	75.0
Sandstone; buff, fine-grained, weathers dark brown. . .	12.0
Unit Pwk-4	
Covered: probably shale; not measured	

10. Sec. 32, T. 15 N., R. 12 E.; measured outcrop below dam of Beggs Lake, from base of exposure, vertically to top.

Wewoka formation	
Unit Pwk-7	
Covered: probably shale; not measured	
Sandstone; buff, fine-grained, weathers brown	16.0
Sandstone; buff, fine-grained, weathers brown, ripple marks.	2.5
Siltstone; shaly, gray-tan, even-bedded	2.0
Sandstone; buff, fine- to medium-grained, thin-bedded .	1.3
Siltstone; shaly, gray-tan, ungraded bedding.	3.0
Sandstone; buff, fine-grained, weathers dark brown, minor interbedded siltstone and shale zones, thin-bedded.	9.0

11. Sec. 33, T. 15 N., R. 12 E.; measured from point where trail crosses south line, at base of hill, west, 1/8 mile, to top of hill.

Wewoka formation	
Unit Pwk-9	
Sandstone; buff, fine-grained, weathers brown	6.0
Covered: probably shale.	9.0
Sandstone; buff, fine-grained, weathers brown	7.0
Unit Pwk-8	
Covered: probably shale.	20.0
Sandstone; buff, fine-grained, weathers brown	5.0
Covered: probably shale.	8.0
Sandstone; buff, fine-grained, weathers brown	7.0
Unit Pwk-7	
Covered: probably shale.	22.0

12. Sec. 35, T. 15 N., R. 12 E.; measured along proposed highway, from southeast corner, northward, to top of highest hill, center of section.

Wewoka formation
Unit Pwk-7
Siltstone; gray-tan, cross-bedded, ripple marks, not measured

	Feet
Sandstone; tan to cream, fine-grained, fossiliferous, massive, weathers brown	10.0
Unit Pwk-6	
Shale; gray-blue at base, gray-tan at top, fissile	27.0
Sandstone; dark red-brown to cream, fine- to medium-grained, massive, poorly preserved fossils	10.0
Siltstone; gray-tan, massive, thin gray-blue shales interbedded	60.0
Sandstone; tan, fine-grained, slightly calcareous, fossil flora and fauna, weathers red-brown	12.0
Unit Pwk-5	
Shale; silty, gray-blue to tan, carbonaceous fossil flora	8.0
Shale; gray-blue, fissile	13.0
Sandstone; gray-tan, fine-grained, weathers brown	8.0
Unit Pwk-4	
Shale; gray-blue, fissile	22.0
Sandstone; gray-tan, fine-grained, weathers brown	8.0
Unit Pwk-3	
Covered: probably shale	11.0
Sandstone; gray-tan, fine-grained, weathers brown	17.0
Unit Pwk-2	
Shale; gray-blue, fissile	20.0
Sandstone; tan, patchy iron stains, fine-grained	14.0
Shale; dark gray-blue, few fossils, massive, thin calcareous zones interbedded, contains concretions	16.0
Sandstone; tan, patchy iron stains, fine-grained	5.0
Unit Pwk-1	
Shale; gray-blue, fissile, not measured	

13. Sec. 36, T. 15 N , R. 12 E.; measured from the southeast corner, north, along east line, 1/8 mile, to top of hill.

Wewoka formation

Unit Pwk-2	
Covered: probably shale; not measured	
Sandstone; buff, fine-grained, massive, weathers brown	3.0
Siltstone; gray-green, sandy zones, massive	4.5
Sandstone; buff, fine-grained, thin-bedded	4.0
Unit Pwk-1	
Shale; gray-tan, silty	33.0

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14. Sec. 19, T. 16 N., R. 11 E.; measured from creek bottom, northeast corner $NW\frac{1}{4}$ $SW\frac{1}{4}$, southwest, to southwest corner, $NW\frac{1}{4}$ $SW\frac{1}{4}$.

Nellie Bly formation

	Feet
Unit Pnb-4	
Covered: probably shale; silty, not measured	
Sandstone; fine- to medium-grained, buff	5.0
Unit Pnb-3	
Covered: probably shale; silty	3.5
Sandstone; buff, fine-grained	1.0
Covered: probably shale; silty	11.0
Sandstone; buff, fine-grained	1.0
Covered: probably shale; silty	16.5
Sandstone; buff, fine-grained	1.0
Covered: probably shale; silty	16.5
Sandstone; tan, fine-grained, red iron staining	3.0
Covered: probably shale; silty	16.0
Sandstone; red-tan, fine-grained, friable, iron stain, weathers brown	5.5
Unit Pnb-2	
Covered: probably shale; silty	22.0
Sandstone; rust to tan, fine-grained, friable, weathers dark brown	14.0
Unit Pnb-1	
Covered: probably shale; silty	44.0

15. Sec. 21, T. 16 N., R. 11 E.; measured from creek bottom, center of W½, northeast, to top of hill, NE¼.

Coffeyville formation	
Unit Pcf-2d	
Covered: probably siltstone; shaly, not measured	
Sandstone; buff, medium-grained, friable, massive, weathers brown	23.0
Unit Pcf-2c	
Covered: probably siltstone; shaly	39.0

16. Sec. 28, T. 16 N., R. 11 E.; measured from creek bottom, center of north line NW¼, east to top of hill on north line.

Nellie Bly formation	
Unit Pnb-1	
Sandstone; buff, fine-grained, slightly calcareous, friable	1.5
Hogshooter formation	
Limestone; blue-gray, sandy, fossiliferous, weathers red-brown to buff	0.8
Limestone; tan, shaly, platy, fucoidal, thin sandstone stringers interbedded, weathers to off-white	10.5
Coffeyville formation	
Unit Pcf-3	
Shale; light gray-green, thin-bedded, partly covered	31.0
Unit Pcf-2d	
Covered: probably siltstone; shaly	16.0
Sandstone; buff, fine-grained, weathers brown	18.0

Feet

Unit Pcf-2c
Covered: probably siltstone; shaly, not measured

17. Sec. 32, T. 16 N., R. 11 E.; measured from the bottom of the gully on the southeast face of the hill, $NW\frac{1}{4}$, northwest, to top of hill.

Nellie Bly formation	
Unit Pnb-2	
Sandstone; buff, fine-grained, friable, ripple marks. .	12.0
Unit Pnb-1	
Covered: probably shale; silty	55.0
Sandstone; buff, fine- to medium-grained, friable, slightly calcareous	3.0
Hogshooter formation	
Limestone; gray-tan, sandy, weathers off-white.	0.7
Coffeyville formation	
Unit Pcf-3	
Shale; gray, fissile.	2.5

18. Sec. 34, T. 16 N., R. 11 E.; measured along south line road, from base of hill, $\frac{1}{4}$ mile east of southwest corner, west, to top of hill, at southwest corner.

Coffeyville formation	
Unit Pcf-2d	
Sandstone; buff, fine- to medium-grained, weathers brown	19.0
Unit Pcf-2c	
Siltstone; shaly, tan, poorly exposed	25.0
Sandstone; buff, fine- to medium-grained, weathers brown	16.0
Unit Pcf-2a	
Siltstone; shaly, tan, poorly exposed	37.0
Sandstone; buff, medium-grained, weathers brown	31.0
Unit Pcf-1	
Shale; gray-tan, slightly silty, thin-bedded.	27.5
Shale; tan with off-white limestone stringers of 0.2 feet interbedded.	2.5
Shale; gray-tan, thin-bedded, platy	6.0
Shale; tan with off-white limestone stringers of 0.2 feet interbedded.	3.0
Shale; tan to gray-blue, thin-bedded, not measured	

19. Sec. 29, T. 16 N., R. 12 E.; measured in road cut on east line, south of South Duck Creek, $NE\frac{1}{4}$ from lowest shale outcrop, south 100 feet, to top of hill.

Seminole formation
Unit Ps-1; basal part
Sandstone; gray-tan, massive at top, thin-bedded at base,

	Feet
friable, slightly conglomeratic, grades into siltstone at the bottom	19.2
Shale; gray-tan, thin-bedded, silty, some concretions	5.5
Coal; varies in occurrence from one inch stringers to a solid zone	0.6
Unconformity (?)	
Holdenville shale	
Shale; gray-blue, platy, not measured	

20. Sec. 30, T. 16 N., R. 12 E.; measured on South Duck Creek, from below unnamed coal, SW$\frac{1}{4}$ NE$\frac{1}{4}$, up the creek, west to outcrop of Checkerboard limestone, center W$\frac{1}{2}$.

	Feet
Checkerboard limestone	
Limestone; gray-blue, fossiliferous, "checkerboard" jointing, weathers yellow	2.2
Seminole formation	
Unit Ps-1	
Shale; tan, thin sandy limestone stringers, silty at base, poorly exposed, about	10.0
Sandstone; tan, fine-grained, some iron stain	4.0
Siltstone; gray-green, sandy, micaceous, thin-bedded, top not exposed, about.	22.0
Sandstone; gray-tan, fine-grained, calcareous, "checkerboard" jointing	0.3
Shale; tan, thin-bedded.	2.0
Sandstone; gray-tan, fine-grained, calcareous, "checkerboard" jointing.	0.5
Shale; gray to black, thin-bedded, poorly exposed, about	6.0
Coal; platy at top, clayey at bottom with plant remains interbedded.	1.3
Shale; gray-black, silty, poorly exposed, not measured	

APPENDIX B

GENERALIZED ALIDADE STRATIGRAPHIC SECTIONS
IN
THE BEGGS AREA

Township 15 North

1. Alidade traverse measured from the top of hill in south-central part of sec. 20, T. 15 N., R. 11 E., southeast to south section line road, then east to center of south line sec. 21, T. 15 N., R. 12 E. Thicknesses computed using average dips of formations along traverse line.

	Feet
Coffeyville formation	
Unit Pcf-2a	
Sandstone; buff, fine-grained, weathers brown	35.0
Unit Pcf-1	
Covered: probably shale	136.0
Unit Pcf-1e	
Bench: probably sandstone; about	2.0
Unit Pcf-1	
Covered: probably shale	60.0
Unit Pcf-1d	
Bench: probably sandstone; about	3.0
Unit Pcf-1	
Covered: probably shale	2.0
Unit Pcf-1c	
Bench: probably limestone; sandy, about	2.0
Unit Pcf-1	
Covered: probably shale	79.0
Checkerboard limestone	
Bench: limestone; gray-blue, fossiliferous, weathers yellow, boulders beside road	2.0
Seminole formation	
Unit Ps-2	
Covered: probably shale, about	85.0
Bench: probably sandstone	8.0
Unit Ps-1	
Covered: probably shale, about	10.0
Bench: probably sandstone	9.0
Holdenville shale	

Feet

Unit Phd-8
Limestone; gray-blue, dense, fossiliferous at top, weathers yellow 4.0
Unit Phd
Covered: probably shale. 49.0
Unit Phd-7
Bench: sandstone; tan, fine-grained, poorly exposed. 5.0
Unit Phd
Covered: probably shale. 72.0
Unit Phd-3
Bench: probably sandstone. 3.0
Covered: probably siltstone. 1.0
Bench: probably sandstone. 4.0
Unit Phd
Covered: probably shale. 62.0
Wewoka formation
Unit Pwk-10
Dip slope, covered: probably sandstone; not measured

2. Alidade traverse measured along Oklahoma Highway No. 16, from intersection with west line sec. 26, T. 15 N., R. 12 E., west to center of west line sec. 28, T. 15 N., R. 12 E. Thicknesses computed using average dips of units along traverse line.

Wewoka formation
Unit Pwk-10
Bench: sandstone; about. 4.0
Unit Pwk-9
Shale; gray-tan, silty, thin-bedded 4.0
Units Pwk-9, Pwk-8 (top of sandy zone of Pwk-9 to top of sandy zone of Pwk-8, undifferentiated)
Siltstone; gray-tan, sandy, massive 60.0
Unit Pwk-8
Sandstone; gray-tan, massive. 12.0
Unit Pwk-7, undifferentiated
Covered: sandstone bench and overlying shale 34.0
Unit Pwk-6, undifferentiated
Covered: sandstone bench and overlying shale 44.0
Unit Pwk-5
Covered: probably shale. 16.0
Bench: sandstone 21.0
Unit Pwk-4
Covered: probably shale; not measured

Township 16 North

3. Alidade traverse measured from the top of hill, south central part of sec. 34, T. 16 N., R. 11 E., southeast to point of

junction of trail and south line road, then east, to southwest corner sec. 36, T. 16 N., R. 12 E. Thicknesses computed using average dips of formations along traverse line.

	Feet
Coffeyville formation	
Unit Pcf-2a	
Sandstone; buff, fine-grained	39.0
Unit Pcf-1	
Covered: probably shale	152.0
Unit Pcf-1b	
Bench: probably limestone; sandy, about	4.0
Unit Pcf-1	
Covered: probably shale	75.0
Unit Pcf-1a	
Bench: probably sandstone; about	3.0
Unit Pcf-1	
Covered: probably shale	60.0
Checkerboard limestone	
Bench: limestone	2.0
Seminole formation	
Unit Ps-2	
Covered: probably shale	37.0
Bench: probably sandstone	22.0
Unit Ps-1	
Covered: probably shale	69.0
Unit Ps-1a	
Bench: probably sandstone	11.0
Unit Ps-1	
Covered: probably shale	24.0
Bench: probably sandstone	26.0
Holdenville shale	
Covered: probably shale	18.0
Unit Phd-4	
Sandstone; poorly exposed	12.0
Unit Phd	
Covered: probably shale	48.0
Unit Phd-3	
Bench: limestone flags	3.0
Unit Phd	
Covered: probably shale	18.0
Unit Phd-2	
Bench: probably sandstone	3.0
Unit Phd	
Covered: probably shale	54.0
Unit Phd-1	
Bench: sandstone	12.0
Unit Phd	
Covered: probably shale	92.0
Wewoka formation	
Unit Pwk-9a	
Bench: mudstone flags, about	2.0

APPENDIX C

TABLE I

INSOLUBLE RESIDUE ANALYSES OF CARBONATE ROCKS

IN

THE BEGGS AREA

Sample	Location	Fraction percentages		
C1. Hogshooter fm.	$NW\frac{1}{4}$ sec. 32, T. 16 N., R. 11 E.	Carbonate	-	39.26
		Decanted	-	53.71
		Filtered	-	7.03
		Insoluble	-	60.74
C2. Hogshooter fm.	center of south line sec. 21, T. 16 N., R. 11 E.	Carbonate	-	45.06
		Decanted	-	35.26
		Filtered	-	19.68
		Insoluble	-	54.94
C3. Coffeyville fm., Unit Pcf-lc	center $N\frac{1}{2}$ sec. 28, T. 15 N., R. 11 E.	Carbonate	-	42.35
		Decanted	-	26.42
		Filtered	-	31.23
		Insoluble	-	57.65
C4. Checkerboard ls.	outcrop on north line sec. 20, T. 16 N., R. 12 E.	Carbonate	-	86.46
		Decanted	-	2.26
		Filtered	-	11.28
		Insoluble	-	13.54
C5. Checkerboard ls.	type locality, $NW\frac{1}{4}$ $SE\frac{1}{4}$ sec. 22, T. 15 N., R. 11 E.	Carbonate	-	80.36
		Decanted	-	3.07
		Filtered	-	16.57
		Insoluble	-	19.64
C6. Seminole fm., Unit Ps-2, underlime below unnamed coal	$SW\frac{1}{4}$ sec. 12, T. 15 N., R. 11 E.	Carbonate	-	45.06
		Decanted	-	27.58
		Filtered	-	27.36
		Insoluble	-	54.94

Sample	Location	Fraction percentages
C7. Seminole fm., Unit Ps-1, thin ls. base of Seminole fm.	NW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 25, T. 15 N., R. 11 E.	Carbonate - 37.22 Decanted - 49.54 Filtered - 13.24 Insoluble - 62.78
C8. Seminole fm., Unit Ps-1, carbonaceous ls. base of Seminole fm.	NW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 25, T. 15 N., R. 11 E.	Carbonate - 24.45 Decanted - 60.80 Filtered - 14.75 Insoluble - 75.55
C9. Holdenville sh., Unit Phd-8 upper fossilifer- ous zone	outcrop on south line sec. 24, T. 15 N., R. 11 E.	Carbonate - 67.36 Decanted - 6.88 Filtered - 25.76 Insoluble - 32.64
C10. Holdenville sh., Unit Phd-8, lower dense zone	outcrop on east line sec. 24, T. 15 N., R. 11 E.	Carbonate - 83.44 Decanted - 2.22 Filtered - 14.34 Insoluble - 16.56
C11. Holdenville sh., thin ls. below Unit Phd-1	SE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 26, T. 16 N., R. 12 E.	Carbonate - 60.10 Decanted - 25.08 Filtered - 14.82 Insoluble - 39.90
C12. Lenepah ls. equivalent	center NW$\frac{1}{4}$ sec. 15, T. 15 N., R. 12 E.	Carbonate - 85.52 Decanted - 2.78 Filtered - 11.70 Insoluble - 14.48
C13. Wewoka fm., Unit Pwk-9a, ls.	SE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 2, T. 15 N., R. 12 E.	Carbonate - 35.79 Decanted - 56.68 Filtered - 7.53 Insoluble - 64.21
C14. Wewoka fm., Unit Pwk-9a, calcareous mud- stone flags	SW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 25, T. 16 N., R. 12 E.	Carbonate - 39.54 Decanted - 48.68 Filtered - 11.78 Insoluble - 60.46

TABLE II

INSOLUBLE RESIDUE ANALYSES OF SANDSTONE ROCKS

IN

THE BEGGS AREA

Sample		Location	Fraction percentages		
S1.	Nellie Bly fm., Unit Pnb-4	NW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 19, T. 16 N., R. 11 E.	Dissolved	-	1.12
			Decanted	-	96.44
			Filtered	-	2.44
			Insoluble	-	98.88
S2.	Nellie Bly fm., Unit Pnb-4	NW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 6, T. 15 N., R. 11 E.	Dissolved	-	2.54
			Decanted	-	94.52
			Filtered	-	2.94
			Insoluble	-	97.46
S3.	Nellie Bly fm., Unit Pnb-2	NW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 19, T. 16 N., R. 11 E.	Dissolved	-	0.90
			Decanted	-	96.12
			Filtered	-	2.98
			Insoluble	-	99.10
S4.	Nellie Bly fm., Unit Pnb-2	NW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 6, T. 15 N., R. 11 E.	Dissolved	-	2.98
			Decanted	-	91.54
			Filtered	-	5.48
			Insoluble	-	97.02
S5.	Coffeyville fm., Unit Pcf-2c	SW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 34, T. 16 N., R. 11 E.	Dissolved	-	3.58
			Decanted	-	91.78
			Filtered	-	4.64
			Insoluble	-	96.42
S6.	Coffeyville fm., Unit Pcf-2c	SE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 30, T. 15 N., R. 11 E.	Dissolved	-	3.28
			Decanted	-	94.04
			Filtered	-	2.68
			Insoluble	-	96.72
S7.	Coffeyville fm., Unit Pcf-2a	NW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 24, T. 16 N., R. 11 E.	Dissolved	-	1.16
			Decanted	-	94.32
			Filtered	-	4.52
			Insoluble	-	98.84

Sample		Location	Fraction percentages	
S8.	Coffeyville fm., Unit Pcf-2a	center NE¼ sec. 30, T. 15 N., R. 11 E.	Dissolved	1.08
			Decanted	97.32
			Filtered	1.60
			Insoluble	98.92
S9.	Seminole fm., Unit Ps-2, silty sandstone	SW¼ NE¼ sec. 30, T. 16 N., R. 12 E.	Dissolved	4.18
			Decanted	79.72
			Filtered	16.10
			Insoluble	95.82
S10.	Seminole fm., Unit Ps-2	NW¼ NW¼ sec. 21, T. 16 N., R. 12 E.	Dissolved	3.44
			Decanted	81.94
			Filtered	14.62
			Insoluble	96.56
S11.	Seminole fm., Unit Ps-2	southeast corner sec. 33, T. 15 N., R. 11 E.	Dissolved	7.42
			Decanted	91.56
			Filtered	1.02
			Insoluble	92.58
S12.	Seminole fm., Unit Ps-1	NE¼ NW¼ sec. 21, T. 16 N., R. 12 E.	Dissolved	2.96
			Decanted	93.58
			Filtered	3.46
			Insoluble	97.04
S13.	Seminole fm., Unit Ps-1	southeast corner sec. 35, T. 15 N., R. 11 E.	Dissolved	5.08
			Decanted	90.02
			Filtered	4.90
			Insoluble	94.92
S14.	Seminole fm., Unit Ps-1, chert conglomerate	outcrop on north line sec. 36, T. 15 N., R. 11 E.	Dissolved	31.66
			Decanted	62.12
			Filtered	6.22
			Insoluble	68.34
S15.	Holdenville sh., Unit Phd-6	southwest corner sec. 31, T. 15 N., R. 12 E.	Dissolved	1.76
			Decanted	96.48
			Filtered	2.76
			Insoluble	98.24
S16.	Holdenville sh., Unit Phd-1	northwest corner sec. 24, T. 16 N., R. 12 E.	Dissolved	5.86
			Decanted	91.72
			Filtered	2.42
			Insoluble	94.14

Sample	Location	Fraction percentages
S17. Wewoka fm., Unit Pwk-10	SE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 15, T. 15 N., R. 12 E.	Dissolved - 5.14 Decanted - 89.96 Filtered - 4.90 Insoluble - 94.86
S18. Wewoka fm., Unit Pwk-10	northeast corner sec. 32, T. 15 N., R. 12 E.	Dissolved - 1.88 Decanted - 95.32 Filtered - 2.80 Insoluble - 98.12
S19. Wewoka fm., Unit Pwk-8	outcrop on east line sec. 36, T. 16 N., R. 12 E.	Dissolved - 0.92 Decanted - 97.04 Filtered - 2.04 Insoluble - 99.08
S20. Wewoka fm., Unit Pwk-8	outcrop center south line sec. 32, T. 15 N., R. 12 E.	Dissolved - 1.42 Decanted - 96.86 Filtered - 1.72 Insoluble - 98.58
S21. Wewoka fm., Unit Pwk-6	northeast corner sec. 25, T. 15 N., R. 12 E.	Dissolved - 0.08 Decanted - 96.86 Filtered - 3.06 Insoluble - 99.92
S22. Wewoka fm., Unit Pwk-6	center SE$\frac{1}{4}$ sec. 35, T. 15 N., R. 12 E.	Dissolved - 1.44 Decanted - 95.02 Filtered - 3.54 Insoluble - 98.56

TABLE III

MECHANICAL SIEVE ANALYSES OF SANDSTONE ROCKS

IN

THE BEGGS AREA

Refer to Table II for sample nomenclature and locations. Size groups are fractions of an inch. Fraction weights of each size group are listed by percentage. Trace fractions are listed as T.

Sample	.590	.500	.250	.125	.062	<.062	Total
S1.	-	-	0.24	57.24	37.08	4.40	98.96
S2.	-	T	9.32	65.52	17.68	6.40	98.92
S3.	-	T	1.64	36.88	53.68	6.88	99.08
S4.	-	T	1.20	46.08	38.84	13.20	99.32
S5.	-	-	0.32	34.52	52.48	11.76	99.08
S6.	-	T	0.08	27.72	62.80	8.48	99.08
S7.	-	-	0.36	56.64	37.52	4.16	98.68
S8.	-	T	8.00	89.32	1.96	0.20	99.48
S9.	-	-	0.12	2.80	54.88	41.48	99.28
S10.	-	T	0.24	10.52	58.64	29.68	99.08
S11.	-	-	0.20	4.60	70.80	23.72	99.32
S12.	-	-	3.16	57.40	32.56	6.04	99.16
S13.	-	-	0.48	27.53	54.04	17.12	99.16
S14.	0.12	0.40	30.04	54.24	8.64	5.16	98.60
S15.	-	-	4.24	80.52	13.60	1.24	99.60
S16.	-	-	0.20	64.20	29.52	5.12	99.04
S17.	-	-	1.00	83.68	11.08	3.44	99.20
S18.	-	-	0.72	51.60	40.64	6.32	99.28
S19.	T	T	25.92	54.32	13.24	5.64	99.12
S20.	-	T	15.68	74.76	7.52	1.24	99.20
S21.	-	-	9.52	65.08	20.60	4.08	99.28
S22.	T	0.68	37.64	45.28	12.60	3.12	99.32